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Proceedings of the Pacific regional peer review on the reassessment of the Ecologically and Biologically Significant Areas (EBSAs) in the Pacific Northern Shelf Bioregion

November 1-2, 2017
Sidney, British Columbia

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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 of November 1 – 2, 2017, at the Institute of Ocean Sciences in Sidney, British Columbia (BC). A Working Paper focusing on the reassessment of the Ecologically and Biologically Significant Areas (EBSAs) in the Pacific Northern Shelf Bioregion was presented for peer review.

In-person and web-based participation included Fisheries and Oceans Canada (DFO) Science, Oceans, and Fisheries Management staff; Environment and Climate Change Canada, Parks Canada, BC Parks and external participants from First Nations organizations, environmental non-governmental organizations, commercial fisheries and academia.

The conclusions and advice resulting from this review will be provided in the form of one Science Advisory Report providing advice to the Oceans Sector with respect to tools and procedures for the designation and assessment of EBSAs and EBSA boundaries in the Northern Shelf Bioregion and other Pacific and DFO regions.

The Science Advisory Report and the two supporting Research Documents will be made publicly available on the Canadian Science Advisory Secretariat (CSAS) website.

INTRODUCTION

Nadja Steiner (Chair, DFO Science) opened the meeting by welcoming the participants. Each participant was introduced as there was representation from various sectors of Fisheries and Oceans Canada, as well as Environment and Climate Change Canada, Parks Canada, BC Parks, the Canadian Parks and Wilderness Society, the Central Coast Indigenous Resource Alliance, the University of Victoria, the Haida Oceans Technical Team, SciTech Consulting, Commercial Fisheries Caucus and the West Coast Environmental Law (Appendix A).

The Chair then provided a brief overview of the CSAS peer-review process, and highlighted that all participants are reviewers of the Working Paper (WP).

The Terms of Reference (Appendix B) indicate that the objectives of this meeting were to evaluate previously identified EBSAs in the Northern Shelf Bioregion (NSB) using available empirical biological data and to: a) summarize support for existing EBSAs based on the outcome of this analysis; and b) evaluate the analytical approach for identifying areas of high biodiversity and high productivity. The Chair requested that everyone consider, throughout the course of the meeting, the objectives set out in the Terms of Reference, how the WP must address these, and the advice that could be developed in relation to these. The Chair reviewed the agenda (Appendix C) and verbally determined that there was consensus for the Terms of Reference.

THE REASSESSMENT OF THE ECOLOGICALLY AND BIOLOGICALLY SIGNIFICANT AREAS (EBSAS) IN THE PACIFIC NORTHERN SHELF BIOREGION

PRESENTATION – EBSAS IN THE NETWORK

Presenter: Joy Hillier, DFO Oceans

The role of EBSAs in the Marine Protected Areas (MPA) Network was briefly presented. Spatial information is important for DFO Oceans managers to respond to needs, especially in cases of emergencies such as oil spill responses (i.e. sinking of the Queen of the North).

Both Important Areas (IAs) and EBSAs will be incorporated into the network. How much and which components of the IAs and EBSAs are to be prioritized for inclusion depends on the network objectives, the conservation priorities and the design strategies and targets. EBSAs are a part of the integrated management process and helps guide decisions in ocean management.

PRESENTATION OF WORKING PAPER – PART 1: REASSESSMENT OF EXISTING EBSAS

Presenter: Emily Rubidge, DFO Science

Synopsis of Presentation

IAs and EBSAs were defined. A diagram described how EBSA's are the starting point for many other processes, such as the MPA Network, while noting that the designation of EBSAs does not automatically trigger any protections or management activities.

The previous steps in the identification of the 18 EBSAs in the NSB were described (Clarke and Jamieson, 2006a; 2006b); as were the limitations of this previous work. The initial designation of the NSB EBSA's occurred in two phases:

1. Phase I used expert opinion to identify areas worth of enhanced protection for each species and habitat feature based on five EBSA criteria (uniqueness, aggregation, fitness consequences, naturalness and resilience). These areas were called IAs. It was noted that the expert opinions sourced in this phase were based on data owned by the experts.
2. Phase II used three categories of unique physical features and analyses of the IAs, to allow the identification of EBSAs for the NSB.

These phases were followed by other work, including a lessons learned perspective (DFO 2011), and further identification of EBSAs (Jamieson and Levesque, 2014).

The current reassessment of the NSB EBSAs was initiated by a request for science advice from Oceans Management. The objectives of this reassessment were clarified as:

1. Evaluate previously identified EBSAs in the NSB using available empirical biological data
2. Identify areas of high biodiversity and high productivity in the NSB, two EBSA criteria not directly addressed in the last process.

Part 1 of the WP addresses the first objective, and focuses on reassessing the existing EBSA boundaries with available biological data (aka. “the reassessment”). The purpose of the analysis is to better understand how well the empirical analysis of the previous EBSA process captured the now available biological information, and whether or not there is room for improvement or refinement for the EBSA boundaries.

An overview of the methods of Part 1 of the WP was provided. The key steps were:

1. Summarized species listed as important for each existing EBSA.
2. Recorded the EBSA criteria that the area fulfilled for each important species or species group listed.
3. Collated data sources available to examine empirical support for existing EBSA.
4. Developed method for “inside-outside” EBSA comparison.

The original work on designating EBSAs in the NSB was focused on the continental shelf. Estuaries were added later, to partially fill that gap, and the current reassessment included nearshore areas. The original work was also done prior to the identification of Ecologically Significant Species (ESS). There have been 94 ESS identified and 19 of these were included in the reassessment.

Presenter noted that data for marine birds were originally included in the reassessment analyses, but were taken out primarily due to insufficient time to familiarize with the data and perform the analyses. These limitations led the authors of the WP to exclude the data, however, it was noted that this approach can be revisited during this CSAS process, since some analyses were readily available (bird colony data).

The presenter provided a clarification of the use of the term “unsupported” in the WP: it means lack of empirical support, but should not be interpreted as the areas being unimportant. Empirical data can support expert knowledge, but cannot negate or discount expert knowledge.

Results and associated maps were presented. Some trends and limitations were highlighted, such as how empirical support varies depending on the species, and how some datasets analyzed were perhaps not ideal for certain species (i.e. synoptic trawl survey data used for herring).

The main findings of Part 1 were:

- In general, empirical support was found for nearly all EBSAs tested.

- In many cases, new species were identified that weren't originally listed in the Phase I justification.
- There is potential for EBSA boundaries to be refined, but expert knowledge should not be lost (lack of empirical support may be due to data limitations, and should not negate expert opinion).
- Reassessment method (inside-outside) provided a straightforward approach to identify empirical support for existing EBSAs.

The presenter provided several suggestions on how to better capture spatial ecological information in Phase II (prioritization and designation of EBSAs), including the creation of a management tool with a variety of attribute tables associated with spatial layers, feature count (overlay all IAS or spatial datasets representing EBSA criteria), Marxan (equal weight to each EBSA criteria data layer) and making spatial datasets of ecological components readily available to decision makers (identify core areas within EBSA boundaries).

The presenter responded to some clarifying questions from the room (included in summary of discussions below).

PRESENTATIONS OF REVIEWER COMMENTS – PART 1

Presenters: Stephen Ban, BC Parks and Cathryn Clarke-Murray, DFO Science

Synopsis of Presentations

The reviewers of the WP presented a summary of their reviews of Part 1 (Appendix D).

It was noted that the inside-outside comparison method is useful, as is revisiting the original EBSAs with empirical data.

An additional point made by one reviewer was that though the initial assessment was based on expert opinion, these experts based their opinions on empirical data that existed at the time. For example, rookeries meet EBSA criteria, and the expert added them to the maps, along with a foraging range around them (buffer).

Also noteworthy is that some of the data used in the reassessment were in fact, expert opinion, so it should be clarified that the reassessment doesn't solely source empirical data.

Response to Reviewers

The authors of the WP responded to each of the reviewers comments. The reviewers were satisfied with the responses from the authors. The detailed recommended changes for the WP were noted (Appendix E).

