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Pacific Region

Proceedings of the Pacific regional peer review on the identification of important seamount areas in the Offshore Pacific Bioregion, Canada

November 25-26, 2020
Virtual Meeting

Chairperson: Katie Gale
Editor: Jill Campbell

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Science Branch
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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 of November 25-26, 2020 via the online meeting platform Zoom where the working paper focusing on identifying representative seamount areas in the Offshore Pacific Bioregion was presented for peer review.

Due to the COVID-19 pandemic, in person gatherings have been restricted and a virtual format for this meeting was adopted. Web-based participation included Fisheries and Oceans Canada Science and Fisheries Management Sectors staff, and external representatives from First Nations, Province of BC, commercial fishing sectors, environmental non-governmental organizations, academia, and the New Zealand National Institute of Water and Atmosphere Research.

The conclusions and advice resulting from this review will be provided in the form of a Science Advisory Report providing advice to the DFO Oceans Program to inform them of the representative seamount areas within the Area of Interest (AOI).

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 on November 25-26, 2020 via the online meeting platform Zoom where the working paper focusing on identifying representative seamount areas in the Offshore Pacific Bioregion was presented for peer review.

The Terms of Reference (TOR) for the science review (Appendix A) were developed in response to a request for advice from the DFO Oceans Program (the clients). Notification of the science review and conditions for participation were sent to representatives with relevant expertise from First Nations, Province of BC, commercial fishing sectors, environmental non-governmental organizations, academia, and the New Zealand National Institute of Water and Atmosphere Research (NIWA).

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

DuPreez, Cherisse and Norgard, Tammy. 2020. Identification of Important Seamount Areas in the Offshore Pacific Bioregion, Canada. CSAP Working Paper 2018OCN03

The meeting Chair, Katie Gale, welcomed participants, reviewed the role of CSAS in the provision of peer-reviewed advice, and gave a general overview of the CSAS process. The Chair 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 papers, written reviews, and draft SARs.

The Chair reviewed the Agenda (Appendix C) and the Terms of Reference for the meeting, highlighting the objectives and identifying the Rapporteur, Jill Campbell, for the review. The Chair then reviewed the ground rules and process for exchange, reminding participants that the meeting was a science review and not a consultation. The meeting was held on the online meeting platform Zoom where audio and text conversations were conducted. Video was only used by presenters during formal presentations or by participants during question period.

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. In total, 39 people participated in the RPR (Appendix D).

Participants were informed that Emily Rubidge (DFO Science, Pacific) and Ashley Rowden (NIWA) had been asked before the meeting to provide detailed written reviews for the working paper to assist everyone attending the peer-review meeting. Participants were provided with copies of the written reviews.

The conclusions and advice resulting from this review will be provided in the form of a Science Advisory Report to the DFO Oceans Program to provide them with an evaluation, based on ecological criteria, to identify representative areas on seamounts in the AOI. The Science Advisory Report and supporting Research Document will be made publicly available on the Canadian Science Advisory Secretariat (CSAS) website.

REVIEW

Working Paper: DuPreez, Cherisse and Norgard, Tammy. 2020. Identification of Important Seamount Areas in the Offshore Pacific Bioregion, Canada. CSAP Working Paper 2018OCN03

Rapporteur: Jill Campbell

Presenter: Cherisse DuPreez

PRESENTATION OF THE WORKING PAPER

In addition to presenting on the context, methods, results, and discussion of the paper (see Appendix B for the working paper abstract) the authors also spoke to some of the comments raised by the reviewers. As a result, the authors indicated they would add the following information to the paper, although during the course of the meeting the specifics of some of the revisions changed.

- The authors suggest using the term “seamount proxy areas” as opposed to “important seamount areas” to reduce some of the confusion the reviewers had with the “important areas” terminology.
- Section 1.1, 1.3: The impact of the marine protected area (MPA) will be to ensure long-term protection from, at a minimum, oil and gas activities, mining, dumping, and bottom trawl fishing and the ability to implement specific conservation objectives as they are established.
- Context: Need to identify areas to focus our effort and resources to notice/detect changes in the MPA with respect to ecosystem recovery or decline.
    - Changes caused by removal of fishing stressors, ocean acidification, deoxygenation, changing temperatures, etc.
        - Information on limitations and adaptations: What is possible? How will the animals and the systems adapt? How and where can we still mitigate stressors?
        - Foreshadowing: isolated seamounts as “canary in the coal mine” for coastal waters
        - Information for the bigger picture: the global climate crisis.
- Context: Identify good proxy areas to monitor for change (across local-, regional- and global-scales).
    - Reason for examining all Canadian seamounts (representativity) and including pragmatic considerations.
    - Will help inform future work (careful not to overlap):
        - Ecological Risk Assessment Framework (ERAF) to identify indicators to monitor (significant ecosystem components: species, habitat, community; activities; stressors).
        - MPA management plan by helping to develop SMART conservation objectives (specific, measurable, realistic, consistent, and comprehensive).
        - Monitoring framework and plan.
- Objective 1: Add text to indicate that the seamount location is identified by the location of the shallowest peak.
- Section 3.4.1.2: Add text mentioning threats from mining, shipping, noise, and pollution and that these will be covered in detail in the ERAF.
- Section 3.6: Add text around the limitations of the analyses and methods especially in comparison to other options.

