

**National Technical Guidance
Document**

**Ecosystem Overview and
Assessment (EOA) Reports**

Prepared by

DFO Oceans Directorate

April 2005

DRAFT

“The success of ocean and coastal management depends largely on three basic elements, namely information, knowledge, and a structure for decision making. Information provides a description of the developing situation at a time and scale appropriate to the process or event taking place. Knowledge encompasses a sufficient understanding of the processes and complex interactions to make the necessary decisions and to give strategic directions to government.”

(Oceans 2020 – Science, Trends and the Challenge of Sustainability, 2002)

National Technical Guidance Document: Ecosystem Overview and Assessment Report

Table of Contents

INTRODUCTION

CHAPTER ONE INTERNATIONAL AND DOMESTIC EXAMPLES

- 1.1 International Examples
 - 1.1.1 International “EOA”
 - 1.1.2 Terms and Definitions

- 1.2 Domestic Examples
 - 1.2.1 Fisheries and Oceans Canada’s Ecosystem-Based Management Approach
 - 1.2.2 Other Domestic Assessment
 - 1.2.3 Terms and Definitions

CHAPTER TWO GUIDANCE FOR A MORE CONSISTENT APPROACH TO ECOSYSTEM OVERVIEW AND ASSESSMENT REPORT (EOA) DEVELOPMENT

- 2.1 Rationale for a more consistent approach

- 2.2 EOA Guiding Principles
 - 2.2.1 Principles to guide the EOA content
 - 2.2.1.1 Ecosystem-focused
 - 2.2.1.2 Brevity and Highlights
 - 2.2.1.3 State of Knowledge
 - 2.2.1.4 Scale Integration / Nested Systems
 - 2.2.1.5 Ecologically significant boundaries
 - 2.2.1.6 Plain Language

 - 2.2.2 Principles to guide the EOA process
 - 2.2.2.1 Collaborative and Team Project
 - 2.2.2.2 Flexibility to Regional Constraints
 - 2.2.2.3 Multiple Volume Document (to be achieved over time)
 - 2.2.2.4 Information Management

CHAPTER THREE STANDARD CONTENT OF AN ECOSYSTEM OVERVIEW AND ASSESSMENT REPORT (EOA)

- 3.1 Template for a Standard Table of Contents

General Information

- 1. Project Definition
- 2. Methodology of Study

Volume One: Status and Trends

Part A: Geological Systems

3. Marine Geology (Bedrock features)
4. Geomorphology
5. Sedimentology

Part B: Oceanographic System

6. Atmosphere / Ocean Exchange
7. Physical Oceanography (models)
8. Physical-Chemical Properties of Seawater

Part C: Biological Systems

9. Flora and Fauna
10. Habitat Use and Functional Areas

Part D: Ecosystem Description

11. How does the ecosystem work? Ecosystem Relationships

Volume Two: Ecological Assessment and Conclusions

Part E: Ecological Assessment

12. Areas of Concern (maps)
13. Impacting Activities and Stressors
14. Threats and Impacts on Ecosystem Properties and Components
– Cumulative Impacts

Part F: Conclusions and Recommendations

15. Uncertainties, Unknowns and Limits of Science Support
16. Major Environmental Issues and Concerns for the Study Area
17. Recommendations to Science Managers
18. Recommendations to Integrated Management

Cited References / Resources and Expertise / Annexes

GLOSSARY

REFERENCES

ANNEX

INTRODUCTION

Canada's *Oceans Act* states that "conservation, based on an ecosystem approach, is of fundamental importance to maintaining biological diversity and productivity in the marine environment." Taking an ecosystem approach to oceans management (or Ecosystem-Based Management) recognizes the complexity of marine ecosystems including the interrelationships between organisms, their habitats and the physical environment. Ecosystem-Based Management (EBM) is complex and therefore implementation must be planned in advance using a step-by-step process. Before EBM can be implemented in a management area, managers and stakeholders need to know the status and trends of the area's ecosystem and must conduct an ecological assessment to demonstrate what impacts human activities will have on that ecosystem. This assessment will provide managers with recommendations and will outline areas and activities that need priority actions. To get the required information Integrated Management Practitioners need to complete an Ecosystem Overview and Assessment report (EOA).

Ecosystem Overview and Assessment Report

What?

An Ecosystem Overview and Assessment Report is a technical document with the aim at providing integrated oceans management (IM) partners and stakeholders with relevant information on marine and coastal ecosystems, including the status and trends, an impact assessment and recommendations to management – based on the best science and knowledge available – in order to support IM planning and further decision-making

By providing the basic information that management needs, the EOA can also serve to engage IM stakeholders, support the identification of ecosystem objectives, identify science gaps, in terms of knowledge and monitoring, and suggest tracks to fill gaps.

Why?

An Ecosystem Overview and Assessment Report fulfills a portion of the first step in the Integrated Management process "Defining and assessing a management area" as laid out in the *Policy and Operational Framework for Integrated Management (2002)*. The social, economic and cultural aspects of a management area will be discussed in other documents (e.g. Socio-Economic Overview and Assessment Report). The Government of Canada's *Marine Protected Area Policy and Operational Framework* (in press) also requires that an EOA be completed as an initial step in assessing a Marine Protected Area- Area of Interest.

Who?

The EOA document will be produced by Fisheries and Oceans Canada, as the lead agency under the *Oceans Act*, on behalf of the scientific and ocean management

community. Although DFO has the lead role there will be many different organization and interest that will contribute to the process. Scientific expertise in the marine environment are found in the; federal government (e.g. information on geological processes, oceanography, fisheries, marine birds); the provinces and territories (e.g. land-based sources of pollution); academia, NGOs, aboriginal groups (e.g. Traditional Ecological Knowledge) and local communities (e.g. Local Ecological Knowledge). The document can be written internally (within DFO), with partners, or through a contract.

An EOA should be considered as a science-based document, but should not be written as a scientific paper since the targeted audience, the Integrated Management Table, is very diverse in its composition (i.e., stakeholders, partners, oceans users, interest groups, and other government departments) and will likely consist of non-specialists that will not be science experts. On the other hand, an EOA is a technical document and is not intended to target the general public, although they will probably be public documents at the end of the process. It therefore must be assumed that the audience will have sufficient background and knowledge to understand and effectively use such technical documents.

When?

In order to ensure that oceans integrated management needs are met in terms of scientific information, Ecosystem Overview and Assessment reports (EOAs) have to be produced in a timely fashion, i.e., as soon as an area of concern is recommended for IM planning or as MPA - Area of Interest. An EOA will have to be regularly updated to make it useful for Management in their attempt to create IM and MPA plans based on ecological considerations. An EOA should be updated every five years.

How?

In order to assist in the preparation of an EOA it is suggested that the authors follow a standard table of contents to ensure national consistency and a set of guiding principles.

Standard Table of Content

Specifically, an EOA must contain two main parts:

1) The first part is the ecosystem description *per se*, to report on ecosystem Status and Trends, as the basic information necessary to inventory key properties and components of ecosystems, understand how the ecosystem works (chapter on ecosystem relationships) and assess the state of the ecosystem; this part therefore should consist of different sections to report on influencing systems:

- a) Geological systems (e.g. sedimentology)
- b) Oceanographic systems (e.g. physical oceanography)
- c) Biological systems (e.g. flora and fauna)

2) Based on this background information, the second part of the document, Assessment and Conclusions is to provide managers with:

- a) An ecological assessment that is to: i) make a review of threats and human activities which have – or are suspected to have – significant impacts at the ecosystem scale; ii) assess and report on the impacts of human activities on ecosystem structure and function, and the overall marine environmental quality; and iii) identify the ecologically and biologically significant areas (EBSAs);
- b) Recommendations to the IM governance structure in place to support planning and management actions in the area of concern. These recommendations should also include recommendations to science managers, in terms of knowledge gaps identification, science research planning and the use of monitoring programs – be they existing or specifically designed – to effectively support oceans management in future.

Guiding Principles

In addition to following the standard Table of Content, EOAs writing should meet a series of guiding principles dealing with both, the process (as “*Collaborative and team project*”, “*Flexibility to regional constraints*”, “*Multiple-volumes*” and “*Information Management*”) and content (“*Ecosystem-focused*”, “*Brevity and highlights*” “*State of knowledge*”, “*Scale integration and nested systems*”, “*Ecologically significant boundaries*” and “*Plain language*”).

Brief History of this project

In 2003, Delaney & Associates Inc. conducted initial surveys and interviews, with DFO IM, MPA and MEQ practitioners from across Canada, to explore what should be included in an EOR for Ocean Management purposes. Based on this starting point and initial inputs, the Oceans Directorate along with feedback and comments from regions and other sectors expanded on the Table of Contents and provided some detailed explanations on how to write up certain sections of the Ecosystem Overview Report (EOR), including an ecological assessment. In addition to the standard Table of Contents, draft Guiding Principles for the EOR were also presented and discussed during an Integrated Management Practitioners’ Annual Meeting (Montréal, June 2003).

The Gulf of St. Lawrence Integrated Management (GOSLIM) was the first initiative that used the standard Table of Contents and Guiding Principles as guiding pieces, the 2004 draft, and has contributed to it throughout its process. The overall EOR process and the proposed standard Table of Content were then updated and validated during a national workshop organized by DFO (Moncton, January 2005) where draft EORs for two pilot LOMAs, the GOSLIM and Eastern Scotian Shelf Integrated Management (ESSIM), were assessed by Science, in terms of their scientific content, information reliability and relevance to Integrated Oceans Management. After the workshop the term EOR was change to Ecosystem Overview and Assessment report (EOA) to assist in clarifying that

the report not only contains a status and trends section but also included an ecological assessment.

Based on the fact that EOAs are key short-term deliverables identified in the Oceans Action Plan's Phase I for certain regions, the overall reporting process of EOAs was also discussed and refined during a joint Regional Director Oceans/Regional Directors Science national meeting (Quebec City, March 2005).

This guidance document has incorporated all the valuable feedback and comments from the above consultations and national workshops. In this respect, we hopefully see this guidance document as a living document that may also incorporate over time inputs and lessons learned from various draft "EOAs" initiatives under development in all the regions across the country.

About the content of this technical guidance document

The following EOA Technical Guidance Document is aimed at providing IM practitioners with some general guidance on how to write and what to include in an EOA. This document will provide an international and domestic context (Chapter 1), provide more details on the ten Guiding Principles to consider when writing an EOA (Chapter 2), and finally provide more details on what should be included under the introduction, ecosystem trends and status, and assessment and recommendation sections of the Table of Contents (Chapter 3). The document will conclude with a glossary of terms and a list of reference documents.

CHAPTER ONE: INTERNATIONAL AND DOMESTIC EXAMPLES

1.1 International Examples

Integrated Management practitioners and EOA authors may want to review similar initiatives conducted in other countries, or by other organizations worldwide, as “best practices” or just as sources of inspiration; for example:

- OSPAR Quality Status Reports (QSR 2000 series)
- Snapshot of the South-east - The South-East Regional Marine Plan (Australia)

Authors may also want to review the terminology and definitions used by other organizations.

- International Council for the Exploration of the Sea
- Millennium Ecosystem Assessment Initiatives

1.1.1 International “EOA”

OSPAR Commission – Quality Status Report 2000

<http://www.ospar.org/eng/html/qsr2000/QSR2000welcome3.htm>

The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention 1992) required that Contracting parties “take all possible steps to prevent and eliminate pollution and shall take the necessary measures to protect the maritime area against the adverse effects of human activities so as to safeguard human health and to conserve marine ecosystems and, when practicable, restore marine areas which have been adversely affected.”

The Ministerial meeting at which OSPAR Convention was signed issued an action plan which committed that quality assessments would be completed on the whole maritime area by 2000. The North-East Atlantic was divided up into 5 regions all producing a Quality Status Report: Arctic Waters, Greater North Sea, The Celtic Seas, Bay of Biscay and Iberia Coast, and Wider Atlantic. Each report provides an assessment of the marine environment and the effects that different uses have on it

A Quality Status Report is divided-up into 6 chapters:

- Chapter 1: Introduction
- Chapter 2: Geography, hydrography and climate
- Chapter 3: Human Activities
- Chapter 4: Chemistry
- Chapter 5: Biology
- Chapter 6: Overall assessment

Snapshot of the South-east - The South-East Regional Marine Plan (Australia)

http://www.oceans.gov.au/se_description_paper.jsp

In Australia, the completion of a description paper is one of the first steps in developing a marine plan. The description paper introduces the management area; its biological and physical nature; history; how it's used and how it's managed –from the coast to the deep seas. This paper is then followed by a scoping paper, which outlines the management process that is currently underway, and an assessment phase on what should be done in the future. The assessment phase includes a longer analysis of the interconnectivity of the bio-physical elements of the South-east ecosystem:

http://www.oceans.gov.au/pdf/natures_diversity.pdf

The description paper is divided into the following chapter:

1. Introduction
2. Australia's oceans (South-east marine region)
3. The Environment (ecosystems, habitats, fish, mammals, birds)
4. History and People (history, present, ocean organizations)
5. Use and Management (shipping, ports, fisheries, oil and gas, minerals and extractive resources, defence, conservation and marine protected areas)
6. Pressures (water quality, waste and pollution, habitat modification, threatened species, introduced species)
7. Overarching management within the Region (Australia's maritime zones, Commonwealth and States responsibilities, International obligations)
8. Conclusion

European Environmental Agency (EEA) Signals Series

<http://reports.eea.eu.int/signals-2004/en>

“The 2004 edition of the EEA's annual survey of environmental trends in its member countries covers aspects of agriculture, water pollution, nature protection, packaging waste, energy, transport, air pollution and climate change. It also provides an environmental perspective on the economic and social situation in Europe, including trends in demography and resource use, in the context of progress towards sustainability.”

These reports provide an example of how to do an ecosystem assessment summary for a large geographic area. Although this assessment covers terrestrial, freshwater and marine ecosystems there are a number of marine references such as marine protected areas.

1.1.2 Terms and Definitions

The International Council for the Exploration of the Sea (ICES)

<http://www.ices.dk>

The International Council for the Exploration of the Sea (ICES) describes an assessment as both a process and its product. As a process, a marine environmental assessment is a procedure by which information is collected and evaluated. It is undertaken from time to time to estimate the state of knowledge. Its product is an assessment report, which is a document synthesizing information, presenting the findings of the assessment (process) and making recommendations for action for future work. Assessments should include both a scientific/technical assessments and a management-oriented summary.

Based on this general definition, ICES proposed the following definition for a marine ecosystem assessment: Ecosystem Assessment is an analysis of and statement on the state of a marine ecosystem, including the influences of man, for the purpose of evaluating the need for and effectiveness of management measures.

ICES also makes distinction between different types of assessments: the product of an environmental assessment can either be a thematic assessment dealing with one aspect of the marine environment (e.g.: fish stock assessments), or a general (or holistic) assessment of all aspects of that environment. According to the ICES terminology, integrated assessments can be used in contexts both of thematic and general assessments. For example, a “eutrophication assessment” that looks at input of nutrients, and biological effects of nutrients can be considered an integrated assessment, integrating across input-concentration-effects.

Millennium Ecosystem Assessment initiative (MEA)

<http://www.millenniumassessment.org/en/about/index.htm>

On a global scale, the Millennium Ecosystem Assessment initiative (MEA) proposes definition of integrated ecosystem assessment as follows: An analysis of the capacity of an ecosystem to provide goods and services important for human development. According to MEA, the capacity of ecosystems to produce goods and services ranging from food to clean water is fundamentally important for meeting human needs and ultimately influences the development prospects of nations. From the MEA’s perspective, an integrated ecosystem assessment includes both the ecological and economic analysis (should be multi-sectoral assessment) and it considers both the current state of the ecosystem and its future potential. Finally, because the geographic boundaries of an ecosystem are arbitrary, MEA suggested that an ecosystem assessment could be conducted at a single site, for a region, or globally (should be place-based assessment).

1.2 Domestic Examples

Domestically Fisheries and Oceans Canada has the mandate under the *Oceans Act* to lead and facilitate integrated oceans management. As such the department has developed an ecosystem-based management approach which includes the completion of an EOA. It is however important to note that there are initiatives, led by other government agencies and organizations, which partially meet the needs of an EOA. IM practitioners should be aware of these initiatives in their area and if possible collaborate with them to ensure that there is no duplication of effort.

1.2.1 Fisheries and Oceans Canada’s Ecosystem-Based Management Approach

Canada’s *Oceans Act* states that “conservation, based on an ecosystem approach, is of fundamental importance to maintaining biological diversity and productivity in the marine environment”. An ecosystem approach to management (Ecosystem-Based Management) is a guiding principle for implementing oceans management and preserving the health of oceans under Canada’s Oceans Action Plan.

Ecosystem-Based Management (EBM) is the management of human activities, so that, ecosystems, their structure (e.g. diversity of species), function (e.g. productivity) and overall marine environmental quality, are maintained. This ecosystem approach to oceans management recognizes that activities must be managed in consideration of the interrelationships between organisms, their habitats and the physical environment.

A visual representation of Canada’s EBM framework can be seen in Annex 1

An EOA is an important product in the ecosystem approach and ensures that the Integrated Oceans Management process has the scientific tools necessary to develop a suite of ecosystem objectives and indicators to maintain ecosystem structure and function. With an EOA as a scientific base it is then very important for the IM process to include social, cultural and economic considerations. The challenge is to manage humans within the ecosystem and not the ecosystem itself. Therefore equal attention should be given to these elements in the form of similar reports such as a socio-economic overview and assessment report, as seen in Annex 2. Once all these considerations have been described and analyzed it is important to pull all the relative information together and ensure that socio-economic objectives are being met within the ecosystem objectives and where this is not possible that the right trade-off are done to ensure the sustainability of the system.

1.2.2 Other Domestic Assessments

Strategic Environmental Assessments (SEAs)

Canada’s offshore petroleum boards require that applications for projects that will involve field work include an environmental assessment consistent with the requirements of the *Canadian Environmental Assessment Act (CEAA)*.

SEA represents a broader, more proactive approach to assessing and managing environmental effects than those done on a case by case basis. SEA typically focus on “regional-scale” environmental concerns, and allow any such issues to be considered early, before project-specific activities are defined. Because SEAs are undertaken early in the planning process, there is often little or no information available regarding the nature, timing and location of specific projects and activities. Therefore, these assessments usually focus on general environmental issues and describe potential effects in relatively broad terms. SEA is not meant as a replacement for project-specific environmental assessment processes. Rather, the objective is to provide the type and level of information necessary to aid decision-making at the early stages of the planning process. This process is very similar in nature to an EOA.

Elements to be considered in an RSEA, in a regional context:

- The purpose of an offshore petroleum proposal;
- The potential environmental effects, including cumulative effects;
- The significance of the above effects;
- Any uncertain significant environmental effects and how they could be dealt with;
- The manner in which any potential adverse significant environmental effects could be mitigated, and any positive environmental effects enhanced;
- The manner in which the proposal could contribute to the sustainable development of a region;
- Alternative means of carrying out the proposal, and the environmental effects of each option;
- Relevant national and international obligations;
- Parallel policies, regulations or agreements (e.g. Oceans Act, Fisheries Act, Species at Risk Act, Migratory Birds Convention Act, National Marine Conservation Act and relevant Aboriginal lands claims or self-government agreements)
- Interests of regional stakeholders, the public and relevant Aboriginal interests;
- Other existing and proposed activities in the subject region;
- The need for follow-up measures in respect of the proposal; and
- Other federal sustainable development priorities

Example

<http://www.cnopb.nfnet.com/newsr/2004nr/env/sealsb.pdf>

A Strategic Environmental Assessment was done for the Laurentian Basin (see references). This document included sections on the physical, biological and socio-economic environments; environmental effects analyses; and a section on environmental planning and management considerations.

Tides of Change Across the Gulf – An Environmental Report on the Gulf of Maine and Bay of Fundy

<http://www.gulfofmaine.org/council/publications/tidesofchangeacrossthegulf.pdf>

This document provides a brief overview of the Gulf of Maine Ecosystem, a state of the Gulf (e.g. status on water quality and biodiversity), and analyses some of the main stressors on the Gulf (Land use; Contaminants and Pathogens; Fisheries and Aquaculture).