DISCUSSION – PART 1

The discussion was opened up to the full meeting participants, for Part 1 of the WP.

Broader Discussions

Inside-Outside Method and Boundaries

- The WP found that although limited, this inside-outside method used in this reassessment did provide empirical support for EBSAs, and that there is potential for EBSA boundaries to be refined.

- If the meeting participants endorse the inside-outside method, it could then be used in the future, and summarized in technical reports, rather than in full CSAS processes.
- There was discussion on whether the inside-outside method is suitable for addressing objective 1, “Evaluate previously identified EBSAs in the NSB using available empirical biological data. Based on the outcome of this analysis summarize support for existing EBSA boundaries”. Some interpreted this objective as seeking to redefine existing boundaries; however, it was clarified that the objective only refers to determining if there is support for existing boundaries. Therefore, Part 1 of the WP only sought to determine if there is empirical support for existing boundaries, and notes that there may be sufficient information to further refine the boundaries.
- It was outside the scope of this reassessment to redefine the boundaries of the EBSAs.
- It was noted that while the inside-outside method used in this reassessment can find support for existing EBSAs, it cannot find enough evidence to overrule expert opinion entirely. Redefining all EBSA boundaries would require the Phase I methodology (sourcing expert opinion to identify IAs) to be repeated, which is unlikely to be worth the effort.
- It was suggested that it might be worthwhile to consider how to assess the boundaries, even if only for one EBSA, to develop a methodology. However, it was noted that the EBSA boundaries are not that important if you use the feature count method, so boundaries can be transparent. The WP concludes that the general area and shapes of existing EBSAs are confirmed and supported by ecological data. Thus, the boundaries themselves are not as important (further discussions below on management implications).
- The Convention for Biodiversity (CBD) has considered this issue of EBSA boundaries, and they are now allowing more flexibility in defining boundaries.
- It was also outside the scope to define new EBSAs, though suggestions were provided as to how the new information collected could be used in future assessments.
- The meeting participants endorsed the inside-outside method used in this reassessment, for the identification of empirical support for existing EBSAs; and, acknowledged that the method does not adequately address the question of redefining boundaries. The method identified in Part 2 may be more suitable for the latter.

Management

- It was asked whether management implications were considered in the reassessment. Some discussion of management occurs in the WP in terms management objectives, and when discussing next steps. While the end use of EBSAs can include integrated management and decision making, the EBSA identification process is independent of such considerations, and should only be based on the EBSA criteria. It was confirmed that there is no consideration of costs to humans, or impacts to humans in any of the reassessment analyses. It was agreed that management should therefore be couched in broader terms, to avoid confusion.

Spatial Efficiency

- The concept of being spatially efficient when defining EBSAs was challenged. Why is it important to limit the size of EBSAs? Why is there a narrowing of EBSA boundaries, to the exclusion of all important features?

- It was acknowledged that all of the NSB is likely important to some species. However, the CBD advice is to prioritize EBSAs, and to be spatially efficient, partly because not all management decisions make sense at the scale of an EBSA.
- This creates a trade-off: how to identify these important areas and areas of human use. In general, we need better information on human activities and stressors, as well as better data to delineate areas used to define EBSAs.
- All Important Areas and their reasons for being designated should be accessible for managers to use in their decision-making, even if outside of EBSAs

Gaps and Limitations

Marine Birds

- As mentioned during the presentation, marine bird data were excluded from the reassessment for several reasons. The rationale for its exclusion was challenged as being inconsistent. Specifically, marine bird colony data were excluded; whereas, Steller Sea Lion rookery data were included. These datasets are very similar and no reason was given for this inconsistent approach.
- It was recommended that this marine bird colony data (peak abundance) should be included in the WP at this point, and there are at-sea datasets, which could be included in further technical reports.
- There was a call to provide an accurate assessment and rationale in the WP why certain datasets were excluded.

Nearshore and Intertidal

- The nearshore and intertidal areas of NSB do have some available data (i.e. Aquatic Invasive Species and clam intertidal survey data), but were, for the most part, excluded from these analyses. These areas were not included in the initial assessment of the EBSAs, and so they were not reassessed. However, there was a science response process in June 2017 for the assessment of nearshore, which followed the CBD template, and assessed features against EBSA criteria. It included eel grass meadows, estuaries and other nearshore features, and a few were identified as meeting EBSA criteria. There are also additional nearshore and sponge reef data which are likely forthcoming for the central coast, which will help to fill many of the gaps.

Traditional Ecological Knowledge

- Traditional Ecological Knowledge (TEK) and Local Ecological Knowledge (LEK) were not included in the WP. There was no process for its inclusion in these analyses, and it should be highlighted as a gap.

Coral Aggregations and Predictive Modelling

- Coral data layers are currently being developed, but were not ready in time to be included in the WP. Coral aggregations exist in several of the Haida Gwaii EBSAs, they meet many of the EBSA criteria and so should be emphasized. Predictive modelling of coral distribution would be useful to help fill gaps, and this work is ongoing at DFO.

Data Suitability, Biases, and Limitations

- It was acknowledged that a great deal of good work went into this WP, and the difficult task of analyzing the many datasets.

- While the WP does suitably address whether data supports, or does not support EBSAs (Table 4), it is lacking clarity in some other aspects of the source data, such as assumptions, biases and limitations. Some datasets:
    - appear to be incomplete or duplicative (e.g. presentation in WP makes the crab data appear to be incomplete, and the Geoduck data to be duplicative. What is needed is clarity on why certain datasets were used, and how they are complimentary to others).
    - were considered but excluded/not reassessed for various reasons (e.g. marine birds, salmon)
    - contain seasonal and temporal biases (e.g. Humpback whale foraging areas, and the potential use of prey as a proxy)
    - are not the most suitable data for particular species (e.g. Trawl surveys cannot sample structurally complex areas, and so likely not ideal for reassessing ground fish)
- It is important to add additional clarity on data availability, quality, and relevance, so that uncertainties are understood and the results can be appropriately interpreted and used by end users.
- In many cases, these are the best available data, and it highlights how critical these surveys are to understanding the ecology of the area. It also highlights the continuing value of the expert opinion collected during the initial assessment.

Other

Manila Clam

- Manila clam was flagged as a non-native species that was included in this WP. A question was asked as to whether that is appropriate, given that we are ultimately assessing EBSAs. Do Aquatic Invasive Species (AIS) contribute to ecological significance? Does this go against departmental policy? The authors clarified that the species was included in the initial assessment, and so was included in the species table in the WP by default. However, it was not reassessed here. Should all references to this species be removed from the WP? The manila clam was later discussed, in the context of the Science Advisory Report.

Inclusion of Additional Species

- 94 ESS have been identified for the NSB. Currently, there is no available list of the 94 species that could be included in the WP.
- 19 of these have been included in this reassessment. Must clarify which species were included in the reassessment. Could draw these 19 species from Table 2 and present them in an appendix.
- Suggestion for future management to include additional species, especially ESS's.

Oceanographic Features

- New data, related to oceanographic processes are now available and discussions suggested that future EBSA assessments should incorporate those datasets as they may help to refine the boundaries.

PRESENTATION OF WORKING PAPER – PART 2: IDENTIFICATION OF AREAS OF HIGH BIODIVERSITY AND HIGH PRODUCTIVITY

Presenter: Emily Rubidge, DFO Science

Synopsis of Presentation

Part 2 presents an approach for identifying areas of high biodiversity and high productivity in the NSB, two EBSA criteria that were not directly addressed in the previous EBSA process. The WP also provides new information that can be used to update the existing Sponge Reef EBSAs.

The hotspot approach was simply defined as an area or region with higher diversity relative to the surrounding area, rather than using endemism or threat definitions. Two approaches were used to identify areas of high species diversity (fish[1] and invertebrates) and productivity (fish and invertebrate biomass):

1. Getis Ord G* or "spatial" approach: spatially clustered high values; incorporates spatial dependence. At least 10 sites are needed to designate a hotspot using this method.
2. Kernel Density Estimation (KDE) or "aspatial" approach: smooths out the contribution of each observed point over a local neighbourhood; identifies the top 10% of areas. It was later noted that using the term "aspatial" to describe this approach is inappropriate as it still has a spatial component, and so that term was avoided in the meeting and will be adjusted in the WP.