PRESENTATION OF WRITTEN REVIEWS

The reviewers presented on the most important points from their written reviews.

EMILY RUBIDGE, DFO SCIENCE, PACIFIC

- The terminology around the definition of “important seamount areas” needs clarification. The term ‘Important Areas’ has a specific meaning and criteria within DFO that are not addressed in the working paper. Many of the DFO Important Area criteria were addressed in the paper, but not within the context of this term. The authors’ use of “proxy” in the presentation may not be necessary if the proper context is explored to justify using “important areas”.
- More context around how this work fits in with previous DFO work on Important Areas and Ecologically and Biologically Significant Areas (EBSA). This was clarified in the authors presentation, but more information is needed in the paper.
- More detail around the methods used to make the analysis repeatable and to identify areas of uncertainty. Since this work is identified as an adaptive approach, being able to recreate the results is key.
- It was suggested that the authors select representative seamounts from all classes, not just the unique and rare classes.
- Clarify if the methods used in objective 4 are intended to reflect the recommended approach or just one way to present how seamount areas can be identified.
- It is unclear if the surface chlorophyll-A (Chl-A) cut-offs were the same as those used by Clark et al. 2014 and if those cut-offs are valuable in this Area of Interest (AOI).
- More justification is needed for the unique, rare, and abundant cut-offs. The sensitivity around these thresholds should be explored.
- It is unclear if “important area” on the seamounts for corals, rockfish, macroalgae, etc. are delineated based on the bathymetric boundaries.

ASHLEY ROWDEN, NEW ZEALAND NATIONAL INSTITUTE OF WATER AND ATMOSPHERE RESEARCH

Overall:

1. More information is needed on the methodology.
2. The paper should be restructured to keep the methods, results, and discussion of each objective together.
3. Consider different analyses and techniques. Use existing forms of analyses on the relative importance of seamounts. The EBSA criteria could have been used to identify differences between seamounts which could have informed groupings.
4. Consider incorporating the formal DFO Important Areas definition and criteria in the paper.

More specific comments:

- More context is needed around the TOR objectives in the paper introduction.
- More information is needed around the use of the term “important seamount area”. The suggested change by the authors to “seamount proxy areas” still requires a specific definition of that term.

- The use of Chl-A as a proxy for export production was questioned as there are data layers that could have been used to determine export production more specifically.
- Using alpha diversity to ground truth the seamount classification is concerning. However alpha diversity is a good metric for determining the bathymetric zones.
- The bathymetric analysis methods are not described well enough to review the results.
- The Ecosystem Evaluation Framework (EEF) has not been applied as literally as the original authors intended. It should be better described why the authors have deviated from this.
- An advice/recommendations section at the end of the document would be helpful.
- The uncertainty of the data/methods/analysis needs to be summarized in a section at the end of the paper and it also needs to be tied to the advice/recommendations provided.
- Create a section highlighting the additional research recommendations to summarize all the suggestions provided in the paper.

GENERAL DISCUSSION

THROUGHOUT

Important Areas Definition

- The term “Important Areas” has specific meaning in DFO (Clarke and Jamieson 2006) which was not known to the clients when they created the TOR or the authors when they developed this paper. DFO Important Areas are used to identify areas that are important for species or species groups (i.e., life history, feeding, migratory, high productivity areas, etc.) and are identified following EBSA criteria. The way “important areas” is used in the WP is not in alignment with this definition.
- The authors indicated that since the EBSA analysis was already completed (identifying all seamounts as EBSAs, Ban et al. 2016) and a specific DFO Important Areas analysis was not requested in the TOR that they did not think to use the EBSA criteria in classifying seamounts. As well, the authors interpreted the EBSA criteria as a means to determine which individual seamounts to protect and did not think they had enough data from all the seamounts to be able to use those criteria to do so, and since this is a monitoring concern it is therefore out of the scope of the TOR.
- Participants suggested the authors could use the EBSA criteria on a different scale to classify the seamounts they do have data for and then highlight the data gaps that then become apparent. The reviewers pointed out that the authors have already done most of the work to discuss the EBSA criteria.
- It was decided that rewording the TOR was not required.
- The clients indicated that the results provided in the working paper meet their requirements and that the “important seamount area” wording is not crucial to their interpretation of the work. However, participants noted that because future work will reference and build on this report, using correct, informative, and consistent terminology within DFO processes is important.
- The authors had suggested using “seamount proxy areas” in their presentation but it was pointed out that that language implies a monitoring application, which is out of the scope of the TOR. The term “unique seamount areas” was also explored but it was decided that

"unique" has connotations that might not be correct. The term "representative areas" was suggested, but it was argued that that term did not accurately reflect the results presented in the working paper, as it implies that representative seamounts for all classes be defined (which is out of the scope of the TOR). Using the term "representative" would also be inconsistent with current work being developed for Rockfish Conservation Area (RCA) monitoring, which will be applying the concept of representativity by identifying examples of different habitat types across RCAs.

