



# GUIDELINES ON EVALUATING ECOSYSTEM OVERVIEWS AND ASSESSMENTS: NECESSARY DOCUMENTATION



Figure 1: Map of DFO's six administrative regions.

## Context

Canada's Oceans Act and the associated implementation strategies place an ecosystem approach central in the integrated management of human activities on the sea. In planning many of the activities necessary for integrated management, such as setting ecosystem objectives, identifying areas requiring enhanced protection, and developing regulatory approaches to various activities, it is necessary to have a reasonable understanding of the ecosystem in which the management is occurring. This understanding must include insights into the features of the ecosystem which are important structurally and functionally, the nature and intensity of the human activities, and how the ecosystem features and human activities interact.

In an attempt to gain the necessary understanding, initial ecosystem overview reports (or report series) and partial integrated ecosystem assessments were prepared for two ecosystems currently developing integrated management approaches: the Eastern Scotian Shelf Integrated Management (ESSIM) and Gulf of St. Lawrence Integrated Management (GOSLIM) systems. The overview and assessment documents for the two systems were prepared in quite different ways. Review of the two types of documents at a meeting in Moncton, NB (Jan 17-21, 2005) resulted in conclusion that both Ecosystem Overviews and Integrated Ecosystem Assessment documents are necessary precursors for integrated management planning, and in a number of insights into the desirable contents of both the Overview and Assessment documents.

## SUMMARY

- There are three main target audiences for Ecosystem Overview Reports and Ecosystem Assessments; managers, stakeholders, and the general public. Their needs are different, and documents of similar content but different degrees of technical complexity may be required to meet the needs of all of them.
- The primary functions of both documents are to inform all participants in integrated planning and management of the issues which must be addressed, the “extended consequences” of the activities being managed; and the types of questions which they should be pursuing in depth with the scientific and technical experts for the ecosystem; and to provide a common factual basis for dialogue among the parties in integrated planning and management.
- The key contents of both Ecosystem Overview Reports and Ecosystem Assessments are summarized in the guidance provided below:
  - The Ecosystem Overview document should present the information on current status and recent trends for as many ecosystem components and human activities as possible, the inherent variability in the components, and address issues of ecological scale;
  - The Ecosystem Assessment Document integrates the descriptive information presented in the Ecosystem Overview Document. Two tabulations are valuable; a tabulation of the human activities known or expected to occur in the area by the pressures which each activity puts on ecosystem, and a tabulation of the pressures relative to the ecosystem components (or “states”) identified as important in the first part of the assessment.

## DESCRIPTION OF THE ISSUE

For integrated management planning to proceed, all participants in the governance system must work from a common factual basis, if they are to communicate efficiently. This basis must cover comprehensively the major features of the ecosystem which must be used sustainably, the human activities which must be managed within it, and the major interactions among ecosystem features and human activities. The Department of Fisheries and Oceans has adopted an approach which has the factual background information summarised in one or more documents comprising an Ecosystem Overview Report, and the analysis and interpretation of the interactions among ecosystem components, and between human activities and the ecosystem in an Integrated Ecosystem Assessment.

Both types of documents are necessary to support integrated planning and management effectively. Preparation of both requires significant amounts of effort by diverse technical experts. Guidance is provided in this Status Report on the form and contents of these documents, if they are to be prepared efficiently and to be sufficient to form the foundations for integrated planning and management.

