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SCIENCE GUIDANCE ON THE DEVELOPMENT OF NETWORKS OF MARINE PROTECTED AREAS (MPAs)

Figure 1: Department of Fisheries and Oceans' (DFO) six administrative regions.

Context :

Canada is committed domestically (Oceans Act 35(2)) to the development of a national system of marine protected areas (MPAs) within an integrated management planning context. Canada has also committed to the establishment of a network of MPAs at a number of international fora, including the World Summit on Sustainable Development (WSSD, Johannesburg, 2002), and the Convention on Biological Diversity (CBD) Conference of the Parties (COP) Decision VIII/24. The CBD subsequently provided technical guidance on establishing MPA networks in the CBD-COP9 Decision IX/20 [Marine and Coastal Biodiversity], including its Annexes I-III.

The Canadian Council of Fisheries and Aquaculture Ministers (CCFAM) has established a federal, provincial and territorial (FPT) working group responsible for these policy commitments and the implementation of the national network of MPAs.

This Science Advisory Report (SAR) is in response to a request from DFO Oceans Sector which sought Science guidance to achieve national consistency for the design of MPA networks, particularly at regional scales. The peer-review and advisory meeting from which this SAR is derived focused on providing science guidance for implementing the CBD design features in the Annexes referenced above. The design features include the scientific criteria in Annex I and the scientific guidance in Annexes II and III. This is one of many steps in meeting Canada's commitments for networks of MPAs. As the policy discussion and implementation of MPA networks evolves, further requests for Science advice are expected to address other implementation questions.

SUMMARY

- This DFO Science advisory report provides guidance to achieve national consistency for the design of MPA networks, particularly at regional scales. This guidance focuses on implementing the CBD design features in the Annexes referenced above. The design features include the scientific criteria in Annex I and the scientific guidance in Annexes II and III.

    - For a functional *network* of MPAs to exist, the network should deliver pre-identified outcomes beyond those which would be expected if there were only a *collection* of MPAs, each sited optimally and functioning for some individual specific purpose.

    - This SAR provides guidance that will be applicable at any geospatial scale at which an MPA network may be designed. Cases where the relevance of a specific component of the guidance changes with geospatial scale are discussed explicitly.

    - Development of networks of MPAs to achieve specific objectives should be conducted at the appropriate scale(s), supported by groups of experts with appropriate balance of interpretational perspectives and extensive knowledge (including scientific, traditional, and experiential knowledge) of the respective regions.

    - Specific science guidance is supplied regarding the application of; scale and scope, Canadian (DFO) ecologically or biologically significant area (EBSA) criteria, selection of representative areas, selection of representative areas, replication, connectivity, and adequacy and viability.

BACKGROUND

Canada is committed domestically (*Oceans Act* 35(2)) to the development of a national system of marine protected areas (MPAs) within an integrated management planning context. Canada has also committed to the establishment of a network of MPAs at a number of international fora, including the World Summit on Sustainable Development (WSSD, Johannesburg, 2002), and the Convention on Biological Diversity (CBD) Conference of the Parties (COP) Decision VIII/24. The CBD subsequently provided technical guidance on establishing MPA networks in the CBD-COP9 Decision IX/20 [Marine and Coastal Biodiversity], including its Annexes I-III.

Definitions:

Marine Protected Area (MPA): For the purposes of this SAR, and for consistency with Canada's Federal Marine Protected Areas Strategy, the terminology of "marine protected area" will be: "Any area of inter-tidal or sub-tidal terrain, together with its overlying water and associated flora and fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment" (World Conservation Union IUCN definition).

Region: For the purposes of this SAR, the term "region" is used generically for any biogeographic area within which development of an MPA network may be considered.

Major biogeographic units: Where specific reference is made to the major biogeographic units identified in a previous SAR [SAR 2009/056, results of workshop June 15-16, 2009], the phrase "major biogeographic units" will be used. Otherwise, the phrase "biogeographic units" will be used generically, without reference to any specific biogeographic classification system or hierarchical level within such systems.

Design Feature: refers in part or in whole to Annexes I, II, or III of the CBD COP9 Decision IX/20.

Criteria: refers explicitly to the contents of Annex I of the CBD COP9 Decision IX/20 which address the scientific criteria for identifying ecologically and biologically significant marine areas.

Properties and Components: refers explicitly to the contents of Annex II of the CBD COP9 Decision IX/20 which provides scientific guidance for selecting areas to establish a representative network of marine protected areas.