- It was suggested the authors define "important areas" but indicate that while this wording is in the TOR, identifying DFO Important Areas, following the EBSA framework, within the AOI is not in the scope of the paper. The authors should then present and define the terminology they chose to use.
- The RPR decided that the authors would think more about this after the meeting to decide which terminology would be best. The authors decided to use the term "representative seamount areas" instead of "important seamount areas".
- The authors changed the title of the paper to "Identification of representative seamount areas in the Offshore Pacific Bioregion, Canada" to reflect their change in wording.

Paper Structure

- To aid the flow of the paper, the authors will restructure the paper to have sections for each TOR objective which will include context/intro, methods, analysis, discussion, summary bullets, and limitations.
- The end of the document should have an advice/recommendations section. In the WP this information is presented throughout the paper but is not assembled in a single section. Future potential applications of this work can be provided here as well.
- The end of the document should have an overall uncertainties section which will include data, methods, and analysis uncertainties. The uncertainties section in the WP focused mainly on data uncertainties, so the authors will expand the uncertainties sections throughout the paper to include uncertainties surrounding their methods and analyses. The uncertainties presented should also be tied to the advice/recommendations the authors provide.
- The end of the document should have an additional research section.
- The end of the document should have a "monitoring considerations" section where information on how proxy seamounts can be selected.

Methods Clarification

- The methods sections throughout the WP were found to be lacking in enough detail to make them repeatable. The authors will expand their methods sections as required. This document is intended to be used to classify/reclassify seamounts based on new data so the methods need to be clear enough so this can be done with the same level of accuracy.

TOR OBJECTIVE 1 & 2

Interpretation of Classification Tree

- Providing written descriptions of each class would be helpful.
- Adding the Clark et al. (2011) seamount classification system to Fig 23 could be very useful.

- Two of the figures from the presentation will be added to the paper: the classification flow chart and the figure with the seamount silhouettes.
- A participant suggested the authors try clustering the seamounts using non-metric multi-dimensional (nMDS) scaling plots. The authors indicated these plots do exist and that they will include them in the appendix.
- The section on bathymetric boundary layers (seamount steepness and relief, 3.2.1.4) should be moved into Section 3.1 and possibly Table 1, as it is more about the section discussing different ways of classifying seamounts than it is zones/boundaries within seamounts.
- The limitations of the classification analysis need to be clearer. It appears there is less biological support for class 2, but it is uncertain if this is because there are many class 2 seamounts, as opposed to only one class 5 seamount. The limited data on class 5 seamounts is a source of uncertainty on the ecology for this class, and other classes with only one identified seamount.
- A participant noted the authors mention Springfield seamount as being an outlier with respect to gorgonian community composition relating to seamount class. However, UN16 also looks like an outlier. The authors should provide an explanation on this. It was pointed out that a reviewer provided some comments in the paper about this. The nMDS plots suggested above could aid in determining where UN16 should be grouped.

Export Productivity/Chl-A

- The authors originally tried to calculate export productivity but could not find data layers with high enough resolution to achieve this accurately. They determined that the equation they used was so strongly tied to the degradation of primary productivity as it fell through the water column that the equation ended up being reflective of seamount depth. This did not reflect the personal observations the authors had of the seamounts. They decided Chl-A, as influenced by shelf primary production, was a better fit to their observations.
- The participants highly encouraged the authors to revisit this analysis and tie their analysis more closely to that done by Clark et al. 2011. Other data layers were suggested (e.g., POC layer level 3 from OceanColor) which will be provided to the authors from those participants. The authors will speak to oceanographers who can assist them in establishing the equations and algorithms.
- If an oceanographer cannot be brought onto the project, the authors can use updated, higher resolution data layers to test how closely correlated export production and Chl-A are to determine if further analyses are required. As well, if the authors do use Chl-A as a proxy for export production, they should consider Taylor cones/columns in their equations, proximity to the coastline, express Chl-A as ranges, and consider how Chl-A changes over decades. If these Chl-A layers are used, there is documentation on the GISHub (an internal data repository) of how the imagery was processed; it was suggested that updating the Chl-A data to a more recent year might be beneficial. It was also noted that the standard ocean colour product has difficulty mapping areas close to shore.
- The seamount classification may need to be redone if the data used to identify high productivity seamounts are revised.

Spatial and Temporal Variability

- It was noted that the Clark classification system and simplified oceanographic zonation (Fig 18) gives the appearance of the seamounts being in a static system. It may be that the

variability the seamounts experience is important in characterizing them. Large scale variability and seasonality should be discussed.