## ASSESSMENT

### Guidance and Rationales

Target Audiences: There are three main target audiences for these two types of documents. The first target audience is the professional managers in all levels of government and all departments who are likely to participate in the integrated planning and integrated management. With the cadre of managers, the most crucial component are the levels actually participating in preparing management plans, whether sector-specific or integrated. However, senior managers with primarily a policy oversight role, and field officers who will have to deliver the management plans, once adopted, will also have many reasons to use the Ecosystem Overview and Assessment documents. The second target audience are the main stakeholder groups, whose activities are likely to be regulated, or affected indirectly by the regulations implemented to enact the integrated management plans. The spokespersons or officers of these stakeholder groups may be the most direct users of the Ecosystem Overview and Assessment documents, but it is expected that all stakeholders will be interested in at least parts of both types of documents. The third target audience is the public interest groups which are not considered stakeholders under some governance systems, in that they are not actually *users* of ecosystem resources, but nonetheless have an interest in the well-being of the ecosystem components and/or the coastal communities dependent on the uses made of the marine resources. Note that the technical and scientific community are not a primary target audience for these documents, which are more general and less technical than the primary scientific sources from which they are drawn. Nonetheless, the scientific and technical community must find the contents of both documents credible, if they are to be accepted as a basis for the governance steps in integrated planning and management, and documents must make it easy to find the appropriate technical material, for those who want to dig more deeply into the issues.

Hence, for each type of document, but particularly for the Integrated Ecosystem Assessments, because there are several different audiences, documents of similar content but different degrees of technical complexity may be required to meet the needs of all of them. This aspect will be explored more fully with potential clients of the documents in the near future.

Main Purposes of the Documents: The primary functions of both documents are to:

- 1) Inform all participants in integrated planning and management of:
  - i) The issues which must be addressed;
  - ii) The “extended consequences” of the activities being managed; and
  - iii) The types of questions which they should be pursuing in depth with the scientific and technical experts for the ecosystem.
- 2) Provide a common factual basis for dialogue among the parties in integrated planning and management;
- 3) Provide the factual background for conservation issues on which the Department is unable to compromise with demands of resource users, because to do so would be to place important ecosystem components at unacceptable risk of serious or irreversible harm.

By “issues which must be addressed”, in 1.i) we mean first the identification of the properties of the marine ecosystem which are most important to its structure and functioning, and then, building on the inventory of human activities in the ecosystem, how those activities interact with the key ecosystem properties.

By “extended consequences” in 1.ii) we mean not just the immediate and direct effects of an activity on the ecosystem components, but also the main indirect and cumulative consequences of the first-order direct effects that are like to result from the linkages among ecosystem components.

In 1.iii), we highlight that the Ecosystem Overview document is not an encyclopedic compilation of every research and monitoring study ever conducted in the area. Rather it is a clear but concise presentation of the known status and trends of ecosystem components in the area, and general ecological knowledge for those important ecosystem components where there is no information available for the particular area of interest. This should alert managers of the important ecological issues in which scientific experts should be consulted for support through the integrated planning process.

The “common factual basis” in 2) highlights that the ecosystem overview and assessment documents are objective and empirical, although they may not be highly quantitative about parts of the ecosystem where monitoring data or directed studies are not available. The important consideration is that the documents focus on *describing* the risks as fully and reliably as possible, including indirect as well as direct consequences of perturbations. In this context “risk” means the likelihood and potential severity of any perturbation of an important ecosystem component that is detrimental to the structural or functional integrity of the system, particularly where the perturbation would be the consequence of a manageable human activity. The *management* of those risks comes through the governance system, and not as part of the ecosystem overview and assessment. That means the application of social, economic, and cultural values to the information about which ecosystem components may be affected by activities, or which activities have desirable or undesirable consequences, are not part of the overview and assessment.

On the other hand, 3) confirms that the overview and assessment should highlight cases where perturbations of ecosystem components have a likelihood of being serious or difficult to reverse, if the ecological information warrants. Nonetheless, the documents should leave judgments on the acceptability of those perturbations to the subsequent risk management steps.

## **The Ecosystem Overview Document**

The Ecosystem Overview document should present the information on current status and recent trends for as many ecosystem components as possible. For all components, the best information available should be presented, but the “best” information will not necessarily be really *good* information in all cases. Historic monitoring programs do not cover all components of marine ecosystems with equal thoroughness, so it is expected that much more information will be available on components such as commercially exploited fish and invertebrate stocks. Trends from surveys or population reconstructions should certainly be presented whenever available, but less systematic information on status and trends should be included for parts of

the ecosystem where that is the “best information available”. In all cases traditional and community knowledge may comprise an important part of the information that is available