Methods and datasets analyzed were described. Data were sourced from Pacific Halibut Management Association (PHMA) longline surveys and synoptic trawl surveys and the number of taxa captured in each type of analysis was described. For both diversity and biomass, a fish (synoptic), an invertebrate (synoptic) and a fish (PHMA) analysis were performed. Chlorophyll A (Chl-*a*) concentrations and bloom frequency data were used to highlight areas of high primary productivity. The nearshore and internal waters were delineated for the analysis.

Results and associated maps were presented. It was noted that high habitat diversity can be used as a surrogate for high species diversity. Nearshore, fish and invertebrate high diversity and high productivity hotspots were mapped. The PHMA and synoptic surveys may cause seasonal bias and miss some habitats (like pelagic and sponge reefs) and this was acknowledged as a limitation.

Main findings of Part 2:

- While both methods highlighted similar areas, the Getis Ord G* method is more conservative in the number of hotspots returned. The utility of each approach depends on the research objective.
- The Eastern side of Dixon Entrance is important for fish and invertebrate biodiversity and productivity. This area is currently not well captured in the existing EBSAs.
- Overlap between areas of high diversity and high productivity suggests links between diversity and ecosystem function. However, sometimes there was no overlap between productivity and diversity, particularly for invertebrates.

The presenter provided some potential next steps for this work, including:

[1] It was later noted that this should be qualified as "benthic fish", given the sampling methods.

- Apply methods described to identify ‘core-use’ or species aggregations.
- Use spatial hotspot approach to explore other measures of diversity including species richness, evenness, functional and phylogenetic diversity.
- Improve modelled diversity surfaces by incorporating environmental variables to better understand diversity patterns in under-sampled areas.
- Include a temporal component to determine if hotspots shift seasonally or over time.

The limitations of their analyses included a lack of TEK and LEK, the spatial coverage and the type of data used, they did not assess corals and sponges (except for sponge reefs), they only included 19 of the 94 ESSs, the seasonal limitations already mentioned, and that the EBSA criteria of ‘naturalness’ was not assessed.

Presenter responded to some clarifying questions from the room (included in summary of discussions below).

PRESENTATIONS OF REVIEWER COMMENTS – PART 2

Presenters: Stephen Ban, BC Parks and Cathryn Clarke-Murray, DFO Science

Synopsis of Presentation

The reviewers of the WP presented a summary of their reviews of Part 2 (Appendix D).

One reviewer mentioned the following additional points:

- Biomass may not be the best measure for productivity.
- The Getis Ord G* method may be more suitable for EBSA identification, than the KDE method.
- Asked for clarity on the interpretation of the chlorophyll productivity map.
- Asked if the authors found enough support for the productivity and diversity criteria to define any new EBSA’s.

Response to Reviewers

The authors of the WP thanked the reviewers for their thorough review. The authors, reviewers and other participants then engaged in a discussion on Part 2, which is summarized below. The detailed recommended changes for the WP coming out of these discussions were noted (Appendix E).

DISCUSSION – PART 2

Getis Ord G* Approach vs. KDE Approach

These approaches addressed single criteria EBSAs (high biodiversity, or high productivity). The authors did consider the implications with multi criteria EBSAs: prioritization exercise of trying to identify the areas of highest ecological value. On one hand, we want to maintain individual layers, and on the other, we want to highlight areas that meet multiple criteria as the best ecologically. Currently Part 2 only produces more layers, but they can be included in the EBSA process later, if the meeting participants recommend it. It would be beneficial to do a roll up of these layers, and to identify smaller EBSAs, but that was beyond the scope of this WP. It is best to discuss the two approaches and whether they are viable, and recommend next steps (as we did in Part 1).

The WP does not make strong recommendations on either approach. The authors agree that looking at the diversity layers, the Getis Ord G* approach seems to fit better with the EBSA criteria of relative high value to the surrounding area, which the KDE approach doesn't give. However, one approach is not superior to the other. The approach should depend on the objectives. Setting a threshold may be useful in some situations, for example, with its patchier distribution on the map it may be more useful for management working at smaller scales (i.e. emergency response). It is also useful for identifying IAs. Getis Ord G* is likely a better approach for identifying hotspots in proxy to others (higher than other areas).

Productivity and Biomass

Here, biomass is presented as a proxy for productivity. However, this is not always the case. Firstly, it was noted that biomass is not a rate, and therefore not a measure of productivity. Secondly, fishing pressure may cause lower biomass results in some areas that otherwise have very high productivity. Thirdly, there are also temporal issues to consider. Longer datasets may have higher biomass values in the past, and less now because of exploitation. This can result in strong changes over time. The habitat in those areas may be highly suitable, but is missed because of lower biomass. And finally, it should be acknowledged that it is difficult to extrapolate biomass from longline data – it really provides relative abundance, rather than biomass. Qualifiers are needed in the WP to address these issues.

In terms of primary productivity, the seasonality was flagged as being important, and not currently captured in the WP results. Focusing on only the spring bloom can be misleading, as the spatial distribution varies throughout the year and blooms happen at different times for different locations.

Nearshore

Habitat diversity was used as a proxy for species diversity in the nearshore areas. The WP makes the assumption that all eight nearshore habitat types investigated are basically equivalent, which we know isn't true. Eelgrass, for example, is far more productive and surf grass is relatively uncommon over the extent of the coast. Is there a better way to analyse the data (i.e. presence/absence, proportion of occupation of cells)? Is the current method rigorous enough to identify nearshore hotspots?

Some alternative methods were investigated by the authors to account for these differences but the nature of the datasets made analyses difficult to perform (e.g. proportion of occupancy of cells method was attempted, however the surf grass data are found in a band along the shore, and so cannot extract percent cover). The current nearshore method is a simplification. The nearshore features are considered EBSAs in and of themselves, so this is a way of highlighting areas with those components, and areas of high habitat complexity. More complex analyses could be undertaken but that was beyond the scope of this paper. The authors did not intend to imply that all habitats were equivalent, but rather that they are different, thus they support different species, and therefore, in proxy, they have more species combined. It was agreed that rebranding it as "habitat richness" instead of diversity would solve this issue.

It was agreed that the current method is a good first step – even having nearshore habitats identified as an EBSA by default was a good first step. This method highlights areas of the coast that are important as well. It is some of the earliest nearshore work available and it has value. This method is appropriate for habitat richness; however, the method would need to be revisited to really address habitat diversity.

Other

Synthesizing PHMA and Synoptic Getis Ord G* analyses and comparing with EBSA Boundaries: The Getis Ord G* analyses of each survey type were analyzed separately, but participants wondered how the map would look if the survey layers and their hotspots were overlaid, and then compared to existing EBSA boundaries. It would be difficult to combine the two analyses; however, it would be possible to overlay the maps. On the second day of the meeting, the authors presented this synthesis to the meeting participants (see p. 11 for further discussion).

Harmful phytoplankton: Participants asked if primary productivity maps can differentiate between harmful and non-harmful algal blooms. The maps cannot differentiate between harmful and non-harmful blooms, but for the given time and areas, harmful algal blooms are small and the primary productivity presentation can be regarded as a show of “positive productivity”.

Increasing neighbourhood size for management purposes: the Getis Ord G* approach requires 10 sites in a cluster for a polygon to exist, while the KDE approach only requires two. Could you give management the option of increasing the neighbourhood size for their purposes? It could be done, but if it is too high, it could over-smooth the data.

Gap: Fjords are not included in the assessment, though they are nearshore features, because they have depths greater than 50m.

Sponges: Sponge aggregations are described as unique (uniqueness EBSA criteria). That is true for sponge reefs (large complexes), but is it still true for smaller sponge aggregations? Do we intend to extend the language we use for sponge reefs? Do the smaller aggregations still form in the same oceanographic circumstances as the reefs? Glass sponge aggregations themselves are not unique, however the dense aggregations that are reef-like (but don’t produce the “reef” geological signature) are certainly unusual. Smaller aggregations may actually be young reefs, which simply lack the geological signature. It is likely better to apply the precautionary approach for sponge aggregations – even if they don’t meet the uniqueness criteria; they still meet other criteria, such as biodiversity, productivity and vulnerability.