1.2.3 Terms and Definitions

Canadian Environmental Assessment Agency

<http://www.ceaa.gc.ca/>

According to the Canadian Environmental Assessment Agency (CEAA) an environmental assessment is a planning tool used to identify the possible adverse effects of development projects on the environment – the air, water, land and living organisms, including human populations.

CHAPTER TWO: GUIDANCE FOR A MORE CONSISTENT APPROACH TO ECOSYSTEM OVERVIEW AND ASSESSMENT REPORT (EOA) DEVELOPMENT

2.1 Rationale for a more consistent approach

An EOA supports decision-making for IM and, therefore, it is essential to have all of the management bodies and decision-making authorities participate in the planning and management processes. As such, EOA format should be stakeholder friendly. Part of making overviews “friendly” is to ensure consistency from one document to the next.

A more consistent approach is also focused on practitioners, to facilitate efficient transfer of ecosystem knowledge between the various DFO regions, headquarters and other interested parties. A more consistent approach will support effective development of EOA, facilitating specialization of skills (for specific components of the EOA or EOA inputs) and eventually performance review and improvement.

Multiple approaches also do not fully support the vision of shared stewardship. Integrated management calls for a seamless framework of LOMA and CMA plans with overlapping stakeholders, some of whom are national or multi-national companies or other government departments or agencies.

As well, a more consistent approach will permit the sharing of EOA development best practices and lessons-learned. Consistency of EOA within the same region and nationally will also help to foster the establishment of partnerships and alliances across organizational, functional or jurisdictional boundaries. This will assist in greater efficiency and reduce time required to conduct process.

EXAMPLE

The oil and gas industry is an important player at the IM table. The Canadian Association of Petroleum Producers (CAPP) mandate is to enhance the economic well-being and sustainability of the Canadian upstream petroleum industry in a socially, environmentally and technically responsible manner. As a national body they will be contributing to all the IM processes and therefore should have access to consistent IM products, such as EOA, from across Canada

2.2 EOA Guiding Principles

A series of Guiding Principles has been set up based on comments and feedbacks from the initial interviews and surveys conducted with selected Oceans Management practitioners. These guiding principles were also presented and discussed at the IM

practitioner annual meeting in Montreal in June 2003. The aim of these guiding principles is to guide the national approach to EOA development within the broad IM context, in terms of both, the information needs (some of these are guiding principles dealing with the content of reports), and consistency within regions as well as nationally (some are principles to guide the EOA process). Therefore, in addition to contributing to the EBM development and dissemination, i.e., educate and inform on ecosystem science to IM, these guiding principles will ensure and support national directions and priorities, regional flexibility and innovation, adaptive management, communication strategy and information sharing at both, the internal-DFO (within Oceans Management; with other groups and sectors), and external level (with DFO partners and IM stakeholders, as well as the general public in a certain extent).

2.2.1 Principles to guide the EOA content

2.2.1.1 Ecosystem-focused

The primary focus of an EOA is the ecosystem and all its components and properties– both biological and physical – that support marine life; they have to be detailed whereas the impacts of human activity (the pressures and stressors) on those ecosystems components and properties (the receptors) which support the ecosystem structure, function and processes have to be assessed.

In contrast, neither the human systems nor their impacts on the socio-economic activity have to be detailed or assessed in the EOA, but only briefly reviewed and described in the EOA; they will be the subject of other types of reports such as a Socio-Economic Overview and Assessment report

An ecosystem overview is focused on the ecological elements within the study / management area. However, although biological and physical components are key components of the ecosystem, they have to be presented within an oceanographic context and from an environmental/ecological perspective. Therefore, there is a need to describe and report on all the non-biological information. Indeed, biological elements (species, populations, communities) are influenced by other natural processes running within the atmosphere (e.g. climatic conditions, ocean/atmosphere interactions), the ocean (e.g. water circulation patterns, physical-chemical properties), and the sea floor (e.g. surface sediments, geomorphology). Of particular interest are physical oceanographic processes that should be sufficiently explained and detailed to be able to capture all influences they have on marine life (organisms development, species distribution, ecological assemblages, species abundances and biodiversity, productivity, sensitivity to the seawater/sediment quality, etc.).

In addition, the relevant information on non-biological aspects like socio-economic activity that may potentially affect the ecosystem and its bio-physical components within the study / management area should be also provided (i.e., the description of major human activities) and analyzed (assessment of their impacts on ecosystems) in the EOA. However, socio-economic aspects should not be detailed in the report; rather, they should be documented in an appropriate format (outside the EOA) but their impacts on ecosystem assessed within the EOA. The basic socio-economic data and detailed information should be referenced (e.g.: list of primary sources or pertinent “links” for accessing to complementary information). When the relevant Socio-Economic Overview and Assessment Report – the EOA-like report counterpart – exists, it would be good to prepare and insert an executive summary of this socio-economic overview report into the EOA, in place of the appropriate chapters and sections, with a mention of this report as key reference for linking with socio-economic aspects, both types of overview reports altogether providing the “information package” needed for implementing the broad IM process.

By taking into consideration all the influencing systems, we ensure that all the major impacts on the ecosystem will be captured, described and assessed within the report. These influencing systems, both natural (atmosphere, physical oceanography, geology) and human (socio-economic activity) are integral parts of the “ecosystem” when this concept is taken in its broader (environmental) sense, and therefore, as far as their potential impacts are concerned, they have to be integral parts of an EOA. Of course, for technical and practical reasons, it will be easier to write and describe each of the influencing systems as a separate chapter.

2.2.1.2 Brevity and Highlights

Only concise, synthesized and relevant information based on the best science and knowledge available to put the ecosystem into an IM planning perspective, inform the ecosystem based management, and support decision-making is needed.

Although an exhaustive review of literature in relevant topics will be needed of course, to ensure that the EOA is based on the “best science available” at this moment, an exhaustive description of the study / management area however is not necessary within an “overview” to management. The EOA focuses on the highlights of information that speak directly to the requirement that “triggered” development of the overview. Highlights include summary information about the important aspects (biological and non-biological) of the area, unique or special features, as well as any information that is required to make management decisions that sustain or improve the health of the area or of ecosystems adjoined to or contained within. Any known trends should also be identified and situated.

The overview should provide highlights of historical insights relative to resource use and changes to elements within the system or links outside the system. This helps the reader

to contextualize the information from a temporal perspective, e.g.: population level or water quality has changed over a certain period.

It's assumed that the length of an EOA will depend on the size or scale of the study / management area. A LOMA-scale report is expected to be more lengthy than one developed for an MPA nested within. This is due to the extent of the study area that, at large scale, will likely encompass a greater variety of natural features and processes than within a more limited area. Therefore, as far as the reporting process is concerned, larger the study/management area, greater the chance to have numbers of natural features and processes of concern and/or of interest. For example, when a large area is under consideration (i.e., ecoregion or LOMA), the EOA will have to describe a larger portion of the marine environment with likely a greater variety of shoreline types, supporting a more complex hydrography, a variety of habitats, complex large scale patterns like currents or winds regimes, in addition to a greater number of species, populations or communities of interest (and their habitats) living in this large area.

The maximum length of EOA of course will depend on the complexity and coverage of the study/management area. As such the following general guidance was discussed with IM practitioners and is provided here as a rule of thumb:

- LOMA / ecoregion scale : 200 pages maximum
- CMA/MPA scale: 50–100 p. maximum

Finally, one must point out that the more complex the marine environment and related issues in the study area, the more challenging their description and assessment in a limited in length document, and the more difficult it will be to achieve a common understanding across a broad range of audiences and users (see also the principle of “Plain Language”).

2.2.1.3 State of Knowledge

An EOA should be considered as a snapshot (the picture of the current state of the ecosystem) although in will also use historical information to assist in predicting future trends.

As such they should draw upon or reference existing DFO (and other OGD), aboriginal, and/or public domain information (academic, NGO, local communities, stakeholder, etc.) relevant to management of the area. Including all that is known about the study / management area would, however, be impossible and if attempted would render the document useless for the intended purpose (see principles regarding “Plain Language” and “Brevity and Highlights”). Rather, the overview should review the data/information available and provide key references.

Overviews are developed mostly from existing knowledge (information / data), however it is recognized that this information, for the most part, was collected for other uses and is generally not in a format that empowers / supports integrated management. Therefore, it

should be understood that supplemental information is likely required and should be included as it becomes available. Moreover, knowledge gaps should be identified for the ecosystems and its components, as well as for any “non-biological” systems or components (e.g. human activity as well as natural influencing systems such as geomorphology and climate).

It is also important to note that Local and Traditional Ecological Knowledge should be included where available to complement the scientific knowledge and/or provide information on areas where there are existing scientific gaps.

Whatever the methodology used to develop the report, it will be important to identify any knowledge gaps when discussing the nature and scope of systems that influence or impact the study / management area.

2.2.1.4 Scale Integration / Nested Systems

A “scale integration” approach means authors understand that ecosystems are nested systems and the study / management area is part of larger systems, but also contains smaller systems which both can influence the focus area and components and processes within.

Within an ecosystem overview context, it would be wise to integrate scales with respect to both the ecological and geographical components (see also the principle dealing with boundaries). Indeed, it is important to note that each study / management area is comprised of components of other ecosystems and, typically contain several smaller ecosystems nested within its boundaries. The study area also is linked to, or affected by, other local, regional, and potentially global-level systems. Therefore, the concept of ecosystem overview could be taken to mean: *providing an overview of the important aspect of the ecosystems that are adjacent to or contained within the study or management area.* “Important aspects” should be defined as taken to mean the information that is required to develop management options and supporting activities like monitoring the marine environmental quality, and reporting on the ecosystem health.

From an ecological point of view, the EOA should take account linkages between components (e.g. organisms and their role in food web, biology/physical-chemical coupling) within the scale so that changes in ecosystem components can be traced back to influences outsider the ecosystem. Although EOA mostly focus inward, to understand, document and explain the numerous relationships within the ecosystem, within their sub-structures, and between its components, EOAs should also place these findings within an outward looking context to report on key linkages and interrelationships at broader scales (i.e., outside the ecosystem or area of concern) to capture the nested structure of ecosystems with possible consequences on the way to manage activities based on ecosystem considerations which are necessarily limited in space.

From a spatial perspective, each study area should be placed and described within a local, regional, oceans and global context. There are two levels of scale at which an EOA may be required for oceans management purposes under the Oceans Act: at the large scale, or ecoregion-scale, EOAs will be developed to support IM planning within a LOMA, whereas at a smaller scale, an EOA or EOA-like will be required to inform management around a CMA¹ or provide the ecosystem context to an existing MPA, or assist in the evaluation and selection of a proposed MPA².

From a management perspective, if the study area was an MPA or a CMA, the regional scale would be the LOMA. If the study area was a LOMA or the relevant ecoregion(s), the scale of the study would be truly regional, but planners and managers should still consider smaller (local) and greater (national, or oceans-wide) scales, as well as possible global linkages. It's essential to look at global scale to better understand and address certain issues and global threats, but which are of concern at regional and local scales too (e.g., global warming and climate change, ozone layer decrease, long-range transport of pollutants).

When describing components, properties or systems that influence or impact these ecosystem features, it is important to always consider scales from local / regional to global extent. Sometimes, these are also referred to as: "coastal", "shelf", "oceans" and "global" scales.

2.2.1.5 Ecologically significant boundaries

The boundaries of the study area under consideration for an EOA have to be defined and based on the ecosystem and therefore must take into consideration ecoregions and sub-components of ecoregions with the management area.

In fact, this is the only way to capture the integrity of ecosystem-scale features and meaningfully assess and report on the ecosystem health within a given portion of the marine environment, because it's essentially a multi-dimensional (both spatial/3-D and temporal – i.e., with marked variations with depth, and annual and seasonal variability) as well as moving environment.

To make integrated management and the related ecosystem-based management (EBM) approach operational, ecological regions (ecoregions) had to be delineated in all the Canada's marine environment. Ecoregions are the first level of marine areas in which EBM objectives (ecosystem objectives) have to be established for management purposes. Adopting this management approaches (i.e., management by objectives within distinct oceans areas) requires that marine ecoregions be defined on a consistent basis, as a

¹ Policy and Operational Framework for Integrated Management of Estuarine, Coastal and Marine Environments in Canada, Canada's Oceans Strategy, DFO, 36 p (2002).

² National Framework for Establishing and Managing Marine Protected Areas – A Working Document. DFO, 21 p. (1999).

national set of ecoregions³, providing the science foundation to support oceans integrated management. That means EOA has to inform management about the ecosystem structure, function, and key features in a given geographic unit, so that management plans (based on ecosystem objectives) can be developed and implemented in this area. EOA boundaries should therefore follow as much as possible boundaries of the given ecoregion in which the study / management area is part of, or ecoregions (two or more) which are partly covered by the study / management area.

Alternatively, when a LOMA already exists with defined boundaries, assuming the boundaries delineation has been based on ecological considerations (i.e., following some ecoregion-scale patterns), the EOA may be developed accordingly, and the LOMA boundaries may be taken as the boundaries of the study area for reporting purposes. In contrast, when the LOMA for which an EOA is required overlaps two or more ecoregions, it could be difficult to manage such a case because the rationale behind the science-based ecoregion delineation would lead to consider the scientific information at the scale of these adjacent ecoregions (i.e., taken together) to capture the integrity of large scale ecosystem patterns and features. However, going this way would imply that a very large area (two or more ecoregions) would have to be considered, and that would probably make the reporting process much more complex than considering only one supporting ecoregion, which is already a large and complex portion of the marine environment by it-self. However, in such cases, and when it's possible, it would be wise to consider ecoregion sub-units based on the identification of natural sub-structures at scale smaller than ecoregions⁴.

2.2.1.6 Plain Language

An EOAs is a science-based report but it should not be written, nor considered as a true peer-reviewed scientific paper since the targeted audience is the IM partners and stakeholders, to inform and engage them in the management process, and the aim of the report is to facilitate a common understanding of the basic ecology of the study / management area and related environmental issues.

The targeted audience consists likely of non-scientists, but, interested and informed oceans-oriented people, like natural resources managers, DFO partners, IM stakeholders and users involved at various levels in the integrated management process. EOA authors therefore have to keep in mind that targeted people are not science experts, but people with a certain level of knowledge about oceans processes and issues. On the other hand, an EOA is a technical document and is not intended to target the general public, although

³ Proceedings of the Canadian Marine Ecoregions Workshop. DFO, CSAS Proceedings Series No.2004/016, 47p. (2004).

⁴ During the Ecoregion Workshop, emerging substructures were identified within some ecoregions as natural ecoregions sub-units, and for each of them, the report gave rationales based on science criteria reviewed during the workshop.

such reports will be probably public documents at the end of the process. We must therefore assume that the audience will have sufficient background and knowledge to understand and effectively use such technical documents. This understanding is central to resolving conflicts and achieving consensus among stakeholders when establishing management objectives, targets, indicators, and any thresholds.

The intent of an EOA however is not to popularize marine sciences although they likely could be a good technical reference and starting point to further prepare public-oriented documents such as fact sheets on specific issues of concern, thematic brochures or to support information posted on government and partner websites.

In fact, the real challenge is to evaluate the level of details and technicality actually needed. Such reports need to be readable by a large spectrum of people with different scientific background and knowledge (from managers to practitioners and resource users) while maintaining scientific standards for ensuring reliability and accuracy, as well as the necessary support and buy-in to the overall process.

It is also important that stakeholders and users with relevant local or traditional ecological knowledge (L&TEK) be able to use this knowledge and report on it in order to improve the quality and usefulness of the overall document. That means that both, the “western” science and L&TEK should be merged together and their respective contributions to the EOA process should be put together, described and assessed into the relevant (topical) chapters and sections of the report. When and where this kind of knowledge is available because it has been previously collected and documented, L&TEK should be an integral part of the EOA, and therefore integrated into the relevant thematic sections and not only summarized and reported within one single, most of the time anecdotic, section of the report. The aim is to create a value-added product and possibly a synergy between these complementary approaches of collecting information on the environment and building the knowledge around. With this respect, merging both types of knowledge, rather than just reporting on them within separate compartments would be the best approach to EOA, but probably the most difficult to achieve. This could be envisaged by EOA authors and/or project leaders as a long-term project and could be achieved through subsequent updates of the report.

A glossary would be essential, where scientific terms can be elaborated or briefly explained to non-specialists. It’s also recommended to include a list of acronyms, in addition to providing lists of scientific references and suggested readings (bibliography) as well as a selection of the most pertinent and reliable websites on related topics.

2.2.2 Principles to guide the EOA process

2.2.2.1 Collaborative and Team Project

Regional experts, scientists and managers in the various fields of expertise need to be involved at all stages of the project and a structured team devoted to the project management and coordination will ensure the quality, coherence and timely release of the final product.

The writing of an EOA should be a team project. In this respect, regarding the complexity of such a document and process as well, it is therefore strongly recommended that an *ad-hoc* organization and team structure be set up at the very beginning of the project. For example, it will be wise to identify at least four different levels of task within the EOA organization structure, each of them being involved at a certain period in time during the EOA process:

- At the management level: a *Steering Committee* or like for project planning and management; the SC will be in charge of the overall process, secure funding and have the responsibility to present the final document ultimately to the IM Table;

- At the implementation level: a *Project Leader* who should be entirely dedicated to the project for the necessary period of time (or alternatively, and depending on regional constraints, this task can be split and collectively achieved by a *Project Coordination Team*. These people will be well aware of the process, main objective and content of an EOA. The project leader or coordination team will have to coordinate the overall process, guide the assessment part, report to SC on the advancement of the project, solve problems during the process, and prepare the final conclusions and recommendations of the report. This coordination team will be in charge of the organization and guidance of the Task Group and should be able to report on the on-going work to high level management when required. In order to avoid delays or miscommunication and to be able to quickly fill the process gaps, the Project Leader ideally would be a member of the Task Group him-self.

- At the working level: a *Task Group* for the bibliographic search, data gathering and compilation, drafting report and editing work; This group should consist of several people with a strong science background (scientists, biologists, Ph.D. students in Oceanography) who have collectively a large expertise in all the scientific domains of interest (physical oceanography, ecology, biology, geology, etc.). In addition, they should know very well the area of study, in addition to having a good knowledge of environmental issues of concern. The Task Group should be already informed – or should be educated before the beginning of the work – about the purposes of the EOA. Depending on regional constraints, human resources available and/or expertise of people, the tasks and responsibilities within the Task Group may be partitioned and organized around geographic areas, sub-regions, themes, issues, or just around EOA chapters. If the Task Group is to go this way, the coordination task and the role of the Project Leader (or Coordination Team) will become critical to meet deadlines and ensure the consistency of the final product.

- At the external level: a *Review Panel* which consists of internal (DFO scientists) and/or external experts in the topics of interest with the aim at: 1) Reviewing the basic science information used in the EOA (i.e., assessment the data quality, reporting on important missing information, ensuring that the best science available has been effectively used); and 2) Validating the reliability of the ecological assessment and conclusions which are based on.

Although the EOA Process is coordinated by Oceans Act Programs staff, DFO scientists as well as external experts from other government agencies and academia covering the various topics of interest will be likely involved in the process, whatever they act as data providers, primary authors, collaborators or reviewers. Since the EOA is supposed to be based on the best science available, the best regional experts should therefore be involved and contribute to the report. The Project Coordination Team or Project Leader will have the challenging task to contact, and engage regional experts and coordinate their work during all the process. To get involved in the EOA will ensure the best quality for the final value-added product. However, collaborators, authors and the project coordinator must keep in mind the “content” principles and particularly the “Plain Language” and “State of Knowledge”.

2.2.2.2 Flexibility to Regional Constraints

Project managers and authors should strive to follow the EOA protocol as closely as possible, although the protocol – and guidance tools it includes – should be applied in a way that best meets regional needs and constraints.

