

Three Oceans of Biodiversity

A Canadian National Plan 2004-2009



THREE OCEANS OF BIODIVERSITY

A CANADIAN NATIONAL PLAN: 2004-2009

Based upon deliberations arising from the White Point CoML
- DFO sponsored workshop, February 2002

A REPORT OF THE CENTRE FOR MARINE BIODIVERSITY

Vision Statement and Mission

A bringing together of the scientific community to focus research on marine biodiversity in Canada's three oceans

The National Advisory Group on Marine Biodiversity (Appendix I) envisages a response from scientists, scientific organisations and governments to this vision statement. Our goal is to increase our knowledge of marine biodiversity in Canada at all levels of organization (e.g., genes, populations, species and communities) in our territorial waters of the Pacific, Arctic and Atlantic Oceans. This vision embodies:

A census of marine life as well as an understanding of the processes that influence biodiversity

Given the vastness of our submarine landscape, this mission can only be met through a concerted national endeavour that is closely allied with the global Census of Marine Life.

Introduction

In 1992 at the Earth Summit in Rio de Janeiro, Canada and more than 145 other countries, signed the legally binding agreement referred to as the Convention on Biological Diversity. Those signing parties agreed on a program for implementing the CBD with respect to marine and coastal biodiversity at their second Conference of Parties held in Jakarta, Indonesia in 1995. In these accords, diversity is defined as “*the variability among living organisms from all sources, including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems.*”

In the same year as the Jakarta meeting, the Food and Agriculture Organization (FAO) of the United Nations (FAO) Code of Conduct for Responsible Fisheries was endorsed. The Code requires that: “*States and users of living aquatic resources should conserve aquatic ecosystems. The right to fish carries with it the obligation to do so in a responsible manner so as to ensure effective conservation and management of the living aquatic resources*”.

Together, these agreements have significant potential to assist in the preservation of biodiversity. Canada, as signatory to both documents, has responded with measures to protect marine resources for the future. The 1997 Oceans Act defines Canada’s obligation to incorporate ecosystem considerations within an Oceans Management Strategy (OMS). Species-At-Risk legislation (SARA) addresses a high profile component of biodiversity, while in 2003, Canada established its first Marine Protected Area in the Queen Charlotte Islands through the Marine Parks Bill. The Federal Fisheries Act predates the CBD and provides protection for fish species and their habitats.

Recent institutional changes also support better biodiversity protection. These include the Biodiversity Convention office established in Environment Canada, new federal-provincial structures for species-at-risk, increased interdepartmental activities, and changes within

Fisheries and Oceans (DFO) - support for the Centre for Marine Biodiversity, establishment of the Biodiversity Science Branch.

However, these legal and institutional instruments and governance structures can only operate within our sphere of knowledge. Canada has the world's longest coastline (approx. 244,000 km) and a total of 6.5 million square kilometres of marine habitat. These include intertidal shores, vast continental shelves with shallow offshore banks, deep holes and channels, as well as underwater canyons, seamounts and rifts. These habitats occur across



three broad climate zones: temperate, boreal and arctic, with influences and incursions from tropical waters, and in three oceans: Pacific, Arctic and Atlantic with great inland seas, Hudson's Bay and the Gulf of St. Lawrence marine ecosystem. No other country in the world shares this range of ecosystem diversity in the marine environment.

It is safe to say that many of the species living in our waters are completely undocumented, meaning that we have no knowledge of their

population dynamics and the processes that influence their distribution and abundance. This ignorance distorts our vision of biodiversity and hinders our ability to provide adequate protection. Current major issues constraining biodiversity protection include a lack of taxonomists to identify organisms, incomplete inventories, monitoring and assessments, insufficient knowledge on processes that regulate and help to maintain biodiversity and a lack of agreement on which metrics best represent "biodiversity". In short, we lack the necessary information needed to make informed decisions on protection and management of marine biodiversity. By embracing the Three Oceans of Biodiversity vision statement, we will gain the knowledge to provide Canadians with a true picture of the diversity of their marine life, which in turn will empower existing legislation to protect this priceless heritage for future generations.