- A participant suggested the authors discuss how Haida eddies and time of year may impact shallow seamounts. This will also help to address the current wording indicating the AOI is a static system. Haida eddies may have considerable effect on productivity and may in fact be a better proxy than Chl-A. However, another participant indicated that Haida eddies rarely impact the AOI and may not be an ecological impact. An author responded by saying that storms may provide a mechanism for delivering recruits from the continental shelf, acting as a connectivity mechanism, and that this warrants some more research.
- It was unclear if any differences in productivity from the more northern seamounts versus the more southern seamounts is due to the Haida eddies, Chl-A bulges from the coast, or if the northern seamounts are more productive only because they are shallow. The authors should indicate these are confounding variables.
- There is also no data on if/how seamounts alter currents (i.e., up/down currents) and if seamounts then alter primary production.
- It is not clear if/how eddies impact oxygen concentrations on seamounts. The oxygen sensor of the remotely operated vehicle (ROV), the data from Line P, and data from Ocean Atlas all correlate. There does not appear to be a seamount effect on oxygen levels.
- A participant suggested that it should be assumed there are no seamount effects (e.g., oxygen, salinity, currents, productivity), and to state this clearly in the paper. However, anecdotally it appears as though seamounts do attract animals which may be due to advection of phyto- or zooplankton. A more thorough literature review on the existence of seamounts effects, and the sources of uncertainty around the mechanism of increased productivity is required.
- If there are short term effects from variability in oceanographic conditions, it may only register as part of the background noise for many of the long-lived species that inhabit seamounts.
- There should be discussion in the “places of change” section of how there has already been measured changes over time that may have already impacted seamounts.

Substrate Characterization

- The in situ video data is currently being annotated for substrate and this information will be presented in future primary publications and reports.
- Substrate and sediment type vary within transects but does not appear to affect community composition, however more research is needed. Substrate variability was considered when the seamounts were classified. Text will be added to the paper to indicate this.

Other Classification Variables

- A participant wondered if the thresholds used by Clark et al. (2011) in their global analysis are relevant to the Offshore Pacific Bioregion (OPB), and if other variables could be useful, such as proximity to the continental shelf or peak omnidirectional relief and steepness (ORS). Later discussion suggested that the classification system did have regional relevance, as the oxygen concentrations and depth criteria align with boundaries observed in the OPB (e.g., the depths at which the oxygen minimum zone (OMZ) is observed).

- It is important that the seamount classifications used here are in alignment with international seamount scoring methods. The Clark classification system has been applied worldwide, so in order to understand the OPB seamounts in a global context it is important to use the classification system as-is (i.e., do not add or change the criteria).
- The proximity variable the authors used (proximity to other seamounts) did not inform the seamount classification, because all OPB seamounts are within 100 km of another seamount (the classification threshold). The authors indicated there does not appear to be dispersal barriers in the OPB and that proximity might be more relevant if defined as "proximity to the coastline". The authors will explore altering the classification system to change proximity to be distance from the coastline.

Transect Selection

- More information about how the video transects were selected for ground truthing is required. It should also be made clear how the transects were subsampled and processed (e.g., clipping within upper and lower depth boundaries). It was suggested that a table be inserted indicating the number of transects conducted on each seamount, and the start and end depths, speed, length, and area covered for each video transect.
- Maps of where surveys were conducted might be useful to understand how representative the transects are.
- Because transects were selected based on their start and end depths, seamount slope could confound the comparison between transects (i.e., a very steep transect would cover less area than a very long one with the same depth range). The authors will provide some text on how this is a source of uncertainty/limitation of the data.
- Species accumulation curves should be considered.

Alpha Diversity

- A reviewer was concerned that the alpha diversity analysis was not appropriate to use to ground truth the seamount classification. However, alpha diversity should be used, as applied, to assess the bathymetric zones.
- The authors were supportive of this concern and indicated that since the seamount classification system is highly tied to seamount elevation that the relationship between seamount class and alpha diversity is not very useful.
- Gorgonian corals were used to assess seamount alpha diversity, but some taxa were grouped, and it was not clear which taxa were grouped and why. More text is needed to clarify. As well, it should be indicated that because video annotations are ongoing there was insufficient data available, at a high enough resolution, to include other species in the community analysis at the time of writing. The authors indicated that it is difficult to find taxonomists to help with species identifications and that video analysis is a lengthy process. A coral taxonomist helped with this study and therefore more species of gorgonian corals were identified than other species, which is why the community analysis only included gorgonians. The authors should add information on the limitations and justifications for the taxa they used for this analysis.

Other Data Sources

- A participant wanted to know if historical fishery by-catch data could be used to identify additional coral or sponge species from seamounts that have been fished. While there is

some limited data, it has low taxonomic resolution (i.e., generally not to species). This fishery information should be referenced as well as a paper by Chu et al., (2019) which models cold water coral habitat using silica, oxygen, depth, and a range of data sources including the fishery bycatch records.

