2023 Annual Report of Working Group 47 on Ecology of Seamounts

Janelle Curtis and Mai Miyamoto, the co-chairs of Working Group on Ecology of Seamounts (WG 47) convened a virtual business meeting as well as an in-person hybrid business meeting at the PICES 2023 Annual Meeting in Seattle, USA. The business meeting focused on introductions of national representatives and observers, discussions of WG 47's terms of reference, and exchange of information and ideas about participants' seamount research activities.

The virtual business meeting was held on 14 September 2023 from 17:00-18:00 PDT (*WG 47 Endnote 2*) and there were five participants (*WG 47 Endnote 1*). The in-person hybrid meeting was held on 25 October from 14:00–17:30 PDT (*WG 47 Endnote 3*) and there were 14 participants (*WG-47 Endnote 4*), including eight WG 47 members, two colleagues from PICES Section on Marine Birds and Mammals (S-MBM), and three observers with expertise in seamount biodiversity. The meetings had similar agendas to the business meeting in 2022. The PICES Secretariat arranged for the business meeting in Seattle to be a hybrid meeting and one WG 47 member joined the meeting remotely, as did one of the members of the S-MBM.

Meeting participants introduced themselves after WG 47 co-chairs welcomed everyone and shared their opening remarks. Meeting participants adopted the agenda and Devon Warawa served as the meeting rapporteur. A few group photos were taken (*WG 47 Endnote 5*).

WG 47 had a few changes in membership since PICES 2022. Dr. Kota Sawada (Japan) is a new member of the WG 47 replacing Tatsuki Oshima (also from Japan). Kuidong Xu (China) is a new member of WG 47. Jinhui Wang (China) resigned from WG 47.

Agenda item 4: Update from PICES Future SSC

Jennifer Boldt provided updates from PICES FUTURE SSC, which is an integrative Scientific Program to understand how marine ecosystems in the North Pacific respond to climate change and human activities, to forecast ecosystem status based on a contemporary understanding of how nature functions, and to communicate new insights to its members, governments, stakeholders, and the public. WG 47 falls within the Marine Ecosystem element of their integrative schematic: see Scientific-Programs - PICES - North Pacific Marine Science Organization.

Agenda item 6: Presentations by members about their expertise, research interests, and contributions to achieving WG-47's Terms of Reference (ToR)

Most meeting participants on 25 October shared presentations about their research and contributions to achieving WG 47's ToR. Presentations were made by Janelle Curtis, Kota Sawada, Les Watling, Hye-Won Moon, Jae Kyu Lim, Won-Gi Min, Seonock Woo, Patrick Ohara, Chris Rooper, and Amy Baco-Taylor to describe their research interest, expertise, and

contributions to WG 47's ToR. Based on participant presentations, questions, and ensuing discussions, most of WG 47's ToR have been or will be addressed. These are outlined in the table that follows.

Term year	**ToR**	**Contributions to the ToR**
Year 1	Gather data on the distribution and life history of pelagic, demersal, and benthic taxa, including fish and invertebrate assemblages associated with seamounts in the North Pacific Ocean and facilitate their submission to appropriate biodiversity databases, *e.g.*, Ocean Biogeographic Information System (OBIS).	***This ToR has been partially addressed***. Canada is submitting benthic data collected using an Autonomous underwater vehicle (or AUV) and a remotely operated vehicle (or ROV) on Cobb Seamount in 2012 to Canada's Open Government Portal and to Ocean Biogeographic Information System (OBIS). Canada is also submitting benthic data collected with a drop camera along the Cobb Eickelberg seamount chain in 2022. Les Watling is anticipating submitting data on benthic taxa from the Emperor Seamounts. Seonock Woo described deep sea coral bioinformatics data in Genbank that are shared as open data.
Year 1	Gather data on key environmental variables (e.g., temperature, depth, steepness, substratum, current velocity, isolation, ocean acidification) hypothesized to influence the distribution and diversity of species associated with seamounts.	***This ToR has been addressed***. The World Ocean Atlas data that was compiled for use by PICES WG 32 on the Biodiversity of Biogenic Habitats a few years ago was updated by Samuel Georgian and is available to WG 47 members. Canada also collected oceanographic data along the Cobb-Eickelberg seamount chain in 2022.
Year 1	Convene a 2-day workshop on "Distributions of pelagic, demersal, and benthic species associated with seamounts in the North Pacific Ocean and factors influencing their distributions".	***This ToR was completed during PICES 2022:*** see PICES 2022 Annual Meeting - Program - PICES
Year 2	Identify environmental and ecological predictors of patterns in the distribution and biodiversity of pelagic, demersal, and benthic taxa associated with seamounts in the North Pacific Ocean.	***This ToR has been partially addressed*** by Canada for benthic seamount taxa along the Cobb-Eickelberg seamount chain in the northeast Pacific Ocean.
Year 2	Apply one or more modeling approaches (e.g., MaxEnt, Boosted Regression Trees, or high-resolution bathymetry-based models) to predict the distribution of pelagic, demersal, and benthic biodiversity associated with seamounts in the North Pacific Ocean.	***This ToR has been partially addressed*** by Canada for benthic seamount taxa in the northeast Pacific Ocean. Specifically, Canada used MaxEnt in 2021 and ensemble models in 2022 to predict the distribution of VME indicator taxa along the Cobb-Eickelberg seamount chain in the Northeast Pacific Ocean. The ensemble model coupled a random forest, generalized additive model (GAM), and a boosted regression tree model. In 2023, a GAM model predicted the distribution of potential VMEs in the same area. Chris Rooper noted that guidelines and code for developing predictive habitat models, including random Forest (RF), Generalized Additive Models (GAM), Generalized Linear Models (GLM) and Boosted Regression Trees (BRT) are available through ICES.