The Three Oceans of Biodiversity Strategy

Research, Development and Technology Strategy

A research, development and technology (RD&T) strategy based on and complementing this mission statement, underpin this National Plan. Given the broad range of topic areas that have relevance to the question of marine biodiversity, it is imperative to adopt a conceptual framework to define the scope of our objectives. The conceptual framework, which has guided the development of this plan, is encapsulated in the following matrix:

	Inventory	Monitor	Conserve
Ecosystem			
Species			
Population			

This matrix presents both a summary of Canada’s obligations under the Convention for Biological Diversity (to inventory, monitor, and make plans to conserve biological diversity), and three levels of biological organization (communities or ecosystems, species, and populations). This biological hierarchy does not explicitly define variability below the level of species and above the level of population (e.g., sub-species, ecologically significant units), genetic variability that crosses all categories, or collections of species into functional guilds or by habitat. The framework is simplified for practical purposes. The intersection of these topics, represented by the elements of this matrix, defines the ambit of strategic RD&T activities in the five-year plan. Background for the development of this National Plan can be found in Zwanenburg et al. 2003. Institutional development in support of this plan is essential. The following five goals were defined at the White Point meeting:

Goal 1. Complete and maintain a national Marine Biodiversity Registry with metadata compiled by region and taxon and following international standards

Historical information on marine biodiversity is fragmented and often not available electronically. Collections reside in museums, universities, government labs and private institutions and require experienced personnel to verify metadata and correct taxonomic misidentifications and changes in nomenclature. The strategy for this goal is to fund biodiversity informatics through establishment of a national Marine Biodiversity Registry. In order to maintain the registry, recipients of government funds should be required to register their metadata as a condition of funding. Through such a database, it will be possible to map the distributions of most of the larger and more abundant species in Canada’s oceans and identify their habitat characteristics.

Goal 2. Document the marine species of Canada including their distribution with an emphasis on Arctic marine species, species living below 300 m depth, and microfauna

The strategy for this goal is to mount research expeditions to document biotic diversity in poorly known environments following the All Taxon Biodiversity Inventory (ATBI) model, e.g. BioICE in Iceland, BioFAR in the Faeroe Islands. This requires an increased number of well-trained taxonomists. This strategy should be coupled with programs to encourage young scientists to train with the dwindling number of experienced taxonomists and to participate in data collection, identification and archiving. This effort must integrate genetic surveys with morphology-base taxonomy to ensure the comparability and accuracy of

taxonomic designations, and evaluate genetic variability in representative species. Currently we have very little knowledge of the genetic structure of marine species, including exploited species. This knowledge is critical for their sustainable management. Although both approaches are currently used in Canada, they are typically poorly coordinated and rarely directed at broad-scale biodiversity questions.

Goal 3. Apply existing and developing technologies and sampling designs to identify, collect, measure and enumerate marine biodiversity

Traditional methods of identifying species and documenting their abundance and distribution represent a basic and essential tool for evaluating biodiversity, but they are time consuming. DNA-based technologies, such as the DNA-barcoding concept, will be useful as a means of rapidly identifying specimens only if the species are first accurately identified as DNA reference data are accumulated. This approach offers a means of rapidly identifying species, while technological improvements to sampling equipment, image analysis of underwater video and design of optimal sampling programmes are critical to achieving an accurate assessment of marine biodiversity.

Goal 4. Characterize factors influencing biological diversity

Efforts to understand how biodiversity is structured and maintained require a two-tiered approach. The first is descriptive work on pattern and environment, and the second is process-oriented studies. The fundamental characteristics of pelagic marine ecosystems are determined by a relatively small number of physical factors (e.g., irradiance and wind mixing of the upper water column) much as soil types determine terrestrial biomes. For benthic marine ecosystems, habitat heterogeneity is an important factor in shaping community diversity. Research on the determinants of biological diversity, including the structure and functioning of populations and communities is fundamental to interpreting human dependence and influence on them. Habitat characterization allows for extrapolation of detailed biodiversity studies to broader regions, and thereby improves our ability to predict species distributions and diversity patterns at large spatial scales. Patterns of biodiversity are also influenced by other factors such as biological interactions and physical disturbance. Descriptive studies must therefore be conducted in parallel with process studies.