EOA are developed in the regions, with regional resources, to address regional issues and accountabilities; therefore the guidelines should be applied in a way that best meets regional needs. The guidelines are provided to foster a consistent approach to implementation of legal and policy drivers to help engage stakeholders early in the IM planning process, to manage knowledge about ecosystems effectively and to enable continuous improvement. EOA project managers should strive to follow the national approach as closely as possible, and use these “guiding principles” to guide any modifications to the suggested framework.

Regions may follow the national guidelines however they may wish to expand or emphasize certain sections (or add new sections) around topics that are regionally significant. For example the Pacific region might have a section dedicated on salmon due to its ecological significance whereas the Central and Arctic region might place more emphasis on climate change and Traditional Ecological Knowledge and the Gulf of St. Lawrence on freshwater influences.

2.2.2.3. Multiple Volumes Document

A “multiple volumes” approach based on the nested structure of marine ecosystems and IM areas should be envisaged in the long term in order to provide the needed information when/where required and facilitate the update and use of reports by a large audience of users.

It’s not expected that this principle can be met at the beginning of the EOA development, but it would be wise to apply this principle over time, as the EOA process is going on, when the report is updated (see: the Information Management principle), when new information is requested by management and/or new science and data are made available over time. For example, one can assume that more details on a specific ecosystem component or property for which there are still science gaps (e.g. deep-sea corals, genetic diversity of marine life) or new environmental issues (e.g. seismic activity, offshore aquaculture) will be needed over time to support planning or decision-making with respect to emerging activities and increasing number of oceans users within IM areas. That will be also the case in Arctic areas where a lot of science on the ecosystem structure and function is needed to inform the IM planning, and this need will certainly increase in future as climate change goes on and affects arctic ecosystems.

Finally, this principle will become obvious and will be probably the best way to manage the huge amount of information and reports likely produced over time on the focus area. At this point in time, the current EOA process could serve to provide a framework to organize and make sound linkages between all the relevant information and documentation available in the area of study. At this time, managers and planners will need to have an overall document to review, highlight and summarize all the EOA-like documents available to management.

The “Brevity and Highlights” principle assumes that a “multiple volumes” approach can be used to develop the EOA in an effective and practical way, i.e., based on the current nested approach that is being developed for delivering on IM areas for oceans management purposes. For example, if a CMA or MPA was developed within an existing LOMA, the final document (that is: LOMA-EOA) should not exceed 200 pages, the CMA (or MPA) EOA (or EOA-like) becoming an integral part of the overall EOA developed at the LOMA-scale. In this case, the LOMA-EOA would serve to set up the broad environmental context to the nested CMA or MPA. In subsequent reports at this smaller scale, there would not need to repeat again the large scale features and ecosystem characteristics already described at large scale. However, this small-scale overview report would be the opportunity to insist on site-specific features or patterns which are characteristic of the study area (CMA or MPA) under consideration (e.g. a significant habitat for an MPA, or an environmental issue of local concern for a CMA).

This maximum length should include all charts, maps, references, etc. Authors should, furthermore, keep in mind that a picture is truly worth a thousand words. As much as possible use graphs, charts, pictures, and any other value-added products to transform information. Overviews should maximize the use of graphical information (figures, maps,

charts, videos, etc.) to clearly illustrate the boundaries of the study / management area, any internal or external linkages, or important and unique features. The EBSA framework and methodologies under development will be certainly very useful to achieve that. As well, synthesis tables should be developed to summarize important data on specific topics and synthesize the most relevant information on issues of concern and the related complex relationships that may exist (e.g. cumulative effects).

In this respect, we can assume that a significant part of the contextual and spatial information needed for management purpose (IM planning) would be already included in previous report developed at larger (LOMA)-scale. Over time, the overall EOA could be built as a multiple-volume report, making the update process easier and timely, and probably more workable at both scales.

Over time, general species information can be contained within a “summary sheet”, be transferable from one overview to the next, and available over the internet, thus freeing “space” to discuss important historical, use, population or genetic information, rather than for a basic description.

2.2.2.4 Information Management

An EOA represents a significant resource investment and should be regularly updated to maintain them as the most relevant science-based information to oceans planning and management. The periodicity of updates will be decided by IM practitioners and will be designed accordingly (coordination, team authors, science inputs etc...)

As noted previously, much of the existing information used to develop and implement Oceans Act programs initiatives was likely not collected through an oceans management or ecosystem-based perspective so far. Ecosystem-focused information will likely require the completion of the EOA or require that certain aspects of the ecosystem structure, function or processes (e.g. relationships between species, trophic structure, natural cycles and pathways, biology/physical components coupling), including recent discoveries of unknown features (e.g. deep-sea corals) and the lack of basic data in remote areas (e.g. Arctic ecosystems), be identified as knowledge gaps for the time being to be hopefully addressed in future and reported in subsequent versions of the EOA (see the Information Management principle).

Therefore EOA should be considered as an important “knowledge asset” for Oceans Management and DFO as a whole, since several sectors (e.g.: Oceans-Habitat Management, Science, Fisheries Management) would contribute to EOA through their own expertise and mandate. As an example, new research activities, collection/analysis of new data series and significant improvements in scientific knowledge within a study / management area where an EOA exists should be used to update the EOA. This various technical information will help meet oceans management needs and allow IM planners

and regional coordinators to engage stakeholders and further nurture the decision-making process.

One should take into account the fact that an increasing amount of data and datasets will be available via the web (re: the GoL initiative). So, when building background documents, compiling references, and writing factual text, we should look at this opportunity to: 1) facilitate the editing and updating process, and 2) ensure that the reporting process is as transparent as possible in terms of access to data, data validation, availability and reliability of the information.

Without any other opportunity (trigger) for initiating *ad-hoc* update of existing reports, it is strongly recommended to plan the EOA life cycle on a 5 year update process, the Oceans Management community seems to have a consensus on that, based on previous interviews and discussions.

The initial EOA that is produced by DFO and other experts should remain in draft format until presented at the IM table. This will provide the stakeholders to provide feedback before it becomes a final product. Final versions of EOA should become public documents available through all possible means of dissemination using the structures already in place to ensure an effective and timely release of the report (e.g. posted on DFO or partners websites, published as technical documents through the various DFO publication processes and formats, CSAS, HSR, etc., and *via* the departmental library system) so that they can be referenced by other IM practitioners and managers, available to other functions within the department, as well as outside DFO. It would be also important to make final version of EOA available via the internet in order for local communities to access to this information. Furthermore, by posting EOA on a web site could make the editing process easier and also facilitate further updates.

Finally, EOA should also be seen as an opportunity to record undocumented corporate knowledge about the study / management area or the ecosystem components within. Depending on the stakeholders involved in the IM/EOA process, the unpublished/undocumented “corporate” knowledge could also include that which resides in the hands of the industry and others governments (provincial, territorial, municipal); the type of information that federal departments – or any other public services – cannot afford to duplicate.

CHAPTER THREE : STANDARD CONTENT OF AN ECOSYSTEM OVERVIEW AND ASSESSMENT REPORT (EOA)

This chapter begins with providing authors a standard table of contents to be used when writing up an Ecosystem Overview and Assessment Report (EOA). The rest of the chapter provides more details around the content and/or the usefulness of all individual sections that are listed in the table of contents. After reading this chapter authors should have a general idea of what to include for their specific EOA.

3.1 Template for a Standard Table of Contents

A Standard Table of Content has been developed as national guidance, to ensure that there is a consistency in regional EOAs, in terms of content and level of details and that Management needs are met in terms of science-based information

Ecosystem Overview and Assessment reports – Standard Table of Contents

GENERAL INFORMATION

Title Page

Credits and Study Administration

- a. Project Team, Authors and Collaborators
- b. Credits, Copyrights and Disclaimer

Executive Summary – Highlights

Table of Content

1. Project Definition

- a. Context and Purpose of Report
- b. Boundaries of Study Area

2. Methodology of Study

- a. Sources of Information
- b. Information Use and Reliability

VOLUME ONE. STATUS & TRENDS

Part A – GEOLOGICAL SYSTEM

3. Marine Geology (Bedrock features)

4. Geomorphology

- a. Topography of Coastal Landscapes
- b. Hydrography and Watersheds
- c. Bathymetry and Seascapes

5. Sedimentology

- a. Characterization of Surface Sediments
- b. Biogeochemistry (Trace-Metals and Natural Hydrocarbons)

- c. Resource Potential (overview)

Part B – OCEANOGRAPHIC SYSTEM

6. Atmosphere/Ocean Exchange

- a. Seasonal Climatic Patterns
 - i. Air Temperature
 - ii. Precipitations
 - iii. Prevailing Winds and Storms Tracks
- b. Heat Exchange and Budgets

7. Physical Oceanography (models)

- a. Freshwater inputs
- b. Sea level and Tides
- c. Water Masses and Currents
- d. Stratification and Mixing (Fronts, Gyres and Upwellings)
- e. Waves and Turbulence
- f. Ice (Permanent and Seasonal Coverage)
- g. Underwater Sound – Sources and propagation

8. Physical-Chemical Properties of Seawater

- a. Temperature, Salinity and Water Density
- b. Dissolved Oxygen – Areas of Hypoxia
- c. Suspended Matter – Light Availability
- d. Organic Carbon (DOC/POC)
- e. Nutrients – Flux and Budgets
- f. Biogeochemistry (Dissolved Trace-Metals and Natural Hydrocarbons)

Part C – BIOLOGICAL SYSTEM

9. Flora and Fauna

- a. Planktonic Communities
 - i. Bacterioplankton
 - ii. Phyto- and Zooplankton

- iii. Ichthyoplankton
- b. Benthic Communities
 - i. Microalgae
 - ii. Macrophytes
 - iii. Infauna
 - iv. Invertebrates
 - a. Commercial Species
 - b. Non-Commercial Key Species
 - v. Ground Fish
 - a. Commercial Species
 - b. Non-Commercial Key Species
- c. Pelagic Communities
 - i. Invertebrates
 - ii. Marine Turtles
 - iii. Pelagic Fish
 - a. Commercial Species
 - b. Non-Commercial Key Species
 - ii. Marine Mammals
 - iii. Sea Birds

10. Habitat Use and Functional Areas

- a. Mating / Spawning / Breeding Areas
- b. Rearing Areas
- c. Foraging / Feeding Areas
- d. Migration Routes
- e. Critical Habitats (under SARA)

Part D – ECOSYSTEM DESCRIPTION

11. How does the ecosystem work? Ecosystem Relationships

- a. Physical-Biological Linkages
 - i. Influence of physical factors on biology and species distributions
 - ii. Nutrient Cycles, Blooms, Upwellings
- b. Biological Interactions
 - i. Functional Processes
 - ii. Food Web and Trophic Structure

- c. Natural Variability – Seasonal, Inter-Annual and Long-Term Changes
- d. Resilience of the Ecosystem

VOLUME TWO
ASSESSMENT AND CONCLUSIONS

PART E – ECOLOGICAL ASSESSMENT

12. Areas of Concern (maps)

- a. Ecologically and Biologically Significant Areas (EBSAs)
- b. Conservation Areas (MPAs, NMCAs, Wildlife Conservation Areas, etc.)
- c. Heavily Impacted Areas (e.g. ‘hot spots’ of contaminants, habitat degradation)
- d. Ocean Space Uses (Fishing zones, Oil & Gas Licenses, Aquaculture sites, Corridors, etc.)

13. Impacting Activities and Stressors

- a. Major Human Activities of Concern
 - i. Land-Based Activities
 - ii. Harvesting of Renewable Resources
 - iii. Extraction of Non-renewable Resources
 - iv. Transportation and Communications
 - v. Recreational Activities
 - vi. Other Sea-Based Activities
- b. Anticipated / Emerging Activities
- c. Global Stressors (regional focus)

- i. Global Warming and Climate Change
- ii. Ozone and UV Radiations
- iii. Long-Range Transport of Pollutants
- iv. Aquatic Invasive Species

14. Threats and Impacts on Ecosystem

Properties and Components

– Cumulative Impacts

- a. Biodiversity and Species at Risk
- b. Productivity and Use of Oceans Resources
- c. Water/Sediment, Habitat and Biota Quality
- d. Integrity of Coastal Landscapes and Bottomscapes
- e. Cumulative impacts/effects

PART F – CONCLUSIONS AND RECOMMENDATIONS

15. Uncertainties, Unknowns and Limits of Science Support

16. Recommendations to Science Managers

- a. Identification of Knowledge Gaps (*may be discussed in appropriate sections above*)
- b. Monitoring and Research Needs

17. Recommendations to the Integrated Management

- a. Summary of the Major Environmental Issues and Concerns for the Study area
- b. Identification of Priority Areas and Actions Needed
 - i. In the short-term (1 year)
 - ii. In the medium term (2-5 years)
 - iii. In the long term (> 5 years)
- c. Best Practices – Examples of Interest

CITED REFERENCES

(Or may be listed at the end of each corresponding sections)

RESOURCES AND EXPERTISE

- List of regional experts in fields of expertise
- List of ongoing initiatives in topics of interest
- Selected Bibliography and Web Resources

ANNEXES

- Glossary (technical terms used in the report)
- List of acronyms
- Supporting Technical Documents (*if needed*)

IMPORTANT NOTICE

How to use this standard Table of Content

The EOA Protocol is under development; it will give explanations on the content of each chapter and section proposed in the Standard ToC. In the interim, the aim of this standard ToC is to provide EOA project coordinators and authors with a guidance to organize the information in order to describe ecosystem features and discuss environmental issues that may be observed in all Canada’s Oceans and regions. It must be noted that not all sections of the standard ToC may be necessary, according to the study area. Only those relevant to Ecosystem-Based Management should be detailed and discussed in the EOA for IM purposes. On the other hand, only overall chapters and sections are mentioned in the Standard ToC. Authors may want to re-organize the proposed chapters or add new sections to highlight specific features and/or regional issues that are considered important for meeting IM needs in the study area / at the regional scale. Additional sub-divisions can be added into a given chapter/section if necessary

General Information

Title Page

The title page should contain the name of the management area as the title followed by the words “Ecosystem Overview and Assessment report”. It should also list the principal author and steering committee chairperson, the date published, draft (or not) and the WAVES reference number (Re: DFO on-line library system), if one has been assigned.

Credits and Study Administration

a. Project Team, Authors and Collaborators

Only the main authors/editors and name of the committees should be mentioned. The complete list of participants, committee members and collaborators should be listed in an annex.

b. Credits, Copyrights and Disclaimer

It is recommended to write down the official document citation on this page.

Executive Summary

This section should be written last, based upon findings uncovered during the EOA development. The summary should be no longer than 40 pages. It is also important to note that this will be the section that will be the most read out of the EOA and therefore should be written in a style that targets a wider audience while still capturing the essence of the document.

Table of Contents

The table of contents should follow the national template outlined in section 3.1. If a section is not relevant for a specific management area then this should be explained in the text. Regions can also add section depending on their regional differences.

1. Project Definition

a. Context and purpose of Report

When writing the content and purpose section refer to the introduction provided in this guidance document.

b. Boundaries of study area

It is important to define the boundary of the study area and to provide the criteria used in its delineation; such as ecoregions, jurisdictional boundaries etc. A map of the management area should be provided along with a larger scale map situating the area in a regional, national or international context.

2. Methodology

a. Sources of Information

This section describes in general the sources of information that are used in this text and the uncertainties that come with various types of information. This description can also be done throughout the EOA in thematic sections. In this case, every section should start and use general sentences like: “*The info available on this topic are: ...*” (to review and briefly describe the info available). If existing literature reviews are used to review the info available, authors should add a section to provide up-to-date information on the topic: “*From this time, it has been reported that....*” and “*Major knowledge gaps are...*”.

It is also important to reference any other “EOA” like initiatives that have already been completed in the area. These past initiatives can be a great starting point for this process.

b. Information Use and Reliability

Emphasize that these documents are produced with the best available science.

Volume One: Status and Trends

The purpose of volume one is to get a better understanding of the ecosystem(s) in the management area in order to have a base upon which an impact assessment can be completed and recommendation can be provided to managers concerning the sustainable use of the area. This volume will include a description of geological, oceanographic and biological systems and their interrelationships at the habitat and ecosystem levels. It will also briefly talk about human systems discussing the various governance structures that provide the mandate for decision making in the area of interest and will discuss the human activities that have an impact on the ecosystem. Human systems will be discussed in more detail in the Socio-Economic Overview and Assessment report.

Part A - Geological Systems

The section should focus on marine geology. Marine geographic components within the system are important to understanding how other systems function (Geology of the area, such as bedrock and sediments, may influence and drive the habitat types and in turn the species distribution) and will provide important information for modelling, scenario-building and incident response. To date, unique geographical components have been the driver for several MPA-focused overviews.

Example

The Endeavour Hydrothermal Vents Marine Protected Area has been designated to ensure the protection of the hydrothermal vents, which consist of large hot black smokers (chimney-like structures), and the unique ecosystem associated with them. In this case strong scientific background and knowledge on these geological features is of particular importance.

In this section it is important to document the overall structure of the study area and to pay special attention to unique or special features.

3. Marine Geology

Include a brief description of the geological history of the area (glaciations, post-glacial variations of sea level) and present day geologic composition (e.g. bedrock features).

4. Geomorphology

The geomorphology section goes more into detail on the topography of coastal landscapes, the hydrology and watersheds adjacent to or affecting the LOMA and the bathymetry and seascapes of the management area.

a. Topography of Coastal Landscapes

According to the brevity principle (section 2.2.1.2), authors should use any established or emerging classification systems, such as the Coastal Classification system, and provide a full description as an attachment (avoid reinventing the wheel). Description of coastal landscapes should, at a minimum, provide information on influencing watersheds and individual rivers, estuaries, and any significant bays, islands, wetlands, etc.

b. Hydrography and Watersheds

It is important to make the connection between the management area and its adjacent watersheds. This will provide useful information on a variety of topics such as freshwater discharge, land base sources of pollution, and the life history of species such as anadromous fish. If available inset a map indicating all the watersheds.

c. Bathymetry and Seascapes

There are a number of tools (e.g. multi-beam mapping) that are currently being used to map the ocean floor. This section should detail the level of knowledge that is presently known in the management area.

5. Sedimentology

A description of the Sedimentology of the area will capture the characterization of the surface sediments (providing a geological link to habitats), and the distribution of trace-metals and natural hydrocarbons (providing managers with a spatial representation of current and potential geological resources).

a. Characterization of Surface Sediments

The term sediment is used to refer to all consolidated particles transported and deposited by water, wind, glaciers, and gravity. Most sediments are deposited in the oceans along the margins of continents. The spatial distribution and composition of sediments depend on their geological history and the recent physical, biological, and chemical processes that modify and transport them.

b. Biogeochemistry (Trace-metals and Natural Hydrocarbons)

This section includes the mixture and distribution of trace metals in the management area, which would include unconsolidated mineral aggregates (e.g. sand and gravel), siliceous sand, calcium carbonate and heavy metals (e.g. gold, iron, magnetite, titanium, chromite). In the mining industry Coal is also classified as a non-fuel mineral.

There should also be a description of the distribution and amount of known natural hydrocarbons such as oil and gas,

c. Resource Potential

The author should capture areas in the LOMA where there is resource potential (e.g. Oil and gas in the Pacific Region). This can play an important role in future management decisions.

Part B - Oceanographic System

The oceanographic system section describes the physical oceanography of the region (e.g. water masses and currents, ice, underwater sound); the physical-chemical properties of seawater (e.g. temperature, salinity, dissolved oxygen) and on the atmosphere / ocean exchange (e.g. air temperature, precipitation). Historically a lot of oceanographic data was collected at sea however now this information can be supplemented with new satellite technologies and computer model simulations.

6. Atmosphere / Ocean Exchange

Not a lot of detail is needed in this section however it's useful for making links to storm events, climate change, as well as long range transport of contaminants.