- Water was collected during seamount surveys to be analyzed for environmental DNA (eDNA), and a reference library is being constructed which may aid in future species identifications. If more information on this library is available prior to publishing the research document, it should be added.
- National Oceanic and Atmospheric Administration (NOAA) has a database of species observations from seamounts outside of Canadian waters, which might be of use to determine which species may be specific to certain seamount classes. This information should be referenced.

Representative Seamounts

- A reviewer suggested the authors identify representative seamounts from each class that could be considered for monitoring. Since some of the classes only have one representative seamount the authors have indicated that those seamounts would be suitable for monitoring. However, it was decided that specifying those seamounts, although obvious, falls under monitoring frameworks and is therefore out of the scope of the TOR. The authors will therefore only present the seamounts in each class and indicate that by default some classes only have one seamount in them. The number of seamounts assigned to each class may change as higher-resolution bathymetric data is acquired.
- A section on monitoring considerations will be created at the end of the paper which can include some of this information.
- The seamount classifications and boundaries should be separate from future applications (e.g., monitoring plans). This paper is intended to provide flexible outputs for future research questions.

TOR OBJECTIVE 3

EEF Framework

- As originally published (Pitcher and Bulman 2007, Pitcher et al. 2007), the EEF framework was intended to help determine data availability and identify what is known about seamounts. However, the authors here used the EEF to aid in their identification of ecosystem functions. The ecosystem function methods section will be clarified and the EEF framework will be referenced but how the authors used the EEF to inform the ecosystem functions does not need to be mentioned. The EBSA criteria will frame the ecosystem functions. The paper by Taranto et al. (2012) used a mixture of the EEF and the approach taken by Clark et al. (2014) and it may provide the authors with some direction.
- The authors will use the EEF as intended to identify data availability.
- The authors will add text to better explain how the classes/zones from Objectives 1 & 2 can be used to describe ecosystem functions. This will allow Objective 3 to be a stepping stone into Objective 4.
- A participant suggested the authors use a summary table similar to that in Ban et al. (2016) but with the current information the authors have.

- How the pelagic habitat is addressed needs clarification. Sharks, marine mammals, and sea birds also benefit from seamounts.

TOR OBJECTIVE 4

- It was suggested that the authors use the EBSA framework instead of their report cards to score the classes and zones. Taranto et al. (2012) and Clark et al. (2014) used similar approaches the authors could use to achieve this suggestion. However, the authors indicated that the objective was not to score the seamounts using the EBSA criteria and that the approach taken by Taranto would be best (see "Portfolio Plot" bullet under the "Threats" section below). However, the EBSA language will be used in the ecosystem function section to help frame the table (see the table provided by reviewer Emily Rubidge in their written review). A full EBSA scoring is valuable, but is out of the scope of the paper.
- The authors should provide information on how the seamounts differ, but should avoid ranking the seamounts by, for example, ecological importance.
- The current state of knowledge for individual seamounts should be summarized. See the plot used in the Taranto et al. (2012) paper. Identify natural groupings, summaries of existing knowledge per seamount, and a summary of places we expect change.
- To avoid recommending proxy seamounts for monitoring, the authors should indicate that there is a selection that can occur from each class. The narratives on Dellwood, Union, and Explorer can remain, but the authors will indicate that future research can aid in determining potential monitoring sites, but that this is out of the scope of this paper.
- The observations of interesting/notable assemblages within individual seamounts should be moved to the ground truthing section (3.4.1.1 to 3.2).

Unique/Rare/Abundant Categorization

- The terms unique, rare, and abundant are used in two different analyses: section 3.1 (seamount classification) and section 3.4. ("important seamount areas"). The methods for applying these terms and the difference between the two sections should be clarified. The suggested restructuring of the paper may make this more clear as the methods and results sections will be adjacent.

Anthropogenic Impacts and Threats

- The terminology used in this section was discussed, with the group finding "threats" and "anthropogenic impacts" not completely appropriate. A participant suggested the language used here be in line with other DFO processes The term "stressor" is used in the text, but this implies an impact that is being continuously applied. The term "response" was suggested as it does not imply good or bad and could then represent degradation or recovery. It was also suggested to use the term "human drivers" and then discuss the ability of the system to recover from the human drivers and if the drivers are positive or negative in natures. The terminology to be used was not finalized, but will be revised by the authors.
- The authors subsequently changed the title of this section to "representative areas to detect change".
- The authors should be clear that this section is not meant to inform or constrain the upcoming ERAF and that the list of potential places of change is not meant to be comprehensive.