Goal 5. Understand the role biodiversity plays in the functioning of marine ecosystems

This goal is inter-related with Goal 4 but places an emphasis on determining the importance of biodiversity to the viability and integrity of marine ecosystems, for example, what is the relative importance of species diversity versus functional diversity? Marine ecosystems have been estimated to account for two thirds of the ecosystem services provided on Earth, but the role that biodiversity plays in delivering these services is almost completely unknown. Thus, carbon sequestration, provisioning of food resources and other trophic support processes, provisioning of critical habitat, cycling of nutrients, metabolism of pollutants and stabilization of shorelines are all key goods and services provided by marine organisms, but our knowledge of whether biodiversity influences the delivery of these goods and services represents a large unknown for any marine environment.

Funding Strategy

In order to engage scientists it is necessary to establish funding envelopes directed at marine biodiversity research. In Canada, the Natural Sciences and Engineering Research Council of Canada (NSERC) is the most appropriate body for funding of research on marine biodiversity. NSERC allocates research funds on a competitive peer-reviewed basis to university scientists. In the past, the *Strategic Project Grants* Program was a vehicle for encouraging project research in targeted areas of national importance. However, this program has been phased out and replaced by a new program, *Special Research Opportunities* (SRO) that does not target specific research priorities. The criteria established by the SRO program encourage national and international collaboration, which facilitates Canadian involvement in programs such as the International Census of Marine Life (CoML). The only funding envelope specifically dedicated to biodiversity research within NSERC is the *Supplements Program*, which offers incremental funding to graduates students conducting Systematics Research.

Government scientists depend upon Treasury Board (TB) for targeted funding for new initiatives, or upon departmental realignments to free up resources for new activities. At present, there is no TB submission to target marine biodiversity research within government labs, and no new resources for marine biodiversity research within Fisheries and Oceans.

Recommendation:

National funding envelopes available to both academic and government scientists must be established to target research on marine biodiversity. Subprograms in Taxonomy, Surveys and Inventories, Informatics and Processes are recommended.

The Future

The adoption of the Recommendation and five RD&T goals outlined in this five year National Plan will lay the groundwork for marine biodiversity research in Canada and ultimately fulfilment of our mission statement:

A census of marine life as well as an understanding of the processes that influence biodiversity

Implementation of these objectives can be addressed through activities outlined in the Science Plan (Appendix II).

References

Zwanenburg, K.C.T., K. Querbach, E. Kenchington and K. Frank (editors). 2003. Three Oceans of Biodiversity. Development of a Science Plan for Marine Biodiversity in Canada. Canadian Technical Report of Fisheries and Aquatic Sciences No. 2432: viii + 72pp.

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APPENDIX II - SCIENCE PLAN

Elements of the Science Plan (2004-2009)

Goal 1. Complete and maintain a national Marine Biodiversity Registry with metadata compiled by region and taxon and following international standards

- Establish regional registries for species diversity and produce an accessible dynamic atlas for this information
- Establish data base standards for species diversity
- Collate information on genetic diversity of marine species, including population structure
- Expand regional databases by filling gaps
- The Canadian databases should be developed consistent and interoperable with the Ocean Biogeographic Information System (OBIS), which aims as part of the Global Biodiversity Information Facility (GBIF) to integrate databases on marine life and its context from all over the world

Goal 2. Document the marine species of Canada including their distribution with an emphasis on Arctic marine species, species living below 300 m depth, and microfauna

- Establish criteria for identification of geographic focus areas where species and habitat mapping will be concentrated. Potential criteria include areas that are representative of specific habitat types, areas that are poorly sampled, areas that might represent biodiversity “hotspots”, and areas where key ecosystem functions are believed to occur
- Encourage taxonomic and descriptive research in focus areas and the publication of identification manuals, taxonomic papers and monographs in a newly established taxonomic journal or series
- Partner with International Census of Marine Life (CoML) Arctic transect project to document Arctic marine species
- Partner with International CoML projects in development on Continental margins, Deep corals, Marine microbial diversity and Seamounts
- Partner with Gulf of Maine GOMA-GOOS initiative to describe biodiversity

