A summary of Canadian domestic experiences with the use of scientific criteria for the identification of ecologically and biologically significant marine areas.

Introduction

As part of the Ocean Action Plan (2004-2007), five Large Ocean Management Areas (LOMA) were selected as pilot areas for developing Integrated Management Plans. The aforementioned Canadian LOMAs include the north coast of British Columbia in the Pacific, the eastern Beaufort Sea in the Arctic, the southern Grand Bank and inshore Placentia Bay of Newfoundland, the semi-enclosed Gulf of St. Lawrence, and the eastern Scotian Shelf. An important early step in that process was identifying Conservation Objectives for each LOMA. A key driver of the Conservation Objectives was the identification of areas which met the criteria for being ecologically or biologically significant (EBSA). Fisheries and Oceans Canada (DFO) developed EBSA criteria before the "Ottawa workshop" in 2005, which input to the CBD Azores Workshop in 2007; hence the DFO EBSA criteria are not identical in language to the CBD criteria. However, they are similar enough that experience with the Canadian EBSA criteria in the LOMA process is relevant to the upcoming CBD review of experiences with the official CBD EBSA criteria.

Included in Annex 1 of this document are web links to a variety of reports which highlight national science advisory processes related to the development of the Canadian EBSA criteria, determining Conservation Objectives, etc. In addition, relevant reports specific to each of the Canadian LOMA are also included.

Also of note are the outcomes of several recent scientific peer-review processes which are not yet available (i.e. a review of biogeographic classification systems, the development of guidelines for the application of the CBD guidance to aid in the establishment of a representative network of Marine Protected Areas (MPA), and a review of Canadian experiences with EBSA in the Northeast Pacific). The reports from these meetings will be provided for consideration as soon as possible.

Development of the Canadian EBSA Criteria

In response to a request for scientific advice from the Oceans Management Program, the Canadian Science Advisory Secretariat organized a national peer-review advisory meeting to produce scientific advice on criteria to aid in the identification of marine areas which are considered ecologically or biologically significant. In general, these areas are in need of more risk averse management than others. Experts prepared working papers on a number of candidate criteria, which were drawn from a wide range of primary and secondary scientific and technical sources. Literature presenting criteria proposed for identifying areas suitable for potential designation as MPAs were among the sources considered, however a number of other sources on marine conservation, sustainable use, spatial planning, and general conservation biology were also consulted.

For each candidate criterion, one or more technical Working Papers (WP) were prepared for the peer review and advisory process. Each WP contained a thorough and critical review of the scientific literature relevant to one or more candidate criteria being addressed. At the meeting these WPs were peer-reviewed in challenge format for completeness in the coverage of the scientific literature as well as objectivity and balance in the interpretation of literature relative to the candidate criterion(ia) being addressed. Following the peer-review of the WPs, the meeting produced consensus advice on EBSA criteria to be considered and to aid in the setting of Conservation Objectives in the LOMAs. Not only were names and definitions for the criteria identified, but guidance was also provided regarding the application of each criteria and the role of EBSA in conservation and integrated management.

Preparatory work on the information available from the LOMAs

Part of OAP was preparation of an Ecosystem Overview and Assessment Report (EOAR) for each LOMA. The five LOMAs used different institutional approaches to preparing the EOARs (mixtures of assigned Ministry staff and external consultants), but in all cases important similarities were evident. In every case databases on ecological and human-use aspects of the ecosystems in the LOMAs were consolidated and geo-referenced. To the fullest extent possible, data from both government and academic research centres were included, with workshops including experts such as federal and provincial scientists, academics, industry, and environmental non-government organisations held periodically throughout the whole process. These workshops were variably successful in getting contributions of most relevant data sets for the EOARs, but in the end most major data sets were included in the information bases for the EOARs.

When combining data from multiple sources, care was taken to consider aspects of sampling design in space and time. The usual strategy was not to merge datasets taken under very different sampling designs, but to ensure all the relevant datasets were consulted when spatial or temporal patterns in ecological properties were investigated. Significant gaps in scientific databases existed for all LOMAs, forcing those preparing the EOARs to make use of traditional and experiential knowledge, in addition to the scientific information available. Although the primary objective in setting up processes to access experiential knowledge was to fill data gaps, for most LOMAs they also provided additional information on topics for which datasets existed. This was particularly the case because the individuals and communities providing the experiential knowledge were generally very comfortable providing their information using maps. In all five LOMAs it proved possible to prepare EOARs that did not necessarily *contain* all the available information and data on the ecosystem(s) in the respective LOMA, but which summarized the major patterns and conclusions from the data. Therefore the "best available scientific and technical information (including experiential knowledge)" was provided on each system for application of the Canadian EBSA criteria.

Application of the Canadian EBSA Criteria in the LOMAs

The actual application of the Canadian EBSA criteria was done separately for each LOMA to ensure the greatest local expertise possible. Inclusion of local knowledge into the process allowed for a sense of ownership of the products at the scale at which they were to be used. This brings out an important strength of the criterion-based approach to identification of EBSA; it was possible to work at highly differing regional scales and have products tailored to the unique ecological and knowledge conditions of each LOMA. Application of the criteria to each individual LOMA ensured national consistency of both process and products that made the OAP process move forward in a coherent and objectively defensible manner.

A key step in the process of preparing the EOAR and identifying the Conservation Objectives for each LOMA was the application of the EBSA criteria to the "best available information". Even when this was started by a small group of experts working directly on the EOAR, it became the focus of dedicated workshops with broad, inclusive participation. Multiple scientific disciplines such as physical oceanographers, marine geologists, and fisheries, seabird, and marine mammal experts generally participated, as did resource users (particularly commercial fishers and subsistence hunters) and ENGO experts. The broader the participation at the workshop, the longer it took to gain consensus on what areas were considered EBSA. However, these deliberations resulted in stronger support of the particularly risk adverse management of human activities in subsequent steps in the LOMA integrated management process. In every case, contributors indicated that they found the process professionally satisfying as they witnessed their specialities combining with others to generate a spatial product. The extensive common ground regarding spatial locations of the ecosystem(s) and features that were ecologically or biologically significant provided a constructive platform for further discussions on conservation and sustainable use as well.

In all LOMAs in the preliminary stages of the application process, it seemed that nearly every part of a LOMA "qualified" under at least one of the EBSA criterion. Therefore, had the process stopped at that early stage, the criteria would have been of little value in supporting the identification of Conservation Objectives and integrated management due to their limited discriminatory powers in setting priorities. However, it was noted from the outset that the EBSA criteria were *relative* not *absolute*, and the intent from the outset was to use them to help set priorities, not just to make the already-evident point that all areas have some ecological or biological value. By layering multiple sources of information, and taking into consideration the relative strength with which specific areas met various criteria, all five LOMA processes were able to identify areas that were identified as EBSA, and provide objective, criterion-based rationales for their selection. This was a major step in the OAP initiative to move towards integrated management for conservation and sustainable use in each LOMA.

In terms of practical issues associated with the implementation of the EBSA criteria, different types of datasets could be "layered quite effectively, as could layers developed from consistent surveys and monitoring and those based largely on experiential knowledge". GIS tools were found to be extremely helpful in the layering process.

The EBSA criteria were not the only factors contributing to the identification of Conservation Objectives for each of the LOMA. From the beginning, there were four different ecological factors contributing to the identification of Conservation Objectives: EBSA, Ecologically and Biologically Significant Species and Community Properties (ESS), Depleted Species, and Degraded Areas. EBSAs and ESSs were candidate areas for the establishment of Conservation Objectives for planning and future conservation, in order to ensure that ecosystem structure and function/integrity and resilience were protected. The Depleted Species and Degraded Areas were candidates for the establishment of Conservation Objectives intended to stop further loss/harm to populations and places that were already suffering severely from the effects of past unsustainable use. Legal and scientific processes already existed for identifying the latter two types of candidate Conservation Objectives; only the EBSA and ESS required new criteria. The ESS criteria were produced by a similar process of a national peer review and advisory meeting, held nearly two years later.

The five LOMA were at different stages of moving towards a science basis for integrated management when the OAP commenced; thus they were at different stages of preparedness for applying the EBSA criteria. Those that were furthest along in consolidating information when the EBSA criteria came available found themselves applying the EBSA criteria with no knowledge of what the as-yet-undeveloped ESS criteria might contain. This led to a number of difficulties in the application of the EBSA criteria in some of the early meetings. There was an effort to make every conservation issue of concern into a spatially-based issue, so it could be captured by one or more of the EBSA criteria. This led to some very Procrustean fits of ecological concerns to spatial outcomes of the EBSA criteria. Some of the high-level ecological priorities for some of the LOMAs were simply not closely linked to specific places. Once the ESS criteria came available, and issues (e.g. highly risk adverse management of fisheries on widely migrating forage species) could be readily captured with an ESS criterion, many of the most severe difficulties associated with the application of the EBSA criteria were removed from the debates.

A final challenge in the initial application of EBSA criteria was that once these criteria were placed in a context of Conservation Objectives, along with species and community features meeting the ESS criteria and the Degraded Areas and Depleted Species, there were real problems merging the four independently-generated lists of candidate conservation issues. This challenge was dealt with by yet another peer review and advisory meeting, which developed a final set of criteria and guidelines for merging and ranking the individual conservation priorities. These criteria and guidelines again worked fairly well, although with more debate and difficulty in reaching consensus than with the application of the EBSA or ESS criteria. Some of the greater challenges seem to be rooted in the task of making priority decisions between, for example, a species assessed as (i) at risk of extirpation and (ii) a place of great functional significance. Challenges may also arise from this final step being much closer to the point where management decisions are made and interest groups may be less willing to compromise, even when provided with guidance on objective approaches to merging different types of conservation priorities.

General Lessons Learned

1. The EBSA criteria could be applied, as intended, to provide an objective basis for identifying areas in need of particularly risk averse management. The criteria allowed consistent ecological reasoning to be applied in very different ecological settings.

2. Although none of the LOMA attempted to apply the EBSA criteria without the guidelines for their use, all participants felt that the guidelines played a necessary role in clarifying the intent of the criteria in the face of very different ecological conditions.

3. The criteria have to be viewed as aids for prioritization, as not as absolute standards that an area does or does not meet.