- The authors note that the list of ”threats” are not meant to be weighted equally, and this wording should be especially clear in the Science Advisory Report.
- An alternative structure would be to move the threats section into Objective 3 section about what data is known, and change Objective 4 into distinctiveness of the seamounts using the Clark classification system. However, the authors indicated that since the clients asked for all the “threat” information in one place that moving this information could be confusing for the client and that their idea for a portfolio plot (see below) would be of most value.
- Portfolio Plot: A new figure will be created based on one used by Taranto et al. (2012). The y axis will show the existing data, the x axis will show the potential for change (information from the “threat” assessment). The seamount class for each seamount will be marked with different symbols. This figure then becomes a summary of the pragmatic data considerations and how unique the seamounts are under the criteria that were considered.
- Calcite/Aragonite Saturation: The text needs to be more clear how these saturation boundaries affect animals. Site-specific examples should also be provided (e.g., Ross et al. 2020). The authors will also note that it is not just the threshold horizons that are changing but the sea calcite and aragonite saturations are changing as well.

TOR OBJECTIVE 5

- The authors will better describe what the ERAF is, what it is used for, and how this work fits into that process. As well, section 2.8 needs more wording around the phases of the ERAF process. It should be made clear that this section will inform the scoping of significant ecosystem components and this will then take the weight off the threats/places of change section.
- The heading for section 3.5.1 (“Significant Ecosystem Components”) is misleading. The authors have provided a list of species, habitats, and communities that could be considered in the ERAF scoring exercise, which is carried out to identify significant ecosystem components. They have not done any scoring. The authors should make it clear in the text that the suggested list of ecosystem components is not meant to be comprehensive and is not intended to constrain the future development of the ERAF.

TOR OBJECTIVE 6

- The uncertainties section should also include data/knowledge gaps.

MINOR EDITS/ADDITIONS

- The text suggested by the authors in their presentation will be added to the paper (See Presentation of the Working Paper Section above).
- The reviewers suggested additional content be added in the context, specifically surrounding the TOR objectives and where this work fits in with previous work by DFO on Important Areas and EBSAs. Much of this information was provided in the authors’ presentation and now needs to be added to the paper.
- The authors will emphasize that the high density of seamounts in the AOI is regionally notable (although not globally unique) and has implications for connectivity among the seamounts (e.g., with respect to larval dispersal).
- The term “network” has specific meanings in relation to MPAs, and should be avoided when describing the seamounts within the AOI. A participant noted that the AOI, being very large

and having a high density of seamounts ("habitat patches") presents the opportunity to study broad-scale connectivity *within* an MPA; most MPAs are relatively small, so planning tends to consider connectivity *among* MPAs. The authors can add some text describing this.

- The authors will add the Clark classification system to Figure 23.
- Clarify in the text how the 800 m boundary in the Clark classification system is derived.
- Authors will clarify that in Table 1 the depth oxygen level estimate refers to the oxygen level at the summit of the seamount.
- The authors can provide text indicating that good data exists on how depth and the OMZ structure life and therefore it is reasonable to predict the types of life that can be expected on newly discovered seamounts or seamounts that have yet to be visually surveyed.
- The authors should clearly indicate that good baseline data from the Line P survey exists (i.e., physics, water chemistry, phyto- and zooplankton) that can be used to monitor change.
- It should be clear in the ecosystem functions table/section of the paper that pelagic animals and sea birds benefit from the enhancement of Chl-A around seamounts (even though the mechanism is poorly understood).
- Possible typo in table 3 caption (and possibly elsewhere): "lack of evidence should (*not*?) be interpreted as evidence of absence".
- Possible typo in Table 8: the text indicates that seamounts with a history of fishing are inferred to *not* have lost fishing gear if they have not been surveyed.

CONCLUSIONS

The participants agreed the TOR objective were met. The paper was accepted with the above-mentioned revisions.

RECOMMENDATIONS & ADVICE

- It is recommended that this information is suitable for a range of potential applications, such as the ERAF, an MPA management plan, conservation objectives, a monitoring framework and plan, and future survey design.
- It is recommended that the methods presented here be used to update the seamount classifications (classes and zones) as new data becomes available.

ACKNOWLEDGEMENTS

We appreciate the time contributed to the RPR process by all participants. In particular, we thank the reviewers, Emily Rubidge and Ashley Rowden, for their time and expertise. We also thank Katie Gale as Chair of the meeting and Jill Campbell as the Rapporteur.

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APPENDIX A: TERMS OF REFERENCE

IDENTIFICATION OF IMPORTANT SEAMOUNT AREAS IN THE OFFSHORE PACIFIC BIOREGION, CANADA

Regional Peer Review – Pacific Region

November 25-26, 2020

Virtual meeting

Chairperson: Katie Gale

Context

Canada's Oceans Act provides the legislative framework for an integrated ecosystem approach to manage oceans, particularly in areas considered ecologically or biologically significant. To guide efforts, in 2015, Canada adopted international and domestic 2020 Biodiversity Goals and Targets. The United Nations Convention on Biological Diversity (CBD) Aichi Biodiversity Target 11 (reformatted as Target 1 of the 2020 Biodiversity Goals and Targets for Canada) calls for the conservation of 10% of coastal and marine areas by 2020 (CBD 2020). Under the Oceans Act, Fisheries and Oceans Canada (DFO) is legislated to provide protection to areas of the oceans and coasts through the establishment of Marine Protected Areas (MPAs), where the identification of an Area of Interest (AOI) is the first step in this process.