Example

The Eastern Scotian Shelf is a region which is strongly influenced by atmospheric systems and physics. It is as an open area with major currents acting offshore as its boundaries. This atmospheric system acts quite different then in areas where the management is more landlocked such as GOSLIM.

a. Seasonal Climatic Patterns

i. Air Temperature

A brief description of the air temperature throughout the seasons and some indication of temperature extremes that have occurred are sufficient.

ii. Precipitations

Include data on monthly average precipitation and indicate areas with high rain and snowfall.

iii. Prevailing Winds and Storms Tracks

It is important to focus on the effect of winds and storms on the ecosystem and local habitats. The potential impact on humans will be captured in other documents.

b. Heat Exchange and Budgets

Management areas at different latitudes will play different roles in the global ocean/atmosphere heat exchange.

7. Physical Oceanography (models)

There is a need to first look at the large scale, by using physical oceanography models before looking at the local scale with local issues.

In terms of describing the physical oceanography, a good model based on (calibrated against) the best data available is sufficient and would do a better job –in terms of providing relevant and synthesized info – rather than several tables of raw data inserted into the document. This is pertinent as long as the model can apply to the study area as a whole, with well identified external forcers.

The key question would be: Given the model results in this area, what are the major sources of uncertainties? They should be identified in the document, along with the discussion on model validation and reliability. If several models exist for a given area (e.g. Gulf of St. Lawrence), they should be taken into consideration and the document should try and provide a non-biased point of view, describing – and showing results from – all the models available.

a. Freshwater inputs

Freshwater inputs and drainage basins are very influencing in certain areas and may have important impacts on coastal and marine ecosystems (eg. Mackenzie Delta - Beaufort Sea).

b. Sea level and Tides

The sea level is defined as the variation of the water surface elevation with respect to a reference level. In oceanography, this reference level is generally taken as the mean sea level that follows the Earth's Geoid.

Tides are relatively easy to predict. They can be quite important to look at in some areas because they can produce turbulent energy through friction with the bottom as well as internal gravity waves. They also play a role in shaping coastal habitats.

In DFO, Marine Environmental Data Services (MEDS) acquires, processes, quality controls, archives and distributes tide and water level (TWL) data reported on a daily to monthly basis from the DFO Canadian Hydrographic Service (CHS) water level gauging network.

c. Water Masses and Currents

Water masses are the result of the fluxes in its properties, such as air temperature, freshwater runoff, and shelf water, and the subsequent redistribution of these properties through circulation and mixing. It is useful to know the residence time and distribution of the water masses.

The instantaneous variations in currents are dominated by difference sources such as tides and winds. The longer term mean currents are in geostrophic equilibriums that are sensitive to local density changes and wind fields that are much harder to predict.

d. Stratification, and Mixing (fronts, Gyres and Upwelling)

Areas of strong upwelling, in which cold, dense water from the bottom is forced to the surface, are often areas of enhanced biological productivity. These areas are useful to know and can provide information needed to select Ecologically and Biologically Significant Areas and assist in information for the Species At Risk program.

e. Waves and Turbulence

A description is needed on surface waves (wind driven) and internal waves (eg. Areas of a shelf edges and slopes, currents, tidal processes and bottom topography promote upwelling events and enhanced mixing of water masses creating internal waves.)

f. Ice (Permanent and Seasonal Coverage)

Sea-ice can be an important limiting factor for biological activity and human activities such as navigation in some areas (e.g. Gulf of St. Lawrence). The decrease in ice coverage, due to climate change, can also have limiting factors for biological activities, such as Polar Bears habitat in the north.

g. Underwater Sound – Sources and propagation

It is important to describe both the natural variability of noise in the marine environment and noise resulting from human activity (vessels, seismic activity).

8. Physical-Chemical Properties of Seawater

Physical-Chemical properties in seawater are important to track. A small change in any of these properties can cause a significant impact on the ecosystem.

a. Temperature, Salinity and Water Density

Temperature is an important environmental factor because many species have narrow temperature tolerances. Changes in temperature will affect their spatial distribution. Temperature also influences metabolism, growth rate, and reproductive output.

Salinity influences the presence of marine species both directly through salinity preferences of particular species and indirectly through its effects on stratification, water movements and hence, phytoplankton productivity.

Differences in the density of seawater throughout the water column (i.e. stratification) affect the aggregation of biological matter in the upper layers of the ocean. Density is a function of salinity, temperature and pressure and therefore varies in depth. These parameters (Temperature/Salinity and density) are commonly measured in any oceanographic survey and stock assessment conducted by DFO, other departments and universities.

b. Dissolved Oxygen – Areas of Hypoxia

It is important to be able to map out areas of Hypoxia (areas with low dissolved oxygen concentrations). This will provide information on the location of “dead zones” in the management area and will allow managers to track the location and percent coverage of these zones over time.

c. Suspended Matter – Light Availability

Light i.e., solar light available to the system (re: photosynthetic process, euphotic zone, etc.) is important to include in volume 1. This can be done in this section or else within another section like Plankton (phytoplankton). On the other hand, light pollution should not be addressed in the EOA since this issue will unlikely be a priority at the large scale.

d. Organic carbon (DOC/POC)

About 50% of the dry weight of living organisms is carbon. Studying carbon informs us about life, ecosystem and their functioning. Carbon, in the form of carbon dioxide, is also a major greenhouse gas released to the atmosphere as a result of human activities. The oceans carbon cycle is believed to play a key role in controlling atmospheric carbon dioxide levels. This type of information will provide managers with information on what role the management area has in the large context (e.g. important carbon sink)

e. Nutrients – Flux and Budgets

The three major nutrients that are found in seawater are nitrates, phosphate and silicate. Nitrate is the most abundant, but nitrate, ammonia and organic compounds also contribute to organic build-up. When nutrient levels are deficient in the surface waters they can limit primary productivity.

f. Biogeochemistry (dissolved trace-metals and Natural hydrocarbons)

A trace metal is a chemical element that is present in the water column or in the sediment (discussed in the geological systems section) at very low concentrations. Some of these elements are necessary at extremely low concentrations for normal metabolism of animals and plants. However when some of these concentrations increase they can be toxic to living organisms.

Natural hydrocarbons (essentially from the alkane family) can be produced by certain species of microalgae. They usually are used as bio-tracers and it's important to distinguish them from anthropogenic hydrocarbons (e.g. from fires, oil spills, fuel and chemicals). Natural hydrocarbons are not really toxic compounds in contrast to other types of hydro-like aromatics and PAHs.

Part C - Biological Systems

The biological systems section will cover the taxonomic groups that occur in the ecoregion(s) along with and some specific examples of species that occur in the area. Habitats and habitat use (e.g. spawning, foraging) will also be discussed.

9. Flora and Fauna

This section summarizes the major biological components of the coastal and offshore water and is divided up by Planktonic Communities, Benthic Communities, Groundfish and Pelagic Communities. Each section describes the communities, the populations and the species present and where necessary will provide details of individual species' biology, life history, diet, migration route, habitat, and interrelationship with other species.

Throughout this section it is useful to have description of non-commercial and commercial species in different categories. There is a lot more information on commercial species and

therefore the data sets will be more complete and will provide more input for analysis. The non-commercial species, which are also very important in the ecosystem, will generally have a lot less information and therefore will demonstrate the gaps in current knowledge. Non-commercial species have recently received more attention in areas such as: species at risk (e.g. Wolffish), by catch issue, forage species.

a. Planktonic Communities

It's important to have information, not only on ecosystem components that management can manage directly but also on components which are important to sustain the rest of the ecosystem, food webs, etc. like plankton. A large amount of information is available from the global Continuous Plankton Recorder Monitoring Program (CPR) initiative which has collected data world-wide for decades (global trends), and from local/regional programs like the Atlantic Zonal Monitoring Program which focuses on seasonal changes at regional scales.

There is also a need to report on the plankton biodiversity and on plankton sensitivity to contaminants (For example, some plankton species may be used as indicator –or sentinel– species for early warning signals of impacts or change in the ecosystem health.) There are very few data on this latter point.

The plankton community is subdivided into three categories

i. Bacterioplankton

Bacterioplankton are non-photosynthetic bacteria. Although very little is known about this “ecosystem” component an increasing number of scientific studies give evidence that in certain areas and periods of time bacterioplankton could play a major role in flow and transfer of energy, recycling, biodegradation, organic matter and nutrients in the lower level of the ecosystem.

ii. Phyto- and Zooplankton

Phytoplankton are the main primary producer of the ocean. They convert inorganic carbon into organic compounds through photosynthesis and constitute the basic source of energy in the marine environment. Growth and survival of primary producers are highly affected by environmental factors.

Zooplankton are the link between the primary producers and the larger organisms. They are prey for many organisms, from large whales to small invertebrates. All species of fish feed on zooplankton during some stage of their lifecycle. The availability of zooplankton is a limiting factor for the success of many other species in the ocean.

The spatial distribution of phyto- and zooplankton may provide information on the distribution of higher trophic levels, and vice-versa.

iii. *Ichthyoplankton*

Plankton that are larval stages of fish are called Ichthyoplankton.

b. *Benthic Communities*

The benthic community, organisms that live at the bottom of water bodies, comprises a wide variety of organisms ranging from bottom-dwelling groundfish and commercially valuable crustacean to bivalves to invertebrates and microorganisms of many forms with little or no commercial value but with significant ecological importance.

i. *Microalgae (epiphytes)*

In the benthic community microalgae will be attached to other organisms (epiphytes). All pelagic microalgae is captured in the plankton section.

ii. *Macrophytes*

Macrophytes are divided into two categories: macro-algae (plants with no root system) and vascular plants (plants with a root system).

iii. *Infauna*

Benthic infauna live in sediments (e.g. soft substrate such as shallow mud flats). Infauna provide a significant food source for many species of fish and wading birds.

iv. *Invertebrates*

This section should describe the diversity and distribution of benthic invertebrates. The planktonic stage of many of these species should be discussed in the plankton section. Benthic invertebrates provide food for groundfish, bottom-dwelling commercial invertebrates and marine birds.

- a. Commercial Species
- b. Non-Commercial Key Species

v. *Groundfish*

Groundfish live near the bottom for much of their adult life but often have eggs and larvae that float near the surface or suspended in the water column.

- a. Commercial Species
- b. Non-Commercial Key Species

c. *Pelagic Communities*

i. *Invertebrates*

Most of the invertebrates that have been studied are found in benthic communities however there are several important pelagic species that should be described (e.g. squid, shrimp, octopus)

ii. *Marine Turtles*

Although marine turtles are a highly migratory species they do spend some of their time in Canadian waters. It is important to note that many of these species are Species At Risk.

iii. *Pelagic Fish*

Pelagic fish are those fish that spend most of their adult life in the water column as opposed to the bottom, such as groundfish.

- i. Commercial Species
- ii. Non-Commercial Key Species

iv. *Marine Mammals*

Two groups of marine mammals are found in Canadian waters: the cetaceans (e.g. whales, dolphins, porpoises) and the pinnipeds (seal, sea lions and walruses). Authors should also emphasize areas that are known as being rich in marine mammals (number of species and number of individuals) often contributing as significant habitats for many of the population including Species At Risk.

v. *Sea Birds*

Sea birds can be used as indicators for fish breeding areas, and of ecosystem-scale changes like changes in fish distribution and abundance.

10. Habitat Use and Functional Areas

A description of habitats and habitat use is essential in starting to make the links among the systems. This can be done in an independent section or else can be detailed while describing various species and their communities. If the latter option is selected then this section can act as a summary of what has been described elsewhere in the forms of geographical maps.

Habitat systems are an extremely complex and important component of any ecosystem. A well-established classification structure for marine habitats has not been adopted by DFO, however,

the lifecycle of many species within the system follows a predictable pattern. This pattern offers a structure for identifying important components of the habitat systems for species within the ecosystem. Under each component, for each species discussed, a description of the routes or areas should be provided and they should be located on a map. Where many species are being discussed a matrix approach (as illustrated below) to information sorting may be appropriate.

- a. Migration Routes
- b. Spawning Areas
- c. Rearing Areas
- d. Foraging Areas
- e. Critical Habitat (under SARA)

SPECIES	Migration	Spawning	Rearing	Foraging
Species A	A.1		A.3	
Species B	B.1	B.2	B.3	B.4
Species C	C	C	C	
Species D	D.1, A.1	D.2	D.3	D.4
Species E	E.1	E.2	E.3	E.4, B.4, D.2

In the above example five species are listed as spend part or all of their lifecycle in the ecosystem. An alpha-numeric descriptor (cross-referenced to a map) can be used to illustrate the location of “critical habitat” for a number of different species, thus outlining the interrelationship between species and their habitat system components. By using a matrix to “map” various species habitat a picture interconnections develops. For example, species D, in the example above, shares a portion of its migration route with species A, and species E shares a common foraging area with species B and D. The matrix illustrates that the forage area for species E is also a spawning ground for species D and that species A will only migrate to and rear within the ecosystem.

When describing the various habitat system components authors should include the location and nature of any plant beds, shellfish beds, important substrate, reefs, shoals, estuaries, bays or lagoons, or rivers that link geographic components to habitat components for the spawning or migration purposes. Marine mammals should be grouped together in a separate sub-section and permanent versus seasonal preferences noted.

Habitat components are best documented through the use of species maps. For example, one map is used to illustrate the various habitat components for a particular type of fish and a separate map used to outline a particular mammal habitat. Overlays can then be used to illustrate the linkages between the two species throughout their life cycle, within the study area.

It is also important to include in this section the critical habitats that are identified under the Species At Risk process.

Part D - Ecosystem Description

11. How does the ecosystem work? Ecosystem Relationships

The aim of this section is to ensure the integrated assessment of the ecosystem. This section gives the story line; how the big stuff (e.g. processes at large scales) influences the small/local features; e.g. temperature, oxygen, currents regimes.

The description of the ecosystem (how does it work?) should be based on existing and well known models like Ecopath, when they exist and have been validated for the study area, for example in the Gulf of St. Lawrence, Pacific coast.

a. Physical – Biological Linkages

Linking physical and biological processes and components

For example, this is the influence of physical factors on lower trophic levels (which is well enough known and investigated by Science), but also describe how physical oceanography drives higher trophic levels (e.g. how does the temperature influence Cod distribution), as well as links with the benthos. The latter are much less known.

i. Influence of physical features on biology and species distributions

ii. Nutrient Cycles, Blooms, Upwellings

b. Biological interactions

Biological interactions i.e., between species, within biological components (e.g. predator/prey, key stone species, food webs, etc.)

i. Functional Processes

ii. Food web and Trophic Structure

All aspects of an ecosystem are interconnected, but a given species or population will be heavily dependent on some relationships and influenced to varying degrees by many others. For example, some species may be heavily dependent on a single prey species, and will decline rapidly if the prey species declines. Other species are opportunistic and switch easily within a wide range of prey species. Similarly, some species will be highly dependent on a specific habitat feature or temperature range while others may thrive in a range of environments. Highly mobile or adaptable species may seek out new environments if conditions deteriorate, while highly sensitive or less mobile species may decline. Given the size and diversity of the marine environment, these relationships are highly complex and difficult to quantify, but nevertheless are critical in understanding and managing the human use of marine ecosystems.

This section is also the appropriate place to give indications on the role and magnitude of environmental forcings, and to draw conclusions about which ecosystem properties and relationships are important. Here again, models –where they exist – may be helpful to

characterize and give an overview of the ecosystem functioning. For example, using data from models like Ecopath, and/or results from programs using this model like CDEENA in Atlantic regions.

c. Natural Variability – Seasonal, Inter-Annual and Long-Term Changes

There is also a need to report on changes in the ecosystem (e.g. trends over time; assessing the natural variability, etc.)

d. Resilience of the Ecosystem

Provide an indication of the resilience of the ecosystem.

Presently, our understanding of the ecosystem linkages is limited, but growing every day as the merging “ecosystem science” develops in terms of capacity building, development of new tools and approaches etc. As understanding and knowledge grows it will be important to update the EOA to ensure as comprehensive as possible an overview of the study / management area highlights. At this time, however, it is likely that insufficient data exists for an exhaustive listing of ecosystem interrelationships, therefore it is suggested that EOA should contain at least the highlights of linkages of those “key species” (“keystone” species) that are ecologically or economically important, or are considered good indicators for the overall health of the ecosystem. It’s important to note that if there is missing information concerning the relationships or interrelationships between system components at the local, regional or global level, it should be identified as a knowledge gap.

Use of a “multi-scale linkages” matrix

In order to integrate linkages and knowledge gaps into a composite picture for key species within the study / management area, it’s proposed to use the below matrix which has been specifically designed to meet guiding principles developed within this protocol (ecosystem focus, integration of scale, highlight, etc.) Keep in mind that only highlight information should be provided, with details in the appendices or referenced. The example of Capelin, a well known forage species, is provided below:

Scale	Coastal / Local scale	Regional (ecosystem) scale	Global scale
<p>Key linkages with other components and related issues</p>	<p>Habitat issue: Spawning areas have to be coarse sand or small gravel beaches at temperatures of 5-11°C.</p> <p>Habitat issue: May also spawn in shallow coastal areas ((2-3m) or in depths of up to 80m in offshore banks</p> <p>Links to physical properties of water column: beach spawning is most intensive during periods of intermediate tides.</p> <p>Links to atmospheric conditions: larvae emerge and are swept out of coastal areas by (warmer) onshore winds.</p>	<p>Productivity issue: Capelin forms an estimated 40% of cod diet.</p> <p>Food web structure issue: Capelin is one of the most important links in the food chain for the entire Northwest Atlantic. Capelin feeds on zooplankton (emphasis on Euphausiids) and are preyed upon by most larger fish.</p>	<p>Productivity issue: Capelin are very important forage fish for haddock, Atlantic salmon, founders, turbot, whales (minke, fin and humpback), seals (harp and ringed) and seabirds (murre, gulls, gannets, puffins, etc)</p>
<p>Knowledge gaps and/or concerns</p>	<p>Water Quality issue: Industrial activity: poor forestry, agricultural, aquaculture and construction practices can lead to increased turbidity and siltation of spawning beaches.</p> <p>Water Quality issue: industrial effluent can alter water temperature and salinity, thus changing larvae emergent timing and survival rates.</p>	<p>Water Quality issue: eggs and larvae are most susceptible to water quality and spawning habitat impacts.</p> <p>Water Quality issue: waste and spill oil from marine traffic can render local condition unsuitable for spawning.</p> <p>Habitat Loss issue: local dredging operations can alter, disturb or destroy spawning habitat</p>	<p>Biodiversity and Productivity issues: How will climate change affect the Capelin life cycle and what will be the consequences on the productivity of this forage species and further on the structure of all the food-web ?</p>

Volume Two: Assessment and Conclusions

Ecological Assessment (EA) and the Oceans Management perspective

The EA part should focus on environmental issues of concern at the regional scale for IM-LOMA purposes and at the smaller (local) scale for IM-CMA (or MPA) purposes. (see: the guiding principle of the Scale Integration). Whatever the scale of concern, the EA should be specific enough (to the area of concern) rather than just a discussion supported by general comments and global knowledge. For example, in addition to being supported by collective and general knowledge about major environmental issues and concerns, the EA should first and foremost refer to (and discussion built around) regional specificity, in terms of environmental problems (current and expected in near future), concerns and threats, science issues (knowledge, gaps and uncertainties), management priorities (in terms of both spatial scales and timeframe), etc..

How does the EA part fit within the broad document?

General consideration.

While the Volume I (Status and Trends) provides a description of the key features of the ecosystem (what they are, how they work, interact and respond to changes, etc.), based on the best science available, including local and traditional ecological knowledge, as well as a review of human activities of concern at the appropriate scale⁵, the ecological assessment (Vol. II) is to review, discuss and assess when, where and how these activities may have impacts on these key ecosystem components and properties (the receptors of impacts). Then from this assessment, the report may provide conclusions and recommendations to management (IM) on how to deal with the results of the assessment, for example, how to cope with those activities that are considered as the most impacting at the management area scale, the receptors that have been identified as such, i.e., key components or emerging properties that are threatening (e.g., species at risk, biodiversity, integrity of coastal habitats), as well as major environmental issues the management area is facing (e.g. exotic species, contamination, regime shift). When looking at the overall structure of the EOA report, it's really based upon the information flow, moving from the basic information and collective knowledge collected on the ecosystem and compiled from all various sources of knowledge available to an evaluation of the threats, impacts and concerns, then providing recommendations on how to address these issues timely and within the management (IM) context, in order to manage human activities at appropriate spatial and temporal scales, as per the definition of the ecosystem approach to integrated oceans management⁶.