4. The criteria worked with a variety of different types of information. No criteria can be applied in the absence of all knowledge, but many combinations of information from scientific surveys, monitoring, targeted research, experiential knowledge and traditional knowledge were all amenable to application of the criteria.

5. Geo-referenced information and spatial visualization tools contribute greatly to application of the criteria. Optimization tools may not be necessary at the stage of identification of areas that meet the criteria to varying degrees, but may be useful at later stages when more of the competing properties to be optimized have been delineated.

6. The criteria worked best when users understood that EBSAs were not the only tool available for achieving conservation, and would be complemented with population and community-based tools as well.

7. The criteria are valuable in assisting discussions which include a variety of perspectives reach consensus on key place-based conservation concerns. Subsequent buy-in after such a consensus is reached appears robust.

Annex 1

National Science Advisory Processes

- Identification of ecologically and biologically significant areas

http://www.dfo-mpo.gc.ca/csas/Csas/status/2004/ESR2004_006_e.pdf
http://www.dfo-mpo.gc.ca/csas/Csas/etat/2004/ESR2004_006_f.pdf

- Development of criteria to identify ecologically significant species

http://www.dfo-mpo.gc.ca/csas/Csas/Proceedings/2006/PRO2006_028_B.pdf

- Identification of ecologically significant species and community properties

http://www.dfo-mpo.gc.ca/csas/Csas/status/2006/SAR-AS2006_041_E.pdf

- Background scientific information for candidate criteria for considering species and community properties to be ecologically significant

http://www.dfo-mpo.gc.ca/csas/Csas/DocREC/2006/RES2006_089_e.pdf

- Identification of conservation priorities and phrasing conservation objectives for large ocean management areas

http://www.dfo-mpo.gc.ca/CSAS/Csas/Publications/SAR-AS/2008/SAR-AS2008_029_E.pdf
http://www.dfo-mpo.gc.ca/CSAS/Csas/Publications/SAR-AS/2008/SAR-AS2008_029_F.pdf

Placentia Bay – Grand Banks Large Ocean Management Area

- Placentia Bay – Grand Banks Large Ocean Management Area Science-Based Conservation Objectives

http://www.dfo-mpo.gc.ca/csas/Csas/status/2007/SAR-AS2007_042_E.pdf

- Placentia Bay – Grand Banks Large Ocean Management Area Ecologically and Biologically Significant Areas

http://www.dfo-mpo.gc.ca/csas/Csas/DocREC/2007/RES2007_052_e.pdf

Estuary and Gulf of St. Lawrence Large Ocean Management Area

- Ecologically and biologically significant areas (EBSA) in the Estuary and Gulf of St. Lawrence: identification and characterization

http://www.dfo-mpo.gc.ca/csas/Csas/status/2007/SAR-AS2007_016_E.pdf

- Identification of Ecologically and Biologically Significant Areas for the Estuary and Gulf of St. Lawrence

http://www.dfo-mpo.gc.ca/csas/Csas/DocREC/2007/RES2007_015_e.pdf

- Proceedings of the zonal workshop on the identification of ecologically and biologically significant areas (EBSA) within the Gulf of St. Lawrence and Estuary

http://www.dfo-mpo.gc.ca/csas/Csas/Proceedings/2006/PRO2006_011_B.pdf

- Ecologically and biologically significant areas (EBSA) in the Estuary and Gulf of St. Lawrence: a marine mammal perspective

http://www.dfo-mpo.gc.ca/csas/Csas/DocREC/2007/RES2007_046_e.pdf

- Contribution to the identification of ecologically and biologically significant areas (EBSA) for the Estuary and the Gulf of St. Lawrence: The fish eggs and larvae and crustacean decapods larvae layer

http://www.dfo-mpo.gc.ca/csas/Csas/DocREC/2007/RES2007_011_E.pdf

- Ecologically and biologically significant areas for demersal fishes in the southern Gulf of St. Lawrence

http://www.dfo-mpo.gc.ca/csas/Csas/DocREC/2007/RES2007_012_e.pdf

- Ecologically and biologically significant areas for demersal fishes in the northern Gulf of St. Lawrence

http://www.dfo-mpo.gc.ca/csas/Csas/DocREC/2007/RES2007_014_f.pdf

- Identification of ecologically and biologically significant areas (EBSA) in the Estuary and Gulf of St. Lawrence: Primary production

http://www.dfo-mpo.gc.ca/csas/Csas/DocREC/2007/RES2007_079_e.pdf

Eastern Scotian Shelf Large Ocean Management Area

- Eastern Scotian Shelf Integrated Management Plan: Strategic Plan

http://www.dfo-mpo.gc.ca/Library/333115.pdf

- Review of criteria for selecting ecologically significant areas of the Scotian Shelf and Slope: a discussion paper

http://www.dfo-mpo.gc.ca/Library/283936.pdf

- DFO/FSRS Workshop on Inshore Ecosystems and Significant Areas of the Scotian Shelf

http://www.mar.dfo-mpo.gc.ca/science/rap/internet/pro2006_002.pdf

- Ecologically and biologically significant areas of the Scotian Shelf and environs: a compilation of scientific expert opinion

http://www.dfo-mpo.gc.ca/Library/331606.pdf

Beaufort Sea Large Ocean Management Area

- Proceedings for the identification of ecologically and biologically significant areas in the Beaufort Sea Large Ocean Management Area

- Beaufort Sea Large Ocean Management Area: Ecosystem Overview and Assessment Report

http://www.dfo-mpo.gc.ca/Library/331896.pdf

Pacific North Coast Large Ocean Management Area

- Identification of ecologically and biologically significant areas in the Pacific North Coast Integrated Management Area: Phase II – Final Report

http://www.pncima.org/pdfs/PNCIMATechReports/PNCIMATechReport2686.pdf

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Proceedings of a National Science Advisory Process to Review Canadian Experiences with Ecologically and Biologically Significant Areas (EBSA) in the Northeast Pacific

29-30 June 2009
Nanaimo, British Columbia

Les 29 et 30 juin, 2009
Nanaimo, Colombie-Britannique

J. Boutillier - Chairperson
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J. Boutillier - Président
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Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings include research recommendations, uncertainties, and the rationale for decisions made by the meeting. Proceedings 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.

Avant-propos

Le présent compte rendu a pour but de documenter les principales activités et discussions qui ont eu lieu au cours de la réunion. Il contient des recommandations sur les recherches à effectuer, traite des incertitudes et expose les motifs ayant mené à la prise de décisions pendant la réunion. En outre, il fait état de données, d'analyses ou d'interprétations passées en revue et rejetées pour des raisons scientifiques, en donnant la raison du rejet. Bien que les interprétations et les opinions contenus dans le présent rapport puissent être inexacts ou propres à induire en erreur, ils sont quand même reproduits aussi fidèlement que possible afin de refléter les échanges tenus au cours de la réunion. Ainsi, aucune partie de ce rapport ne doit être considéré en tant que reflet des conclusions de la réunion, à moins d'indication précise en ce sens. De plus, un examen ultérieur de la question pourrait entraîner des changements aux conclusions, notamment si l'information supplémentaire pertinente, non disponible au moment de la réunion, est fournie par la suite. Finalement, dans les rares cas où des opinions divergentes sont exprimées officiellement, celles-ci sont également consignées dans les annexes du compte rendu.

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SUMMARY

A regional science advisory process was held 29-30 June 2009 at the Pacific Biological Station in Nanaimo, British Columbia. The purpose of the meeting was to review experiences with, and synthesize progress related to, the application of scientific criteria to identify ecologically and biologically significant areas (EBSA) in the Canadian Northeast Pacific Ocean. Twelve different presentations were given by participants highlighting the use of EBSA and/or VME in specific scientific research projects.

A total of 26 participants from multiple sectors of the Pacific Region of DFO (i.e. Science, Oceans), as well as from Parks Canada, Natural Resources Canada, and the Province of British Columbia attended this workshop. These proceedings summarize the discussions at the meeting and provide a summary of Canadian experiences using the scientific criteria for EBSA in the Northeast Pacific. These discussions may be useful in informing domestic and/or international policies intending to further the application and effectiveness of EBSA identification.

SOMMAIRE

INTRODUCTION

Welcome

The meeting Chair, J. Boutillier, welcomed participants (Appendix I) to the Regional Science Advisory Process on the Review Canadian Experiences with Ecologically and Biologically Significant Areas (EBSA) in the Northeast Pacific, and did a round of introductions. A total of 26 participants from multiple sectors of the Pacific Region of DFO (i.e. Science, Oceans), as well as from Parks Canada, Natural Resources Canada, and the Province of British Columbia attended this advisory process. A. White participated as rapporteur for the meeting.

The Chair provided a brief overview of the Terms of Reference of the meeting (Appendix II) as well as the Agenda (Appendix III).

Context for Meeting

At the 9th Meeting of the Conference of the Parties to the Convention on Biological Diversity (CBD), Canada endorsed the adoption of Decision IX/20 [Marine and Coastal Biodiversity] to address issues relating to the conservation and sustainable use of biodiversity in marine areas beyond national jurisdiction.

A CBD Expert Workshop will convene in fall 2009 to review and synthesize progress on the identification of areas beyond national jurisdiction which meet the scientific criteria for identifying ecologically or biologically significant areas (EBSA) (CBD CoP9 Decision IX/20; Annex I), as well as develop guidance on the use and development of biogeographic classification systems.

In preparation for the CBD Workshop, as well as advancing Canada's commitment to develop networks of marine protected areas, a CSAS science advisory process was identified as the best approach to assemble, review, and synthesize Canadian experiences in the Northeast Pacific with the use of the scientific EBSA criteria in CBD CoP9 Decision IX/20. A summary of relevant literature which reflects some of the general work completed in Canada, and also specifically in the Northeast Pacific related to EBSA is provided in Appendix IV.

Objectives

The primary objectives of the meeting were:

1) Review experiences on the current and potential uses of EBSA criteria in the Northeast Pacific;
2) Synthesize regional progress on the application of scientific criteria to identify EBSA;
3) Identify biological datasets for the Northeast Pacific that could be used to i) aid in the identification of sensitive marine regions for individual species or functional groups, and ii) aid in the provision of guidance related to EBSA; and
4) Conduct feasibility analysis on how to apply the CBD EBSA criteria.

