NATIONAL SYNTHESIS OF THE 'ECOSYSTEM RESEARCH INITIATIVES'

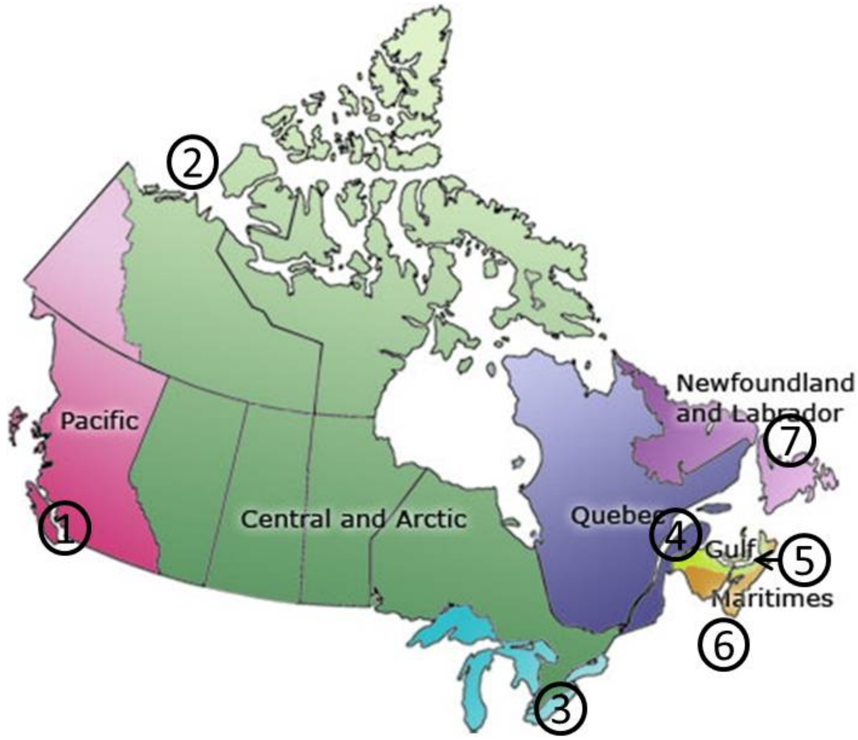

Figure 1: The Fisheries and Oceans Canada Ecosystem Research Initiatives focused on seven geographically-distinct areas with defined boundaries. These areas were: 1) the Strait of Georgia, 2) the Beaufort Sea Shelf, 3) Lake Ontario, 4) the Lower St. Lawrence Estuary, 5) the Northumberland Strait, 6) the Gulf of Maine, and 7) the Newfoundland Shelf.

Context:

In support of Fisheries and Oceans Canada's (DFO) Five-Year Research Plan, the 'Ecosystem Research Initiatives' (ERI) were conducted from 2007-2012. They have now concluded and Regional syntheses of their respective research and advice have been produced. This national meeting discussed the 'lessons learned' from the ERIs in general, examined the current or potential application of these initiatives in support of an ecosystem approach to management, and provided recommendations on the path forward for ecosystem science within the Department.

This Science Advisory Report is from the DFO, Canadian Science Advisory Secretariat, national science advisory process of November 14-15, 2012 held in Sidney, British Columbia to synthesis the ERIs. Additional publications from this process will be posted as they become available on the [Fisheries and Oceans Canada (DFO) Science Advisory Schedule](#).

SUMMARY

- The ‘Ecosystem Research Initiative’ (ERI) was a program conducted by the Ecosystems and Oceans Science Sector of Fisheries and Oceans Canada (DFO) from 2007-2012. The ERI program was comprised of seven large-scale ecosystem research programs that focused on how Science could support the Department’s implementation of an ecosystem approach to management (EAM).

- Delivery of the ERIs varied among Regions, but all studies advanced understanding of how Canadian aquatic ecosystems are structured and how they function, which are prerequisites for an EAM. The ERI program also provided the opportunity to learn valuable lessons with respect to the design, coordination, and implementation of complex science programming at the ecosystem scale.

- There is significant benefit in establishing approaches, mandates, and direction for scientific research initiatives, in particular those relevant to EAM, through ongoing multi-sector collaborations. These interactions ensure results will be relevant to Departmental needs and priorities and improve the likelihood of their integration into decision-making.