Because the “best information available” will be of different qualities for different ecosystem components, it is crucial that the uncertainty associated with each status and trend indicator be communicated clearly. Where a number of trends are extracted from the same information source, such as a multi-species monitoring survey, the nature of the uncertainty could be explained only once for the survey but its magnitude presented with each species’ status. For ecosystem components where the best information is from more opportunistic sources the uncertainty may have to be explained in more narrative rather than quantitative manners, but it must still be communicated. When the information comes from a restricted area within the ecosystem, such as a single monitoring site, it is particularly important to report on the extent to which the trends at the site can be considered representative of trends of the features in the ecosystem as a whole.

Although only the best information needs to be presented concisely on each ecosystem component, coverage of the ecosystem should be as comprehensive as possible, from the sea floor to the sky. Sections should address:

- Major seasonal features in the weather and climate, and trends over years;
- The structure features of the seafloor and bathymetry;
- Physical oceanographic properties, particularly currents, freshwater inputs, and patterns of variation in temperature and salinity in space, seasonally, and interannually;
- Chemical oceanographic properties, including nutrients, and suspended solids in the water column and sediments;
- Benthic biomass, abundance, and dominant species, both emergent and in-fauna, and the known variation in space and time;
- Primary productivity and how it varies in space and time, as well as dominant species;
- Zooplankton species composition and biomass, and variation in space, seasonally, and interannually;
- Trends in biomass, abundance, and size composition of the major fish, invertebrate, seabird, and marine mammal species, and key features of their spatial distribution;
- Trends in integrative community properties of the fish community and, if information permits, the larger ecosystem.

For each ecosystem component, it is important to identify clearly the major sources of the information, the key expert(s) involved in preparation of the section, and guide readers who wish to dig deeper into the subject towards the original information sources which are condensed and summarised in the Ecosystem Overview Document.

In addition to information on the natural ecosystem, the Ecosystem Overview should report the current status, recent trends and expected developments in the near future for the major human

activities which affect the ecosystem. These may include land-based activities which are the source of freshwater inputs, nutrients, or contaminants, as well as activities in the ocean. Where quantitative information on the magnitude / intensity of the activities is available, it should be summarized (for example, sizes of fishing fleets, volume of shipping traffic, number of gas or oil wells, etc). Where quantitative information is lacking a verbal description of current levels and expected trends is still helpful.

The information in the Ecosystem Overview should convey more than just the current point value for each ecosystem component. It should also convey the magnitude of inherent variability (sampling variation as well as interannual variance) in those values. It also needs to convey clearly what is not known about the ecosystem, in ways that allow users to differentiate the uncertainty which is due to the ecosystem being inherently variable in space and time from the uncertainty which is due to inadequate sampling of many parts of the ecosystem. The purpose, overall, is to make clear to users of the Ecosystem Overview, the level of conclusion about trends and possible impacts that can be supported from the information which is available on the various ecosystem components.

Scale both in space and in time was identified frequently as important to presenting and interpreting information in the Ecosystem Overview Document. There is no single scale which is appropriate for all information; some features such as rare structural habitat features may exist only on small spatial (but large temporal) scales, whereas other features such as the feeding grounds for highly migratory species may only be meaningful at large spatial scales. A detailed consideration of "scale" in space and time might uncover some useful general guidelines to apply in preparing Ecosystem Overview Documents, but at this time only two bits of guidance are available. First, the scale of various observations should be made clear in the Document, particularly when it varies from one topic or ecosystem property to another. Second, failure to consider scale when reporting on status and trends of ecosystem components (or human activities) could lead to highly misleading interpretations and conclusions.

## **The Ecosystem Assessment Document**

The Ecosystem Assessment Document integrates the descriptive information presented in the Ecosystem Overview Document. This is done in a series of integrations of increasing complexity from how the physical and chemical ecosystem properties serve as forcers for the trends in the biological components, through the interactions among the biological components of the ecosystem, to how human activities serve as pressures and have impacts on the ecosystem properties and relationships.