⁵ i.e., those activities that may have significant impacts at the ecosystem-level when the EOA is for a LOMA purpose, or activities that may have an impact on specific sub-components of the ecosystem which are important at the smaller scale, for the area of interest, for example a CMA or an MPA)

⁶ IM Policy and Operational Framework, COS companion document, DFO, 2002.

Example: Fishing as activity of concern

In the case of fishing (as the pressure and human activity of concern), background ecosystem-related information should be found in following sections:

- In Part B (Oceanographic System) / Chapter 7 (Physical Oceanography) and Chapter 8 (Physical-Chemical Properties of Seawater):

The necessary information for a good understanding of oceanographic processes and water properties (e.g. currents, water temperature) that have a significant influence on the species distribution and their ecology; e.g. range of distribution for fish, marine mammals and benthic species, larvae moving and dissemination with currents, availability of light and nutrients for determining phytoplankton blooms and maximum peaks, etc.

- In Part C (Biological System) / Chapter 9 (Flora and Fauna) and Chapter 10 (Habitat Use and Functional Area):

The relevant information on the various species (or groups of species) of interest, i.e., in this example, those species which are caught either by commercial or recreational fishing, including species which are not targets but harvested as by-catch of targeted fisheries. In addition to providing the relevant information on the biology of these species (e.g. growth, reproduction, recruitment process, life cycles) this part provides the description of the habitat, the main features required for achieving important biological functions of species of interest (e.g. spawning or feeding areas). When habitat features are considered as important characteristics for achieving specific vital functions in life cycles of species, this type of information should be compiled and reported in relation to the parallel process of the identification of ecologically and biologically significant areas. (See: section (a) in chapter 16 of the Ecological Assessment)

- In Part D (Ecosystem Description) / Chapter 11 (Ecosystem relationships):

The general understanding of possible interrelations between species of interest (in this example, those species which are targeted and accidentally caught by fisheries) and other key components of the ecosystem. Both types of interactions have to be investigated here: the influence of the physical environment on the biology of the species (e.g. the range of benthic species distribution with bottom water temperature) and interactions between the species of interest and other species (e.g. predations-prey relationships; the place and role of the species in the trophic structure; its historic/natural role; its relations with forage species and other groups of species of interest like species at risk, invasive species, etc. For example, important relationships (i.e., those that are key support to the structure and function of the ecosystem under consideration) existing between commercial species and other species of interest – but not necessary with commercial interest (eg: keystone or “glass hour” species, forage species, endangered species and/or species exposed to specific threats, etc.) and links to other ecosystem components (eg: physical components), and relations to (influence of) human stressors and associated impacts as well will be highlighted as part of the ecological assessment (see: Key Ecosystem relationships). This section will serve to integrate all the information into an ecosystem perspective, by making linkages between ecosystem components when these links are sufficiently known (food web structure, change in predation pressures, impacts of change in water properties, or impact of habitat degradation, etc.). The aim is to provide enough information on the ecosystem relationships so that the indirect (and hopefully cumulative) impacts of a human activity may be assessed, not only direct

and obviously trivial impacts of a specific activity on a specific receptor or ecosystem component.

Considerations on the assessment of impacts and related terminology

Several terms are frequently used in environmental impacts assessments and related documentation, in an attempt to characterize those impacts we want to assess and report on. The problem is that impacts of human activities on ecosystems are the result of complex processes, involving complex “living” systems (networks, pathways, multiple components with their own characteristics and sensitivity), and therefore they are “things” like impacts of human activities on ecosystem components that are not easy to quantify or even to predict, because we have no supporting data or we don’t know exactly how “important” these impacts are or will be actually. So, because we need at least, to report on such impacts in ecological assessments, and for the purposes of this report, we propose below “definitions” (meanings) for a series of adjectives that are often used to qualify/quantify these impacts, and how they are ranked (impact assessment) on various axes (or scales) of interest. The intent here is not to give a rigid glossary, but rather providing a guidance on the significance of terms that are frequently used by people who have to do environmental assessments, i.e., using attributes to assess human impacts which are, most of the time, not black or white, but moving within a full range of grey. This guidance hopefully will help make EA reports consistent from each others, and even comparable, despite different authors participate in their writing. So, as much as possible, we recommend authors to use the above terms and keep in mind their meanings when they prepare EA chapters and sections.

- The importance of the impact

Impacts are usually rated from “major” to “negligible”. In order to fix these terms (i.e., attached to them some significance on their meanings and importance) a common threshold is to say that an impact is considered as “**major**” when it’s expected (or anticipated) that it results in a change of 10% or more in a given indicator or attribute of an ecosystem property. This indicator may be the size of a population (e.g. a major impact will be a greater than 10% in decrease the number of individuals of whales, or decline in >10% of biomass of a fish population, etc.); the species diversity of a community (e.g. an impact will be major if the species richness is reduced to 10% or more in the community); or indicator measuring the water or sediment quality like an increase of 10% or more in current levels of contaminants. On the other hand, “**negligible impacts**” are those which are judged to have no measurable (or observable) impacts. Because, the qualification/quantification of impacts is actually a continuum, impacts which are considered as intermediate “values” on this axis are usually characterized as “**moderate**” (from 1% to 10% in change of indicators) and “**minor**” (<1% change in indicators). Of course, this is not a definitive framework since the qualification of a given impact may be different depending on the indicator used to assess the impact. However, such thresholds may be helpful as first approximation, when assessing the importance of a given impact, or comparing (ranking) various impacts in terms of their importance.

- The spatial scale of the impact

Here again, it’s important to keep in mind that the scale axis is a continuum, mainly when dealing with marine ecosystems that are interconnected and nested each other at various scales.

As far as the spatial scale is concerned, impacts on ecosystems are usually rated from “global” to “local”. A “**global**” impact will be an impact that is measurable (or observable) at the global scale, like the Earth or a large part of the Earth (e.g. hemisphere, pole, continent). On the other side of the spatial axis, a “**local**” impact will have effects observable or quantifiable only at the smaller scale, i.e., locally. Of course, depending on the purpose and scope of the assessment, local impacts may be defined by the authors in terms of actual distance (e.g. from the source of the impact) or area covered (diffuse sources), but usually, and particularly when the assessment is conducted at the regional level, local is about 0 to 50 km, which correspond somewhat to the scale of fine geomorphological features like small bays, beaches, estuaries, etc., as well as the small scale for IM. In this respect, in a EOA report prepared for a CMA, most of the impacts reported will be likely local impacts i.e., of local interest from a management perspective. In contrast, local impacts should not be considered in a EOA prepared for a LOMA purposes, although there are some exceptions (see the section on Areas of Concerns above). As an intermediate scale of interest, from a management perspective, there is the regional scale. A “**regional**” impact will have measurable or observable effects at the regional scale; here it’s recommended keeping in mind that, within the IM context, the regional scale is the scale of Canadian ecoregions or LOMAs. For example, for the purpose of the marine ecoregions delineation⁷ in Canada’s marine environment, the following definition of ecoregion was adopted: *“A part of a larger marine area (usually so-called “ecoprovince”) characterized by continental shelf-scale regions that reflect regional variations in salinity, marine flora and fauna, and productivity”*.

It’s worth noting that reports that are produced by international organizations (e.g. ICES, NAFO, IOC) coping with global issues usually refer in their assessments and related documentation to the “**regional scale**” for defining much larger areas than our LOMAs; at this international (global) level, regional usually means the national level, and even may encompass several countries in the same “region” or a large part of one country or continent. On the other hand, within the Canadian IM context, an EOA report has to be prepared for management areas, which is essentially set up at both scales, i.e., for LOMAs (regional scale) and CMAs or MPAs (local scale) purposes. However, as far as impacts on ecosystems are concerned, it may be necessary to consider (and report on) impacts which are observed at larger scales than the study area, if these impacts are of great influence at the regional scale (eg climate change which is a global issue with regional impacts and consequences; see the specific section below). Also, we have to keep in mind that, because of the nested structure and interconnections within/between marine ecosystems, it may be pertinent to also consider certain impacts (e.g. sources of contaminants, freshwater inputs) that may affect adjacent ecosystems and that could influence the study area as well, after transiting through another management area (e.g. long-range transport of contaminants, regime shifts, introduction of exotic species, displacement of local species or populations)

- The timeframe of the impact

The impact on ecosystem components may be immediate (e.g. change in flow regime, habitat disturbance or loss) or its influence may be still observed after a long period of time (e.g.

⁷ Proceedings of the Canadian Marine Ecoregions Workshop. Ottawa, March 23-25, 2004. Fisheries and Oceans Canada (Ottawa), CSAS Proc. Ser. No. 2004/016, August 2004, 47 p.
Available at: http://www.dfo-mpo.gc.ca/csas/Csas/English/Publications/Proceedings_e.htm

contaminated sediments, exotic species). Depending on the impact and the type of stressor which cause the impact, effects will last more or less longtime. Here again, some thresholds may be necessary to help quantify impacts in term of the duration of the effects. For example, a “**long-term**” impact will be an impact that lasts for about or more than 5 years, whereas a “**medium-term**” and “**short-term**” impacts last for periods from one to five years and for up to one yer respectively. Although these thresholds are inherently arbitrary, they can help authors to assess impacts in terms of their duration. In addition, the “5 years” threshold to define “long-term” is consistent with management terms and with the period which is proposed for regularly updating EOA reports for IM planning and adaptive management purposes.

- The **significance** of the impact

As a result or combination of the assessment using terminology and thresholds here above, impacts may also be overall rated as “**significant**” or “**not significant**”. This is actually the level of the impact. That may be useful to briefly characterize an impact, combining the knowledge about the importance, spatial extent and duration of the impacts, as rated in the axes above. In order to evaluate the significance of an impact, it would be also helpful to know, and to distinguish between, **direct** (first order) *versus* **indirect** (second order) impacts.

Of course, an impact will be “significant” if it’s a direct impact rated as major in terms of importance, with a long-term effect at regional scale. In contrast, an impact will be “not significant” if it’s negligible or minor, short-term and local. Between these easiest cases, authors will have to balance the ratings based on scientific evidences or their knowledge of the situation. For example, an impact may be judged as “significant” too if it’s of regional concern and long-term, although it’s moderate, or if it’s local (i.e., limited in an area smaller than the study regional-scale area), but with major effects at long-term. Likewise, an impact that is considered as major and regional but with short-term influence can be also considered as significant from the management perspective. Whatever the impact from a given activity, authors will have to scale it, as part of the EA. For example, a “significant” effect of seismic noise on planktonic organisms is around 5 meters maximum! Authors will have to base this assessment upon their judgment and the collective knowledge available, keeping in mind that this ecological assessment is to make recommendations to IM planners and oceans managers, and is conducted within an ecosystem-based management context and for conservation purposes.

Note: Existing terminology. Authors should take into consideration the fact that other terms have been defined and used for characterizing and reporting on specific features in assessments of ecosystem components. For example, as far as the importance of habitat is concerned, a given habitat may be considered as “critical habitat” for a species at risk (i.e., under the Species at Risk Act), or as “sensitive habitat” from a Habitat Management point of view (Habitat Management Policy). Also, some marine areas may be important because of their ecological or biological functions, and they will be therefore characterized as “ecologically and biologically significant areas” for Oceans Management (IM) purposes. All these terms have been the subject of discussions between scientists and managers, and their meanings have been defined from a management perspective⁸. EOA authors are encouraged to take them into account to avoid confusion when reporting on specific habitats or areas, i.e., those habitats and areas that are considered relatively more important than the surrounding marine environment.

⁸ See for example the EBSAs identification section.

The level of details issue

First of all, it's important to well understand the aim of conducting an EA within the IM process and document information needs for IM plan purposes, so that we will know what level of details is needed within a given IM plan. Depending on the scale under consideration, this level of details will be likely very different, for example, at LOMA-scale or smaller scale (CMA or MPA). Smaller the management area, finer the details on the ecosystem nested within. A LOMA-scale IM plan will not require the same type of information and level of details than a plan prepared at smaller scale (CMA, MPA) will. At large scale (LOMA or ecoregion), it would be unrealistic to believe that we can report on detailed all the ecosystem features, components, properties and processes, in addition to assessing all stressors and impacts that affect them in a concise and workable report (i.e., reasonable length) useful for management purposes. Over time, such a large-scale EOA report providing the overall context and flagging issues of concern, could be act hopefully as a sort of “umbrella” (contextual) document for a series of thematic (e.g. issues of global/national concern like invasive species, undersea noise or climate change) or site-specific (local issues like impacts of sewage or aquaculture) reports, obviously much more detailed than the “parent” EOA document. This could be initiated when and where additional details are needed to inform IM planning, for example when dealing with smaller scales features (e.g. focusing on a given ecologically and biologically significant area within a given LOMA) or management initiatives (e.g. identifying an Areas of Interest, informing an MPA plan, reporting on the marine environmental quality within a CMA).

See also: “Scale Integration” guiding principle

For example, to be properly protected (eg: MPAs) will not be detailed at the same level of information. No need to provide a comprehensive list of species (and biology of each species) living within a given LOMA, nor a comprehensive list of all coastal streams within LOMA related watersheds. This kind of information will be more useful at MPA or CMA levels because it relates to local issues and problems that therefore have to be address and manage locally, through local IM (eg: species to be protected within an MPA; local pollution from streams or habitat degradation to be reduced within a CMA).

However, giving the same previous topics as examples, we definitively need to know information to identify ecological and biological significant areas (or network of areas) or what are the characteristics and impacts of contaminants that frequently enter and accumulate into the marine environment, i.e., those released by most important sectors or activities located around or within a given LOMA; known as significant sources of pollution for a given region, so that not only a very limited area or number of components are affected but all the ecosystem as a whole.

The timeline issue

In addition to providing IM planners with relevant basic information on ecosystem characteristics and features of interest, EOA should also try to anticipate priorities for action and make distinction about immediate *versus* medium and long term priorities in order to timely provide relevant information that will help take management actions (support to IM plans and decision-making).

Part E. Ecological Assessment

12. Areas of Concern (maps)

One of the main purposes of the EOA is to identify key areas for further study, management intervention, or protection. In this section the author should outline and report (maps) areas that have special characteristics because of their ecological significance, exposure to contaminants or other threats, or their use for specific activities (zoning) for example, those areas that warrant further attention within the IM planning process. For example, they may be functional or structural areas, i.e., those areas that support key ecosystem features, components and properties that should not be jeopardized like Ecologically and Biologically Significant Areas (EBSAs), or areas that need immediate or greater protection like threatened areas (e.g. heavily contaminated “hot spots”) and /or areas that need remediation (e.g. areas of hypoxia)

a) Ecologically and Biologically Significant Areas (EBSAs)

A national workshop led by DFO was held in November 2004 with the aim at developing science-based criteria for the EBSAs identification for management (IM) purposes within an ecosystem-based management context. EOA authors should refer to the EBSAs guidelines which were developed after this workshop⁹. These guidelines provide a guidance and a framework on how to interpret and apply the selected criteria and attributes that must be taken into account when identifying EBSAs for management purposes. The EOA process is a useful and timely framework for conducting the identification of EBSAs. EOA report is the basic document to report on EBSAs (incl. maps) in the study area.

b) Conservation Areas

All the conservation areas (e.g. those areas that are to contribute to the federal MPA strategy like Oceans Act MPAs, Parks Canada NMCAs, EC-CWS Marine Wildlife Areas, etc.) together with provincial and territorial conservation areas established in the coastal and marine environment (i.e., designated or under development as Area of Interest for example) or that are expected to be designated in near future within the study area should be mentioned and briefly described here

⁹ EBSAs identification criteria and guidelines have been released as Ecosystem Status Report (No. 2004/006) on the DFO-CSAS Website at: http://www.dfo-mpo.gc.ca/csas/Csas/English/Status/Status_Reports2004_e.htm

(or the EOA report should refer to similar documents specific to these areas if they have been already prepared.

c) Heavily impacted areas

Here again, it's important to take account the study area coverage. At a LOMA-scale for example, a very limited contaminant "hot spot" (coming from a punctual sources of pollution) in a given area should not be reported, but if it's a major concern for all the region; eg: toxic chemicals found in sediments in concentration much higher than anywhere else that could demonstrates there is a real problem of contamination in the region, as the "tip of the iceberg", or that endangers a species or its habitat, or jeopardizes an important resource or ecosystem component, or that identifies the region as the final receptacle for a certain type of contaminants. In contrast, if number of "hot spots" are reported scattered but covering all the area under consideration, that should be mentioned and discussed as areas of concerns, mainly if it's suspected that numerous spots could show the extend of the pollution in the study area, or could serve as indicators to track pollution change and future trends.

At CMA level, contamination profiles could be looked at using a finer screen, and so areas of concern (whatever the stressor is, pollution, bottom disturbance, etc.) could be discussed in more details, and would be probably linked to more local activities and/or point sources of impacts or disturbance).

Such local "hot spots" however may be so contaminated and/or of so high concern that even if they are limited in space, EOA authors can decide to mention them, or even discuss them into the ecological assessment, even within a LOMA-scale overview report. The rationale for that could be based on the fact these contaminated areas – most impacted of them are well identified and have been well documented up to date – are strongly related to high population densities and authors may want to take this opportunity to make sound linkages between ecosystem health and the human systems, and beyond that to the socio-economic aspects of the region around (by referring to socio-economic assessments if available at this time). Examples of such limited but highly contaminated areas can be found in Gulf of St. Lawrence (New-Brunswick side of Baie des Chaleurs, Sept-Iles harbour and terminals, Bay of Islands and Corner Brook's Harbour facilities, the Irving Whale wreck site), on Maritimes coast/Scotian Shelf area (Halifax harbours and Bedford Basin), on Newfoundland's Atlantic coast (St. John's harbour) and Pacific coast (Strait of GeoAgia, the great Vancouver area, incl. harbours).

* Other areas of interest: examples are munitions dumping sites (chemicals release), natural oil seeps, etc.

Habitat degradation, bottom disturbance, hypoxia (oxygen depletion), oil spill, erosion are other examples of "stressors" that may lead to characterize a limited area as "heavily impacted" area. Such areas should be also reported and mapped in the EA when they are large enough to be significant at the ecosystem-scale, well known and circumscribed and/or when they are of particular interest from a management perspective (i.e., management actions needed or on-going).

d) Ocean space use (zoning)

Zoning is already established in Canada's oceans for conducting and regulating certain activities of interest. Therefore, such "zones" will likely exist already within the study area; these zones may be fishing zones (for example, the NAFO zones system in Atlantic's Canada); Oil & Gas licenses (mention the different categories of licenses?); Aquaculture sites (which are, most of the time, concentrated in enclosed bays, sounds or estuaries); National Defence sites, etc. Linear corridors (e.g. shipping lanes, underwater telecommunication cables, pipelines) should be also briefly mentioned here since they are also limited ocean spaces that support specific activities and purposes.

After reviewing (and ideally mapping) areas of concerns, it would be pertinent from a management perspective, to superimpose these various layers of information (EBSAs, threatened areas, activity zones), for example by using GIS tools, and look at them simultaneously as a snapshot of the current situation, i.e., ecosystem status and human activities, through the lens of the IM planning and ecosystem-based management. Putting together different information layers into the same scale could result in informative overlaps (in terms of areas of concerns), those overlaps, in turn, showing potential conflicts (e.g. conservation versus development), and likely potential cumulative impacts (from various sources or activities) in certain areas. From results of this exercise, authors may prepare recommendations on priority areas, those areas that need immediate management actions for example.

13. Impacting Activities and Stressors

In this chapter, authors will review and list all activities and uses which have or are suspected to have "significant" impacts on marine ecosystems in the study area; that means: to be considered here the impact of a given activity or use must be significant (i.e., at the regional scale when the EOA document focuses on a LOMA). Human activities that have limited (local) impacts will be considered within smaller-scale EOAs (i.e., focused on MPAs or CMAs).