In 2017, DFO identified the southern portion of the Offshore Pacific Bioregion (OPB) as an AOI, in anticipation of a proposed Marine Protected Area (MPA). The proposed Offshore Pacific MPA would contribute to the protection and conservation of the region's unique seamounts and hydrothermal vents. These Ecologically and Biologically Significant Areas (EBSAs) occur nowhere else in Canada other than the OPB, with the majority located inside the AOI (DFO 2019).

Seamounts are underwater volcanic mountains that rise abruptly above the deep abyssal and bathyal plains, dramatically altering environmental conditions. The OPB seamounts are known to provide habitat and food for species of conservation concern, as well as socially, culturally, and commercially valuable species, including cold-water corals and sponges, rockfish, halibut, whales, and seabirds (Ban et al. 2016; DFO 2019).

The DFO Oceans Program requested that Science Branch develop an evaluation, based on ecological criteria, to identify important areas on seamounts in the AOI. The following evaluation is based on a global seamount classification scheme (Clark et al. 2011) and the seamount Ecosystem Evaluation Framework (EEF) (Pitcher and Bulman 2007; Pitcher et al. 2007). It focuses on physical, oceanographic, and ecological seamount attributes. The classification scheme was developed to aid the scientific design of MPAs. The EEF was initially developed as a summary of the principal findings on seamount ecology, fisheries, and conservation to date. Both list important measurable attributes that interact to produce the range of seamount ecosystems. Since its initial development, the EEF has provided a standardized multidisciplinary list of parameters by which seamounts are characterized for consistent seamount ecosystem modeling, meta-analysis, and, for management, development of ecosystem-based plans (e.g., modified and used in Ban et al. 2016). The resulting evaluation is designed to identify areas with regionally rare, significant, or functionally important species, as well as assess the ecological uniqueness and ecosystem functions provided by each seamount allowing for the identification of natural seamount boundaries. To identify important seamount areas within a regional scope (i.e., the OPB), the evaluation includes all 62 Canadian seamounts.

The evaluation arising from this Canadian Science Advisory Secretariat (CSAS) Science Regional Peer Review (RPR) will guide management decisions for seamount conservation and protection within the Offshore Pacific AOI. It will also inform the future application of the Ecological Risk Assessment Framework (ERAF; O et al. 2015) related to the proposed Offshore Pacific MPA.

Objectives

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

DuPreez, Cherisse and Norgard, Tammy. 2020. Identification of Important Seamount Areas in the Offshore Pacific Bioregion, Canada. CSAP Working Paper 2018OCN03

The specific objectives of this working paper are to:

1. Update information for the nomenclature, location and systematic classification of seamounts in the Offshore Pacific Bioregion (OPB);
2. Identify natural boundaries or zones within the OPB;
3. Assess the uniqueness and ecosystem functions provided by each seamount within the OPB;
4. Identify important seamount areas within the OPB, focusing on the Area of Interest (AOI) related to the proposed Offshore Pacific Marine Protected Area (MPA);
5. Inform the future application of the Ecological Risk Assessment Framework (ERAF);
6. Examine and identify uncertainties in the data and methods.

Expected Publications

- Science Advisory Report
- Research Document
- Proceedings

Expected Participation

- Fisheries and Oceans Canada (Ecosystems and Oceans Science, Oceans Management, Fisheries Management)
- Academia
- First Nations communities/organizations
- Industry (e.g., fishing)
- Government organizations
- Environmental non-government organizations

References

Ban, S., Curtis, J.M.R., St. Germain, C., Perry, R. 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.

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APPENDIX B: WORKING PAPER ABSTRACT

The Offshore Pacific Bioregion (OPB) is a dense patchwork of ecologically and biologically significant areas (EBSAs), most of which are underwater mountain ranges known as seamounts. Seamounts support a range of ecosystems, depending on a suite of physical and biological characteristics. Little is known about the variety of ecosystems and species supported by the OPB seamounts. The Fisheries and Oceans (DFO) Policy Program, Oceans, requested that Science Branch develop an evaluation, based on ecological criteria, to identify important areas within the seamount network with a focus on a large Area of Interest (AOI). The AOI is in anticipation of a proposed Large-Scale Marine Protected Area (LSMPA; ~133,000 km2).