Year 2	Use available data to predict climate induced changes in the distributions of seamount fauna.	***This ToR is not anticipated to be addressed*** because of a lack of capacity within WG 47.
Year 2	Convene a topic session on the pelagic, demersal, and benthic species associated with seamounts at the PICES Annual Meeting.	***This ToR was completed during PICES 2023***: see PICES 2023 Annual Meeting - Program - PICES
Year 3	Identify potential indicators for assessing and monitoring the biodiversity of pelagic demersal, and benthic taxa associated with seamounts.	***This ToR has been addressed partially*** by Canada for benthic seamount taxa in the northeast Pacific Ocean. Specifically, a density of 0.6 North Pacific Fisheries Commission (NPFC) vulnerable marine ecosystem (VME) indicator taxa (stony corals, black corals, gorgonian and non-gorgonian soft corals, glass sponges, and demosponges) per m^2 are indicative of the presence of VMEs. Kota Sawada also noted that indicators that have been applied to other areas might also be applicable to seamounts. Amy Baco-Taylor noted that precious corals may be indicators of the effects of disturbance. Other participants noted that different suites of indicators may be appropriate for different seamounts (e.g., shallow vs deep) and the size distribution of seamount taxa may indicate recruitment dynamics.
Year 3	Use cluster analysis and/or association analysis to review and document ecological interactions among seamount taxa.	***This ToR has been addressed partially.*** Janelle Curtis and Devon Warawa undertook an analysis of species richness associated with structurally complex habitats. Chris Rooper is undertaking association analysis with 2022 data from the Cobb-Eickelberg seamount chain and he suggested that it would be interesting to compare similar analyses on Cobb Seamount and in the Emperor Seamounts. Les Watling described his research defining large-scale biogeographic patterns and suggested he could contribute to multivariate analyses over broad scales of benthic organisms. Hye-Won Moon suggested that an assessment of functional diversity could be applied to any seamount and could inform this ToR.
Year 3	Prepare scientific reports for dissemination of results.	***This ToR is in progress.*** Canada published a series of working papers about seamounts in the northeast Pacific Ocean to the North Pacific Fisheries Commission (NPFC) in 2021, 2022, and 2023. Most WG 47 members described primary papers or reports that address this ToR.

WG 47 convened two virtual business meetings in 2021, an in-person business meeting during PICES 2022 in Busan, Korea, and a hybrid meeting during PICES 2023 in Seattle, USA. WG 47's term was extended by one year by Governing Council in 2023. Thus, WG 47 anticipates its last business meeting during PICES 2024 before it completes its final report for PICES 2025.

Agenda Item 7. Requests or recommendations about WG 47 terms of reference (ToR)

Because WG 47 has one more year (2024) to complete its work, and there are a few outstanding ToR to complete, meeting participants agreed to recommend that Science Board change its ToR.

The first recommendation from WG 47 was to omit one of the outstanding ToR from Year 2: *Use available data to predict climate induced changes in the distributions of seamount fauna*. There is considerable interest among WG 47 members to undertake such analyses, but no participants at the meeting anticipated having the capacity to address this ToR before the end of WG 47's term in 2024.