This review has to consider the following categories:

- Major human activities of concern (i.e., current sources of impacts)
- Emerging and anticipated activities
- Global stressors (with regional focus)

To achieve this task, it is suggested to have first a good general understanding of environmental issues the study area has faced up to date (see: the next chapter on key issues)

a. Major Human Activities of Concern

When listing human activities occurring in the management area, it may be wise to conduct a systematic review and sort activities into high level categories, for example, starting from major drivers and pressures (Table X?). Drivers and Pressures are described in more detail in Annex 3.

TABLE X? Examples of drivers, pressures, and resulting human activities and their anticipated impacts on ecosystems features.

<u>Drivers</u> and associated Pressures	Human activities (high level grouping)	Impacts on ecosystems (environmental issues)
<p><u>Socio-economic development (production)</u></p> <p>Land-based activities</p>	<p>→ Agriculture and forestry</p> <p>→ Coastal/Urban sprawl (i.e., large coastal cities and harbours, coastal infrastructures and defense, “sea-fronts” development, etc.)</p> <p>→ Industry: chemical and processing plants</p> <p>→ Sewage (municipal and industrial)</p> <p>→ Hydro-electricity (i.e., upstream dams,)</p> <p>→ Water diversion (i.e., change in upstream flow)</p>	<p>Contaminant loads (water/sediment quality issue); nutrient inputs (eutrophication); untreated and not completely treated sewage: introduction of high loads of organic matter (hypoxia areas), toxic chemicals, and bacteria, pathogens and disease vectors (seafood quality issue); habitat loss and degradation; affect coastal landscapes/seascapes integrity; changes in freshwater flows and local currents (incl. coastal transport of sediments)</p>
<p><u>Human needs (food) and population growth</u></p> <p>Harvesting of biological renewable resources</p>	<p>→ Fishing (commercial and recreational)</p> <p>→ Aquaculture</p> <p>→ Hunting (marine mammals and waterfowl)</p> <p>→ Plant harvesting</p>	<p>Fish/shellfish stocks depletion (over-fishing) and biomass removal (decrease in productivity, unbalance of trophic structures and food web); harvest of non-target species (by-catch) and discards; release of contaminants; habitat degradation (bottom disturbance); introduction of disease vectors; impact on genetic diversity of wild species (decrease in biodiversity); impact on species at risk, etc.</p>
<p><u>Human needs (energy, materials) and population growth</u></p> <p>Extraction of non-renewable resources</p>	<p>→ Oil & Gas activities (incl., exploration, exploitation and decommissioning phases)</p> <p>→ Mineral extraction and mining</p>	<p>Oil spills and release of contaminants; benthic habitat degradation, loss and fragmentation; change in physical-chemical properties and nature of surface sediment; increase loads of suspended material and increase in turbidity (decreases light available to photosynthetic organisms)</p>

<p><u>Human needs (communication, travels) and socio-economic development (trade)</u></p> <p>Transportation & communications</p>	<p>→ Shipping (incl., cargo, cruise ships, ferries and local links)</p> <p>→ Harbours and shipping facilities (i.e. shipyards, channel maintenance and dredging)</p> <p>→ Pipelines</p> <p>→ Communication cables and other linear corridors uses of oceans space</p>	<p>Ballast waters exchange (introduction of invasive species and changes in biodiversity); marine mammal harassment; introduction of contaminants and sewage; oil spills; increase in suspended matter and turbidity; bottom disturbance and habitat fragmentation;</p>
<p><u>Human needs (Health & Welfare) and socio-economic development</u></p> <p>Recreational activities</p>	<p>→ Recreational fishing</p> <p>→ Boating, kayaking, scuba-diving, camping, etc.</p> <p>→ Eco-tourism activities (e.g. whales and wildlife watching)</p> <p>→ Conservation and Educational activities (e.g. marine protected areas and coastal parks)</p>	<p>Release of contaminants; wildlife harassment; decrease in biodiversity and productivity</p>
<p><u>Human needs (knowledge, security) and socio-economic development</u></p> <p>Others sea-based activities</p>	<p>→ Energy production (e.g. wind power, tidal power)</p> <p>→ Science activities (Research and Monitoring), Defense & Sovereignty</p> <p>→ Research and Rescue</p> <p>→ Navigation aids (incl. coastal infrastructures and ice-breaking)</p> <p>→ Ocean dumping</p>	<p>Affect the coastal landscapes/seascapes integrity; wildlife harassment (marine mammals, sea-birds)</p>
<p><u>Global warming and global environmental processes</u></p> <p>“Locally non controllable”¹⁰ factors (<i>forcing</i>)</p>	<p>→ Climate change</p> <p>→ Ozone hole and UV radiation</p> <p>→ Long-range transport of pollutants</p>	<p>Sea level rise; regime shifts (change in water temperature, salinity, currents, mixing/stratification areas, etc.); habitat loss; water quality degradation; change in biodiversity and productivity; release of contaminants, etc.</p>

Then, for some of the high-level groupings of activities, authors may want to focus on more specific activities, based on regional/local specificity, customs or environmental constraints for example. The following list provides a detailed nomenclature of all the human activities and their

¹⁰ That means, the stressor is not directly controllable by means of regional / local scale management actions undertaken within an ICOM/EBM framework.

potential impacts on marine ecosystems This is a comprehensive list of activities i.e., all activities that could potentially take place in certain areas of Canada's marine environment (three Oceans) and at certain periods of time. Authors are encouraged to use this as a "check-list"; here again, not all activities have to be considered and described for EA purposes. Only those that are known (or suspected) to have significant impacts within the study area should be considered.

Nomenclature of all possible human activities¹¹

- Aquaculture
 - o Beach culture; long line; raft culture; cage culture; bottom culture (eg: clams); land-based (intertidal water tanks); offshore aquaculture
- Cable & Pipelines
 - o Trenching; burying; operation and maintenance; booster stations
- Channel Maintenance
 - o Suction dredging; clam shell dredging; disposal of spoils; river training
- Conservation and Restoration Activities
 - o Predator control; conservation areas (eg MPAs, NMCAs); resource enhancement (eg : seeding); restoration; habitat alteration/compensation; gene banking
- Defense
- Energy Development
 - o Tidal power; hydro-electricity; waves; nuclear; wind-farms; thermal (oil, coal)
- Extraction of non-renewable resources
 - o Mineral extraction, i.e., mining
 - o Sand sluicing / dredging
- Fishing and Resource Harvesting (eg: fish processing)
 - o Dragging (eg: scallops); digging; long lines; diving; seines; trolling; traps; raking (for marine plants); gill nets; marine mammals harvesting (culling); dredging (clams); trawling (bottom); hook's lines; spawn-on-kelp; enhancement (SEP); aboriginal harvest; recreational fishing; bio-prospecting; live capture and aquarium trade; (sea birds)
- Land-based Activities
 - o Urban development; industrial development (eg: chemical plants); agriculture; forestry; linear development; water use; hydro development; transportation (i.e., inland waterways, canals, locks)
- Ocean Dumping
 - o Industrial dumping (dredge spoil); organic (offal / dead); scuttling
- Oil & Gas
 - o Exploration:
 - seismic activities, exploration drilling
 - o Development / Production
 - Platform building; drilling muds; production waters; transport pipelines; tanker transfer
 - o Abandonment (decommissioning)
- Safety
 - o Aerial surveillance; communication and navigation aids; ice-breaking

¹¹ Adapted from the "Think Tank on Human Impacts and Ecosystem Objectives" (Joint Oceans/Science exercise, Econiche retreat, September 2003)

- Scientific Research
 - o Fishing; sampling (water, sediment); marking; acoustics; moorings; field experiments (eg: dyes, nutrients, ROV/submersibles, exclusion zones)
- Tourism (incl. ecotourism)
 - o Land-based tourism:
 - Channeling; dyking; beach maintenance; sewage; curios
 - o Sea-based tourism:
 - Recreational boating and fishing; ecotourism and whale watching; artificial reefs; diving; cruise ships
- Transportation
 - o Shipping; recreational boating (incl. harbours and marinas); launches; ferries; bridges, causeways, breakwaters; icebreaking; Search & Rescue (bilge water, ballast water)
 - o Ship movements; weapons testing; munitions dumping; surveillance; anti-terrorist related CBRN activities (Chemical Biological Radio Nuclears program); Sovereignty; ship maintenance; research; manoeuvres
- Water Usage
 - o Water flow diversion (upstream); use of water for cooling systems (energy production);

b. Anticipated / Emerging Activities

Emerging activities:

For example, ecotourism, offshore aquaculture or Oil & Gas exploration could be considered as emerging activities with special concerns in certain regions of Canada. In these areas, in addition to environmental issues created by these emerging activities (e.g cumulative impacts with traditional, well established activities) we may also anticipate possible users conflicts about resources and ocean space, strengthening the need of an IM structure. Users conflicts should not be considered in EOA reports, except when it's thought that such conflicts would result in environmental problems or create threats on ecosystems.

Anticipated activities:

When we anticipate that a given activity will be emerging in the study area at relatively short-term, i.e., within a 5 years period, which may likely correspond to the updating schedule of such EOA reports.

c. Global stressors with regional focus

i. Global warming and climate change

This is one of the most important environmental and socioeconomic issues we have to face at the global scale and for a long-term. Of course we cannot stop the impacts of climate change within a limited space and time. In fact, from an ecosystem-based management perspective, what we want to preserve is the ability of ecosystems to adapt to climate change, i.e., preserve its natural resilience, and how we can contribute to strengthen this emerging property by looking after

ecosystem health, reducing human stress and foot-print with the aim at maintaining ecosystems as healthy as possible. In this way, EA should document and discuss climate change impacts on ecosystem structure (biodiversity), function (productivity) and overall marine environmental quality. In addition to climate change impacts, it's important to discuss how this stressor can combine to other human activities and probably modify or even amplify their impacts (cumulative impacts), and therefore the way to manage them in future.

Following are examples of climate change-induced impacts that should be discussed in the assessment part, in parallel with the natural variability of these oceanographic processes:

- Sea level rise* (eg: change in coastline, change in flow regimes, flooding, etc.). The most exposed habitats –some of them are very productive like wetlands, seagrass beds– will be affected/lost over time.
- Change in climatic patterns; we anticipate an increasing frequency of violent climatic events, storms and hurricanes; some coastal and fragile habitats will be increasingly affected by coastal storms and associated impacts (flooding, erosions, etc.)
- Change in oceanographic features, like water temperature, currents, freshwater inputs, mixing and stratification processes, etc. Regime shifts are long-term and irreversible processes we are not able to stop; however, we can work and manage to better know, monitor, predict and adapt to these changes. Scientists (and wise managers!) agree to consider that climate change is definitively different from the other human activities and stressors; we cannot regulate or manage this issue (and more generally the global warming) as we can with other environmental issues, in terms of timeline, scale, etc. The best place where to discuss climate change and its direct impacts on ecosystems would be in the physical oceanography; “change in physical oceanography” is the main stressor, for example: changes in temperature, sea level, etc.; these are receptors.

* In fact, not all regions in the world (including in Canada) actually experience global warming-related sea level rise because of natural fluctuations of sea level that occur over geological periods of time (glaciations, subsidence/uplift). However, whatever the cause, IM planning and coastal communities will have to deal with sea level fluctuations in future, and climate change is going to increase the rate and speed of this variation.

The scale issue in climate change assessment:

This global stressor has impacts at local/regional scales with consequences on coastal marine ecosystems, particularly low-lying islands and coastal environments. For example, according to recent global assessments¹², the global mean sea level is projected to rise by about 0.09 to 0.88 meters depending on regions within the current century; a range that can be critical in certain regions in Canada. Low-lying islands (e.g. Prince Edward Islands, Magdalen Islands in the Gulf of St. Lawrence) and low slope shorelines (e.g. New-Brunswick's Northumberland Strait coast and Bay of Fundy) of course will be more impacted, and in a shorter period of time. Moreover, there are exposed and fragile coastal environments, like wetlands, beach and dunes systems, all environments that are very sensitive to waves and storms, erosion, flooding etc. Although there is new and stronger evidence that most of the warming (and associated sea level rising) observed over the past 50 years are attributable to human activities, it will be particularly important and

¹² Source: Intergovernmental Panel on Climate Change (IPCC). Various scenarios have been investigated by IPCC in the Special Report on Emission Scenarios.

challenging within an EOA report, that is essentially a regional-scale document, to discuss natural variability as well. In addition, it must be noted that there are still much uncertainty in climate model predictions on the distribution, frequency and intensity of violent climatic events (cyclones, storms, flooding) and how large-scale oceanographic features like El-Nino, North Atlantic oscillation (NAO), etc. can influence them. Oceans management consequently will continue seeking science input, improvements and better reliability on predictions for climate changes impacts; eg: modeling, refining global/regional coupling, analyzing scenarios, new data from historical series analysis and current trends, monitoring, etc. To timely achieve that, and especially because sea level fluctuations is a global and “long-term action” issue, it’s important to identify and engage key regional scientists (and external experts if needed, incl. physical oceanographers and geology specialists as well) to the process as soon as possible, i.e., through the EOA build up.

ii. Ozone and UV radiation

iii. Long-range transport of pollutants

iv. Aquatic invasive species

Aquatic invasive species (AIS) emerged as a great concern in Canada in the 80s with the introduction of *Zebra* mussels into the Great Lakes, and their rapid dissemination into large portion of the Canada’s aquatic environment, including part of marine coastal and connected areas like rivers and estuaries. The main vector for the AIS introduction is the ships’ ballast waters which are exchanged in Canadian waters. This is really a global issue; for example, it has been estimated that ballast waters may be transporting 3,000 species of animals and plants, incl. all life stages, a day around the world. Based on the impacts observed so far, this is actually one of the most important threats on marine biodiversity. When they are discharged into a new aquatic environment (freshwaters and marine), “exotic” organisms may become invasive, may grow and reproduce very fast, and finally can severely affect certain native species (displacement or death) and even disrupt the ecology of the area as a whole (the receiving environment). Although the survival rate of species after discharged into a new environment depends on the environmental conditions of the receiving area, it has been demonstrated – and observed – that AIS are generally capable of surviving and prospering in a wide range of environmental/climatic conditions. When a new species adapts to a new environment, it’s an indication that its vital range of environmental conditions (in which the species can live) is likely wider than most of the native species. That means they are more prolific and adaptable to environmental change (e.g. natural variability or climate change) than the native species, and the risk is that native species are displaced from their ecological niche over time, leading to drastic change in biodiversity and productivity of the ecosystem. So, it’s of particular interest for management to be informed about this environmental issue, i.e., assessment of the ecological damages and their progress over time (new introductions, inventory and number of invasive species, spatial extent, “hot spots” etc.) whatever the region in Canada. For examples, authors

may consult the recent DFO science advice to Transport Canada to support new regulations on ballast water exchanges in Canada's three oceans¹³.

A “step-by step” process to prepare an ecological assessment

As soon as the science-based information has been compiled, gathered and synthesized (Volume I), we can proceed with the ecological assessment (EA), which is the core of the overall EOA document. The aim of this section is therefore to guide authors on how to select and present the information pertinent to management? That is: moving from the science knowledge available (volume I) to the assessment of threats and impacts (volume II). When working on the ecological assessment, authors must keep in mind that this analytical part of the EOA document should lead to recommendations to management to help the planning and decision-making. In other words, based on these assessment and recommendations, IM managers should be sufficiently informed to be able to address major environmental issues, those issues that are currently the most critical in the management area, and put priorities for further action plans accordingly.

At each step of the EA process, a series of key questions will have to be asked to prepare the following step, to ensure that any important elements is missing during the analytical process, and finally to meet the objective of the EA which is to inform and advise management.

STEP 1. The key question is: *Based on the current collective knowledge, what are the human activities which are thought having impacts on ecosystem and should be therefore considered in this first screening review?*

The output from this first screening will be a list – that may be long enough – of all the activities that may have impacts on the ecosystem nested within the management area.

STEP 2. The key question is: *For each of the activities of concern (listed in step 1), what are the impacts –direct and indirect, including cumulative impacts from various activities or sectors?*

At this stage of the process, and from a practical point of view, it may be difficult enough to move directly from the list of impacting activities (the stressors) to the impacted ecosystem components (the receptors)¹⁴, mainly when they are part of a complex environmental issue, involving a lot of biological, physical and chemical processes. It would be easier to make this

¹³ Alternative Ballast Water Exchange Zones. Science Advice National Workshop, Montreal, 30 November – 1 December 2004. Proceedings available on the DFO-CSAS Website : Tbc

¹⁴ Note that definitions of stressor, receptor direct/indirect impacts, etc. have been provided by OECD, ICES, OSPAR, etc. and EOA authors are strongly encouraged to consult this documentation available from other similar initiatives for guidance, terminology, examples or, more generally, source of inspiration.

move in two steps, particularly when the management area under consideration is facing a lot of activities and/or where a great deal of ecosystem components is expected to be significantly impacted. This step approach will be particularly helpful when authors have to deal with a great number of activities in one hand, and ecosystem components and receptors on the other hand, as in the case when many oceans uses are already well established in the area under consideration. In that case, it's recommended considering first the stressors associated with activities as an intermediate step in the impact assessment process, as conceptualized in Figure X?

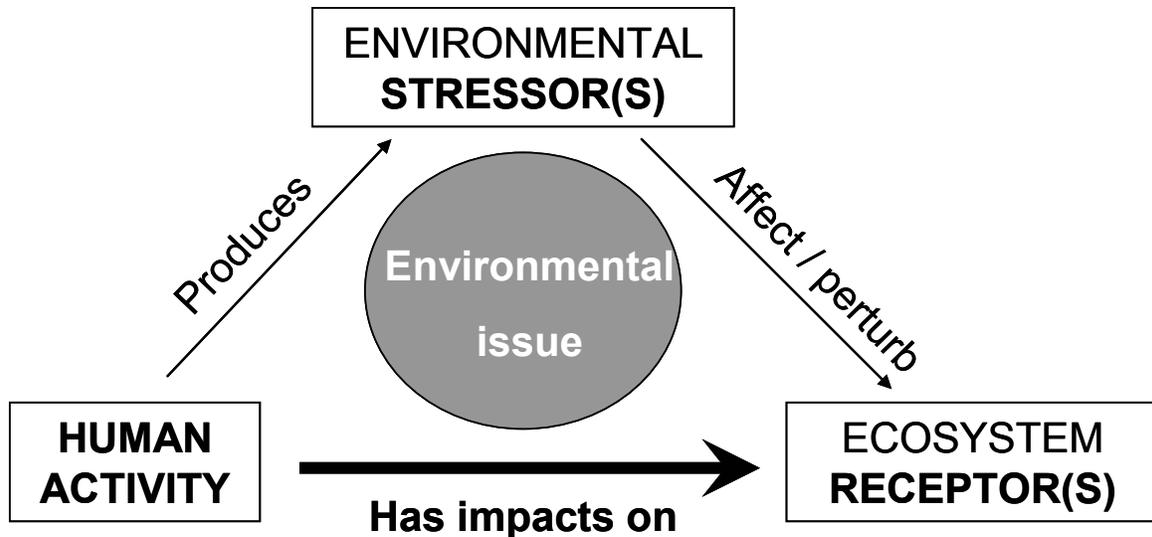


Figure X?. Conceptual figure of the key poles of any environmental issue: the human activity, the associated stressors, the ecosystem receptors and how they are related.

Step 2a. The key question is: *For each of the activities of concern (listed in step 1), what are the associated stressors?*

Note that one specific activity may have several types of stressors. On the other hand, the same stressor may be associated with various types of activities or sectors of activity. Therefore, authors may want to use a table to organize the relevant information on stressors attached to each activity (Table X?)