Are These Approaches Viable for Proposing Potential EBSAs?

The Getis Ord G* approach is recommended for identifying areas that meet the diversity and productivity criteria for EBSAs, and the KDE method is useful for meeting different objectives. The meeting participants recommended validation of these methods with further work.

It is notable that the Getis Ord G* approach has identified areas that are not within existing EBSAs, but that meet the biodiversity criteria (i.e. nearshore). These areas may also meet other criteria, and could undergo a Phase II prioritization process later, but their identification is the first step. It was noted that meeting the biodiversity criteria itself is sufficient to identify an EBSA (according to CBD). Forthcoming data may help to ground truth these areas.

Can We Recommend Any New EBSA’s From The Results of Part 2?

With the overlay of the Synoptic and PHMA Getis Ord G* layers, and their comparison to existing EBSA boundaries (see above, p. 10), certain areas of the NSB are easily identified as meeting EBSA biodiversity and productivity criteria, but currently not captured in any existing EBSAs (i.e. Dixon Entrance). While it was noted that the approach and data are sound, and that meeting these criteria alone would be sufficient to identify the areas as EBSAs in other regions, there is a discomfort with formally identifying EBSAs in the context of this WP. It is beyond the scope of the current work to identify new EBSAs or adjust boundaries. There is agreement that the WP should describe the approaches (noting their usefulness) and results, call the areas

what they are (shelf benthic fish and invertebrate diversity hotspots) and then defer the incorporation of these areas into EBSAs to a later process. Additionally, further ground-truthing (nearshore) and data validation is recommended.

It was agreed that a statement on this issue should be included in the Science Advisory Report and should be relatively general: “There are several areas identified as important for multiple reasons, are not currently included in EBSAs, but could be evaluated as future EBSAs (i.e. Dixon Entrance)”.

CONSENSUS ON OBJECTIVES AND WORKING PAPER

The Chair reviewed the objectives from the Terms of Reference to identify which objectives have been met through the WP, and the associated discussions (recorded above).

- There was agreement the objective: “Evaluate previously identified EBSAs in the NSB using available empirical biological data” has been achieved.
- For the objective: “Based on the outcome of this analysis summarize support for existing EBSA boundaries”, it is agreed that there is empirical support for existing EBSAs as they were drawn in the initial assessment, and that there could be further refinement of boundaries using the inside-outside method.
- For the objective: “Evaluate the analytical approach for identifying areas of high biodiversity and high productivity”, it was agreed that the approaches presented are appropriate for this purpose.
- For the objective “This analysis may result in the identification of additional EBSAs in the NSB as high biodiversity and productivity EBSA criteria were not assessed in the previous EBSA identification process”, it was agreed that the proposed approaches would allow us to identify new EBSAs, but clarified that this process did not itself seek to identify new EBSAs.

Therefore, there was agreement that all of the objectives of the Terms of Reference were met.

The WP was accepted with the agreed upon changes from this meeting. The authors will include the revisions as suggested by the meeting participants.

SCIENCE ADVISORY REPORT

The Chair provided background information on the Science Advisory Report (SAR), its purpose, components and timelines. It was clarified that the SAR cannot make management recommendations directly; but rather, can present evidence and identify risks, and highlight the best option.

Draft bullets for inclusion in the SAR were presented to the meeting participants for discussion.

DISCUSSION

There was a recommendation to document the application of EBSAs in marine spatial planning. However, this is a broader issue that is not specific to the EBSA process and is something that DFO’s Marine Spatial Ecology and Analysis Section is working on; specifically, streamlining management recommendations across projects. The meeting participants decided to keep the recommendation in the summary so that it can be put in the ‘Recommendations’ section of the SAR, but it was noted that the word ‘recommendation’ should be avoided if possible.

MARXAN analysis can be left in the WP as a literature review discussion as an analysis that is used in other countries, but its use should not be included as a recommendation.

The question of whether non-native species should be included as important ecological components was discussed further. The manila clam was included in the WP as it was a part of the previous EBSA process for commercial reasons. However, EBSAs are not supposed to consider commercial importance. The rationale for including it in the current document need to be made clear, though it was noted that analysis was not done on the manila clam, it was only included in a table. The point about consideration of non-native species in EBSAs will be included in the SAR.

Fish biomass may not be a good proxy for productivity as fishing will reduce biomass in highly productive areas. The productivity link was made based on literature that uses higher trophic levels as an estimate of productivity; however, this issue needs to be mentioned in the WP. Another issue is that the estimate of biomass based on abundance assumed the same weight relationship for all fish species. A question was raised of whether the use of productivity in the WP is consistent with what is used in fisheries studies. In addition, productivity is usually expressed as a rate, but both fish biomass and chl-a values were not reported as rates. Rather than referring to biomass as productivity, it should just be represented as biomass.

The authors will include bird colonies in their updated analysis.

The meeting participants requested that data sources be provided so that other organizations can find the data for future work. It was stated that the data will eventually be open source, and it will be made clearer in the WP which data were included and which data were available but not included, and why. Also, it should be noted in 'uncertainties' why some data were not included; for instance, because of lack of expertise or time. This referred to the marine bird data in particular.

Future field surveys are needed to fill in data gaps. It was unclear whether this could be stated in the SAR, as the need for surveys is not solely applicable to this process.

The intertidal zone was included in the analysis as part of the bottom patches. Intertidal species were not included, but some intertidal areas may have been included in the habitat richness analysis.

The above discussion, advice, gaps/uncertainties, future work and ecosystem consideration bullets were drafted and agreed to for incorporation into the SAR (see Appendix F).

CONCLUSION

In conclusion, the Chair thanked all of the participants for their valuable feedback during the process. CSAP thanked the Chair, the authors and the rapporteurs.

The next steps were presented as:

- Proceedings to be drafted in the next two weeks.
- Science Advisory Report to be drafted and provided to participants for review. Targeting delivery at five weeks after the meeting
- Authors to include revisions in the WP. This process could take several months.

REFERENCES CITED

Clarke, C.L., and Jamieson, G.S. 2006a. Identification of ecologically and biologically significant areas in the Pacific North Coast Integrated Management Area: Phase I – Identification of important areas. Can. Tech. Rep. Fish. Aquat. Sci. 2678: 59 p.

Clarke, C.L., and Jamieson, G.S. 2006b. Identification of ecologically and biologically significant areas in the Pacific North Coast Integrated Management Area: Phase II – Final Report. Can. Tech. Rep. Fish. Aquat. Sci. 2686: v + 25 p.

DFO. 2011. Ecologically and Biologically Significant Areas – Lessons Learned. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/049.

Jamieson, G.S., and Levesque, C. 2014. Identification of Ecologically and Biologically Significant Areas on the West Coast of Vancouver Island and the Strait of Georgia, and in some nearshore areas on the North Coast: Phase II – Designation of EBSAs. DFO Can. Sci. Advis. Sec. Res. Doc. 2014/101. vii + 36 p.