Goal 3. Apply existing and developing technologies and sampling designs to identify, collect, measure and enumerate marine biodiversity

- Select methodology for delineation of geographic patterns of benthic and pelagic ecosystem types
- Evaluate metrics for marine biodiversity
- Investigate DNA-based identification methods

Goal 4. Characterize factors influencing biological diversity

- Using common classification schemes delineate geographic patterns of benthic and pelagic ecosystem types based on available information
- Prepare research proposals to investigate utility of competing hypotheses on control of species diversity in oceans (e.g., Huston, Hubbell), and seek funding
- Prepare research proposals to identify the size and spacing of protected areas in order to protect ecosystem types and species diversity, and seek funding
- Take advantage of available infrastructure that will facilitate accessing and researching process-related studies (e.g., field stations, observatories)
- Prepare research proposals on priority issues/questions on effective population size (N_e), as well as connectivity among populations, for a range of marine species with contrasting life histories, and seek funding
- Hold an international symposium on “Processes Controlling Marine Biodiversity” in order to generate a synthesis of extant knowledge and to identify key questions

Goal 5. Understand the role biodiversity plays in the functioning of marine ecosystems

- Identify and establish reference sites ("discovery corridors") for the monitoring of ecosystems types and species diversity
- Select species (commercial and non-commercial) for the tracking of changes in genetic diversity, with particular attention to species of special concern (i.e. COSEWIC listed species)
- Incorporate monitoring observations in state-of-the-ecosystem reports (ecosystem type, species and genetic diversity levels) with directed field and laboratory experiments that complement observational data to determine how diversity influences the way that ecosystems function

Development of Institutions in Support of Biodiversity Research

- Establish a national oversight committee on marine biodiversity, with regional sub-units, to help implement and adapt the Science Plan
- Prepare CFI and NSERC submissions to establish Marine Biodiversity Knowledge Network
- Consolidate the Centre for Marine Biodiversity (CMB) in the Atlantic and foster parallel initiatives for the Pacific and Arctic Oceans
- Establish CoML pilot in Gulf of Maine area
- Prepare national inventory of expertise in taxonomy with identification of gaps
- Integrate Canadian institutions within the global governance structure for biodiversity
- Establishment of secure funding for Science Plan activities within government departments, museums and universities

Expected Products

- A comprehensive synthesis of decadal scale trends in biodiversity in the well-studied parts of Canada's oceans at the three levels of biodiversity (1950's to the present). This is an

inventory product

- Publication of taxonomic papers and monographs
- An electronic clearing house for existing identification manuals, unpublished keys and guides presently held by individuals at regional labs
- A series of papers on the processes controlling marine biodiversity and on the interpretations of observed pattern trends. The papers will both address the controversial literature on the regulation of biodiversity (predominantly based on terrestrial and freshwater observations) and the specific causes of biodiversity within respective regional seas. These papers will partially address the “processes” activities of the plan
- State-of-the-ecosystem reports for the “study areas” that will provide evaluations of biodiversity status and trends. The evaluations will examine the degree to which well studied areas have been impacted, and possibly the degree to which there is resilience to human activities. This product will also address the “processes” activities
- A Canadian biodiversity monitoring strategy that meets the needs of ecosystem-based management of ocean and coastal zone activities. It is envisioned that within a decade the diverse ocean use sectors will have adopted a common set of ecosystem objectives that constrain their practices. These objectives will require associated indices of biodiversity. The monitoring will provide the data products for the indicators, as well as for decision making. The strategy will also promote monitoring activities required for interpretation of biodiversity trends. This product obviously addresses the monitoring activities
- A “dynamic atlas” of Canada’s marine biodiversity will be an overarching product. This will be a tool that will help with the inventory processes and monitoring activities in support of biodiversity conservation. The atlas, which will be accessible on the web, will allow ongoing updates and provide access of all of the information generated by the “science plan” to decision-makers and the general public



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About the Census of Marine Life: www.coml.org

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