TABLE X? Activities versus Stressors (this is an example for guidance purposes)

		Oil & Gas		Commercial fishing		Marine transport	Land based activities	Aqua culture	Climate change
		Seismic	Explor. drilling	Mobile gear	Fixed gear				
Water & sediment quality	Organic waste		X			X		X	
	Bacteria							X	
	Nutrients					X		X	
	Oil waste		X					X	
	Chemical contaminants		X	X	X	X		X	
	Sediment transport		X	X				X	
Biological stressors	Invasive species	X	X	X	X	X		X	X
	Biomass removal			X	X			X	
	Incidental mortality	X		X	X			X	
	Disease & parasites							X	
	Behaviour	X						X	
Physical stressors (physical disturbance, regime shifts)	Change in currents								X
	Change in Temperature								X
	Fresh water inputs								X
	Marine Debris		X			X		X	
	Obstructions		X		X	X			
	Bottom disturbance		X			X		X	
	Collisions							X	
	Noise	X	X			X		X	
	Light	X	X			X		X	

(X indicates that the stressor is associated with the activity).

Note that, for each activity of concern, authors may want to subdivide it into a number of more specific activities when it is thought that such activities could have different types of stressors

associated with (and therefore could have different impacts and/or different receptors impacted). See for example Oil & Gas and Commercial fishing in the examples given in Table X?

Rather than just putting a “X” when it’s pertinent, it would be useful to add a couple of key-words or bullet-format information into the Activity/Stressor box to briefly describe characteristics of the stressor and/or to explain the link with the activity (how the stressor is associated with).

Step 2b. The key question is: *For each stressor (listed in step 2a), what are the impacted ecosystem receptors?*

Here again, one specific stressor may impact several ecosystem receptors, and the same receptor (an ecosystem component or property) may be impacted by various stressors, leading to cumulative impacts. Therefore, authors may want to use the following table to organize the relevant information on impacts of each stressor (Table X?)

Rather than just putting a “X” when it’s pertinent, it would be useful to add a couple of key-words or bullet-format information into the Stressor/Receptor box to briefly describe characteristics of the receptor and/or to explain how it is impacted by the stressors.

Note that the same list of stressors as in Table X? should be also used in this table, so doing allowing authors to make sound linkages between activities and receptors at the end of this process (Figure X?), then making the analytical part of the assessment more structured and workable.

TABLE X?. Stressors *versus* Receptors (these are examples for guidance purposes)

		Biota							Physical processes			Watershed		Marine ecosystem	
		Fish life cycles	Fish population	Shellfish	Lobster & Crab	Benthos	Marine mammals	Birds	biodiversity	Temperature	Salinity	Currents	Water quality		Sediment quality
Water & sediment quality	Organic waste		x	x	x	x							x	x	
	Bacteria												x	x	
	Nutrients												x		
	Oil waste							x					x		
	Chemical contaminants	x	x	x	x	x	x	x	x				x	x	
Biological stressors	Sediment transport	x		x	x	x							x	x	
	Invasive species		x	x	x				x						
	Biomass removal	x	x	x	x	x			x						
	Incidental mortality		x	x		x	x	x							
	Disease & parasites	x	x	x	x	x	x	x	x						
Physical stressors	Behaviour	x					x	x							x
	Changes in currents	x				x	x	x	x	x	x				x
	Change in temperature	x	x	x	x	x	x	x	x		x	x			x
	Freshwater inputs	x	x	x	x	x	x	x			x	x			x
	Marine debris		x				x	x							
	Obstructions											x	x		x
	Bottom disturbance			x		x							x	x	
	Collisions						x								
Noise	x	x		x		x	x								x
Light		x					x								

Warning! During the preparation of the EA and when authors are building these types of tables and matrices for reporting and communication purposes, the challenge is to cope with activities, stressors, receptors, impacts within the same context and framework (ecological assessment); in other words, authors have to consider all these key elements of the assessment, putting them together and highlighting links between them (cause-impact). At the same time, when using a table to communicate results of the assessment, they must avoid mixing apples and oranges; i.e. do not present activities and stressors for example in the same column or row of the table. For example, shipping is an activity; ballast water exchange may be considered in this case as a sub-element of the principal activity, the stressor associated with ballast waters is invasive species, and the ecosystem receptors (i.e. subject to major impacts) are mainly the indigenous biota; expected major (direct) impacts will be on ecosystem properties like biodiversity and marine environmental quality. Therefore, based on the higher level of risk and probability to occur when compared to other impacts and/or other activities, invasive species should be first and foremost connected to shipping in the Activities/Stressors table.

STEP 3. The key question is: *Based on outputs from previous steps (review of activities, identification of stressors and impacts), what are the human activities that have the most significant impacts at the management area scale under consideration, so that they should be considered as priority concern for IM planning?*

These “priorities for further management” and the related environmental issues have to be discussed because they are of great concern for the study area, based on the best science information available at this point of time. At this stage, it would be important to have a good idea on the level of knowledge we have on each of these science-related issues (or identify knowledge gaps). This task will help authors have a better idea on the actual science-based information needed for achieving the ecological assessment.

Here again, it’s a question of scale and significance of the impacts. At small scale, due to the limited number of human activities within a limited area of interest, it will be relatively easy to well identify what the main sources of impacts are, e.g. pollution plume coming from a sewage treatment plant, nutrients or other land-based activities tracers entering the system *via* freshwater runoff, local rivers; chemicals released from a coastal industry; change in benthos (e.g. smothering) and/or chemical concentrations found near aquaculture facilities located in a bay, etc. At broader scale however, due to a greater number of environmental issues to consider with many activities and possible sources of impacts, each of them being more or less harmful, it may be difficult to get an exact picture of the overall situation in terms of marine environmental quality and ecosystem health. When selecting activities of concern, authors will have to take into consideration key dimensions like the risk of impacts and the zone of influence (or extent), both criteria can be combined as follows (Figure X?):

1 ? Large Zone / Low Risk	2 YES Large Zone / High Risk
3 NO Small Zone / Low Risk	4 ? Small Zone / High Risk

Figure X? “Extent/Risk” matrix

X axis = RISK [i.e., how high the risk of impact for each activity and stressor is?]

Y axis = EXTENT [i.e., how large the zone of influence (impacted area) of each activity is?]

For example, at broad scale (eg: LOMA), box 3 should not be considered at all, since the risk of impact is considered low and the zone of influence is expected to be small (i.e, limited when compare to the coverage of the entire study area), based on the information available. In contrast, activities and stressors grouped into the box 2 (i.e., having a high risk of impacts at large scale) should be the focus of the EOA-EA. However, because risks of impacts associated to a given activity can be site-specific (local influence) or region-wide (large zone of influence), questions can remain about the pertinence of discussing these activities within the EOA (boxes 1 and 4), and when preparing the EOA, preliminary discussions should focus on these groups of activities. Actually, this will be discussed in a case by case approach because that depends on the environmental and regional context. At this point in time, both the knowledge of science-based environmental issues and good understanding of the IM process and information needs will be of critical importance.

14. Threats and Impacts on Ecosystem Properties and Components – Cumulative Impacts

Impacts should include not only direct or well known impacts, but also anticipated, potential and indirect impacts (second order impacts) if they have been already investigated through scientific studies and are considered “significant” at the geographic scale where the EOA is looking at.

Ecosystem-Based Management / Ecosystem Objectives framework

When preparing the EOA report, authors and team coordinators should keep in mind that it is to be used by IM managers and planners to develop a set of ecosystem objectives (EOs) with the aim at guiding the management of human activities within each of the management area (LOMAs). This is not the only purpose of such a report, however, the EOs development is an important step in the EBM/IM implementation and, as such, has to be based on the best science and knowledge available. Although EOA reports are not the only science-based documents that IM planners and managers will consider, they are to be one of the most important and pertinent for IM information and EOs set up purposes (See Annex 1: the EBM conceptual model). For example, for each of these broad themes, the EOs “unpacking” process (that is: moving from general statements to operational objectives by increasing the degree of specificity, selecting indicators, and thresholds, etc.) is going on and it’s at different stages of development depending on the IM area. However, high level statements objectives have been extensively discussed and proposed as over-arching guidance and starting point for further development¹⁵. In this respect, this chapter has been designed to favor the discussion on threats and impacts under these major EBM/EOs themes which relate to biodiversity, productivity, environmental quality and landscapes/bottomscapes integrity issues. At the very beginning of each section below, we have therefore mentioned the corresponding EO high level statement, some of them being slightly adapted from previous initiatives. This should be used as a general guidance and “friendly reminder” about one of the purposes of the ecological assessment and what the report is about. In addition, we propose to discuss cumulative impacts separately since they are, by-themselves, common to various themes i.e., caused by different activities and/or impacting different ecosystem receptors.

In the following sections, we also provide examples of current environmental issues that should be discussed in the light of the activities and stressors identified in previous chapters and sections. Authors may want to add other issues of interest (i.e., regional concern).

a. Biodiversity and Species at Risk

“Conserve enough components – at all levels of biological organization – so as to maintain the natural resilience of the ecosystem”

Biodiversity conservation

The biological diversity (or biodiversity) has been defined as “the variety of living forms, the ecological roles they perform, and the genetic diversity they contain” (Wilcox, 1984). In the goal statement above, the wording “at all levels of biological organization” aims at capturing these

¹⁵ Working Group on Ecosystem Objectives (WGEO). Conclusions and Recommendations Report, 2001.

various aspects that contribute to the overall biodiversity. In accordance with the Convention for the Biological Diversity (CBD) the 1992 Rio's Earth Summit agreed on, when management actions deal with the biodiversity, as an ecosystem property, they have therefore to consider the following components, based on the main organization levels and units for life in Earth:

- Genetic diversity (“within species” diversity, or diversity within populations)
- Species diversity (“between species” diversity, or diversity within communities)
- Ecosystem diversity (diversity of habitats or communities, ecosystem types, etc.)

Species at risk

Under the biodiversity heading, any species that has been designated under SARA, for which a COSEWIC list has previously been submitted or is currently being considered, should be identified, including its present status. Note that a brief overview of biology/ecology of the species at risk should be also given in the appropriate section of the descriptive (overview) part (Volume One).

Invasive species (ballast waters)

See details in previous chapter.

Harmful algal blooms (HABs)

It has been demonstrated that an excess in nutrients, or changes in the relative amounts of different nutrients can stimulate the growth (leading to intense blooms) of toxic phytoplankton species, the so-called “harmful algal blooms” (HABs). The toxins produced by certain species of phytoplankton can accumulate in shellfish and poison animals or people who eat them. Toxic algae can also affect other marine life like fish and marine mammals, and have the potential of damaging commercial fish stock and aquaculture species. There are indications that HABs are increasing worldwide, including in Canada. Very few species produce such toxins; however, because high concentrations of toxins can accumulate through the trophic chain especially in flesh of filter-feeder organisms, the HABs impacts on other organisms (incl. humans that feed poisoned shellfish) may be very damageable. The main algal toxins that have been reported in Canada's waters during the last two decades are the so-called “paralytic shellfish poisoning” (PSP), “amnesic shellfish poisoning” (ASP) and “diarrhetic shellfish poisoning” (DSP). Monitoring and surveys programs have been set up in almost all coastal areas since the potential for HABs is everywhere, and closures of impacted areas (shellfish beds, aquaculture sites) have already occurred in Canada.

Habitat degradation and loss

It's now well established that the greatest of all threats to marine biodiversity, and the most widespread impact on coastal zones, comes from the destruction, alteration, and ultimately loss of habitats¹⁶. This can happen for example after bottom disturbance by fishing or industrial activities (Oil & Gas, mineral extraction), deposition of sediments coming from shoreline erosion, coastal development, freshwater inputs, change in coastal regimes (currents, sediment transport), etc. The physical alteration of habitats may have cumulative effects with contaminants, resulting in the degradation of the habitat quality, in turn, likely affecting the

¹⁶ See for example: *A Sea of Troubles* (2001) Report from the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP), published under the auspices of the UNEP, GESAMP Reports and Studies No. 70. 34 p.

overall biodiversity of the impacted areas, i.e., in terms of diversity of species and habitats (ecosystems). As far as cumulative impacts are concerned, it's important to note that numbers of scientific studies conducted over long period of time in areas where habitats had been degraded, have clearly demonstrated their important role as structural and functional component of the marine ecosystem: destroying habitats has often dramatic “knock-on” effects; as far as the integrity of coastal landscapes and habitats is concerned, the “cascade effect” of the loss of coastal habitats like wetlands, saltmarsh, eelgrass beds, etc. is particularly informative: In addition to have direct impacts on the biodiversity and productivity of the ecosystem (wetlands usually accommodate and sustain a rich flora and fauna), their loss or degradation may increase the flow of sediments (normally trapped in roots), may precipitate the oxygen depletion (normally they are efficient depuration systems) and likely make the coast more vulnerable to erosion and natural events (ice, waves, storms, etc.).

b. Productivity and Use of Oceans Resources

“Conserve the function of each component of the ecosystem so that it can play its natural role in the food web”.

The followings are examples of related environmental issues that should be discussed in the light of the activities and stressors previously identified:

- Over-fishing and stock decline
- Bottom disturbance (trawling, plant harvesting)
- Aquaculture (mixing / genetic impact on wild populations)

From an ecosystem health perspective, fishing is much more complex than just harvesting fish from the marine environment. Fishing can have various classes of impacts on the ecosystem. In addition to having effects on the size (biomass) and composition (quality) of the target population, which is the most obvious impacts of this activity (impact on productivity), fishing has also effects on non-target populations (impact on biodiversity), on the rates of ecosystem processes like food web, change in predator-prey relationships, etc. (impact on ecosystem structure and biodiversity), and direct alterations of habitats (biodiversity) and on water/sediment quality as well (fuels, organic waste, debris, lost nets, etc.). Definitely, fishing is an activity that should be discussed also in terms of cumulative impacts.

c. Water / Sediment, Habitat and Biota Quality

“Conserve the geological, physical, and chemical properties of the ecosystem so as to maintain the overall marine environmental quality, i.e., water, sediment, biota and habitat quality”.

The followings are examples of related environmental issues that should be discussed in the light of the activities and stressors previously identified:

- Water and sediment pollution by toxic chemicals (contaminants issues)

This type of contaminants may originate from a great variety of sources and types of discharges, and their ecotoxicology involves also various biological, physical and chemical pathways and processes. For example, they may come from land-based (rivers, estuaries) or sea-based activities; they may be discharged from point sources (e.g. municipal sewage) or diffuse sources (e.g. pesticides from coastal agriculture and rainfalls); they may be released into limited receiving areas, in enclosed (e.g. harbours, bays) or open environments. Depending on the type of chemicals, their behavior in the environment, and their intrinsic toxicity, the resulting effects on the flora and fauna will be very different; for example, the effects of chemicals may be chronic/sub-lethal (e.g. industrial effluents), or acute and short-term (e.g. punctual discharges like accidental events), and sometimes impacting very large areas, large amount of chemicals and/or massive mortalities (e.g. oil spills).

Air pollution: atmospheric transport of contaminants over long distances

This process is complex and may be a major source of pollution in some regions of Canada like remote areas (eg: Arctic) and deep-sea environments (Laurentian Channel). This section should review and discuss possible inputs of contaminants from land-based sources if they are significant; some are among the most toxic like PAH, PCBs, trace metals, dioxins and furans, entering marine ecosystems after long range atmospheric transport (winds, particles adsorption, precipitation) combined with local oceanographic processes (deposition/sedimentation).

Eutrophication

An excess of nutrients loads coming from land-based activities via rivers, local streams and sewage may lead to the eutrophication of marine/coastal environments. This is one of the major environmental issues common in all the Canada. The so-called “nutrients” is a group of chemical compounds that consist essentially of various chemical forms of nitrogen and phosphorus and, in a lesser extent, of silicon naturally present in the marine environment. They are essential compounds for biological processes; plants and algae need nutrients for growth. The problem with nutrients in marine environment is that they are both naturally present and introduced by human activities, sometimes in excess which leads to the eutrophication. Associated impacts on the ecosystem and its components are the growth stimulation of certain species of plants or algae to the detriment of others, unbalance in the trophic structure, increase in the growth of aerobic microorganisms and oxygen consumption (biological oxygen demand), oxygen depletion and massive mortalities. Eutrophication can also cause intense explosions of microalgae (e.g. the “red-tides”), some of these algae, can be toxic when they are eaten after accumulated into higher trophic levels like shellfish; these are the so-called “harmful algal blooms” (see Biodiversity section above). However, eutrophication is generally restricted to limited coastal areas, those areas where nutrients are directly discharged (sewage, rivers, streams). Depending on the region, sources of nutrients may include atmospheric deposition, sewage, surface runoff, agriculture activities in coastal areas, waste products from plant processing (food, fish), finfish aquaculture facilities, forestry and mining operations, and fishing operations (discards, offal).

Biota contamination (bioaccumulation through the food web)

The biota contamination is due to the process of bioaccumulation through the food web, involving complex physical-chemical and biological processes; for example, one of the major factors enhancing bioaccumulation in the marine environment is the fact that certain of pollutants discharged into the marine environment are lipophiles (great affinity with fats where they

accumulate over time and can remain trapped into fatty organs, bodies). After bioaccumulation, these chemicals can remain trapped into animals fats, fatty tissues and organs, etc. This is particularly the case of the so-called Persistent Organic Pollutants (POPs) which is a group of pollutants including a great variety of organic chemicals, all with high toxicities (e.g. pesticides, HAPs, dioxins, furans, etc). Bioaccumulation potentially affects all organisms exposed to lipophile chemicals either they live in the water column (those organism exposed to dissolved chemicals or chemicals adsorbed into suspended particles) or in the benthos (exposed to contaminated sediments). All species living in a contaminated environment may be likely affected; that includes wildlife (the species at risk issue), commercial fish and shellfish (the seafood quality issue), and ultimately humans may be affected as well (human health issue). However, it's well established that high trophic levels and top-predators (fish, birds and marine mammals) as well as filter-feeding organisms (e.g. mollusks) are the most affected by bioaccumulation of toxic chemicals. In addition to organics, other chemicals with high toxicities like heavy metals (e.g. Mercury, Lead, Chrome, etc.), Light hydrocarbons (e.g. oil spills), Organic-tins (e.g. TBT), etc. are found in contaminated marine environments, and their occurrence, sources, origins, as well as their fate and effects should be considered in the EA.

Notes on the use of toxicity data. When the information is available, it would be helpful for further discussion and assessment to provide some relevant toxicity data (if they exist from literature) on pollutants of concerns (eg: POPs, heavy metals, bacteria, etc.). Depending on the type of chemicals and concentration ranges (i.e., mean concentrations, lowest/highest level) reported from *in-situ* studies, toxicity data from experimental (laboratory) studies could be added as support to the EA discussion and could include both lethal and sub-lethal data if they are relevant for the area of concern. If toxicity data based on indigenous (local) species does exist in the literature, of course such data should be mentioned (and favored) because they would be more relevant to the study area. In the absence of toxicity data, at least general information and/or selected pieces of information relevant to the study area (i.e, toxicants of concern, concentration ranges, target species, etc) should be reviewed and synthesized from the literature to provide IM planners and decision-makers with sufficient background to have a good understanding on which the most harmful pollutants are, on their intrinsic / potential toxicity (even if it's based only on experimental studies), their place on the broad toxicity range, etc. In addition to toxicity data, it's important also to outline the most important biological and physical processes that can affect the fate and effects of toxicants in the marine environment given the specific context of the area under consideration (eg: if we can expect to have bioaccumulation through pathways and food web; water dispersion and transport with currents and water masses or sedimentation and *in-situ* accumulation; if we are looking at persistent contaminants, or if they sensitive to weathering and biodegradation, etc. That will influence recommendations from the assessment with respect to the severity and urgency of the situation (eg: hot spots of contaminants or chronic sources of pollution) and further the IM planning and decision-making.

In addition to contamination by toxic chemicals, the “Water/Sediment Quality” theme can also accommodate other environmental issues of concern in certain regions, like the accumulation of marine debris and litters, municipal sewage, microbial contamination (incl., disease vectors), increasing noise under the sea (e.g. seismic activities, shipping, military sonar), etc.