APPENDIX A. PARTICIPANTS LIST

Last Name	First Name	Affiliation
Ban	Stephen	BC Parks
Ban	Natalie	University of Victoria
Barron	Alexandra	Canadian Parks and Wilderness Society
Caron	Chantelle	DFO Fisheries Management
Chaves	Lais	Haida Oceans Technical Team
Clarke-Murray	Cathryn	DFO Science
Davies	Sarah	DFO Science
Dudas	Sarah	DFO Science
Dunham	Anya	DFO Science
Dupuis	Britt	DFO Science
Finney	Jessica	DFO Science
Frid	Alejandro	Central Coast Indigenous Resource Alliance
Gale	Katie	DFO Science
Gregr	Ed	SciTech Consulting
Hillier	Joy	DFO Oceans
Iacarella	Josie	DFO Science
Ladwig	Aleria	DFO Fisheries Management
Lok	Erika	Environment and Climate Change Canada
MacDougall	Lesley	DFO Centre for Science Advice Pacific
McIsaac	Jim	Commercial Fisheries Caucus
Morgan	Ken	Environment and Climate Change Canada
Nephin	Jessica	DFO Science
Norgard	Tammy	DFO Science
O	Miriam	DFO Science
Pena	Angelica	DFO Science
Petersen	Shane	DFO Fisheries Management
Robb	Carrie	DFO Science
Robinson	Cliff	DFO Science
Rubidge	Emily	DFO Science
Setterington	Lisa	DFO Science
Steiner	Nadja	DFO Science
Therriault	Tom	DFO Science
Watson	Maryann	West Coast Environmental Law
Wells	Nadine	DFO Science

APPENDIX B. TERMS OF REFERENCE

REASSESSMENT OF THE ECOLOGICALLY AND BIOLOGICALLY SIGNIFICANT AREAS (EBSAS) IN THE PACIFIC NORTHERN SHELF BIOREGION

Regional Peer Review – Pacific Region

November 1-2, 2017

Sidney, BC

Chairperson: Nadja Steiner

Context

Canada's Oceans Act (1997) provides the legislative framework for an integrated ecosystem approach to management in Canada's oceans, particularly in areas considered ecologically and biologically significant. Fisheries and Oceans Canada (DFO) has developed guidance for the identification of ecologically and biologically significant areas (EBSAs; DFO 2004, DFO 2011), and has endorsed the scientific criteria used by the Convention on Biological Diversity (CBD) for identifying EBSAs as defined in Annex I of Decision IX/20 of its 9th Conference of Parties (UNEP/CBD, 2008). DFO's science advice recommends identifying EBSAs as a first step to planning networks of marine protected areas (DFO 2010). This approach was re-emphasized in Canada's National Framework for Canada's Network of Marine Protected Areas (MPAs; 2011). In addition, the Canada-BC MPA Network Strategy (2014), and the Marine Protected Area Network Technical Team (MPATT[1]) have been developed to provide guidance to MPA network planning, including the identification of EBSAs.

EBSAs in the Canadian Pacific Northern Shelf Bioregion (NSB) were identified in 2006 (Clarke and Jamieson 2006a, 2006b) and peer reviewed in 2012 (DFO 2013). The approach by Clarke and Jamieson was driven by expert opinion and was focused on the continental shelf. EBSAs have also been identified in the Strait of Georgia (Jamieson and Levesque 2014, DFO 2013), and the Pacific Offshore Bioregion (Ban et al. 2016, DFO 2016). Nearshore features in the Northern Shelf Bioregion were recently assessed and canopy-forming kelp forests, eelgrass meadows, estuaries, and high tidal current passages were found to meet the EBSA criteria (DFO 2017).

DFO Oceans Sector of the Ecosystems Management Branch has requested DFO Science to review previously identified EBSAs in the NSB using available biological data, including data for ecologically significant species (ESSs) and conservation priorities (DFO 2017). The information arising from this Canadian Science Advisory Secretariat Regional Peer Review can be used to support the refinement of existing EBSA boundaries, and help to inform MPA network planning in the NSB, including the Pacific North Coast Integrated Management Area Plan.

Objectives

The following working paper will be reviewed and provide the basis for discussion and advice on the specific objectives outlined below.

[1] MPATT is the technical team responsible for the design and implementation of the MPA network planning process in NSB, with representatives from the federal government, the province of British Columbia and First Nations.

Rubidge, E., Nephin, J. Gale, K, Frid, A., and Curtis, J . Reassessment of Ecologically and Biologically Significant Areas in the Northern Shelf Bioregion, BC. 2014OCN01b

1. Evaluate previously identified EBSAs in the NSB using available empirical biological data. Based on the outcome of this analysis summarize support for existing EBSA boundaries.
2. Evaluate the analytical approach for identifying areas of high biodiversity and high productivity. This analysis may result in the identification of additional EBSAs in the NSB as high biodiversity and productivity EBSA criteria were not assessed in the previous EBSA identification process.

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 Management, Fisheries Management, Science)
- Federal Government (Parks Canada, Environment Canada & Climate Change)
- Province of British Columbia
- First Nations
- Academia
- Industry representatives
- Environmental non-government organizations

References

Ban, S., Curtis, J.M., St. Germaine, C., Perry, I., and Therriault, T.W. 2016. Identification of ecologically and biologically significant areas (EBSAs) in Canada's offshore Pacific bioregion. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/034. X + 152 p.

Canada-British Columbia Marine Protected Area Network Strategy. 2014. 36 pp.

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DFO. 2013. Evaluation of proposed ecologically and biologically significant areas in marine waters of British Columbia. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/075.

DFO. 2016. Identification of Ecologically and Biologically Significant Areas (EBSAs) in the Offshore Pacific Bioregion. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2016/011.

DFO. 2017. Framework for Identification of Ecological Conservation Priorities for Marine Protected Area Network Design and its Application in the Northern Shelf Bioregion. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2017/019.

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Jamieson, G.S., and Levesque, C. 2014. Identification of Ecologically and Biologically Significant Areas on the West Coast of Vancouver Island and the Strait of Georgia, and in some nearshore areas on the North Coast: Phase II – Designation of EBSAs. DFO Can. Sci. Advis. Sec. Res. Doc. 2014/101. vii + 36 p.

UNEP/CBD. 2008. Decision adopted by the Conference of the Parties to the Convention on Biological Diversity at its Ninth Meeting IX/20. Marine and coastal biodiversity COP/DEC/IX/20. 12p.

APPENDIX C. AGENDA

Canadian Science Advisory Secretariat

Centre for Science Advice Pacific)

Reassessment of the Ecologically and Biologically Significant Areas (EBSAs) in the Pacific Northern Shelf Bioregion

November 1-2, 2017
Institute of Ocean Sciences, Sidney, BC

Chair: Nadja Steiner

DAY 1 – Wednesday, November 1, 2017

Time	Subject	Presenter
0900	Introductions Review Agenda & Housekeeping CSAS Overview and Procedures	Chair
0915	Review Terms of Reference	Chair
0930	Presentation of Working Paper Part 1	E. Rubidge
1015	***Break***	
1040	Overview Written Reviews Part 1	C. Murray/S. Ban
1100	Identification of key issues Part 1 & Discussion	RPR Participants
1200	***Lunch Break***	
1300	Continued discussion Part 1	RPR Participants
13:50	Presentation of Working Paper Part 2	E. Rubidge
14:15	Overview Written Reviews Part 2	C. Murray/S. Ban
1440	***Break***	
1500	Identification of key issues Part 2 & Discussion	RPR Participants
1630	Discussion & Resolution of Results & Conclusions	RPR Participants
1700	Adjourn for the Day	

DAY 2 - Thursday, November 2, 2017

Time	Subject	Presenter
0900	Introductions, Review Agenda & Housekeeping Review Status of Day 1	Chair
0945	Carry forward outstanding issues from Day 1	RPR Participants
1000	Introduction to Day 2 – review TOR Objectives	Chair
1030	***Break***	
1050	Develop Consensus on Paper Acceptability & Agreed-upon Revisions	RPR Participants
1200	***Lunch Break***	
1300	*Science Advisory Report (SAR)* • finalize summary bullets • guidance and advice for objectives • Results & Conclusions	RPR Participants
1440	***Break***	
1500	*Science Advisory Report (SAR)* • Gaps • Additional advice to Management (as warranted) Required tables/figures	
1530	Next Steps – Chair to review • SAR review/approval process and timelines • Research Document & Proceedings timelines • Other follow-up or commitments (*as necessary)*	Chair/CSAS
1545	Other Business arising from the review	Chair & Participants
1600	***Adjourn meeting***	

APPENDIX D. WORKING PAPER REVIEWS

REVIEWER: CATHRYN MURRAY (FISHERIES AND OCEANS CANADA)

General Review

The working paper by Rubidge et al seeks to evaluate existing EBSAs using available empirical data. The authors have brought a substantial amount of quantitative data together and conducted analyses to reassess the existing EBSAs. The analyses are sound, explained in sufficient detail in the methods and Appendices and provide useful results. Part 1 uses survey data on fish, invertebrates and marine mammals to compare areas inside EBSAs to those outside. Part 2 uses species richness, diversity and productivity data with two different metrics to show potential EBSAs that meet the additional criteria of the CBD. They have also presented updated data on the location of sponge reefs to refine and expand the previous layer.