OVERVIEW OF PRESENTATIONS

All presentations given by the participants aimed to show how current and/or previous research initiatives relate to the identification of EBSA in the Canadian Northeast Pacific.

Presentations were given in the mornings of both Day 1 and 2 of the meeting and in the afternoons participants broke into groups and addressed a variety of questions posed by the Chair. As the presentations were not specifically linked to the afternoon discussions, the summaries of each presentation given are all provided below. The summary of the breakout group discussions are found in the next section of these proceedings.

G. Jamieson provided an overview presentation of the EBSA process in the Canadian Northeast Pacific, discussed the challenges encountered, and provided potential solutions. Key points from this presentation were:

- EBSA should be linked to the identification of Ecologically Significant Species (ESS) exercises to ensure that consideration of all information for regionally significant species and the areas they inhabit occurs.
- Science advice will ultimately be weighed with socio-economic considerations to determine what level of regulation and protection will be provided via Integrated Management.
- As MPAs can be an area-based tool for applying enhanced management, some EBSAs, or portions of them, may be considered in the future establishment of a MPA network in Pacific Canada.
- The identification of appropriate experts is an important consideration as the application of EBSA criteria and selection of EBSA to date has been primarily a Delphic process.
- A standardized database for the kind of information/data considered when applying the EBSA criteria would be useful, although it is recognized that establishing it would be quite resource demanding.
- Establishing a consistent approach in science advice on EBSAs is necessary (i.e. with respect to temporal scale, depleted species, data-poor situations, etc.). In many situations, physical and oceanographic features that concentrate plankton (e.g. upwellings, gyres, etc.) or that act as bottlenecks in the movements of a species are good proxies to use as a basis for EBSA identification.
- The DFO EBSA criteria, which are based on those defined by the CBD are not always easy to utilize, as different experts may use subjective thresholds when considering them.

L. MacDougall provided a brief presentation regarding the status of marine protected areas (MPAs) in the Northeast Pacific. She informed the group that there are currently two designated MPAs (Bowie Seamount and Endeavour Hydrothermal Vents), one in the process of designation (Race Rocks), and one Area of Interest (Hecate Strait/Queen Charlotte Sound Glass Sponge Reef Complexes). Ms. MacDougall noted that determining MPA objectives is a challenge, especially for data-poor areas. She also noted that the process for establishing and monitoring MPAs is complicated, and that the science support required is extensive.

T. Tomascik gave an overview of the Parks Canada experience and the use of the CBD EBSA criteria in the identification of National Marine Conservation Areas (NMCA) which are intended to protect and conserve representative marine areas. Mr. Tomascik recommended using a combination of spatial tools, simple ratios, and expert opinions (Delphic approach) to assess the representativeness of an area. He noted that scale is important and that it is important to consider whether benthic habitats can act as surrogates for species diversity.

E. Gregr provided an overview of existing high-seas biogeographic classification systems and explained how they have evolved with the increase in data availability. Mr. Gregr also explained how recent approaches do not focus primarily on species distributions, but on unsupervised clustering (K means), long-term seasonal averages of surface properties, and seasonal and annual variability. Mr. Gregr compared and contrasted the EBSA criteria of the CBD and DFO, and also the FAO's VME criteria. Mr. Gregr gave an overview of the Global Open Ocean and Deep Ocean (GOODS) Classification system, and the types of biological and physical data that is useful when attempting to identify representative areas. He noted that several global data repositories exist which contain useful information for identifying EBSA as well as representative areas.

V. Barrie provided examples of how geoscience techniques, such as multi-beam sonar and GIS, can be used to inform the EBSA process. Mr. Barrie explained that mapping the distribution of ocean floor characteristics can aid in estimating benthic habitats and ultimately EBSA.

K. Conway gave a presentation which outlined how multi-beam techniques were used to create extensive maps of sponge reefs. His research showed that the distribution of sponge reefs were associated with specific geologic/sediment types, thus demonstrating the usefulness of multi-beam sampling for the identification of EBSA.

In his presentation, D. Mackas illustrated that plankton hotspots are an important consideration when identifying EBSA as they are an essential component of food webs. He showed that three main processes which favor primary productivity are captured in the EBSA criteria:

1) Enrichment (fitness consequences, resilience, and uniqueness);

2) Concentration/Spatial Aggregation (aggregation and uniqueness); and

3) Retention (loosely captured under uniqueness and fitness consequences).

Mr. Mackas noted that it is necessary to plan for long-term (10 years or more) shifts in species ranges and environmental conditions for the identification of EBSA to be effective.

J. Finney showed how predictive modeling can aid in the identification of EBSA and/or vulnerable marine ecosystems. Ms. Finney expressed that the biggest constraint in identifying EBSA is a lack of data. She also illustrated how species distribution models (e.g. Ecological niche factor analysis, Maxtent) can be useful for determining locations of corals and sponge reefs.

C. Holt provided an overview of upcoming research on forecasting Pacific Hake distribution and the application of this work to EBSA. She discussed how satellite-derived oceanographic data at fine spatial and temporal scales may be able to help predict fish distributions. She explained that this approach may provide first steps towards identifying areas of overlap in spatial distribution of various species, assessing temporal changes in the spatial location of "hot spots" of species diversity, and provide a real-time tool for monitoring these "hot spots".

K. Hyatt gave a presentation on how EBSA can contribute to wild salmon conservation objectives and alternately, how wild salmon conservation units may contribute to the establishment of EBSA. Mr. Hyatt explained that as the critical habitats for salmon are influenced by dynamic boundaries, and due to their mobile nature, spatially-limited EBSA would not adequately protect salmon unless they existed as a part of a network. Mr. Hyatt stated that consideration of salmon biodiversity and protection requirements will contribute important criteria to the establishment of EBSA. For example, Pacific salmon as a group satisfy at least four of the five criteria for establishing EBSA including contributions to:

- uniqueness (i.e. Pacific salmon exhibit high genetic diversity);
- aggregation (i.e. salmon populations are clumped in space and form large focal-point aggregations during migration);
- fitness (i.e. measured survival for specific life stages of some populations indicate fitness changes at various spatial and temporal scales); and
- naturalness (i.e. many populations still exist under relatively pristine conditions in Central and North coast areas).

M. Trudel showed in his presentation that variability among environments may have fitness consequences and that serious consideration must be given to climate change and its effect on migration routes when identifying EBSA. However, he noted that for migratory species, EBSA can be difficult to identify.

D. Beamish gave a presentation on the changes in species composition of salmon catches. He correlated the significant decrease in marine survival rate of Coho Salmon to increasing average surface temperature in the Strait of Georgia. Mr. Beamish also illustrated that atmospheric features and trends have been correlated with salmon production. He concluded that it may be possible to correlate changes in atmospheric features and trends with species fitness consequences in salmon, and possibly other species as well.

BREAKOUT GROUP DISCUSSIONS

The Chair posed a suite of questions to the participants in the afternoons of Day 1 and 2. The Chair then divided the participants into smaller groups and invited them to discuss one of the questions posed. Each group presented a summary of their discussion to the meeting participants as a whole, and at that time, all participants discussed and came to a consensus on the messages related to each question. The summary of each breakout group discussion is below.

Question #1: In regards to Regional processes such as EBSA, MPA, and NCMA, what were the positive highlights?

- GIS is a useful tool for this kind of work, in that it provides essential information for the spatial context.
- The compilation of data and maps is a positive outcome and worthwhile for other applications besides EBSA, MPA, and NCMA.
- The communication and dialogue between relevant Departments and agencies is positive, especially as the EBSA, MPA, and NCMA processes are often driven by a Delphic approach.
- Participants noted that the consideration of scientific, Traditional Ecological Knowledge (TEK) and Local Experiential Knowledge (LEK) are key components of the EBSA, MPA, and NCMA processes.
- A data quality ranking system is useful for identifying knowledge/information gaps.

Question #2: In regards to Regional processes such as EBSA, MPA, and NCMA, what were the challenges or problems encountered?

- The objectives of the EBSAs, MPAs, and NCMAs were not always clearly defined which makes the selection of appropriate areas more difficult.
- Areas which meet the EBSA criteria are often very large, and a framework for determining scale would be helpful.
- It is difficult to consistently apply the EBSA criteria across a variety of taxa (i.e. easier for sessile species, but much more challenging for mobile species).
- It was sometimes difficult to determine the connectivity and to weigh the importance of different life history stages.
- There is a general bias towards data-rich species.
- The Delphic approach should not be favoured over reproducible, data-driven outcomes.
- Temporal changes are not adequately considered when identifying EBSA, MPA, or NCMA.
- Representative areas are often overlooked as areas with specific or unique features are often the focus.

<u>Question #3:</u> If there was a consolidated national approach to the identification of EBSA, MPA, and/or NCMA, what would it look like?

- Objectives would be consolidated and consistent before the data to determine results were gathered.
- A common methodology and datasets would be available for consideration.
- Stakeholders would be engaged at the outset to ensure inclusiveness; socio-economic and biological/physical factors would be considered at the same time.
- The Delphic approach would be used as a modifier of a data-driven approach, especially to fill gaps and explain processes that underline the patterns noted in the data.
- TEK and LEK would be included in analysis.

<u>Question #4:</u> What datasets could be used to aid in the guidance related to the identification of EBSA?

- Validated model outputs (e.g. species distribution models, climate projections, etc.).
- Data on ecologically important species, and commercial and non-commercial species.
- Records of catastrophic and extreme events.
- TEK and LEK.
- Joint distributions of predators and prey, as well as their interactions; food webs.
- History of species use (goods and services).

<u>Question #5:</u> What are the barriers and/or challenges to translating regional/domestic approaches to the high-seas?

- It can be difficult to define appropriate scales, particularly for pelagic/highly mobile species.
- Knowing the probabilities of occurrence for oceanographic/bathymetric features to aid in determination of species distribution.

- The effectiveness of transferring primarily terrestrial methods to the marine environment is unknown. May need to develop new types of methods and/or ecological principles which are more appropriate for the marine environment.
- The lack of baseline information, the relatively data-poor status, and the coarse resolution of the high-seas will make the identification of EBSA difficult.
- Data consistency may be an issue, in particular when considering jurisdictional complications.
- There is a general lack of understanding of temporal, spatial, and seasonal changes, and also of the large-scale impacts on high-seas ecosystems.