- Although supporting immediate, short-term management and policy needs are a priority for DFO scientists, investments should be made in research that addresses broader scale questions over longer timeframes to provide the scientific basis to support anticipated future management and policy needs.

- An overarching and comprehensive framework that outlines the Department’s intentions, including roles and responsibilities, with respect to implementing EAM would greatly assist in the development of relevant future scientific research programs and the design of related scientific projects.

- Key conclusions and advice from the ERI programs include:

    1. the need for multi-sector working groups at regional and national levels to identify priorities for science support within an EAM;
    2. a national ecosystem modelling and analysis working group to address ecosystem-scale issues;
    3. new tools to assess cumulative effects of multiple stressors; and
    4. improvement of comprehensive ecosystem-level monitoring, assessment, and predictive capabilities.

BACKGROUND

Canada initiated a new approach to managing activities in the marine environment when the *Oceans Act* received Royal Assent in 1996. The *Oceans Act* formally introduced concepts such as sustainability, precautionary approach, ecosystem-based, integration, and adaptation and is a mechanism to harmonise Fisheries and Oceans Canada’s (DFO) implementation of the *Fisheries Act*, *Species At Risk Act*, and the *Canadian Environmental Assessment Act* (Curran et al., 2012).

Since that time, many international agencies have widely endorsed the ecosystem approach to management (EAM) in a fisheries context and the primary literature includes many articles related to its interpretation and implementation (see references included in Rice, 2011 and Curran et al., 2012). Of particular interest to DFO are the initial EAM principles defined by the *Convention on Biological Diversity* (CBD, 2000), the technical paper produced by the *Food and Agriculture Organisation* (Garcia et al., 2003) as well as the ongoing work of the *North Atlantic Fisheries Organisation* and its *Working Group on Ecosystem Approaches to Fisheries Management (e.g. NAFO, 2010a,b,c).*

DFO managers and scientists held initial discussions to determine a path forward with respect to implementing EAM in the Department's Large-Ocean Management Areas (LOMAs) at the 'Dunsmuir I' workshop (DFO, 2001). At 'Dunsmuir II' in 2007, progress in implementing EAM in the LOMAs was reviewed and it was determined that a new direction was needed given the challenges in applying the previous advice. The ERIs were intended to explore opportunities where Science could support the Department's implementation of the ecosystem approach to management through Regionally-focused, multidisciplinary research on ecosystems with pre-defined boundaries (DFO, 2008). A map indicating the general locations of each of the ERIs is shown in Figure 1 and detailed overviews of the ERIs can be found in White et al. (2013).

The knowledge gained from these large-scale ecosystem studies was intended to inform the development and testing of tools required to assess the impacts of various human activities within Canadian aquatic ecosystems. Each Regional ERI had its own specific objectives, however the overarching themes of the national ERI program were: i) understanding ecosystem processes, ii) understanding the impacts of environmental and climate variability, and iii) developing tools for science support of the Department's EAM (DFO, 2008).

ANALYSIS

Comparison of ERI Program Delivery among Regions

Most DFO Regions held open and multi-sectoral workshops at the beginning of the ERI program to refine their particular issues and needs for ecosystem-related research and management advice. Steering committees were usually created to manage each program, with either annual calls for proposals directed towards the research issues, or formation of research teams to identify and address specific issues. One Region followed a top-down process in which the research themes were selected by regional Science management, with the operational framework for the program developed by a steering committee.

All ERIs had multi-sectoral workshops or formal CSAS review processes to evaluate results to date and provide advice to management on relevant issues within an ecosystem approach. The reports from these processes are identified in White et al. (2013).

As noted, all ERIs had several elements directly related to management issues, although the balance between currently identified and anticipated issues within an ecosystem management context differed among the programs. This resulted in more direct interactions with client sectors for those ERIs addressing current management issues.

A detailed summary of each Regional ERI is provided in White et al. (2013). To date, over 160 publications in the scholarly literature have been produced from these ERI programs.