Experiential Knowledge: includes the concepts of Traditional Ecological Knowledge, Local Ecological Knowledge, and knowledge otherwise gained through life experience.

Practices and Processes for Development of an MPA Network(s):

1. All science-based steps in developing MPA networks should be consistent with the Principles and Guidelines for the Effective Use of Science and Technology Advice in Government Decision Making (http://dsp-psd.pwgsc.gc.ca/Collection/C2-500-2000E.pdf) including use of the best scientific and technical information available (including Experiential Knowledge), and should follow federal guidelines for the application of precaution in decision-making [Refer to http://www.pco-bcp.gc.ca/docs/information/publications/precaution/precaution-eng.pdf]. " The application of 'precaution, 'the precautionary principle' or 'the precautionary approach' recognizes that the absence of full scientific certainty shall not be used as a reason for postponing decisions where there is a risk of serious or irreversible harm".

2. Knowledge about the marine ecosystem and the impact or benefits of activities in those ecosystems is expected to increase over time, and likewise there may be changes in the types and/or the severity of identified threats, or in the conservation requirements and priorities outlined for the MPA network. Consequently, processes are necessary to periodically review (and if necessary, update) decisions regarding areas which meet the criteria for ecological and biological significance, and also to review the strategies and tactics being applied to ensure the network properties and components are being achieved.

3. In the management of MPA networks and their constituent MPAs, adaptive management principles should be applied, and network(s) should be adjusted and/or modified as new information on conservation needs and the effectiveness of management practices becomes available.

Outcomes of an MPA network(s):

4. Policy-makers and Managers implementing this MPA network guidance are encouraged to refer to earlier science advice regarding the establishment of conservation objectives (e.g. DFO CSAS SAR 2007/010 and SAR 2008/029). This advice provides important guidance on ensuring that operational objectives are both scientifically sound and represent the higher level objectives that have been established. Any forthcoming CBD guidance emerging from actions prompted by Decision XI/20 should be taken into account when identifying ecologically or biologically significant areas (EBSAs) and developing MPA networks.

5. Science advice on the specific application of the design features for a given MPA network must be developed relative to its management objectives. Objectives can vary greatly among networks depending on the higher order objectives, priorities and mandates of the agencies participating in their respective development and implementation. However, through the provision of scientific guidance on how to implement the individual CBD design features, the advice needed for a case-specific development of MPA networks will be available. Thus the guidance in this SAR is applicable regardless of the overall objectives of any one network.

6. There are two contexts within which the "completeness" of a network could be evaluated:
    a) inclusion and configuration of constituent MPAs relative to achievement of the objectives for a given MPA network; and
    b) whether Canada has met its international commitments vis-à-vis MPA networks

    Both are appropriate, but they are different. In evaluating the completeness of a network, it is important to specify which context applies.

7. If an MPA network is designed well, its design and management should take into account, and be integrated with, the management objectives and conservation measures being applied in adjacent areas and/or areas closely linked ecologically with the areas within the MPA network. In the case of coastal or near-shore MPAs, this may include the consideration of management objectives and conservation measures of adjacent terrestrial areas.

8. MPAs (either individually or in networks) can aid in achieving given objectives under the overarching objectives of maintaining healthy ecosystems and sustainable use in the marine environment. For any specific set of objectives, MPAs, other spatially-based tools, and non-spatial management tools should be considered together in a broad and inclusive planning context. The role of MPAs and MPA networks relative to the roles of other management tools should be informed, and cooperatively decided upon, by the full range of policy makers and managers whose work contributes to achieving these objectives, as informed by the best available science.

9. Not all areas that meet the criteria for an ecologically or biologically significant area (EBSA) need be designated as an MPA under federal or provincial legislation and afforded spatial protection as a marine area (ie: other management tools may be more appropriate to address the nature and extent of the human impact(s)). However, those EBSAs that are experiencing human-induced stresses or threats should, in particular, be given due consideration for protection, through an appropriate and transparent decision-making process. CSAS Ecosystem Status Report 2004/006 and Science Advisory Report 2007/010 provide guidance on how to align management measures to EBSAs.

10. Areas which have secure (i.e. long-term and applied by legitimate authorities with the capacity to ensure compliance), spatially-delineated protection in order to achieve conservation goals are all candidates for contributing to the objectives of any given network of MPAs.