Question #6: What scientific research needs to be addressed to support Canada's domestic and international commitments related to the identification of EBSA/vulnerable marine ecosystems (VME)?

- Basic understanding of species and communities, life history stages, and trophic level interactions.
- Identification of biodiversity hotspots, individual species distributions, and species aggregations.
- Improve understanding of the relationships between species distributions and human activities.
- Knowledge gaps in Traditional Ecological Knowledge (TEK) and Local Experiential Knowledge (LEK).
- Risk assessments and the identification of threats, as well as the determination of vulnerability and/or resilience of species to the threats identified. Cumulative impacts and ecosystem models are important considerations.
- Location and behaviour of transition zones.
- Determination of the appropriate scale(s) in which to monitor biodiversity.
- Development of new technologies/methodologies.

Question #7: Would guidelines on how to use and/or apply the EBSA criteria and network guidance in CBD CoP9 Decision IX/20 be useful? What should be incorporated?

- To ensure consistency, the criteria should be better defined, particularly on their application at different spatial scales.
- Guidance on how to consider new information and/or changing priorities, and how to integrate them into existing EBSA would be helpful.
- How to apply the EBSA criteria in data-poor situations and still achieve useful results. An example might be predictive modeling techniques (e.g. species distribution models such as Ecological Niche Factor Analysis, Maxtent, etc).
- Guidance on how best to prioritize identified EBSA and how to make the process reproducible at various scales and forums (e.g. regional/national/international).

CONCLUDING REMARKS

At the end of the second day of the meeting, the Chair thanked everyone for their participation. There was consensus from the group that meetings such as this one were helpful in ensuring open communication between departments as well as individual researchers. Participants agreed that workshops allow for open dialogue and are useful to identify linkages and potential collaborations, as well as the brainstorming of ideas.

APPENDIX I. LIST OF PARTICIPANTS

Science Advisory Process to Review Canadian
Experiences with Ecologically and Biologically Significant
Areas (EBSA) in the Northeast Pacific.

29-30 June 2009
Nanaimo, British Columbia

NAME	AFFILIATION
Barrie, Vaughn	Natural Resources Canada
Beamish, Dick	DFO Pacific / Science; Salmon & Freshwater Ecosystems
Biffard, Doug	Province of British Columbia
Boutillier, James (Chairperson)	DFO Pacific / Science; Shellfish & Marine Mammals Assessment
Carswell, Baron	Province of British Columbia
Conway, Kim	Natural Resources Canada
Curtis, Janelle	DFO Pacific / Science; Marine Ecosystems & Aquaculture
Davies, Sarah	DFO Pacific / Science; Marine Ecosystems & Aquaculture
Finney, Jessica	DFO Pacific / Science; Shellfish Assessment
Gregr, Ed	SciTech Consulting, Inc.
Holt, Carrie	DFO Pacific / Science; Salmon & Freshwater Ecosystems
Hyatt, Kim	DFO Pacific / Science; Stock Assessment
Levesque, Chantal	DFO Pacific / Science; Marine Ecosystems & Aquaculture
Jamieson, Glen	DFO Pacific / Science; Marine Ecosystems & Aquaculture
MacDougall, Lesley	DFO Pacific / Oceans; Oceans, Habitat & Enhancement
Mackas, Dave	DFO Pacific / Science; Ocean Science and Productivity
Perry, Ian	DFO Pacific / Science; Stock Assessment
Poppe, Katrina	DFO Pacific / Science; Marine Ecosystems & Aquaculture
Scheweigert, Jake	DFO Pacific / Science; Stock Assessment
Stockwell, Margot	DFO Pacific / Science; Stock Assessment
Tomascik, Tom	Parks Canada
Topelko, Karen	Province of British Columbia
Trudel, Marc	DFO Pacific / Science; Ocean Science and Productivity
White, Andrea (Rapporteur)	DFO NCR / Science; Ecosystem Science
Wood, Chris	DFO Pacific / Science; Marine Ecosystems & Aquaculture
Workman, Greg	DFO Pacific / Science; Groundfish Science

APPENDIX II. TERMS OF REFERENCE

Science Advisory Process to Review Canadian
Experiences with Ecologically and Biologically Significant
Areas (EBSA) in the Northeast Pacific.

29-30 June 2009
Nanaimo, British Columbia

Context

In May 2008, at the *9th meeting of the Conference of the Parties (COP) to the Convention on Biological Diversity* (CBD) Decision IX/20 was adopted to address issues relating to the conservation and sustainable use of biodiversity in marine areas beyond national jurisdiction. At this meeting, a suite of scientific criteria were agreed upon for identifying ecologically or biologically significant and/or vulnerable marine areas in need of protection (CBD Decision IX/20, Annex I). Scientific guidance was also provided for selecting areas to establish representative networks of marine protected areas with applicability to open ocean and deep sea habitats (CBD Decision IX/20, Annex II).

At CBD COP9 it was agreed upon that a scientific and technical expert workshop would be convened to provide, using the best available information and data, scientific and technical guidance on the use and further development of biogeographic classification systems (including guidance on identifying areas beyond national jurisdiction which meet the scientific criteria found in *CBD COP9 Decision IX/20, Annex I*). The workshop will convene in the fall of 2009 (to be hosted by Canada with co-financing by Germany) and will review and synthesize progress on the identification of areas beyond national jurisdiction which meet the scientific criteria in *CBD CoP9 Decision IX/20 (Annex I)*, as well as encourage participants to share experiences in the use of biogeographic classification systems. As agreed upon in CBD Decision IX/20, the outcomes of the workshop will be made available to the CBD Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) for consideration prior to CBD COP10. In addition, the CBD COP9 Decision takes note of the Global Open Oceans and Deep Seabed (GOODs) Biogeographic Classification (UNEP/CBD/COP/9/INF/44) and requests that it also be made available to SBSTTA prior to CBD COP10.

In preparation for the aforementioned CBD Workshop in fall 2009, as well as advancing Canada's commitment to develop networks of marine protected areas that meet the obligations under the CBD, the United Nations General Assembly and the World Summit on Sustainable Development, the Canadian Science Advisory Secretariat (CSAS) has been identified as the best approach to assemble and review relevant available information. This CSAS workshop will review experiences with, and synthesize progress related to, the application of scientific criteria to identify ecologically and biologically significant areas (EBSA) in the Canadian Northeast Pacific Ocean. Outcomes of this workshop will be brought forward for consideration at the CBD Workshop in fall 2009.

Objectives

Workshop participants are encouraged to contribute working papers and/or presentations which report on how EBSA criteria have been used and how they have contributed to developing policy or management measures.

The workshop participants will:

1. Review experiences on the current and potential uses of EBSA criteria (with specific reference to developing policies and management measures);
2. Synthesize regional progress on the application of scientific criteria to identify EBSA;
3. Identify biological datasets for the Northeast Pacific that could be used to a) identify sensitive marine regions for individual species or functional groups, and 2) aid in the provision of guidance related to EBSA; and
4. Conduct a feasibility analysis on how to apply the EBSA criteria.

Background information for consideration at the workshop may include:

- *CBD CoP9 Decision IX/20, with particular attention given to Annexes II and III*;
- the report of the CBD Expert Workshop on Ecological Criteria and Biogeographic Classification Systems (Azores, Portugal, October 2-4, 2007);
- DFO, 2004. Identification of Ecologically and Biologically Significant Areas. DFO Can. Sci. Advis. Sec. Ecosystem Status Rep. 2004/006; and
- any other information deemed relevant by the participants

Outputs

Outputs from the meeting will include CSAS Proceedings (to document the discussion of the meeting) and a report containing results and recommendations to be forwarded to the CBD Secretariat for consideration at the CBD Expert Workshop (fall 2009).

Participation

The workshop will be chaired by Jim Boutillier (Research Biologist, DFO - Pacific) and will include experts from DFO Science (Pacific Region and HQ), Ellen Kenchington (nominated Canadian expert to participate in the CBD Expert Workshop), other DFO sectors, and external participants.

APPENDIX III. AGENDA

Science Advisory Process to Review Canadian
Experiences with Ecologically and Biologically Significant
Areas (EBSA) in the Northeast Pacific.

29-30 June 2009
Nanaimo, British Columbia

Monday, June 29, 2009

0900	Opening Remarks and Introductions (J. Boutillier, Chairperson)
0930	Pacific Experience with the EBSA process (Presentation by G. Jamieson)
1000	Marine Protected Areas & Oceans Pacific Management (Presentation by L. MacDougall)
1010	Parks Canada's Approach to National Marine Conservation Areas (NMCAs) (Presentation by T. Tomascik)
1030	*Health Break*
1100	Highseas EBSA Identification (Presentation by E. Gregr)
1120	Geoscience and EBSAs (Presentation by V. Barrie)
1140	Using Geoscience to Identify Sponge Reefs (Presentation by K. Conway)
1200	*Lunch*
1300	Plankton Hotspots (Presentation by D. Mackas)
1320	Species Predictive Modelling (Presentation by J. Finney)
1340	Breakout Session
1415	*Health Break*
1430	Summarize breakout session discussions
1600	Adjournment of Day 1

Tuesday, June 30, 2009

0900	Review of Day 1 and Objectives for Day 2 (J. Boutillier, Chairperson)
0930	IGS Program Overview (Presentation by J. Boutillier, Chairperson)
0940	Satellite Data and Transboundary Issues (Presentation by C. Holt)
1000	*Health Break*
1030	Wild Salmon Policy and Spatial Management (Presentation by K. Hyatt)
1055	Salmon Migration Routes (Presentation by Marc Trudel)
1120	Highseas Salmon Research: International Linkages (Presentation by D. Beamish)
1145	*Lunch*
1245	Breakout Session
1400	*Health Break*
1430	Summarize breakout session discussions
1545	Closing Remarks (J. Boutillier, Chairperson)
1600	Adjournment of Meeting

APPENDIX IV. RELEVANT LITERATURE

Clarke, C.L., and G. S. Jamieson. 2006a. Identification of Ecologically and Biologically Significant Areas in the Pacific North Coast Integrated Management Area: Phase I - Identification of Important Areas. 2678: 97 p.