Linking ERI Research to Policy and Management

Overall, the seven ERIs have significantly advanced understanding of how Canadian large aquatic ecosystems are structured and how they function, which are prerequisites for effective ecosystem approaches to management. While some of the ERI projects aimed specifically to address management and/or policy priorities, others were more focused on improving scientific understanding of ecosystem functioning (e.g. as a whole, or for the ecosystem associated with a specific component) and then deriving specific recommendations for management/policy based on these findings. Although all of the scientific research conducted under the ERIs was valuable in its own right, in some cases there was no clear linkage between a particular project and an immediate, specific management/policy need related to EAM. The high-level objectives of each of the Regional ERIs are listed in Table 1.

Table 1. Regional Ecosystem Research Initiatives (ERI) and their primary objectives.

ERI	Primary Objectives
Strait of Georgia	To establish the basis for the management of ecosystem and human interactions in an integrative ecosystem framework.
Beaufort Sea Shelf	To address the cumulative impacts of multiple stressors on the Beaufort Sea Large Ocean Management Area through an integrated, ecosystem-based approach.
Lake Ontario	To complement and advance the common themes of the national ERI program within a Regional context by building on research and partnerships in Lake Ontario.
Lower St. Lawrence Estuary	To develop and apply an operational framework for the coordination of existing and new projects to address in an integrative manner several management and scientific issues related to impacts of human activities on biological and ecological processes in the Lower St. Lawrence Estuary.
Northumberland Strait	To produce new knowledge and improve existing knowledge that is needed for integrated management, to demonstrate a strong commitment to research to clients and partners, and to align with Departmental mandate.
Gulf of Maine	To augment current research efforts to provide the scientific basis for biodiversity, productivity, and habitat-related objectives, with a focus on southwest Nova Scotia and the Bay of Fundy areas.
Newfoundland Shelf	To fill knowledge gaps in the Regional Science program. The geographic extent of this work encompassed the Newfoundland and Labrador Shelves and Grand Banks (NAFO Divisions 2J3KLNO).

All ERIs contributed to the development of approaches and tools to support management sectors in implementation of an EAM (Table 2). In some cases, science-based products that are required by management and policy sectors can be informed by several different scientific tools and/or approaches.

Table 2. The Ecosystem Research Initiatives (ERIs) contributed to the development of a number of approaches and tools which have a variety of applications that can support management and policy sectors in their implementation of an ecosystem approach to management (EAM).

Scientific Tools and Approaches	Potential Applications	Products (informed by the tools and approaches)
Ecosystem Assessments and Overviews	– Identification of important species and habitats (including ecologically and biologically significant areas (EBSA) and ecologically significant species (ESS)) – Determining status and trends of species and ecosystems – Identification of threats and potential impacts	– State of the Ocean reports – Ecosystem Status and Trends reports – Ecosystem risk assessments – Integrated Fisheries Management Plans (IFMP) – Stock recovery potential / *Species At Risk Act* (SARA) Recovery Planning – Marine Protected Areas (MPA) selection and network design
Multivariate Statistics (e.g. principal components and redundancy analyses; gradient forest; dynamic factor analysis; min/max autocorrelation factor analysis)	– Integrated ecosystem analyses – Identification of drivers and community patterns – Predictive mapping	– Identification of representative areas – Integrated Fisheries Management Plans (IFMP) – Identification of critical habitat – Pathways of Effects – Ecological risk assessments – Inform on the roles of ecosystem goods and services
Probabilistic causal networks	– Identification of key indicator variables – Exploration of alternative management scenarios – Integration of multiple stressors	– Integrated Fisheries Management Plans (IFMP) – Stock and/or habitat assessments – Cumulative effects analyses – Pathways of Effects
Biophysical models e.g. regional ocean modelling system(ROMS); nutrient-phytoplankton-zooplankton models; 3D hydrodynamic models	– Transport of nutrients/larvae – Connectivity analyses – Movement of water masses, oil and sediment, contaminants, etc.	– Selection of indicators – Climate change analyses – Impact assessments (e.g. aquatic invasive species, oil, etc.) – Marine planning (e.g. aquaculture; protected areas)
Multi-species / Ecosystem models e.g. Ecopath with Ecosim and Object-oriented Simulator of Marine Biodiversity Exploitation (OSMOSE) upper-trophic level models; production models; Multi-Species Virtual Population Analyses (MSVPA); bio-energetic models; stable isotope analyses	– Simulations of alternative fishery management scenarios – Complement knowledge of biological properties – Assessment of forage fish policy applications – Estimation of multi-species harvest rates – Understanding of ecosystem structure, function, and drivers	– Integrated Fisheries Management Plans (IFMP) – Climate change analyses – Rebuilding strategies (including *Species At Risk Act*) – Ecosystem goods and services – Selection of ecosystem indicators – Pathways of Effect – Ecological risk assessments – Cumulative effects analyses