Before 2017, research on the AOI seamounts was limited to information from the relatively small fisheries and rare scientific surveys. Since 2017, the Deep Sea Ecology program (DFO Pacific Region) has led three intensive seamount surveys. Herein we use all available data to identify high-priority, ecologically important areas, primarily using habitat-level surrogates and recent survey data. We focus the effort on regionally rare, significant, or functionally important species (e.g., cold-water corals and sponges). We also assess the ecological uniqueness and ecosystem functions provided by each seamount and identify natural seamount boundaries. To evaluate seamounts within a regional scope (i.e., the OPB) and leverage the better-studied seamounts outside the AOI, we include all 62 known Canadian seamounts. Because the AOI is large, remote, and difficult to survey, we offer some pragmatic variables to consider when identifying ecologically important areas for monitoring and protection (e.g., existing baseline data).

We found that depth- and nutrient-related seamount characteristics are often indicative of enhanced ecological characteristics, where seamounts with shallower summits and higher potential flux of particulate organic carbon (POC) are more likely to support regionally unique or rare species or habitats, higher biomass, higher biological diversity, and more ecosystem functions. Shallower, more productive seamounts are also more likely to have pre-existing data (shallow enough to fish), have attracted previous research, and are more likely to suffer anthropogenic impacts, now and in the future (e.g., fishing, climate change). The evaluation herein determined all seamounts are rare offshore ecosystems and support ecologically important species. However, the ecosystems on Union, Explorer, and Dellwood seamounts are unique within the AOI and OPB. The establishment of the proposed MPA will significantly enhance the representivity (represents various constituency groups) of offshore ecosystems and species within conservation areas—with only a few examples of unique or rare seamounts occurring outside of a conservation area (e.g., SAUP 5494 and Tazo Wilson seamounts are outside the existing and proposed MPAs).

This type of thorough ecological assessment is an adaptive research product intended to support ongoing adaptive ecosystem management. The science information and evaluation herein can be re-examined to guide potential questions that arise in the future regarding management and monitoring.

APPENDIX C: AGENDA

Canadian Science Advisory Secretariat

Regional Peer Review Meeting (RPR)

Identification of Important Seamount Areas in the Offshore Pacific Bioregion, Canada

November 25-26, 2020
Virtual Platform on Zoom

Chair: Katie Gale

DAY 1 – Wednesday, November 25, 2020

Time	Subject	Presenter
0900	Introductions/Overview of virtual platform Review Agenda CSAS Overview and Procedures	Chair
0915	Review Terms of Reference	Chair
0930	Presentation of Working Paper	Authors: Cherisse Du Preez & Tammy Norgard
1005	Questions of clarification	RPR Participants
1015	***Break***	
1030	Overview Written Reviews	Reviewers: Emily Rubidge & Ashley Rowden
1115	Discussion of Reviews	Authors & Reviewers
1200	***Lunch Break***	
1300	Identification of Key Issues for Group Discussion	RPR Participants
1330	Discussion of Key Issues	RPR Participants
1430	***Break***	
1445	Discussion of Key Issues, cont'd	RPR Participants
1600	***Adjourn for the Day***	

DAY 2 – Thursday, November 26, 2020

Time	Subject	Presenter
0900	Introductions Review Agenda & Housekeeping	Chair
0915	Carry forward outstanding issues from Day 1, as needed	RPR Participants
1000	Review Terms of Reference Develop consensus on paper acceptability & agreed-upon revisions	RPR Participants
1045	***Break***	
1100	Science Advisory Report (SAR) Develop consensus on the following for inclusion: • Summary Bullets • Results & Conclusions	RPR Participants
1200	***Lunch Break***	
1300	*Science Advisory Report (SAR) cont'd* • Sources of Uncertainty • Gaps • Required Figures/Tables • Additional advice to Management, as needed	RPR Participants
1430	***Break***	
1445	*Science Advisory Report (SAR) cont'd*	RPR Participants
1530	Next Steps – Chair to review • SAR review/approval process and timelines • Research Document & Proceedings timelines • Other follow-up or commitments, as needed	Chair
1545	Other business arising from the review	Chair & Participants
1600	***Adjourn meeting***	

APPENDIX D: PARTICIPANTS

Last Name	First Name	Affiliation
Acuña	Carlo	Canadian Parks and Wilderness Society
Allen	Pamela	DFO Science
Ban	Stephen	Province of BC
Bates	Amanda	Memorial University
Best	Merlin	DFO Science
Boyes	Tiare	BC Tuna Fisherman's Association
Buglass	Salome	University of BC
Burrows	Danielle	Nuu-chah-nulth Tribal Council
Campbell	Jill	DFO Centre for Science Advice Pacific
Carrier	Aline	Nuu-chah-nulth Tribal Council
Carswell	Tyson	Province of BC
Chaves	Lais	Council of Haida Nation
Christensen	Lisa	DFO Centre for Science Advice Pacific
Clyde	Georgia	DFO Science
Curtis	Janelle	DFO Science
DeMille	Patricia	DFO Oceans
Du Preez	Cherisse	DFO Science
Dudas	Sarah	DFO Science
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Hannah	Charles	DFO Science
Lacharite	Myriam	University of Tasmania
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