Clarke, C.L., and G. S. Jamieson. 2006b. Identification of Ecologically and Biologically Significant Areas for the Pacific North Coast Integrated Management Area: Phase II. 2686: 32 p.

DFO 2004. Identification of Ecologically and Biologically Significant Areas. DFO Canadian Scientific Advisory Secretariat Ecosystem Status Report 2004/006: 15 p.

DFO 2006. Development of Criteria to Identify Ecologically and Biologically Significant Species (EBSS). DFO Canadian Scientific Advisory Secretariat Proceedings Series 2006/028: 45 p.

DFO 2007. Development of a Nationally Consistent Approach to Conservation Objectives. DFO Canadian Scientific Advisory Secretariat Proceedings Series 2007/001: 18 p.

DEVELOPMENT OF A FRAMEWORK AND PRINCIPLES FOR THE BIOGEOGRAPHIC CLASSIFICATION OF CANADIAN MARINE AREAS

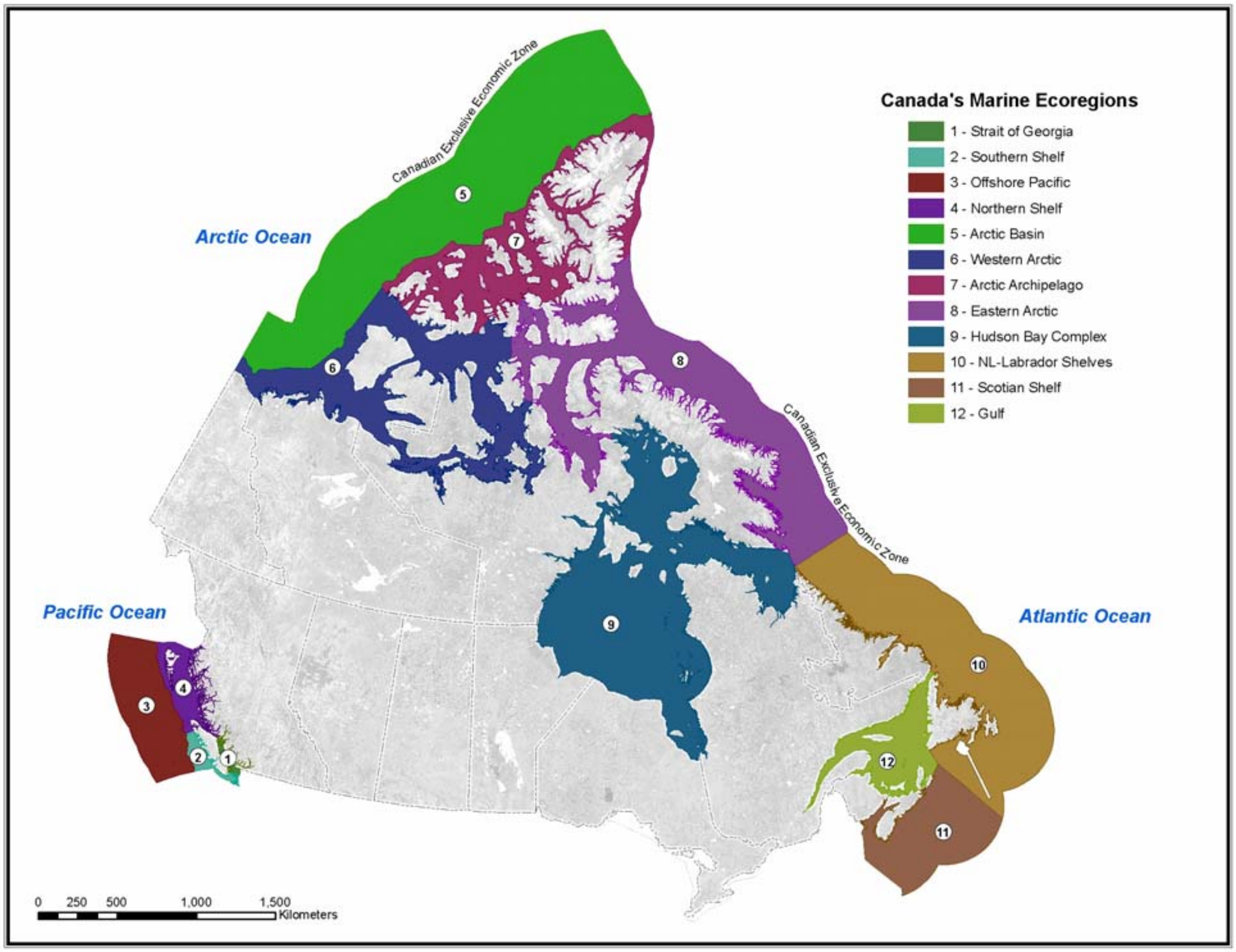

Figure 1. The recommended major biogeographic units for Canadian marine areas (DFO, 2009).

Context:

In May 2008, at the 9th meeting of the Conference of the Parties (COP) to the Convention on Biological Diversity (CBD) Canada endorsed the adoption of Decision IX/20 [Marine and coastal biodiversity] to address issues relating to the conservation and sustainable use of biodiversity in marine areas beyond national jurisdiction.

Decision IX/20 indicates that a scientific and technical expert workshop will be convened to provide, using the best available information and data, scientific and technical guidance on the use and further development of biogeographic classification systems. Canada is co-hosting this workshop, which will take place in Ottawa, Canada from September 29-October 2, 2009.

Canadian experts met to examine various existing biogeographic classification systems and provided scientifically-based recommendations towards the development of a framework and guiding principles *for the biogeographic classification of Canadian marine areas. This science advice will be brought forward for consideration at the aforementioned CBD Workshop and will also contribute to advancing Canada's commitment to develop networks of representative marine protected areas that meet its obligations under the CBD.*

Several initiatives have delineated global and Canadian marine areas into different biogeographic units. A new system has not been devised in this report. However, based on existing biogeographic classification systems, guiding principles which should generally be applied when delineating spatial scales have been identified, and these principles have been utilised to determine acceptable major, first-order biogeographic units for Canadian marine areas.

SUMMARY

- High-level spatial units have been identified for each of Canada's three oceans which are primarily based on oceanographic and bathymetric similarities. For each ocean these units are:
    - **Atlantic Ocean** – the Scotian Shelf, the Newfoundland-Labrador Shelves, and the Gulf of St. Lawrence;
    - **Pacific Ocean** – the Northern Shelf, the Strait of Georgia, the Southern Shelf, and the Offshore Pacific Zone; and
    - **Arctic Ocean** – Hudson Bay Complex, the Arctic Archipelago, the Arctic Basin, the Eastern Arctic, and the Western Arctic.

- Transition zones are important features to consider and should be taken into account when delineating boundaries between biogeographic units.

- There are important scales below the highest spatial scale identified which are defined by similar features, and subdivision of larger biogeographic units should consider bathymetry and oceanography as well as food web structure and benthic communities.

- All available ecological information and data (including experiential/traditional knowledge) should be taken into consideration when forming hypotheses about the location of boundaries between biogeographic units. Testing should consider these data sources, as well as pattern analysis when appropriate.

BACKGROUND

Introduction and Rationale

A number of biogeographic classification systems have emerged in the past decades with differing spatial scales (highly regional to global), approach (based almost entirely on previous work to based on quantitative analyses of extant data), and scope (consideration of one ecosystem dimension versus all possible data sources).

A variety of existing biogeographic classification systems were reviewed to inform the development of a framework and principles which could be applied in a biogeographic classification system assessment. In addition, this information will be useful towards guiding the selection of representative marine protected areas, and to simplify and standardize the spatial units used for reporting on the status and trends of the Canadian marine environment.

Several global biogeographic classification systems exist which differ in spatial scale as well as in ecosystem focus. The Large Marine Ecosystems of Sherman and Alexander (1986) and Marine Ecosystems of the World (Spalding et al, 2007) both focus on coastal and shelf areas, while the bioregional provinces outlined in the Global Open Oceans and Deep Seabeds Biogeographic Classification (UNESCO, 2009) address the open and deep ocean. The Biogeochemical Provinces (Longhurst, 2007) focuses on both the coastal and offshore environments, and is based on physical and biological oceanographic processes. All of these biogeographic classification systems provide a broad perspective of marine ecosystems and applied a range of analytical procedures and data. Therefore, they were deemed relevant to the discussions of the advisory group and are presented in further detail below.

The selection of regionally-focused biogeographic classification systems to be considered was restricted to those based on North America and/or Canada. Only the most recent North American biogeographic classification system from a series of developments was considered (i.e. the Marine Ecoregion Classification of North America). Until recently, Fisheries and Oceans Canada (DFO), Parks Canada (PC), and Environment Canada (EC) have been independently developing biogeographic classification systems to respond to the specific needs of their particular mandates. The latest versions of each of these national initiatives were also considered, as was the biogeographic classification system developed by the Canadian Council of Resource Ministers (CCRM), which is used to achieve Canada's reporting needs under the CBD.

General Overview of the Biogeographic Classification Systems Considered

Large Marine Ecosystems (LME)

The development of LMEs was stimulated by the 1982 United Nations Law of the Sea Convention, which granted coastal states sovereign rights to explore, manage, and conserve the natural resources of their Exclusive Economic Zone (EEZ).

Currently, there are 64 LMEs with the overarching objective to provide a governance basis for the integrated management of ocean resources within a defined geographical area. A significant related objective is to aid in improving our understanding of the productive dynamics of ecosystems in which exploited ocean resources exist.

All 66 LMEs are distinguished on the basis of four criteria:

1) Bathymetry (bottom depth);
2) Hydrography (temperature, salinity, Sigma T, tides and currents);
3) Productivity (chlorophyll, dissolved oxygen, total zooplankton); and
4) Trophic linkages (informed using plankton, demersal and pelagic surveys)

Marine Ecosystems of the World (MEOW)

In the early 2000's, the World Wildlife Fund and the Nature Conservancy recognized i) the existence of a large number of incomplete global and regional marine classification systems, and ii) the need for a comprehensive global marine biogeographic classification system.

MEOW is a mosaic of existing and recognized spatial units with a focus on the marine coastal and shelf realms of the world's oceans. It was primarily developed to support analyses of patterns for marine biodiversity, in understanding processes, and in directing future efforts in marine resource management and conservation.