Scientific Tools and Approaches	Potential Applications	Products (informed by the tools and approaches)
Habitat models e.g. benthic and nearshore habitat classifications; benthoscape; gradient forest; eco-region analysis	– Habitat suitability analyses – Identification of important benthic habitats for particular species (including ecologically and biologically significant areas) – Spatially-based fishery reference points (e.g. scallops)	– Integrated Fisheries Management Plans (IFMP) – Selection of Marine Protected Areas (MPA), network design, and associated management measures – Critical habitat identification – Environmental impact assessments – Ecological Risk assessments – Identification of ecosystem management units – Cumulative effects analyses
Initiation of new data streams and products	– Monitoring protocols – Determination of trends (species and ecosystem) – Contribute to the basis and validation for other tools – Design criteria for long-term observational programs	– Improving predictive capacity – Ecosystem overview reports – Ecosystem status and trends reports – Selection of indicators
Mining of archived data	– Contribute to the basis and validation for other tools – Determination of trends – Leveraging of derived data products for ecosystem-level analyses from existing DFO and other external databases (e.g. spatial representation of benthic currents; diet data)	– Improving predictive capacity – Ecosystem overview reports – Ecosystem status and trends reports – Selection of indicators

Lessons Learned' from the Ecosystem Research Initiatives (ERI)

In addition to advancing understanding of how Canadian aquatic ecosystems are structured and function, the ERI program provided the opportunity to learn valuable lessons with respect to the design, coordination, and implementation of Science programming within the Department.

Collaborations and Interactions

There was a wide range of interaction between Departmental science and client sectors in developing the objectives and research areas for each of the ERIs and there was also variability in the applicability of results to Departmental management and/or policy. A key lesson learned from the ERI program is that there is substantial benefit in determining mandates and directions for research initiatives in collaboration with science, management, and policy colleagues. These interactions allow for clarification of perspectives between different groups, improve linkages between science and management priorities at the onset of the project, and facilitate integration of results into Departmental decision-making. A top-down approach can leave little scope for creativity so there should be ample opportunity for brainstorming sessions among researchers and client sector colleagues to discuss how to best address Departmental needs.

Clear dialogue between sectors is particularly important when designing research projects to address short-term, immediate (1-2 years) management and policy needs, as the science requested is often required to inform a specific, urgent question or issue. However, these collaborations are also essential when designing longer-term (> 2 years) research programs that may be broader in scope and/or may not address an immediate management or policy need. CSAS processes were valuable for summarizing the ERI findings and for providing advice to management and policy sectors; in general, they were, and continue to be, the chosen method of delivery of Science advice to other sectors.

In many cases, the ERIs facilitated the development of regional, national, bilateral, and international linkages with similar programs and/or researchers working on EAM-related initiatives. This was highly beneficial to the researchers involved and ultimately had a positive influence on the ERI projects by allowing for multiple issues to be addressed under one unified effort. The ERIs brought together researchers who may not have previously collaborated which facilitated new combinations of knowledge, expertise, and data. In addition, a team approach to addressing research priorities often resulted in leveraging of other programs, leading to increased budgets to complete the work. Multiple years of guaranteed funding greatly increased the opportunities for leveraging with partners, but often came with challenges (e.g. different schedules/timescales for deliverables, different objectives, unforeseen withdrawals of funding, failure to deliver expected results, and ending of research partnerships once ERI funding ended).

Duration and Focus

In retrospect, while short term projects aimed at answering specific management questions are a useful EAM approach within DFO Science, the five-year timeframe allocated for the ERIs was too short to fully realise the potential benefit of a program of its kind that involves multiple, complex research projects. A longer timeframe may also have eased the pressure on Departmental researchers who juggled competing priorities (e.g. additional regional, national, and international research and advisory responsibilities) while attempting to fulfill their ERI commitments. In some cases, a longer time period may have allowed for the completion of higher quality products. Ellis et al. (2011) conducted a comparative study of four recent regional biodiversity programs and concluded that a 10-year period is a more appropriate timescale for designing, implementing, and assessing the outcomes from large-scale research programs.