There is some nuance to the original EBSA process that is not captured in the current WP. Expert opinion was provided based on varying levels of empirical data. The experts had access to, and in some cases, provided empirical evidence for the Important Areas they put forward. Detailed maps of rookeries and haulouts for pinnipeds, catch data, survey data, and others were used to create the original IAs. Expert opinion was used to interpret this data in the context of the EBSA criteria. Some experts communicated to us that use of the raw data could lead to misinterpretation. For example, sightings data for cetaceans was available but the experts felt that it reflected human use of the areas, rather than importance for cetaceans. Catch data reflects complex socio-economic processes as well as ecology of the fisheries species. Experts thus interpreted the data accordingly in their designation of IAs. This process should be reflected in the working paper.

It should also be noted that regular updates to EBSAs may be needed for a number of reasons; temporal variation, shifts in distribution or habitat use (climate change, large scale oceanographic changes), newly collected or available data, or new concerns about species or habitats. Making a commitment to keep these datasets regularly updated and available will support the continuing EBSA process, allowing regular updates and the addition and revision of areas as required. The reassessment is particularly needed given that there seemed to be less confidence in the EBSA designations because of the expert elicitation process.

I agree with the conclusions of the WP that the new sponge reef areas should be added to the list of EBSAs. I did not see a clear suggestion in the WP of areas that should be added to meet the diversity and productivity criteria of EBSAs but the methods used to analyse data to this end are useful. However, I question the suggestion that there is a need for an alternate or revisited Phase II of the EBSA process. The authors concluded that the Scott Islands EBSA was “arbitrary” despite the failure to include marine bird data in the reassessment process. The reassessment conducted here shows that there is empirical support for the original EBSAs. The original EBSAs would be further supported by the updated sponge reef EBSAs. I suggest some discussion around the need for an alternate Phase II with the larger group before advice is provided on this point.

I provide some additional specific questions and comments for the authors’ consideration below, in reference to the pdf page numbers of the WP document.

Specific Comments and Questions

Section 1.3

The review of original EBSA process is sound but with some nuance. The experts consulted often used their own empirical data and interpreted it for the EBSA criteria. For example, the pinniped IAs were identified based on surveys of haulouts and rearing areas. Commercial fisheries species were identified based on decades of catch and survey data, interpreted by the experts for the EBSA criteria. The coral and sponge IA were based on bycatch survey data analysis done by Living Oceans Society. So it would be inaccurate to say that the original IAs were not based on empirical data, just that the process did not explicitly use empirical data.

P21 "…we first summarized species listed as important for each existing EBSA" – was there any discussion about examining other species or faunal groups that weren't included in the original EBSA? Are those in the EBSAs the same as those deemed "significant species" in other processes? The original EBSA groupings were sometimes large groupings, sometimes single species and there was discussion about the limitations of those groupings in the original process.

P26 – Marine birds –Why weren't the marine bird datasets used in the reassessment? They are listed later in Table 3.

P27 "To standardize the scale of the different datasets to a 1 km2 density estimate, we multiplied the DFO data by 25" Is this the most appropriate way to deal with the differences in scale? Would a resampling method be more robust?

P27 "Sea Otters and Steller Sea Lions were assessed using BCMCA areal extent polygons based on recommendations by marine mammal experts at the BCMCA Marine Mammals Experts Workshop (BCMCA 2008, 2011). The Sea Otter layer represents their range in 2008 and the Steller Sea Lion layer represents a 15 km buffer around known rookery sites." This is another expert opinion exercise, similar to that done in the original EBSA IA exercise. I'm not sure this is an appropriate comparison when the goal is empirical evidence of EBSAs.

2.2.5 Diversity and productivity

P27 Richness and diversity were "…calculated using catch records from the DFO synoptic trawl survey." Why just the trawl data? This suggests that only benthic communities would be assessed against the EBSAs, which included species at multiple depths and community types. Is there discussion on this later?

P27 "Productivity was assessed using surface chlorophyll (ChlA) data from the MODIS satellite (NASA Ocean Color). The MODIS ChlA (mg m-3) band has a resolution of 1 by 1 km. Daily swath data was extracted from March 18 to June 21 from 2012 to 2015 and mosaicked by month. The dates were chosen to encompass the timing of the spring bloom (Stockner et al. 1979, Pan et al. 1988, Peña et al. 1999). The monthly ChlA data was interpolated spatially using Spline with Barriers (ArcGIS 10.4) to fill in any data gaps, which were limited to the nearshore and coastal inlets." – Why just the spring bloom? Because this is the highest productivity for the year? What about spatial variability in summer/winter months?

Table 3 – clearly there are datasets that could be useful for evaluating bird EBSAs. Why weren't they used?

2.3 Analysis

Note that there is already a sampling bias in much of the empirical datasets included. Trawl surveys do not occur in untrawlable habitats… fishing often occurs in areas of known aggregation or high densities or the fleet may avoid areas of high bycatch of certain species.

This was one of the reasons why an expert elicitation approach was used originally, so that experts most familiar with the data and how it was collected could interpret the empirical data. Is there some discussion around this?

P31 “The gridded data were summarized by computing the mean density or % presence by species for each EBSA.” What are the consequences of using the mean, rather than the sum or maximum?

Appendix B, p94 – What do the “Inside EBSA percent of total sample” columns refer to in Table B1? These two tables in the Appendix do not make sense to me. How were the percentages calculated? For reference, what is the total size of the NSB? How many grid cells?

2.4 Reassessment results

P32 “We found adequate data to test empirical support for at least a subset of important species for 16/17 EBSAs.” Which one had no data?

Hecate Strait front EBSA - “However, the current boundary of the HSF EBSA does not adequately capture the spatial extent the area of importance.” Can you give more detail? Is the EBSA too small? Too large? The frontal system was originally designated in part based on survey data of pelagic herring (rather than trawl or spawning), which was not included in the current data.

Figure 5 and following – the size of the points is difficult to see. Suggest adding the values above each point.

Were any datasets used for salmon species? Tagging data?

The paper makes the suggestion that some of the original EBSAs may be larger than the reassessment data indicates (e.g. Cape St James, Central mainland EBSAs). However, those EBSAs identified for sea lion and sea bird aggregation or breeding included a buffer area based on the known feeding area. Without the larger feeding area, the breeding aggregations would no longer be supported. Caution should be used if the decision is made to revise boundaries.

It is good to see the sponge reef EBSA shapefile revised based on latest survey data. Suggest advice to revise this EBSA permanently and add sponge reefs to the list of justifications for the other EBSAs where they occur.

P53 “..it only means there was no empirical evidence *of* support that claim.” Revise sentence

Part 2, Areas of High Biodiversity And Productivity

P56 “Getis-Ord G* analyses were carried out to identify areas of high nearshore habitat diversity (section 3.2.1.1), fish and invertebrate diversity (section 3.2.1.2), and fish and invertebrate productivity (section 3.2.2.1)”. Why only nearshore habitat diversity? There is data on other kinds of habitats throughout the NSB. You mention it later in the section – Gregr 2013 bottom patches.

Nearshore habitat complexity hot spots – these seem quite small in scale compared to the EBSAs. Can you aggregate them in some way? Is there any discussion around the size needed for an area the size of the NSB?

Discussion

P79 “Here we assessed the existing EBSAs with empirical data and identified new EBSAs including Important Areas for biodiversity and productivity, two EBSA criteria that were not previously quantitatively assessed.” Which areas have you proposed as new Important Areas for biodiversity and productivity? There were a number of areas listed for habitat, fish, inverts, chlorophyll, but which are the final set you propose? Are they summarized in a map?

P79 “…or appear arbitrary when compared with the ecological data (e.g., Scott Islands).” Since marine birds were not reassessed, this statement is not justified. The Scott Islands EBSA was identified largely for aggregation and life history importance for marine birds, for which data was not used in this analysis. Support comes from other processes, including the process to designate the Scott Islands and a marine National Wildlife Area, under the Canada Wildlife Act. Suggest revising and including discussion around this point.