The synthesis of existing available information into MEOW was guided by the following principles:

1) Strong biogeographic basis – informed by composite studies that combined multiple divergent taxa or multiple oceanographic drivers in the derivation of boundaries;
2) Practical utility – development of a nested system, operating globally at broadly consistent spatial scales and incorporating the full spectrum of habitats found across shelves; and
3) Parsimony – minimize further divergence from existing systems by adopting a nested hierarchy that uses existing systems and which fits closely within broader-scale systems or alongside regional systems.

MEOW consists of a nested system of 12 realms, 62 provinces, and 232 ecoregions (of which 15 are relevant to Canada).

Global Open Oceans and Deep Seabed Biogeographic Classification (GOODS)

The Johannesburg Plan on the implementation of the World Summit on Sustainable Development (2002) and COP7 of the CBD (2004) adopted 2012 targets related to the establishment of representative networks of marine protected areas. GOODS was the outcome of a series of three multidisciplinary expert workshops in response to these 2012 biodiversity targets.

GOODS is hypothesis-driven and based on a physiognomic approach, which uses geographic and physical characteristics of the benthic and pelagic environments to select homogeneous regions of similar habitat and associated biological community characteristics.
A set of six principles guided the analysis and delineation of the biogeographic classifications. These principles are discussed in more detail later in this report.

GOODS consists of a map of pelagic bioregions (29 provinces; five of which are of relevance to Canada) and a deep-sea benthic classification encompassing three depth zones and 29 biogeographic provinces (of which six are relevant to Canada).

Biogeochemical Provinces of the Ocean (BGCP)

Developed in 2007 by Longhurst, the overarching objective guiding the BGCP classification system is the delimitation of areas of the global ocean based upon the physical oceanographic Sverdrup processes which determine the biological oceanographic processes and thus influence the rest of the food chain.

The BGCP classification uses two spatial scales:

1) Biome - based on how winds and sunlight interact to influence Sverdrup mixing processes; and
2) Provinces – defined by a detailed examination of the Sverdrup mixing processes within each biome.

Latitudinal trends and seasonal changes in plankton composition generally support the biome boundaries. However, provincial boundaries within biomes used a wider set of factors which were able to define interfaces between physically and ecologically distinct regions (e.g. regional circulation and stratification, bathymetry, river discharges, coastal wind systems, islands, land mass distribution).

There are four biomes and 51 provinces in the BGCP classification; six of which are most relevant to Canada's three oceans.

Marine Ecoregion Classification of North America (MECNA)

The Commission for Environmental Cooperation (CEC) first introduced a combined terrestrial and marine ecosystem classification system in 1996. MECNA (2009) is the result of a largely Delphic-based approach which updated the original classification using a group of tri-national (Canada, USA, & Mexico) experts from a variety of disciplines related to marine science and planning.

A set of principles and general rules guided the development of MECNA. The resulting ecoregions may serve as a basis for regional and cooperative stewardship and management efforts, act as reference points for periodic assessments, and aid in defining representative and critical areas for the marine environment.

At the coarsest scale (Level I), there are 23 ecoregions, of which nine have specific relevance to Canada's oceans.

Marine Ecoregion Classifications of Canada

Since the mid-1980's, a number of biogeographic classifications have been developed which have focused specifically on Canadian ecosystems. These have involved a variety of government and non-government bodies such as DFO, EC, PC, CCRM, and World Wildlife Fund (WWF).
Due to the involvement of different governmental departments and non-government organisations, the various initiatives have had differing yet similar objectives:

- PC & WWF – to define representative areas in which to establish national marine conservation areas (PC) and other categories of marine protected areas as well
- EC – to define areas for marine environmental quality monitoring program
- DFO – to identify marine areas as the basis for integrated management
- CCRM – to provide spatial basis for the reporting on the status and trends of Canada's terrestrial and marine ecosystems

In general, the development of these classifications relied heavily on expert judgement. However, each initiative took a different approach to define specific units within Canada's aquatic ecosystems:

- PC – 29 ecoregions based on physical (i.e. oceanography, physiography and coastal environment) and biological features (i.e. species composition and distribution)
- EC – 5 large ecozones containing 12 ecoprovinces, 18 ecoregions, and 48 ecodistricts using a hierarchical approach which considered physical properties (e.g. shoreline configuration, bathymetry, currents, water column properties) to determine ecological boundaries
- DFO – 17 marine ecoregions which considered geological, physical oceanographic, and biological properties when defining units

- CCRM – 9 ecoregions which are generally defined at a higher spatial scale than the others and were selected based on four principles which stated that units should be i) contiguous and integrated, ii) thematically consistent, iii) spatially exclusive, and iv) flexible in their monitoring.

ANALYSIS

Synthesis of Existing Biogeographic Classification Systems

Spatial Scale

Ecosystem processes occur at a wide range of spatial scales, often with lower-level processes hierarchically arranged within those at higher levels. The classification systems reviewed considered a wide range of spatial scales with most systems using a hierarchical approach with small units nested within larger ones. At the various spatial scales, biogeographic units were referred to using a variety of different terms; however at similar spatial scales general definitions could be applied across biogeographic classifications regardless of the specific terminology.

Objectives

Most of the biogeographic classification systems considered were developed in support of some element of an ecosystem approach to management. Objectives ranged from the broad to the specific, but in general they could be categorized as based either in i) conservation (e.g. biodiversity, productivity, habitat), ii) social and economic well-being, and iii) institutional integrated management.

Classification Approaches

Although a number of approaches were used in the biogeographic classification systems considered, they shared common elements among them such as:

1. The establishment of either hypotheses or criteria at the outset to guide the process;
2. A significant information and data compilation stage, including the identification of experts; and
3. The production of maps including the agreed upon biogeographic units, which generally included expert opinion/input at some stage of the process.

Data Usage

The biogeographic classification systems reviewed utilised a wide range and quantity of ecosystem-relevant information, such as geological, physical oceanographic, and/or biological data. The data usage differences between classifications were not considered significant and are perhaps more related to the details of how the information was used (e.g. scale, weighting of data, approach, etc.). In most cases, data were used in a tiered approach with the largest spatial scale classified using the physiognomic data (i.e. geographic and physical characteristics of the benthic and pelagic environments), followed by increasing use of taxonomic and ecological information at finer scale resolutions.

Classification Products

Similarities and differences between the biogeographic classification systems delineation of units are discussed in the report prepared by O'Boyle (2009) for the purposes of this advisory group.

Guiding Principles for the Biogeographic Classification of Canadian Marine Areas

It was agreed that the six principles which guided the GOODS system were those which should be applied in a biogeographic classification system assessment; noting that in practice these principles should be adapted to the types of information available. The principles agreed upon by the advisory group were:

1. As pelagic systems are three-dimensional and dynamic, and benthic systems have a more stable, two-dimensional foundation, the benthic and pelagic environments should be considered separately;
2. Classification should not be based upon the unique characteristics of distinctive areas or upon individual focal species. Therefore, the "diagnostic species" concept should be avoided as it is counter to the goal of identifying representative areas which reflect patterns in total biodiversity;
3. Classification should reflect the taxonomic identity which is not addressed by systems which focus on biomes. As species composition is considered important, the terrestrial biome concept is not appropriate;
4. Generally recognizable communities of species should be emphasized, and do not require the presence of either a single or diagnostic species, or abrupt changes in composition between units. As such, rigid multi-taxa discontinuities should not be expected as the processes affecting distributional histories may differ. In the case of *limited* research efforts, delineating boundaries based solely on the availability of *taxonomic* data is not appropriate;
5. The influences of ecological structures and processes in defining habitats and their arrays of species should be recognized; and
6. Classification should be hierarchical with a nested structure based upon appropriate scales of features.

General Framework for the Biogeographic Classification of Canadian Marine Areas

The two primary uses of biogeographic classification systems were identified as i) assessing and reporting on ecosystem status and trends, and ii) spatial planning for the conservation of ecosystem properties and management of human activities. No ecological reasons were identified that would require using a different approach to biogeographic classification for one use or the other. However, it was agreed that there is justification for using the same classification for both identified uses.

When considering integrated spatial planning uses, the hierarchical subdivision to levels below the maximum spatial scale is important. In those applications, each use of biogeographic classifications will require consideration of the management and/or policy question(s) of concern, and the scale of classification should be matched to the scale of the question.

Spatial Scale

Physical oceanographic processes should receive primary attention at the largest spatial scale of initial interest. These oceanographic processes, combined with bathymetry, are the factors which are most likely to delineate coherent groups of species, population and community dynamics, and their responses to management and/or policy actions.

There is a maximum scale of biogeographic classification that is appropriate for the integrated planning and management of Canadian marine areas, as well as for assessing and reporting on ecosystem status and trends. Below this maximum scale, ecological heterogeneity of the defined unit is likely to dominate over any coherent responses of the fauna to management measures and/or various environmental drivers. Management measures which are implemented at finer scales than the defined maximum biogeographic scale may not always result in coherent and meaningful responses.

Each of the biogeographic units identified at the coarsest scale can be disaggregated into smaller units that are also ecologically meaningful. This subdivision can proceed in a nested manner for many levels of biogeographic units. However, as the subdivision proceeds, information on species occurrences and ranges becomes increasing influential in delineating units, making the successive levels of division increasingly data hungry. While there is no "correct" level of subdivision to seek, the level of resolution selected will depend greatly on the management or policy purpose being made of the biographic classification system in question.

Transition Zones

At the largest spatial scale, boundaries are often vague and represent transitional zones, rather than clearly defined lines between biogeographic units. In general, transition zones are considered either gradients or abrupt transitions. Gradient transition zones can range from several tens to hundreds of kilometres in width, representing a gradual transition from one type of ecosystem to another. Abrupt transitions indicate clear delineations of ecosystem types, but the position of the transition zone can move small to large distances over time.

Both types of transitions need to be acknowledged in biogeographic classification systems for policy, management, or reporting purposes. Biogeographic classification systems should explicitly include transition zones and not obscure them through arbitrary decisions (e.g. analytical averaging, etc). The biogeographic classification should also make clear which type of transitional zone(s) is present in the system, because appropriate management and policy measures will differ depending on the zone(s) present.