Studies with a broader scope than immediate management needs can provide the basis for more targeted questions in the future; this will provide valuable opportunities to further understand how ecosystem features beyond direct management control can affect the ecosystem, or how ecosystems are structured and how they function. One example is changing inputs of nutrients to the food web as a result of oceanographic changes related to variability of environmental conditions. As such, it is important to provide Departmental scientists with the opportunity to conduct research that addresses these broader questions over longer timeframes.

Long-term observations and their analyses were essential for many of the ERIs. Regional ERIs with more extensive long-term datasets were able to undertake more comprehensive analyses and provide stronger recommendations to management. Continuation of these long-term observations and development of new series are necessary for scientific outputs such as models and developing/monitoring indicators. In addition, they are crucial for the validation of management actions and policies.

Resources

The availability of adequate resources (financial and human) is essential as considerable effort and expertise is required to implement individual ecosystem-related research projects and to effectively coordinate multiple projects under large-scale funding envelopes. In some cases, areas of priority science were not addressed owing to a lack of capacity to conduct targeted research, as a result of time and/or financial constraints and/or limited qualified personnel.

Throughout the ERI program, existing data and knowledge were not always readily accessible. Ecosystem data are often dispersed and in a variety of formats, making their collection and synthesis difficult – particularly across Regions and agencies. Common platforms for data collection, storage, and sharing are needed.

The departure of Departmental researchers, through retirement or other reasons, will increase the loss of expertise and knowledge that is essential to providing science support, in particular for implementing EAM. Realities and complexities of short-term staffing and finding/securing qualified talent (e.g. post-doctorates, biologists, technicians) were often a challenge and some ERI research projects were delayed as a result.

Due to the short-term nature of funding for the ERIs, the personnel hired to conduct analyses were often not retained by the Department. The investment made to train these people, the additional capacity for ecosystem research that they represented, and their potential further contributions were ultimately lost.

Research Gaps and Linkages to Management and Policy Applications

Although the ERIs significantly advanced understanding of how large Canadian aquatic ecosystems are structured and how they function, knowledge gaps still remain. Scientific research to address these gaps is necessary in order for Science to continue to inform and support Departmental management and policy applications, in particular with respect to implementing an EAM. Based on the findings of the ERIs, priority areas for ecosystem science pertaining to the specific objectives of the regional ERIs are discussed below (with no relative importance implied within or between categories). It is worth noting that other research priorities that were not addressed by the ERIs also exist in all regions.

Productivity

A broader understanding of the productivity state of the ecosystem in relation to environmental conditions as well as key species interactions is needed. These factors may play a significant role in defining the extent of human use that is sustainable over the long-term (e.g. exploitation levels, coastal and offshore development, resource extraction, etc).

Studies of the linkages between environmental drivers and the trophic transfer through the food web are essential to reveal the mechanisms supporting ecosystem productivity. Detailed understanding of these mechanisms may not only generate a much needed context for the assessment of forage species and productivity at the base of the food web, it may also provide fundamental tools for developing realistic scenarios (e.g. climate change, exploitation, cumulative impacts) for exploring medium to long-term management options.

Development of more robust coupled atmospheric-oceanographic models, including the ability to downscale global climate models to specific locations, are needed to project changes in distribution and productivity of regional ecosystems. This is important to anticipate the future effects of climate change and for spatial planning.

Ecosystem structure

Characterization of the structure and trends of the aquatic community beyond fisheries species (e.g. size distribution and condition of species, composition of benthic communities, primary and secondary production) is a fundamental step to develop baselines that can be used to monitor changes at the ecosystem scale. These types of studies provide the underpinnings for the selection and interpretation of ecosystem indicators, and contribute to the detection of shifts in the productivity state of the system. Analyses of this kind provide contextual information for the interpretation of stock-specific trends and responses (e.g. "ecosystem consideration" sections in stock-assessment reports, evaluation of MPA effectiveness).