P79 “Over the past year, there has been substantial progress on the development of an MPA network in the NSB that can help to underpin and update the EBSA process.” Care must be taken when discussing and comparing the EBSA and MPA planning processes. The goals and priorities of the two are not necessarily overlapping and one need not support the either. In particular, representation is not a goal of the EBSA process and EBSAs are not necessarily going to become MPAs. The goal of EBSAs was to provide enhanced management (through various mechanisms) and not necessarily for them to become full MPAs.

Naturalness is mentioned in the conclusions but the nature of the datasets used already imply a level of human use (trawl and longline sets). Suggest adding some discussion around this point.

P80 “Using this database of spatial datasets currently being created and reviewed for the MPA network, a subset of data layers that fulfil the EBSA criteria for ESSs, plus any other EBSA criteria, can be selected to rerun Phase II of the EBSA process to refine the EBSA boundaries.” These spatial datasets are extremely useful and were not available during the original EBSA process. However, I don’t necessarily agree that there is a need to rerun Phase II of the EBSA process. The addition of productivity and diversity EBSAs would be useful advice as well as the updated sponge reef EBSAs. Given that there was empirical evidence for all EBSAs, except Hecate Strait front, rounding out the list of EBSAs with these additions may serve the region well, without a need to redo previous work. Given that the goal of EBSAs does not include representativeness, a Marxan analysis or feature count may not be necessary or particularly useful.

REVIEWER: STEPHEN BAN (PROVINCE OF BC - BC PARKS)

General Comments

On the whole, I think this was a very succinct and comprehensive revisit of the original NSB EBSA selection process, and that many of the methods employed in this paper can and should be applied to subsequent EBSA delineation and reassessment processes. Specific comments follow.

Page 5 (Section 1.3): Throughout the document, I think it would be useful to show the original areas of exclusion (particularly the nearshore areas) in the maps and figures.

Would it be worth revising the boundaries of the Important Areas, at least where species-specific data are available?

Page 6: I don't see how management objectives (or the lack thereof) pertain to the designation/delineation of EBSAs. None of the EBSA criteria are dependent on management objectives.

Page 8 (Section 1.3.1): Again, it's not clear why management and conservation goals are relevant to the EBSA identification process, or why MPA network conservation priorities need to be incorporated into refinement of EBSAs.

Page 8 (Section 2.1): Again, it's not clear why only "important species" were included in this process. Unless we're considering the EBSA criterion of endangered, threatened, or declining species, there's nothing in the EBSA criteria that prioritizes one species over another. Did the original EBSA reports miss any species that should have been included?

Page 14 (Section 2.2.4): Although it's later mentioned in this paper that the 15 km buffer distance was chosen by experts, it's not clear why this distance was chosen. For example, Merrick and Loughlin (1997) found that the mean foraging distance for adult females during the summer was 17km +-4.6km, and Loughlin et al (2003) found a mean foraging distance for juveniles of 16.6 km.

Page 14 (Section 2.2.5): It can be problematic to use ocean colour measurements in nearshore and coastal (type II) waters, as turbidity and other coloured material (CDOM) can confound the chlorophyll-a signal (e.g., see Moses et al. 2009; Komick, NM, Costa, MPF, Gower 2009). Worth checking that the appropriate algorithm was used – and then specify this in the text.

Page 19 (Section 2.3): I think this is a novel and useful approach for EBSA identification, and would like to see it used in future EBSA identification exercises.

(Section 2.4): Refining/improving is fine, but there's no reason for minimizing an EBSA footprint just for the sake of minimizing it.

Page 20 (Section 2.4.4): This raises an important caveat about the limitations of using trawl survey data: that the surveys are likely to either avoid or be extremely data-limited in areas that are likely to be highly diverse and/or productive because of high benthic topographic complexity, i.e., the same areas that are likely to damage or snag trawl gear are also likely to be highly productive habitats. EDIT - I see this is mentioned in 3.4.1.1.

Page 25 (Figure 5): For all these maps, it would be useful to delineate the nearshore area that is being excluded from the analyses.

Page 35 (Figure 15): No data should be depicted in a different colour than absence.

Page 41 (Section 2.5): I question the use of Marxan for EBSA identification - see my later comment on this.

Page 48 (Figure 23): This should show the boundary of the study area as well.

Page 66 (Section 5.1): Marxan is the wrong approach for EBSA identification, because EBSAs aren't about minimizing cost or balancing competing values.

Page 69 (Section 5.3): Data-poor/empty cells should be shown on the maps.

Page 81 (Table B1): I'm a little unclear on what the column “Inside EBSA percent of total sample” represents - is it the proportion of cells inside the EBSA with data?

Also, given the huge disparities in sample size (inside versus outside), I think it might be instructive to conduct a sensitivity analysis where the number of outside sample cells is varied, to determine the effect of this sampling bias on the resultant densities.

References Cited

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APPENDIX E. RECOMMENDED WORKING PAPER CHANGES

PART 1

- Include spatial layer of data GAPS (i.e. no data)
    - Will make it clearer in Figure legend
- Integrated ocean management – where does that fit into Figure 1 (not mentioned in Fig.)
    - Will make note in schematic
- Clarify original CSAS is based on data from experts, not just expert opinion
- Note BCMCA sea lion and sea otter observations are from expert knowledge - Need to be clear that some expert layers were included as empirical support, Will discuss point about circularity in using expert knowledge as empirical
    - Agreed
- Will be clearer about distinction and relationship between EBSAs and MPAs (portions of EBSAs will be included in MPAs)
    - Discuss EBSAs from broader perspective – multiple uses of data, less focus on MPAs and regulations
    - Agreed
- Make spatial map highlighting overlap where there is both empirical and expert support
    - Agreed to change table column heading to ‘unsupported’ (by empirical data) rather than ‘completely unsupported’ (as there is expert opinion support)
- Can look at additional species not included in original list
    - Agreed to look at other ecologically significant rockfish species using PHMA data (data were better for the species three or four that were focused on)
- Make clear data were not limited to nearshore ‘gap’ mentioned in previous CSAS (.25km from coast…)
    - Agreed
- Clarify reason/purpose for refining EBSAs – i.e. based on ecological data
    - Discuss why there is interest in refining boundaries
- Sensitivity analyses on uneven sample sizes for inside/outside EBSAs – in progress
    - Will be added to appendix
- Uncertainty in MODIS measures, discuss the algorithms and how turbidity affects chl-a
    - Agreed to add paragraph/disclaimer
- Clarify narrative on shape and configuration of boundaries, room for refinement but acknowledge importance of previous work (won’t use word ‘arbitrary’)
- Birds, corals, sponges etc. can be run for inside/outside comparison as data becomes available (separate from CSAS process); Acknowledge locations of coral aggregations and data gap

- Be clear on which data the CSAS uses, i.e. make it clear that salmon, birds, etc. aren't included
- Will include bird colonies
- Highlight that this process should be updated as more data become available
  - SAR and WP

- Use normalized densities for whales to standardize across methods, will update maps (in progress)
- Table 3 changes and related discussion
  - Will better clarify use of data in Table 3 (fix 'no' absence detection)
  - DFO Shellfish Program, should include 'no' detection records
    - Clarify that shellfish data aren't presence only, but only presence was used as there was uncertainty about whether abundances were 'true'.
  - Clarify that no duplication of geoduck data based on presences that were used
  - Clarify data that are available but were not used, and why
- Table 4 changes and related discussion (note some of these points may be better addressed in Table 3, but were discussed as Table 4)
  - Add diversity column in Part 1 Table 4 to show moderate support, etc.
  - Table 4, capture relative strength of different datasets, i.e. 'limitations column', differences in data existing only in EBSA versus data that's not applicable, etc. – availability, quality, appropriateness
    - Need to better clarify use of invertebrate data – why is shrimp trawl missing? Better justify why certain trawls are not included.
    - Can include Tanner crab survey
    - Clarify decision to not use shrimp trawl because of limited spatial coverage
    - Will acknowledge other datasets that exist, but give reasons why they weren't included
  - Seasonal component in Summary Table is important – data are associated with particular time periods; useful for oil spill response (referring to Table 4)
  - Lacking interpretation of biases in data from Table 4, i.e. species are highly mobile, seasonal, may be temporal biases; need more detailed discussion of these biases
- Eulachon trawl data is not a good capture method for this species – shouldn't be used to confirm/deny support for EBSAs; Recommend to not use in the WP
  - Agreed, and will mention reason for not using it in WP
- Be more clear about limitation of using trawl surveys – not great for spatially complex habitats
- IPHC data do not meet 20% data cutoff for spatial coverage of EBSAs – can include this in the paper
- Clarify table headings in Table B (i.e. proportion of data available)
- Might mention a next step of refining boundaries using oceanographic data as these were the original reasons for defining EBSA boundaries