Further attention is required to determine whether policies and management measures appropriate for the core of biogeographic classification units would also be appropriate, or at least of comparable effectiveness, when applied in a transition zone. This is also true when considering the two different transition zones. These questions should be explored scientifically at an early stage in determining biogeographic units and spatial scale to allow for consideration of the most appropriate management approaches.

Additional Guidance on How to Identify Biogeographic Subdivisions

There was agreement that at the onset of subdividing major biogeographic units, the importance of species composition data (e.g. fish, plankton, and benthic communities) should receive increasing attention compared to bathymetry and oceanographic processes. However, at the first level of subdivision of the major biogeographic units, coherence of bathymetry and/or water masses will be important considerations, along with food web functionality and, when available, coherence in variation in recruitment across groups of similar taxa.

The nature of the datasets and metrics that are likely to be available on distribution and abundance of all marine taxa will be incomplete and not fully representative in a number of ways. Data density in space will usually be quite variable, and even in the more data-rich areas only certain taxa are likely to be surveyed with designs giving broad and even spatial coverage; the level of taxonomic identification is usually highly variable among major marine taxa. Lengths of time series of data differ greatly among taxa, even in areas where spatial data are available for multiple higher taxa. As a result, it would be possible to at least partially clarify temporal and spatial variation in the distribution of some taxa. However for many taxa, any data used in pattern analyses of species occurrences would necessarily have those two types of variations fully confounded.

For the biological data likely to be available for statistical analyses of spatial patterns, the distribution of the shortcomings listed above imply that such pattern analyses also will have many shortcomings. Not withstanding this, it is still worth conducting such analyses when there are sufficient data to justify their use. However, in most Canadian marine areas it is unrealistic to expect such analyses to be robust and adequate to serve as the primary guide to finer scale biogeographic classifications. A more appropriate strategy may be to pool the expert knowledge that may be available about oceanographic processes, food web relations, and other ecological processes and species relationships in a larger region, and use that knowledge to form testable hypotheses about the location of boundaries between biogeographic units. Tests of these hypotheses with the best data available on species distributions might provide more robust empirical guidance with regard to biogeographic subdivisions than would a broadly applied pattern analysis of biogeographic data.

In formulating ecological hypotheses, it is necessary to take into account the history of human activity in the area. Past human impacts may have altered the biodiversity of an area in ways that imply that statistical analyses of current species occurrence data may not provide valid tests of the boundaries of biogeographic units within which ecological processes have historically structured species interactions (and likely would structure them in future, if human-induced pressures were not the dominant factor in the abundance and range of the species).

The way that human activities are taken into account will have to consider the particular activity and the part of ecosystem being considered in the subdivision. For example, the scale of the historical footprint of a fishery on a food web is likely to be quite large, whereas the scale of the footprint of the same fishery on the seabed and benthic communities would be much more local. Neither scale is inherently more correct; choice of scale will depend on (among other factors) the planning, reporting, and management uses to be made of the classification results. For example, the appropriate scale for biogeographic units used to manage bycatch of a fishery may be different from the appropriate scale for biogeographic units used to manage habitat impacts of the same fishery.

Because few data sets with wide spatial coverage are available in many areas, it will likely be necessary to use local, experiential, and/or traditional knowledge to augment survey data. These kinds of information are generally acquired on quite fine spatial scales which should be taken into account when using such knowledge in determining appropriate biogeographic subdivisions of larger areas.

Accepted Major Canadian Marine Biogeographic Units

Atlantic Ocean

It was agreed that three biogeographic units were appropriate for the Atlantic Ocean at the coarsest spatial scale (Figure 2). They are the *Scotian Shelf*, the *Newfoundland-Labrador Shelves*, and the *Gulf of St. Lawrence*. These biogeographic units were selected based on those identified by the Canadian Council of Resource Ministers (CCRM).

There are marked differences in the fish and plankton communities between the core areas of the Scotian Shelf and the Newfoundland-Labrador Shelves. However, the exact line between these two biogeographic units is uncertain. The respective slopes down to the Laurentian Channel are part of the respective shelf units. However, the trough itself may be best viewed as a permanent transition zone, with its greater depth contributing to unique features.

On the south end of the Scotian Shelf biogeographic unit, the Bay of Fundy-Georges Bank areas have biogeographic affinities with the Gulf of Maine, as well as with the Scotian Shelf. However, this boundary would be best represented as a first-order subdivision of the larger Scotian Shelf biogeographic unit.

The northern boundary of the Newfoundland-Labrador Shelves biogeographic unit is unclear and this area is considered particularly data-poor. If the location of that boundary was to be important for policy or management, it would be necessary to collect new data on the changes in biodiversity from the waters off northern Labrador up into the Davis Strait. It would also be timely to review the new modelling of physical ocean processes in the north that has been conducted since the last time these biogeographic units were investigated.

For the Gulf of St. Lawrence, there are differences in the fish, plankton, and benthic communities between the southern Gulf and the northern Gulf, and some affinities of those communities in the southern Gulf with those in the Scotian Shelf biogeographic unit. Weaker affinities are also present between those communities in the northern Gulf and those in the southern Newfoundland biogeographic unit. However, the dominant oceanographic processes provide coherence to the Gulf of St. Lawrence as a distinct biogeographic unit, with a major, first-order subdivision between the northern and southern Gulf.

In general, less information is available about the biogeography of the benthos than the fish and plankton. More investigation of benthic communities and their affinities might reveal some different patterns in the benthos than reflected in these major subdivisions. This may be particularly the case with regard to the Gulf of St. Lawrence biogeographic unit.

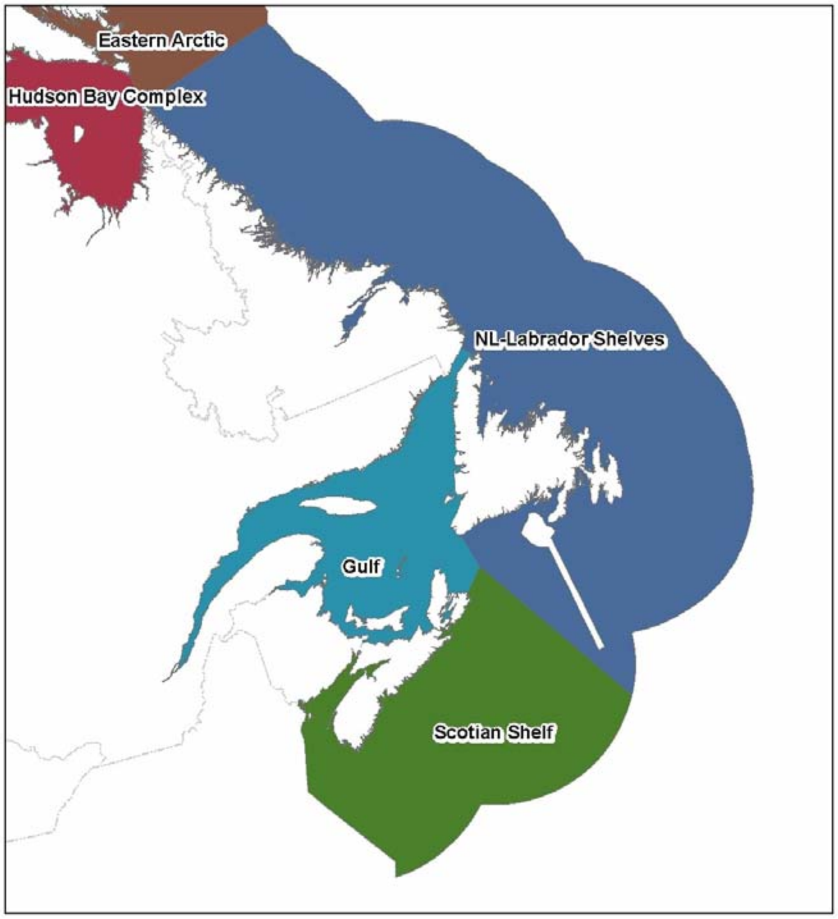

Figure 2. Accepted major biogeographic units for the Canadian Atlantic Ocean. Units are delineated as follows: 1) Newfoundland-Labrador Shelves, 2) Gulf of St. Lawrence, and 3) Scotian Shelf.

Pacific Ocean

It was agreed that four biogeographic units were appropriate for the Pacific Ocean at the coarsest spatial scale (Figure 3). These major biogeographic units were selected based on those identified by the Fisheries and Oceans Canada classification system. The four major biogeographic units for the Pacific are:

i) a complex *Northern Shelf Zone* (including the Queen Charlotte Sound, the Hecate Strait, the west coast of the Queen Charlotte Islands, the Queen Charlotte Strait, and Northwest Vancouver Island);

ii) the Strait of *Georgia*;

iii) a *Southern Shelf* (off West Vancouver Island which includes the Strait of Juan de Fuca); and

iv) a large *Offshore Pacific Zone* extending outward from the shelf break which includes the Alaska Gyre, the California Gyre, and a transition zone.

There is a permanent transition zone which generally begins near Brooks Peninsula and extends north to the Northern Shelf Zone and out to the continental shelf break. The southern boundary of this transition zone can move north as much as several hundred kilometres with strong El Niño conditions, extending it even further along the Pacific coast. Although the boundaries of this transition zone are generally known, they are not fixed in space and management should be designed to be responsive to the dynamic nature of this area (in particular changes in biodiversity and oceanographic conditions).

There are major inshore and offshore differences in the Northern Shelf Zone, particularly in the fiordlands, but it was agreed that those are best represented as a major, first-order subdivision in a hierarchical system. Also, based on the unique characteristics of the Alaska Gyre, the transition zone, and the California Gyre, the Offshore Zone should be subdivided into three biogeographic units at the next level of biogeographic subdivision.