Enhanced understanding of the condition, spatial and temporal dynamics of forage species, particularly when exploited, is necessary to ensure their long-term viability and an adequate food supply for upper trophic levels. These types of studies can directly inform the application of the *Policy on New Fisheries on Forage Species*, as well as provide advice on the bounds for the productivity of higher trophic levels.

Comprehensive trophic structure and diet studies are needed to provide necessary information for the development of expanded single-species models (e.g. predation mortality terms), multispecies models (e.g. species interaction terms), and fisheries production models (e.g. trophic level estimates). These studies also provide useful information for early detection of changes in lower trophic levels, and hence, are indicators of potential changes in the productivity state of the system. They are relevant for considering specific management actions in terms of predation mortality and competition among species.

Studies of the spatial structure of the ecosystem (e.g. distributions of species assemblages, definition of ecoregions) are fundamental to establishing operational boundaries for spatially-defined ecosystem-level units. These units can serve as a basis for ecosystem management, inform identification of EBSAs and representative areas, and serve as the backdrop for the development of spatial-based modelling and management strategies for multiple human activities.

In general, the nearshore zone is poorly described and its role in ecosystem processes is not well understood. In particular, determination of biological productivity in these areas, as well as a comprehensive way to evaluate status and trends, are needed. The nearshore environment is where anthropogenic pressures are likely to be most apparent, and where management issues are increasingly complex, such as cumulative effects, multiple stressors, conflicting objectives, land-water interface, multi-jurisdictional challenges, etc. Spatial and temporal scales and data are major challenges in nearshore environments.

Benthic-pelagic coupling and inshore-offshore linkages remain poorly understood but are critical factors that are needed to develop more comprehensive spatially-explicit ecosystem models. Improved understanding of these linkages would provide a more complete view of how changes in benthic and nearshore regions affect the function of entire ecosystems, and *vice versa*. In several DFO Regions, species which live on or in the bottom, in both offshore and nearshore areas, are among the most valuable of Canadian fisheries resources.

Tool Development

Research on multispecies/ecosystem modelling is central for the integration of ecosystem information. These types of studies provide an avenue to explore ecosystem-level dynamics (e.g. biomass-aggregate production models) and fisheries production potential that can be used to provide advice on sustainable ecosystem exploitation levels and other uses. These studies can also explore trade-offs among human activities (e.g. between fisheries using multispecies models) that can serve as a basis for defining ecologically compatible management objectives, as well as to explore specific questions/hypotheses of management relevance (e.g. the impact of seals on cod, and cod on shrimp, etc.). They are crucial for the evaluation of alternative management strategies.

Prior investment in surveying and assessing the status and trends of benthic and nearshore systems has been rather limited, in part due to some technological challenges, and also due to the inherent spatial complexity of these systems. Newly-developed approaches by the ERI program to integrate optical survey technologies with acoustic-derived representations of seabed environments could be used to improve descriptions of these habitats, in particular at the small scales actually used by benthic fish and invertebrates.

Existing science program activities and mandates, particularly for seabed characterization using acoustic survey technologies, vary both regionally and nationally within DFO (Science, Canadian Hydrographic Survey), and across departments (DFO, Natural Resources Canada). An integrated national approach is required to ensure cost-effective use and application of existing technical approaches, and for development of comprehensive information products on seabed characteristics for use in EAM applications.

Evaluation and prioritisation of key ecosystem indicators, including their data requirements, is needed to ensure that management and conservation objectives are being met. This should include continued evaluation and recovery of existing data, as well as its integration into current data streams. Sufficient resources need to be provided for the analyses of such time series data and indicators so that a predictive capacity using these data can be developed.

The impact of multiple environmental and human pressures and their interactions on aquatic ecosystems are poorly known but are often at the centre of management issues and responses. Improved understanding of multiple stressors and their interactions are necessary for the development of appropriate tools to incorporate cumulative effects into risk assessments.

CONCLUSIONS AND ADVICE

1. An overarching and comprehensive framework for how DFO will implement an ecosystem approach to management (EAM) is required to guide the necessary science support. This framework would also inform other EAM-related initiatives, including current and future funding directions.