11. For a functional *network* of MPAs to exist, the network should deliver specific outcomes beyond those which would be expected if there were only a *collection* of MPAs, each sited optimally and functioning for some individual specific purpose. Examples of the types of network-level outcomes that might be expected from an MPA network are:
    - Protection of critical life history stages for species targeted for protection by the MPA network (particularly those with large ranges or with life histories that may require different habitat types at different stages).
    - "Rescue effects" – that is, the sustainable re-population within individual MPAs (or adjacent areas) via recruits from other MPAs, of one or more species that have undergone a local extirpation.
    - High combined viability in the face of stochastic (and other) events that may pose significant threats to individual MPAs.
    - Protection of the genetic diversity of wide-spread populations.
    - Maintenance of ecological energy flows and the protection of trophic structures.
    - Ability to accommodate alterations in ecological processes and species' ranges caused by climate change and/or in concert with other environmental stressors.
    - Adequate area such that when considered in aggregate, all the species contained in the network receive protection in the network, although not necessarily in each individual MPA.
    - Conservation requirements associated with the land-sea interface are met via the network.

ANALYSIS

Guidance on the Development of Networks of Marine Protected Areas (MPAs)

Scale and Scope of Application:

This SAR provides guidance that will be applicable at any geospatial scale at which an MPA network may be designed. Cases where the relevance of a specific component of the guidance changes with geospatial scale are discussed explicitly.

The design features outlined in CBD COP 9 Decision IX/20 should be applied in a step-wise fashion, followed by a gap analysis to ensure that all the design features necessary to achieve the objectives or outcomes of the MPA network have been included. Although there is a logical step-wise approach recommended in Annex III of the Decision, it is reasonable to expect that the application of any one CBD design feature may *de facto* address, completely or in part, other subsequently considered design feature as well.

12. Annex III of the CBD COP 9 Decision IX/20 proposes a sequence of appropriate steps to consider when developing networks of MPAs. Verbatim, this sequence from Annex III is:

a) Scientific identification of an initial set of ecologically or biologically significant areas. The criteria in Annex I to Decision IX/20 should be used, considering the best scientific information available, and applying the precautionary approach. This identification should focus on developing an initial set of sites already recognized for their ecological values, with the understanding that other sites could be added as more information becomes available.
b) Develop/choose a biogeographic, habitat, and/or community classification system. This system should reflect the scale of the application and address the key ecological features within the area. This step will entail a separation of at least two realms-pelagic and benthic.
c) Drawing upon steps (a) and (b) above, iteratively use qualitative and/or quantitative techniques to identify sites to include in a network. Their selection for consideration of enhanced management should reflect their recognised ecological importance or vulnerability, and address the requirements of ecological coherence through representativity, connectivity, and replication.
d) Assess the adequacy and viability of the selected sites. Consideration should be given to their size, shape, boundaries, buffering, and appropriateness of the site-management regime.

13. In the design of MPA networks, the requirements of species that spend only parts of their life cycle in marine (or aquatic) environments (e.g. seabirds) must also be considered along with the requirements of full-time marine (or aquatic) species. In these cases the science advice on connectivity (Section 33) could apply to the land adjacent to the seashore.

14. The national network of MPAs will build upon multiple regional networks of MPAs. At the level of resolution of the major biogeographic units (please refer to DFO SAR 2009/056), each complete network should have all of the CBD properties and components. An MPA network designed for specific objectives (see Section #5) may be established having only a subset of these properties and components, as long as these networks make it likely to achieve outcomes associated with a the objectives for which the network was established. This would not be achieved with only the individual MPAs functioning independently. Such objective-specific networks could be at a variety of spatial scales.

15. Development of networks of MPAs to achieve specific objectives should be conducted at the appropriate scale(s), supported by groups of experts with appropriate balance of interpretational perspectives and extensive knowledge (including scientific, traditional, and experiential knowledge) of the respective regions. The guidance provided in this document is intended to ensure that these groups of experts approach science-based aspects of the design of regional MPA networks in a nationally consistent fashion.

16. At all steps in developing MPA networks, it should be kept in mind that knowledge of marine ecosystems is incomplete. MPA network design should make the fullest possible use of the information (including scientific, traditional and experiential knowledge) that is available, but the network design process should also include consideration of knowledge gaps and limitations, while applying precaution.