- Possible discussion point - Marine mammal foraging – prey availability may be better test of importance for humpbacks than whale observations
- Can combine fish and invert diversity to look at areas that are higher in species richness
    - Will not re-do analysis with fish and inverts combined
    - Note different areas can be important for inverts vs. fishes
- Goal of Part 1 is unclear, got impression that area delineations of diversity were meant to be new EBSAs
    - Make clear that intent was not to redefine boundaries of EBSAs
- Need consistent summary on ecological accuracy boundaries in Section 2.4 – i.e. more inside than outside, etc.
- Manila clam included, non-native species – may be removed from future analyses, note non-native status in the WP?
- Compile list of species that were assessed in Appendix
- Can objectives be redefined to not focus on 'boundaries'?
    - Objectives will not be changed
- If main species wasn't included in EBSA analysis, then it should be clearly stated that the EBSA couldn't be adequately assessed (not that the EBSA is not supported)

PART 2

- Add map overlaying existing EBSAs, invert diversity, and fish diversity hotspots AND also habitat richness (possible problem with visibility)
- Use different term rather 'aspatial' and 'spatial' – can just use actual names
- Be clear about absences vs. 'no data' for habitat analysis
- Fish biomass is also likely to reflect fishing pressure – qualify this in the text, heavily fished areas may not show high biomass, not necessarily related to productivity
- May want to add reasons for needing to use all data in the WP, rather than just focusing on current conditions
- Conversion of longline data to biomass – used weight across species (?)
    - Need to re-exam biomass by species
- Compare hotspots against current EBSAs (now or in future work?).
- What are the recommendations for EBSAs based on chl-a? Are there new areas that meet productivity and diversity criteria?
- Need higher concentration threshold for determining plankton blooms – should be at least 3-5mg not 2mg, will help isolate hotspots and include all data, March – November, not just spring blooms
    - Can add another map for comparison, using higher bloom threshold
    - Using all data, not just spring blooms, will be important for Part 1 analysis – missing summer blooms for some regions (Cape St. James) – make note in the WP that some blooms are missing, need to add recommendation to use all data in future

- Use ‘benthic fish diversity’ rather than just ‘fish diversity’
- Habitat complexity assessment is not doing nearshore ‘justice’ – discuss limitations/need for more work
- Call this ‘habitat richness’, can also suggest an evenness measure
- Data gap in inlets and fjords – highlight this issue
    - Also, limitation with lack of pelagic data
    - 2000 pixels missing data – can look at where these data are missing (e.g., just deeper areas/fjords?)
- Describe KDE and G* in methods, but then just show G*
    - KDE is useful for single species, but not as much for diversity
    - Will leave KDE in completely, but will make it more clear which is more useful depending on objectives
    - Add recommendation that these areas should be ground-truthed and a sensitivity analysis done
- Potentially can ground-truth habitat richness hotspots using Alejandro’s fish data
    - Recommendation, not a revision (may also be able to use dive survey data)
- Add text for potential false negatives of sponge detection (review with Anya)
- Don’t call the invert/fish diversity polygons ‘EBSAs’, but are OK as high diversity areas
- Note ‘benthic’ invertebrate diversity or ‘shelf’ invertebrate diversity
- Can leave Marxan in as a lit review discussion in the WP , that it is used by other countries, but don’t recommend it for a Phase 2
- Be clear about rationale for including manila clam despite its non-native status
- Change productivity labels to biomass (otherwise should be rate), for both fish and chl-a

APPENDIX F. SUMMARY BULLETS FOR SCIENCE ADVISORY REPORT

(some rewording will be required, but general consensus on concepts)

CONCLUSION AND ADVICE

- In general, we found empirical support for all EBSA's where information was available and chosen for analysis.
- The inside-outside method (comparing ecological data inside indicated EBSAs and outside) is an adequate tool to evaluate empirical support.
- It also provided additional support for existing EBSAs for additional species that have not previously been considered.
- Two approaches (Getis Ord G* and KDE) have been introduced to assess species diversity and biomass. Areas identified via both approaches don't necessarily overlap, but should be seen as complementary. Both methods cater to different requirements and should be chosen based on the objective. Getis Ord G* approach to be more adequate for EBSA criteria of relative high value to surrounding area (showing hotspots in proxy to others) , however threshold approach allows for small scale information on EBSAs, where adjustment of thresholds might be appropriate for particular applications.
- Nearshore: Habitat richness is adequate tool for EBSA assessment; to assess biodiversity additional information is required. Areas of high habitat richness were identified and could be used to identify EBSAs in the future (could be combined as a single bullet with others). Recommend that areas of high habitat richness be validated with species data, where available.
- Recommendation to clearly document the application of EBSAs for marine spatial planning, including integrated management uses, emergency response, species protection. An example schematic has been provided in the WP by DFO science, but should be reviewed by DFO ocean management to ensure all elements are represented.
- Manilla clam, non-native species, was included in original paper and carried over. Shouldn't be included here, due to AIS policy. Include a note in SAR.
- There are several areas identified as having high biodiversity, and biomass (as a potential proxy for productivity). However, some of these areas occur outside of existing EBSAs. They could be evaluated as future EBSAs (Dixon example).
- Sponge reef EBSA has been updated with new information however the analysis may not pick up smaller sponge reefs and aggregations.

GAPS AND UNCERTAINTIES

- Spatial and seasonal gaps exist in several datasets. Future iterations should attempt to include a seasonal or temporal component. This is discussed further in the WP.
- There are more biological surveys available for specific EBSAs, but not available at the spatial extent of the NSB. There may be more datasets available at smaller spatial extents.
- At-sea marine bird data were excluded. Work is ongoing and should be included in future assessment.
- Coral and non-reef forming sponge were not assessed. That data preparation is underway, but the methods in this WP can be applied.

- TEK and LEK are not included in the analyses.
- Inclusion of First Nations science program data is recommended in further assessments, when available.
- To reduce uncertainty, targeted surveys are needed in NSB to better map ecological components (e.g. Haida Gwaii coral aggregations, nearshore, fjords, etc.).
- The intertidal zone has not been fully assessed. Better resolution, include intertidal species.
- To explicitly test EBSA boundaries, targeted surveys with adequate spatial coverage for important species inside and outside those boundaries are needed.
- Lack of empirical support does not indicate negation of the expert assessment, only the lack of empirical data. Empirical data can support expert knowledge, but it can't negate or discount expert knowledge.
- A lack of empirical support for a particular EBSA for a specific species does not necessarily mean that the EBSA is not an important area for that species, it only means there was no empirical evidence to support that claim.
- Current assessment does not take into account fishing pressure

FUTURE WORK

(see points in Gaps and Uncertainties)

- Assess how good is biomass indicator of productivity, and any other methods to assess the productivity of the region.
- Ecological models (predictive) – refine boundaries and track future changes
- Empirical oceanographic models; Empirical process-based descriptions, boundary refinement
- Naturalness criteria have not been assessed.
- Further development of the habitat richness methods to assess diversity
- Nearshore requires comprehensive assessment

ECOSYSTEM CONSIDERATIONS

- Potential vulnerability of EBSAs based on climate change and other stressors including human activities (potential location changes)
- Seasonality (might miss species that migrate or are transient)
- Harmful algae bloom – chlorophyll models do not differentiate between harmful and benign types