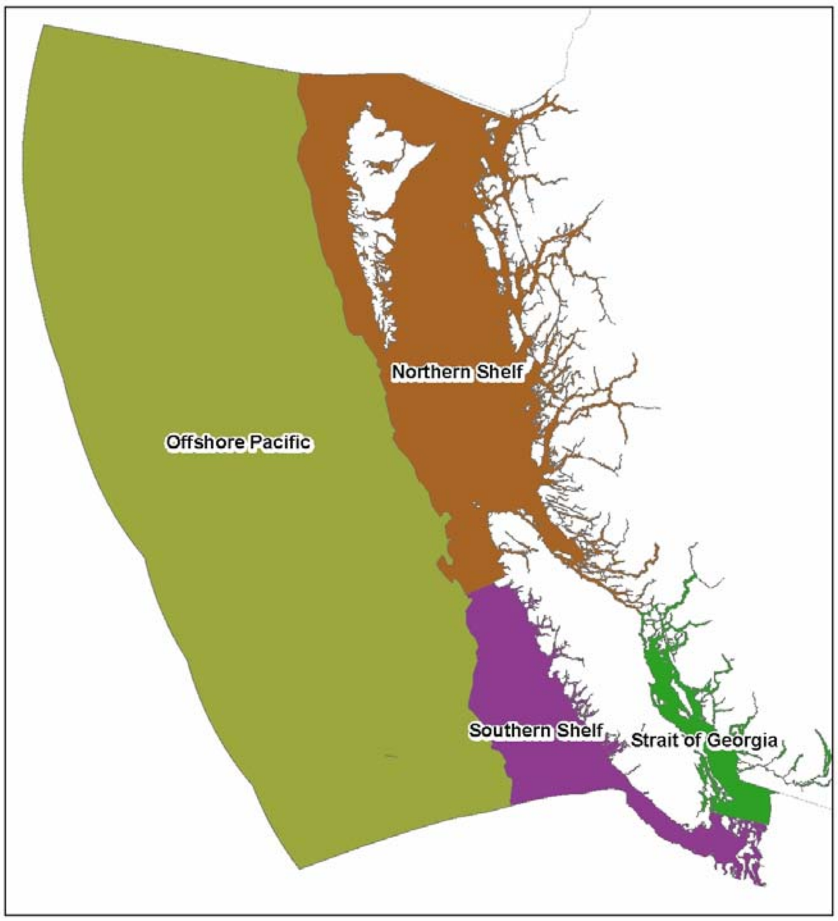

Figure 3. Accepted major biogeographic units for the Canadian Pacific Ocean. Units are delineated as follows: 1) Northern Shelf,, 2) Strait of Georgia, 3) Southern Shelf, and 4) Offshore Pacific Zone.

Arctic Ocean

It was agreed that five major biogeographic units are appropriate for the Arctic Ocean at the coarsest spatial scale: the *Arctic Basin*, the *Arctic Archipelago*, the *Western Arctic* (includes the Beaufort Sea, the Queen Maud Gulf, and Viscount-Melville Sound), the *Hudson Bay Complex* (includes the Hudson Strait, Foxe Basin, James Bay, and Hudson Bay), the *Eastern Arctic* (includes Lancaster Sound and the Baffin Bay-Davis Strait) (Figure 4). These major biogeographic units are based on those identified in the Parks Canada classification system.

Major process-related determinants for the selection of the biogeographic units were bathymetry, influence of freshwater inflows, and distribution of multi-year ice. Several of the units have major, first-order subdivisions that could be considered should a finer spatial scale be desired:

a) Hudson Bay Complex – Hudson Bay, James Bay, Hudson Strait, and Foxe Basin;

b) Eastern Arctic – Lancaster Sound and Baffin Bay-Davis Strait; and

c) Western Arctic – Beaufort Sea-Amundsen Gulf, Queen Maud Gulf, and Viscount Melville Sound.

The Arctic is a very dynamic system with high inputs of freshwater occurring on a regular basis. With changes in freshwater magnitude and occurrence expected, especially considering climate change, the boundaries between the biogeographic units may change in the future. In particular, the transition zone between the Eastern Arctic biogeographic unit and the Newfoundland-Labrador Shelves unit is unknown and data limited. Without more information, it is unknown if the boundary between these biogeographic units is a stable gradient or some other pattern.

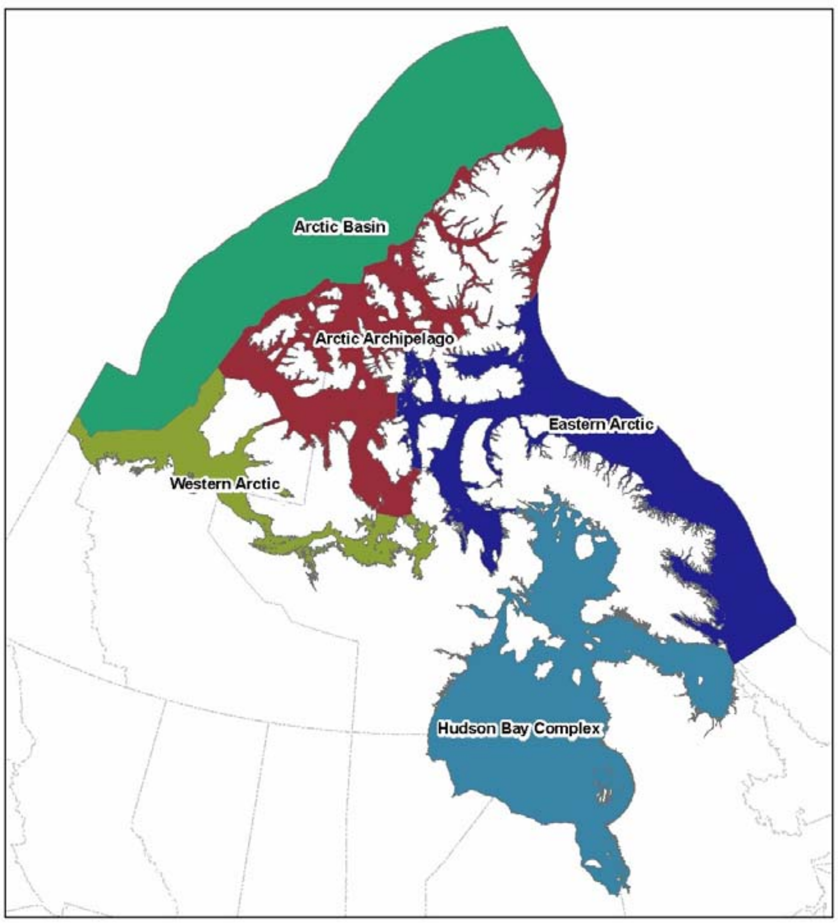

Figure 4. Map representing accepted major biogeographic units for the Canadian Arctic Ocean. Units are delineated as follows: 1) the Arctic Basin, 2) the Arctic Archipelago, 3) the Western Arctic, 4) Hudson Bay Complex, and the Eastern Arctic.

Specific Guidance on Subdividing the 12 Canadian Marine Biogeographic Units

At the first level of subdivision below the 12 major biogeographic units, where knowledge exists to delineate functional food webs, their geographic scale should receive strong consideration. Scientific strategies for delineating functional food web scales are well-developed. These strategies focus on the interactions of major functional feeding groups, which generally occur on scales larger than the ranges of individual predators and prey.

This approach may produce more biogeographic units than would arise from solely conducting a pattern analysis of the species occurrence data, depending on the nature of the trophic relations in the area. It is plausible that very large areas may show few coherent discontinuities in species composition, but have more than one functional food web present. If functionally differentiated food webs can be identified, they should be represented in the biogeographic subdivisions of the larger area.

The other major consideration in the higher-order subdivisions of the 12 primary biogeographic units are the major water mass and/or bathymetric features. Specifically, those that are likely to retain populations increase the likelihood that they interact within rather than across feature boundaries. Pressure barriers that are present at some depth zones along continental shelves may be important to consider when seeking subdivisions of the major biogeographic units.

The scale of biogeographic subdivisions appropriate for reporting, policy development, and management in near-coastal areas is likely to be finer than in offshore areas. The considerations and approaches outlined above for marine areas are relevant for the coastal areas as well, but on smaller scales where habitat features of the seabed and coastal inputs to the ocean both strongly influence biogeographic patterns for the entire water column. How far offshore these coastal scale factors will be dominant is case-specific.

In general, for the finer-scale biogeographic subdivisions, and particularly for the coastal areas, threat analyses will play an important role in matching the scale of the biogeographic unit(s) to management and policy needs. Threat analyses should take account of both the scale of the pressures (anthropogenic or environmental) and the scales of occurrence of the ecosystem features vulnerable to the threats, in informing which scale for finer biogeographic units is appropriately matched to particular management needs. The choice of scale and units also needs to take into account the possibility that spatial management of threats may prompt displacement of the activity posing the threat. The planning units should be large enough and homogeneous enough (relative to suitability for the activity being managed) to allow consideration of future as well as present spatial patterns of the threat(s). It is also noted that some threats may have quite local scales, while those of others (e.g. climate change) may be very large. Strategies for selecting appropriate biogeographic units when undertaking integrated management of multiple threats, potentially operating at multiple scales, warrants further attention.

It is expected that knowledge about the strengths and weaknesses of alternative approaches to identification of biogeographic units, particularly at moderate and small scales, will grow as experience is gained with use of spatial management tools. Data on species occurrences and knowledge of ecological processes giving coherence to species distributions will also increase over time. It will be important to periodically revisit the finer scale biogeographic units being used, to ensure that they have a sound ecological basis, and are appropriate for the policy, management, and reporting needs of government. It is also essential to fully document the information used, the approaches considered, and the decisions made, when there are scientific efforts to identify biogeographic units for use in policy and management.

CONCLUSIONS AND SCIENCE ADVICE

High-level spatial units have been identified for each of Canada's three oceans which are primarily based on oceanographic and bathymetric similarities. For each ocean these units are:

- **Atlantic Ocean** – the Scotian Shelf, the Newfoundland-Labrador Shelves, and the Gulf of St. Lawrence;
- **Pacific Ocean** – the Northern Shelf Zone, the Strait of Georgia, the Southern Shelf Zone, and the Offshore Pacific Zone; and
- **Arctic Ocean** – the Hudson Bay Complex, the Arctic Archipelago, the Arctic Basin, the Eastern Arctic, and the Western Arctic.

Transition zones are important features to consider and should be taken into account when delineating boundaries between biogeographic units.

There are important scales below the highest spatial scale identified which are defined by similar features, and subdivision of larger biogeographic units should consider bathymetry and oceanography as well as food web structure and benthic communities.

All available ecological information and data (including experiential/traditional knowledge) should be taken into consideration when forming hypotheses and testing should consider these data sources, as well as pattern analysis when appropriate.

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