Application of the Criteria:

With regard to application of the EBSA Criteria:

17. Although the Canadian (DFO) EBSA criteria are not identical to the CBD EBSA criteria, the differences are mainly in the packaging of the ecological considerations, and not in the resultant ecological intent. In many of the DFO Large Ocean Management Areas (LOMAs), the existing guidelines for applying the DFO EBSA criteria have worked well and can be used as guidance for the application of the CBD EBSA criteria (see CSAS ESR 2004/006 and SAR 2008/29).

18. These DFO EBSA guidelines provide further details on the definitions of terms associated with the EBSA criteria, while scientific guidance on how to integrate the results of applying individual criteria into conclusions regarding the areas of highest priority for conservation can be found in DFO CSAS SAR 2008/029. The scientific guidance in SAR 2008/029 is an essential companion to the guidance in this present document on the application of individual criteria. However, depending on the scale and objectives of a specific MPA network, it may not be necessary to completely prioritize the candidate EBSAs, before considering the results in the network planning process. Rather, once the results of the application of the individual criteria have been integrated according to those guidelines, it may be helpful to evaluate which candidate EBSAs would be best protected by inclusion in a network of MPAs (see Section #25 of DFO CSAS SAR 2008/29]. DFO CSAS SAR 2008/029 also includes important guidance on the special considerations for application of the criteria in coastal areas and the inclusion of anadromous/diadromous species.

19. With regard to the application of individual criteria, regional rarity (uniqueness) is a legitimate concern in MPA design, even if the features being considered (often species or habitat types) may be common in other areas.

20. The criterion of “naturalness” will usually be addressed through the consideration of other criteria such as biodiversity, and not be evaluated alone. This is consistent with the science guidance regarding the establishment of conservation priorities in LOMA areas (see DFO SAR 2008/029).

With regard to selection of Representative areas:

21. An appropriate interpretation of “representativity” is that representative MPAs should capture examples of different biogeographic subdivisions that reasonably reflect the full range of ecosystems which are present at the scale of network development, including the biotic and habitat diversity of those ecosystems.

22. At broader scales (and especially at the scale of the major biogeographic units) a single MPA cannot normally be expected to be representative of the entire biogeographic region within which it is found.

23. DFO SAR 2009/056 [Development of a Framework and Principles for the Biogeographic Classification of Canadian Marine Areas] notes that biogeographic units can be progressively subdivided into very fine-scale units. The scale of division considered particularly appropriate for integrated management planning and for reporting on ecosystem status and trends was highlighted. The scale of major biogeographic units is where, *depending on availability of information and expert knowledge,* it may be possible to

delineate (i) functional food webs, (ii) water masses that enclose groups of interacting species and habitats (exposing them to common environmental forces), or at least (iii) identify major potential barriers to species' dispersions (often bathymetric or major oceanographic features).

24. The scale of the major biogeographic units or their first-order subdivisions delineated in the Biogeographic Classification of Canadian Marine Areas (DFO SAR 2009/056) may be appropriate for the selection of representative MPAs, and appears to be a reasonable default for starting the process of selection of representative areas. Many concerns about the patchiness of marine ecosystems at finer scales are likely to be addressed at this scale (see following paragraph), and where they are not, they are picked up at a later point in the process (see Section 29). It is noted that approaches to delineating biogeographic units for MPA networks should take full account of knowledge limitations, even in the most information rich parts of the Canadian jurisdiction.

25. If representative MPAs are initially sought at roughly the scale of the major biogeographic units or sub-units suggested above, then they are very likely to include a number of habitat types and species in spatial mosaics. In deciding how large an area should be considered "representative", a reasonable approach would be to calculate the cumulative species-area curve for all species in the entire area being considered. The minimum area needed for a representative MPA would be that in which the species-area curve for the area included in the MPA was at or approaching its asymptote relative to the species composition of the entire area being considered. If these analyses are applied at scales so large that there are strong latitudinal or longitudinal gradients in biodiversity, conducting cumulative species-area analyses from more than one starting point on such gradients is likely to be most efficient in capturing the full species composition of the area being considered. It would be particularly valuable to include benthic species in the cumulative species analysis, because this would require attention to the benthic habitat mosaic in the overall area and not just the species found in the water column which generally aggregate at broader scales than those found in the benthos.

26. Application of such an analysis in determining what size of area would be necessary for a representative MPA is more likely to result in a small number of relatively large representative MPAs, rather than many smaller ones. This result is consistent with a substantial body of ecological research on conservation; including the role of MPAs as a conservation tool.