2. A multi-sector working group is recommended within each Region to identify priorities that require science support within an EAM, to coordinate research efforts, and to implement EAM. These Regional working groups could feed into a similar national-level working group to share experiences and improve consistency.

3. A national ecosystem modelling and analysis working group is recommended to improve the Department's ability to address ecosystem-scale issues.

4. New tools and approaches to assess the cumulative effects of multiple stressors should be further developed. Data and models which support quantifiable impact assessments, especially for cumulative effects scenarios, would better support Departmental decision making. Common platforms for data collection, storage, and sharing are needed.

5. Comprehensive monitoring, analyses, and development of the Department's predictive capability are fundamental to successful implementation of EAM, but cost-benefit evaluation of collecting additional information needs to be considered.

6. Adequate time for integration and synthesis of the results among complex and multiple projects is essential for the provision of meaningful science advice, particularly where extensive field programs are involved.

7. A mechanism to acquire and maintain specialized Departmental personnel to conduct ecosystem science is essential.

SOURCES OF INFORMATION

This Science Advisory Report is from the 14-15 November 2012 National Synthesis of the 'Ecosystem Research Initiatives'. Additional publications from this process will be posted as they become available on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule.

CBD. 2000. Decision V/5 of the 5th Meeting of the Conference of Parties to the Convention on Biological Diversity; 15-26 May 2000, Nairobi, Kenya.

Curran, K., A. Bundy, M. Craig, T. Hall, P. Lawton, and S. Quigley. 2012. Recommendations for Science, Management, and an Ecosystem Approach in Fisheries and Oceans Canada, Maritimes Region. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/061: vii + 55 pp.

DFO. 2001. Proceedings of the National Workshop on Objectives and Indicators for Ecosystem-Based Management; Sidney, British Columbia; 27 February – 2 March 2001. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2011/09.

DFO. 2008. Five-Year Research Plan (2007-2012). Fisheries and Oceans Canada; DFO/2008-1525.

Ellis, S.L., L.S. Incze, P. Lawton, H. Ojaveer, B.R. MacKenzie, C.R. Pitcher, T.C. Shirley, M. Eero, J.W. Tunnell Jr., P.J. Doherty, and B.M. Zeller. 2011. Four regional marine biodiversity studies: approaches and contributions to ecosystem-based management. PLoS ONE, 6:12 pp.

Garcia, S.M., A. Zerbi, C. Aliaume, T. Do Chi, and G. Lasserre. 2003. The ecosystem approach to fisheries: Issues, terminology, principles, institutional foundations, implementation and outlook. *FAO Fisheries Technical Paper*. No. 443. Rome. 71p.

NAFO. 2010a. Report of the NAFO Scientific Council Working Group on Ecosystem Approaches to Fisheries Management (WGEAFM). NAFO SCS 10-19. 101pp.

NAFO. 2010b. Scientific Council Meeting Report: 3-16 June 2010. NAFO SCS 10-18. 247pp.

NAFO. 2010c. Report of the 3rd Meeting of the NAFO Scientific Council Working Group on Ecosystem Approaches to Fisheries Management (WGEAFM). NAFO SCS 10-24. 75pp.

Rice, J. 2011. Managing fisheries well: delivering the promises of an ecosystem approach. Fish and Fisheries. DOI: 10.1111/j.1467-2979.2011.00416.x

White, A.L., R.I. Perry, M.A. Koops, R.G. Randall, A. Bundy, P. Lawton, M. Koen-Alonso, D. Masson, P.S. Galbraith, M. Lebeuf, M. Lanteigne, and C. Hoover. 2013. A National Synthesis of the Fisheries and Oceans Canada Ecosystem Research Initiative. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/027. v + 31 p.

THIS REPORT IS AVAILABLE FROM THE:

Centre for Science Advice (CSA)
National Capital Region
Fisheries and Oceans Canada
200 Kent Street
Ottawa, ON K1A 0E6

Telephone: 613-990-0293
E-Mail: csas-sccs@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas-sccs/

ISSN 1919-5087

Correct citation for this publication:

DFO. 2013. National synthesis of the 'Ecosystem Research Initiatives'. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/026.

Aussi disponible en français :

MPO, 2013. Synthèse nationale des initiatives de recherche écosystémique. Secr. can. de consult. sci. du MPO, Avis sci. 2013/026.