Participants also recognized that the first ToR in Year 1, the first, second, and fourth ToR of Year 2, and the first ToR of Year 3 specify a focus on pelagic, demersal, ***and*** benthic taxa. But because most research and contributions by members have focused solely on benthic (and in some cases demersal) taxa, meeting participants recommended that the focus of those ToR change to pelagic, demersal, ***or*** benthic taxa.

Although PICES Science Board (SB) recommended those changes to WG 47's ToR, PICES Governing Council (GC) suggested that it would be more transparent to include details in the final report indicating which ToR could not be achieved and identifying the reasons. That information would be useful in guiding next steps for PICES work on seamounts.

Agenda Item 8: Review of key scientific outputs (papers)

Participants discussed WG-47's anticipated scientific outputs. Many outputs have been published and/or submitted already. Meeting participants were very enthusiastic about Hye-Won Moon's proposal to lead the writing of a joint WG 47 paper on functional diversity.

Agenda Item 9: Discussion about WG 47's final report

WG 47 members agreed to submit chapters, text, and images for the final report within a few months of WG 47's final business meeting during PICES 2024. Meeting participants agreed that readers would benefit from a list of recommendations for future work.

WG 47 Endnote 1

WG-47 virtual meeting (14 September 2023) participation list

Members
Janelle Curtis (co-chair, Canada)
Mai Miyamoto (co-chair, Japan)
Chris Rooper (Canada)
Kota Sawada (Japan)
Amy Baco-Taylor (USA)

Members unable to attend
Canada: Anders Knudby
China: Kuidong Xu, Zijun Xu
Japan: Kenji Taki
Korea: Seonock Woo, Hye-Won Moon, Sung Yong Kim
Russia: Alexei Orlov, Tatiana Dautova
USA: Samuel Georgian, Les Watling

WG 47 Endnote 2

Agenda for WG 47's virtual meeting on 14 September 2023, 17:00-18:00 PDT

1. Welcome and opening remarks
2. Review achievements of WG-47 against the Terms of Reference (WG-47 ToR: working-groups - PICES - North Pacific Marine Science Organization)
3. Requests/proposals to the Biological Oceanography Committee and Science Board.

WG 47 Endnote 3

Agenda for WG 47's hybrid meeting on 25 October 2023

1. Welcome and opening remarks
2. Introductions
3. Group Photo
4. Update from Future SSC
5. Adoption of agenda and appointment of rapporteur
6. Presentations by members about their expertise, research interests, and contributions to achieving WG47's Terms of Reference
7. Requests or Recommendations to SB about WG47 terms of reference (ToR)
8. Review of key scientific outputs (papers)
9. Discussion of WG47's Final Report
10. Other business

WG 47 Endnote 4

WG-47 hybrid meeting (25 October 2023) participation list.

Members
Janelle Curtis (co-chair, Canada)
Mai Miyamoto (co-chair, Japan)
Chris Rooper (Canada)
Kota Sawada (Japan)
Seonock Woo (Korea)
Hye-Won Moon (Korea)
Amy Baco-Taylor (USA)
Les Watling (USA)

Members unable to attend
Canada: Anders Knudby
China: Kuidong , Zijun Xu
Japan: Kenji Taki
Korea: Sung Yong Kim
Russia: Alexei Orlov, Tatiana Dautova
USA: Samuel Georgian

Observers
Jennifer Boldt (PICES Future-SSC)
Patrick O'Hara (PICES S-MBM)
Ken Morgan (PICES S-MBM)
Devon Warawa (NPFC)
Jae Kyu Lim (Korea)
Won-gi Min (Korea)

WG 47 Endnote 5

WG-47 hybrid meeting (25 October 2023) photo of participants. From left to right on the screen (virtual participants): Ken Morgan and Amy Baco-Taylor. From left to right (back row): Won-gi Min, Patrick O'Hara, Kota Sawada, Les Watling, and Hye-Won Moon. From left to right (bottom row): Jae Kyu Lim, Seanock Woo, Devon Warawa, Janelle Curtis, Chris Rooper, and Mai Miyamoto (photo by Jennifer Boldt).

WG-47 co-chairs, Janelle Curtis (left) and Mai Miyamoto (right), during Session 14: Seamount biodiversity: vulnerable marine ecosystems (VMEs) and species associated with seamounts in the North Pacific Ocean (photo by Kota Sawada).