27. In conducting such a cumulative species frequency by area analysis, it is likely that various area options for MPA network inclusion would become evident (via the best-defined asymptotes). These options are likely to include areas also considered appropriate for inclusion in the MPA network because they meet the EBSA criteria. This is also a desirable outcome, in that providing the necessary protection to the representative MPAs would simultaneously provide protection to many EBSAs with little incremental management effort.

28. Once the representative MPAs are located, a review at a finer scale of habitat patchiness should be applied. This review should seek individually significant areas, distinctive habitats, or communities not yet represented within the "representative" MPAs, and ensure that they are captured appropriately in the network being developed. This sequence of activities (Sections #26-28) will result in the network likely containing MPAs of a variety of sizes.

With regard to Replication of MPAs within the network:

29. Replication is inherently not possible for some types of MPAs, particularly those based on the EBSA criterion of "uniqueness". On the other hand, replication is particularly important for representative MPAs, as well as those intended to protect areas of functional importance to species (where opportunities for replication of areas serving those functions exist). Representative MPAs are likely to include replicates of fine scale attributes within the larger units (see Section 32).

30. There is no universally applicable level of replication for MPAs, and outcomes will be case specific. Decisions on the degree of replication should be informed by a threat assessment, should take full account of the uncertainties and any limitations in knowledge of ecosystem properties, and follow the Canada Privy Council Office (PCO) guidelines for the application of precaution in science-based decision making.

31. The community properties of "resistance" and "resilience" are desired outcomes of the network(s). However, "resistance" and "resilience" are difficult to use as operational MPA network criteria, because these properties cannot be measured directly. Nevertheless, information on both of these properties can be inferred from the results of comprehensive threat assessments, as configurations of MPA networks that have a low vulnerability to most threats are likely to be the most resistant or resilient.

32. Existing guidance on threat assessments should be reviewed in the context of this new application (MPA networks). However, in addition to the standard evaluation of threat (likelihood of perturbation by a threat, consequences of the perturbation if it occurs, and rate of recovery if a pressure is removed), it is at least going to be necessary that the threat assessment consider:
    (i) The specific features and function(s) to be served by the MPA network.
    (ii) The spatial location of each MPA (especially relative to possible catastrophic events)
    (iii) The temporal and spatial scales of likely threats to which the MPA might be exposed.

33. Threat assessments would be suitable places to bring in considerations of longer-term threats like climate change.

With regard to Connectivity in the network:

The definition of connectivity in the CBD COP 9 Decision IX/20 is a reasonable starting point for MPA network design application. However, it is restricted to connectivity amongst different MPAs that are within a given network. The connectivity of the ecosystem components within an MPA with the adjacent ecosystem(s), and when relevant to components of other MPA networks, is an important consideration in overall network design, even though such connectivity is outside the narrower definition of connectivity amongst MPAs within a network. For example, the connectivity between winter and summer habitats of highly migratory species, such as the North Atlantic right whale must be considered.

34. Connectivity is not spatially explicit in all cases. The use of functional food-webs as a surrogate for connectivity may achieve the intended results (i.e. when information to track the movement of individuals from one MPA in a network to another is lacking). Representative MPAs delineated within a functional food web may also achieve the intended results of connectivity among MPAs in a network; particularly when only a few

stages of a species' life history or the trophic interactions of an ecosystem occur in spatially restricted areas.

With regard to Adequacy and Viability:

35. Adequacy and Viability are evaluated relative to the likely effectiveness of each MPA in achieving its objectives. For outcomes desired of the network as a whole, adequacy and viability must be evaluated relative to their intended contribution to the network. This situation strongly suggests that in designing MPA networks, the contribution of each individual MPA to achieving the network outcomes should be explicitly stated. That specification would provide a basis for evaluating the adequacy and viability of each site to make the necessary contribution(s) to the network.

36. When evaluating Adequacy and Viability, it may sometimes be possible to determine that a particular MPA is not adequate or viable for a particular objective or contribution to a network regardless of how it is managed. However, concluding that a particular MPA is adequate and viable will always depend on how the site, the MPA network, and often the adjacent areas are managed.

ADDITIONAL STAKEHOLDER PERSPECTIVES

It should be noted that the objective of this advisory process was to achieve consensus, and for the most part this was achieved. The majority of comments and suggestions have been addressed within this finalized advice, with one notable exception. Please refer to the Proceedings for this advisory process for further context on these additional stakeholder perspective(s).

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