Finally, for the purposes of the discussion around this issue, it may be useful to remind that contaminants is one of the broad themes, in addition to physical alteration and destruction of habitat, which has been retained by the National Programme of Action (NPA) to address land-based activities related issues¹⁷. Under this theme, NPA's priorities are:

- Sewage
- Persistent organic pollutants
- Radionuclides
- Heavy metals
- Oils / Hydrocarbons
- Nutrients
- Contaminated sediments
- Litter

Change in physical-chemical properties

...of water (eg: turbidity, oxygen depletion) and sediments (eg: smothering, organic enrichment).

Change in water flows and supplies.

In addition to the water quality, the water quantity (i.e., freshwater diversion) may be also one of the major issue in certain regions; for example see the Great Lakes/St.Lawrence River hydrographic system¹⁸. As far as the habitat quality, biodiversity and integrity of coastal landscapes are concerned, a significant decline in the water quantity upstream, or a sudden change in the flow regime may have cumulative impacts on aquatic and marine ecosystems downstream, and these have to be considered if they are judged significant at the regional/LOMA scale, or if they strongly affect a significant portion of the management area. Within the EOA context however, impacts of change in the water quantity on human activities like shipping will be assessed in the socio-economic document.

d. Integrity of Coastal Landscapes and Bottomscapes

The followings are examples of related environmental issues that should be discussed in the light of the activities and stressors previously identified:

- Coastal habitat loss / degradation / fragmentation
- Urbanization incl. ports and marinas (eg: dredging, channeling)

For the purposes of the discussion around these issues, it may be useful to remind that the “physical alteration and destruction of habitat” is one of the broad themes, in addition to contaminants, which has been retained by the National Programme of Action (NPA) to address land-based activities related issues¹⁹. Under this theme, NPA's priorities are:

¹⁷ Implementing Canada's National Programme of Action for the Protection of the Marine Environment from Land-Based Activities. National report to the 2001 Intergovernmental Review Meeting on Implementation of the Global Programme of Action, November 2001, Government of Canada.

¹⁸ The water flow coming from the Great Lakes is managed by the International Joint Commission

¹⁹ Implementing Canada's National Programme of Action for the Protection of the Marine Environment from Land-Based Activities. National report to the 2001 Intergovernmental Review Meeting on Implementation of the Global Programme of Action, November 2001, Government of Canada.

- Shoreline construction / alteration
- Intertidal and subtidal alteration
- Mineral and sediment extraction / alteration
- Wetland and saltmarsh alteration
- Marine waters and coastal watershed alteration
- Biological alteration

e. Cumulative impacts/effects

In addition to reviewing activities of concern and stressors individually i.e., looking at impacts from each activity, cumulative impacts should be considered since the aim of the EA is at providing all relevant information that could help IM planning and especially avoid resource user conflicts while meeting ecosystem-based management objectives (ecosystem objectives).

In 2000, ESRF sponsored a workshop which addressed cumulative effects related issues regarding activities in Canada's Atlantic regions²⁰. The workshop report stated that "cumulative effects assessment is a vital tool to ensure progress towards sustainability, and all marine industries and users must be accountable for contributing to cumulative effects". According to CEAA²¹, the concept of "cumulative environmental effects" recognizes that the environmental effects of individual human activities can combine and interact with each other to cause aggregate effects that may be different in nature or extent from the effects of the individual activities. Examples of cumulative effects at the global scale include the degradation of water quality by persistent toxic chemicals, global warming caused by the build-up of green house gases in the upper atmosphere, and decline in the overall biodiversity after degradation and loss of habitats. Numbers of experts actually think that ecosystems cannot always cope with the combined effects of human activities without fundamental functional or structural changes. The concept is simply a recognition of the complex ways in which the effects of individual activities interact and combine with each other over time and distance, and that natural resilience has its limits, as any other emerging properties of the ecosystem. The best example maybe, and likely the most known, is the problem of the long recovery (longer than expected, despite the moratorium) of Cod stocks and other fish stocks over-exploited in past decades, due to bad environmental conditions and probably other causes of mortalities as well (e.g. predation by seals) which have led to cumulative impacts on targeted stocks.

As that has been often mentioned, the need to assess and manage cumulative effects of development and on-going activities presents special challenges to scientists and decision-makers. In situations involving multiple or persistent sources of perturbation caused by human activities, it can be difficult to establish – or even to anticipate – cause-effect relationships. This is especially true when the area under consideration is large, and where human impacts on ecosystem can be superimposed and are confounded by natural variability of oceanographic properties and processes.

²⁰ Hatch Associates Limited & Griffiths Muecke Ass. 2000. *Workshop on cumulative environmental effects assessment and monitoring on the Grand Bank and Scotian Shelf*. Environmental Studies Research Funds, ESRF Report no. 137

²¹ From CEAA documentation available on their Website (www.ceaa.gc.ca ; visited September 2003)

For the purposes of this EOA guidance document, cumulative impacts on marine ecosystems could be tentatively defined, based on previous studies²², as “*impacts on the ecosystem which results from single source human activity (after persistent addition of a material, a force or an effect into the marine environment) at a rate greater than can be dissipated or from multiple activities/users or from impacts combined with those of other past, existing and emerging activities (as a result of the coming together of two or more materials, forces or effects) which individually may not be cumulative*”. Cumulative impacts occur when at least one of these two circumstances prevail and may occur over a certain period of time and distance.

From this definition above, it's therefore important to note that, in addition to dealing with multiple users / sectoral activities, cumulative impacts have to be considered when a single activity or sector is suspected to have significant impacts in the same area over time (eg: continuous release of long-term harmful substances from a point-source, like an industrial plant, a municipal sewage or an aquaculture facility).

In order to help review and organize the information on the assessment of cumulative impacts coming from various activities, we recommend using the “cumulative impacts” matrix (Table X?) in which each human activity is assessed against the others activities of concern identified in the management area, in terms of their impacts on the same receptors or types of receptors. The “impacts matrix” (here above) that is proposed to organize and synthesize the EA discussion may be also useful to point out cumulative impacts (coming from various origins/activities) on ecosystem properties like biodiversity, productivity, etc. One the other hand, it must be noted that a specific activity (or stressor) can have impacts on various ecosystem components and so these impacts have to be discussed around broad themes associated with environmental issues; for example, aquaculture facilities have known impacts on water/sediment quality of surrounding waters and on biodiversity as well; fisheries may have impacts on both productivity (stock depletion) and biodiversity (by-catch, habitat degradation); Oil & gas activities may have impacts on water/sediment quality (produced waters, muds), on living resources (benthic communities) and on habitat quality as well (bottom disturbance).

Example: Resource/ocean space use and cumulative impacts in Grand Banks

The Grand Bank ecosystem(s) would face cumulative impacts (on productivity, biodiversity, habitats and maybe water quality) because of potential conflicts in oceans space use between Oil & Gas development (licenses, offshore exploitation and potential for new ones in this area) and fisheries (major fish stocks and historical fisheries). The use of GIS to map commercial species distribution has led to find significant overlaps between fish stocks and Oil&Gas licences in Grand Bank region²³, i.e., a large proportion of the biomass of commercial species – eg. Haddock – occupies license areas. In addition, concern is about spatial distribution of species of interest that are listed by COSEWIC as “threatened” or “special concern” (wolfish spp.) and species that are currently under commercial fishing moratoria (eg: American plaice, Atlantic cod) in this area.

²² Peterson, E.B., et coll. (1987). *Cumulative effects assessment in Canada: an agenda for action and research. A background paper prepared for the Canadian Environmental Assessment Research Council*. Minister of Supply and Services Canada, Ottawa. 67 p.

²³ From: “*Spatial analysis of 18 demersal species in relation to petroleum licence areas on the Grand Bank (1980-2000)*”, by D.W. Bulka et coll., Can. Tech. Rep. Fish. Aquat. Sci., No. 2473 (2003)

Reporting on the ecological assessment and cumulative impacts

Filling the following matrix can be useful to organize the information needed to produce the ecological assessment, in terms of content and format, and to support discussion around i.e., impacts of human activities on ecosystem properties and components (Table X?). This matrix may also accompany the discussion and filled by key-words and/or bullet formats to highlight the most important points of the ecological assessment. We use the word “matrix” rather than table here, because actually, each box of this table may be derived into another –more specific – table detailing the impacts of each stressor (which is associated with a given activity) on a specific receptor (an ecosystem component) under each broad themes. It may be helpful to prepare such “intermediate” tables prior to building the final impact matrix”. These tables display respectively the Activities *versus* Stressors and Stressors *versus* Receptors, and examples are presented in the section below (how to prepare an ecological assessment?)

TABLE X?. The “impacts matrix” to help review impacts of activities and organize the ecological assessment around over-arching themes

	Key ecosystem properties			
	<i>“Impacts on”</i>			
Activities of concerns <i>“Impacts of”</i>	<i>Biodiversity</i>	<i>Productivity</i>	<i>Water / Sediment Quality</i>	<i>Integrity of marine landscapes/bottomscapes</i>
Fisheries	eg: By-catch issues; Change in food web structure (predator-prey relationships can be affected); Fishery pressures can affect genetic of exploited stocks	eg: Over-fishing and stocks decline	eg: Ocean dumping issues (discard litter; organic detritus and offal); Vessel traffic increases risk of fuel spills	eg: Fishing harbors and facilities can impact coastal landscapes; Impacts on seascapes: habitat/bottom disturbance by intensive trawling in fishing zones
Oil & Gas *	eg: Acoustic /seismic impacts on biota (mainly marine mammals)	eg: Seismic surveys have potential impacts and may interfere with biological processes of certain species and populations more sensitive to noise than others Drillings increase water turbidity and can affect subsequently primary production (links to water quality)	eg: Drilling muds contain toxic chemicals Drilling activity can increase (locally) the water turbidity; sediments can be re-suspended (incl. contaminants in particles) Atmospheric emissions of pollutants + long distance transport + re-deposition process	eg: Bottom disturbance (locally); Habitat fragmentation (broader scale)
Shipping				
Aquaculture				
Tourism				
...other activity				
...				
Climate change				

(*) These examples of impacts are related only to the exploratory phase of Oil & Gas development.

TABLE X?. The “Cumulative Impacts” matrix to help organize the ecological assessment around cumulative impacts when various activities have the same types of impacts or impacts on the same ecosystem components (receptors).

Note: Here the matrix is used to report on Oil & Gas exploratory phase cumulative impacts (as example), i.e. impacts cumulated from this activity and other activities under consideration in the ecological assessment.

Major activities and stressors	Oil & Gas	Commercial Fishing	Marine Transportation	Industrial Activity (incl. land-based)	Climate Change
Oil & Gas *		<ul style="list-style-type: none"> - Seismic impacts on fish stocks if activities are conducted in or close to spawning areas, migration routes, etc. - Disturbance of bottom habitats where O&G areas and fishing zones overlap 	<ul style="list-style-type: none"> - Background noise can increase in areas where O&G activities add to (or lead to an increase in) marine traffic; - Impacts on marine mammals (ship strike + noise + contaminants) 	<ul style="list-style-type: none"> - Increases the overall contaminant loads; - Increase the risk for synergistic toxicity effects - Drilling muds can accumulate over existing / historical contaminated sediments 	<ul style="list-style-type: none"> - Climate change can influence (regionally) water quality, biodiversity, and productivity and that can superimpose (locally) to impacts of O&G activities (seismic, drillings, vessel traffic) in terms of disturbance of biota and habitats.
Commercial Fishing					
Marine Transportation					
Industrial activities (incl. land-based)					
Climate change					

(* Seismic surveys and exploratory drillings are considered only in this example.

Part F. Conclusions and Recommendations

Based on information detailed in EOA descriptive parts and discussed in the Ecological Assessment, authors should make recommendations to IM planners and oceans managers to further take management actions with respect to protection and conservation purposes (i.e., supporting initial phases for identification of MPAs–Areas of Interest, or for planning and management of multiple users/activities within IM/CMAs).

At some point, this analysis will have to be supplemented with a “response” analysis from management bodies and decision makers. However, even if decisions about the use, conservation and access to resources are to be made further within the IM framework and will involve stakeholders and users, we need first to provide and analyze supporting scientific information based on the current understanding of ecosystem structure and function and make science-based recommendations to facilitate IM planning and management actions that will be undertaken within an ecosystem-based management context. This is the aim of the EOA-EA; recommendations therefore can be integral part of the general conclusion of the EOA, Part G – as Conclusions and Recommendations.

Key questions are: What are the implications and consequences of effects of activities on ecosystems? Based on these, what would the EA recommend to IM planning/management in order to meet ecosystem-based management objectives and support stakeholders engagement and further decision-making?

At this stage, when answering this question, it would be wise to consider different timeframe, (i.e., what are the consequences at short-term / at long-term?) because management bodies would have to envisage various actions to timely respond to these threats, depending on the timeline and current pressures (is it an emergency that require immediate actions? Or is a long-term planning needed? For example, fish stocks decline has immediate consequences on local communities (fisheries, socio-economic issues) and ecosystems as well; i.e., disrupting both structure and function of the ecosystem. This latter point will have to be discussed in EA and consequences analyzed in term of short-term and long-term impacts of commercial fishing on ecosystems (biodiversity, productivity, food web) and ecosystem components (other species, species of interest, habitat degradation, etc.) In contrast, global warming and associated climate change is of course a long-term issue. This does not require immediate action to solve the problem. However, that has to be discussed all the same within current EOA because it's a major threat to ecosystems with possibly 'irreversible' consequences we will have to face within coastal planning / IM in future.

Generally speaking, IM planners and oceans managers have to be well informed about consequences of current and planned activities and associated risks to ecosystems as soon as possible. In this way, EOA process will be the starting point for delivering of relevant information to IM community. And because not all marine ecosystems are in good health at this moment and ecosystems resilience has some limits we actually don't know very well, earlier is better than late to address major environmental issues they face and start long-term action plans.

Finally, it's important to recall that we will have the opportunity of updating EOA on regular (3-5 years) or *ad-hoc* basis to refine information and content (incl. the assessment part) and fill knowledge gaps over time, as science make progress (see above: discussion on climate change and fisheries issues

15. Dealing with uncertainties, unknowns, knowledge gaps and limits of Science support

The key question to be asked within the EOA report is: What and where are the big issues in the area of concern? This question has to be answered within the context of the natural variability and unknowns. It would be therefore helpful to consider the underlying questions:

- What is the magnitude of inherent variability?
- What is unknown? Identification of knowledge gaps.
- What is the level of conclusions to management that can be supported by the science available at this moment?

Another important issue inherent to such a document is the natural variability *versus* human impacts. It would be important to distinguish between these two sources of changes, should we want to manage human activities and their impacts on ecosystem components “within bounds of natural variability”, according to the Ecosystem Objectives framework. Authors will have to balance these two sources of changes as much as possible, i.e., based on science/data available, however, recognizing that such a distinction is not easy and more than often, not always possible based on the current scientific knowledge.

On the other hand, how to deal with the plethora *versus* lack of data? How to balance chapters? We should try to have a certain consistency between biological sections in terms of length and level of details (e.g. Fish versus Birds). However, by it-self, such unbalanced sections would be a good indicator of what we know and what we don not know as well, where there is a lack of data, etc. If this case occurs, it should be clearly mentioned that this is the reflection of the amount of information available. Otherwise some stakeholders could interpret this unbalanced information as a DFO fisheries-oriented report, which is not the intent at all.

In fact this is a general problem with all EOA-like reports, based on the fact that we have much more data on commercial fish on which managers have to make some decision, when compared to non commercial –but also important – species. So, within the EOA and EBM context, it's very important to insist on key stone species which are also important from an ecosystem perspective (e.g. sandlance fish, shrimps, in GSL). And because of this huge amount of data on commercial fish species, we are facing increasingly sophisticated requests and questions on fisheries-related issues, which, in turn, would require more and more data and knowledge to be answered!

17. Recommendations to Science Managers

- a. Identification of Knowledge Gaps*
- b. Monitoring and Research Needs*

18. Recommendations to Integrated Management

- a. Summary of the Major Environmental Issues and Concerns for the Study Area
- b. Identification of Priority Areas and Action Needed
 - i. In the short term (1 year)
 - ii. In the medium term (2-5 years)
 - iii. In the long term (> 5 years)
- c. Best Practices – Examples of Interest

Cited References / Resources and Expertise / Annexes

GLOSSARY

REFERENCES

EOA Related Technical Documents

Powles, H., V. Vendette, R. Siron and B. O'Boyle. 2004. Proceedings of the Canadian Marine Ecoregions Workshop, DFO Can. Sci. Advis. Sec. Proceed. Ser. No. 2004/016
http://www.dfo-mpo.gc.ca/csas/Csas/English/Publications/Proceedings_e.htm

GOSLIM and ESSIM EORs Science Peer-Review Workshop, Moncton (NB), January 18-21, 2005. Proceedings will be released via the CSAS Web site

DFO, 2004. *Identification of Ecologically and Biologically Significant Areas*. DFO Can. Sci. Advis. Sec. Ecosystem Status Rep. 2004/006
http://www.dfo-mpo.gc.ca/CSAS/Csas/status/2004/ESR2004_006_E.pdf

General

Oceans and Seas: Harnessing the Marine Environment for Sustainable Development. Towards Earth Summit 2002 series, Environmental briefing No.3 – Oceans briefing paper, 13 p.

Safeguarding Our Seas – A Strategy for the Conservation and Sustainable Development of our Marine Environment (2002). Department for Environment, Food & Rural Affairs (DEFRA), London (UK), 80 p.

A Sea of Troubles. By Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP), Reports and Studies No.70, UNEP, January 2001, 35 p.

Quality Status Reports (2000)*. A series of five regional QSRs released from the OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic. QSRs are available from the OSPAR Commission website: www.ospar.org

*Note: OSPAR Commission launched the QSR framework in 2000; they released QSRs for five regions of concerns (incl. Arctic waters, North Sea, and the wider Atlantic among others). The six chapters of each QSR deal with: geography, hydrography and climate, human activities, chemistry, biology, as well as an overall assessment. The purpose of the conclusions and recommendations contained in OSPAR QSR 2000 is to draw attention to problems and to identify priorities for consideration within appropriate forums as basis for further management actions.

ANNEXES

Annex 1. The EBM Framework (simplified) : The Ecosystem-Based Management (EBM) model that has been developed for supporting the IM implementation in Canada. This conceptual model shows the key steps, core elements and interrelations between them.

Annex 2. Products developed in the Integrated Management Process (Concept Piece)

Annex 3. The DPSIR assessment framework with examples for each category. (Adapted from European Environment Agency, EEA-2002)

Products developed in the Integrated Management Process

Appendix 2: Concept Piece

LOMA Boundary

Based on LOMA Boundary Delineation Criteria

1. Ecoregions or its ecological sub-units
2. Political, administrative and socio-economic considerations

Ecosystem Overview and Assessment Report

Audience: A technical report for the IM table.

Objectives: To provide IM planners, managers and stakeholders with relevant information on ecosystem properties and components, based on the best science and knowledge available. To provide managers with guidance based on an ecological assessment.

Author: DFO with assistance from other government agencies (EC), Universities, provinces, aboriginal groups and local communities

Volume 1: Ecosystem Status and Trends

Volume 2: Ecological Assessment (peer reviewed)

- EBSAs
- Conclusions and Recommendations

Socio-Economic Overview and Assessment Report

Audience: A technical report for the IM table

Objectives: To provide IM planners, managers and stakeholders with relevant information on the socio-economic status of the IM area. To provide managers with guidance based on a socio-economic assessment.

Author: DFO may lead and/or facilitate. Writers could include the provinces, other federal agencies (ACOA) and Universities.

Volume 1: Descriptive section

Volume 2: Socio-Economic Assessment (peer reviewed)

- LOMA maps (e.g. areas of user conflicts)
- Conclusion & Recommendation

LOMA Summary Report

(Summary including both the ecosystem and the socio-economic components) ~ 50 pages

- Ecosystem Objectives, Human-Use Objectives
 - MEQ Guidelines, SMART regulations

IM PLAN

Annex 3. The DPSIR assessment framework with examples for each category. (Adapted from European Environment Agency, EEA-2002)