Assessment of the Physical, Chemical and Biological Components: Usually only a small fraction of possible environmental forcers on ecosystem properties and interactions among ecosystem components will have been quantified locally. Hence some degree of extrapolation from theory or knowledge accumulated elsewhere will usually be necessary at the assessment step. It is important to make clear to readers of the document how much of the assessment is based on local studies or models developed and tested for local conditions, and how much is inferred from more general disciplinary knowledge. The purpose here, again, is to inform users of the assessment, particularly those involved in integrated management, of the uncertainty due to lack of knowledge, and the uncertainty due to variation in space and time of the relationships among the ecosystem properties.

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Because of the very large number of potential linkages among physical, chemical, and biological ecosystem properties, it is easy for the assessment to become so large that it is unwieldy to use. Hence it is important to keep the assessment focused on the major conclusions, and their underlying rationales. These conclusions involve identifying which of the numerous relationships and properties are the important structural and functional ecosystem components. Ecosystem components (properties and relationships) are considered “important” if, when perturbed, they are likely to cause many higher-order follow-on consequences. Ecosystem components may also be considered “important” if they are perturbed readily, and when perturbed are slow to recover after the pressure causing the perturbation is removed. As an analogy, this part of the ecosystem assessment may be likened to a centrifuge where all the information in the Ecosystem Overview used dynamically (although not necessarily with actual models, unless the available information is sound and complete enough to warrant such analytical treatments), and via considering the physical, chemical, and biological inter-relationships dynamically, the most important ones emerge from assessment.

Assessment of the Potential Impacts of Human Activities on the Ecosystem: This portion of the assessment is the starting point for integrated management and planning, and for activities such as setting ecosystem objectives within those integrated management frameworks. It should consider both direct and indirect impacts of the human activities summarised in the Ecosystem Overview Document. As with other parts of the Overview and Assessment, the assessment document should also make clear the types and magnitudes of the uncertainties associated with these potential impacts. Furthermore, the uncertainties should differentiate among lack of knowledge, need to infer local conditions and impacts from studies elsewhere, and inherent variation in the way the human activities may affect the ecosystem components.

To make the assessment particularly useful to managers, planners, and stakeholders, two tabulations are valuable. One is a tabulation of the human activities known or expected to occur in the area, by the pressures which each activity puts on the ecosystem. For example, increased mortality is a potential pressure, and it may be caused by fishing, by contaminants from specific land-based sources, by oil-spills, or by anoxia resulting from eutrophication (caused, in turn perhaps by discharges of municipal waste). The second is a tabulation of the pressures relative to the ecosystem components (or “states”) identified as important in the first part of the assessment. For example, population size of a small cetacean may be an important state variable, and it could be affected by pressures such as direct mortality, productivity (growth and birth rates), or reduction in habitat quality.

Several United Nations scientific and development agencies have adopted a driver-pressure-state-impact-response (DPSIR) framework for integrated management planning. DPSIR is a general framework for organising information about the state of the environment and human uses of it. The framework was derived from social science research and is widely applied internationally, in particular for organising systems of indicators in the context of environmental health and sustainable development. The framework assumes cause-effect relationships between interacting components of social, economic, and environmental systems, which are:

- Driving forces of environmental change (e.g. fishing as an occupation in coastal areas);
- Pressures on the environment (e.g. harvests of fish);

- State of the environment (e.g. state of the fish stocks);
- Impacts on population, economy, ecosystems (fishing mortality on stock, jobs created in communities);
- Response of the society (changing quotas, changing employment patterns).

The two tabulations from the ecosystem assessments can be placed within such a framework readily. This links the DFO approach to a widely used approach to planning and sustainable use of marine ecosystems.

It is acknowledged that this DPSIR framework requires judgments about what is a pressure, what is a state, and what is an impact; for example deaths can be a pressure, mortality rate an state variable, and mortality an impact. Nonetheless, the parts of the general framework outlined in the two suggested tabulations provide a useful way to summarise the results of the assessment for use in subsequent planning and management. As with the assessment of ecosystem relationships, the matter of greatest importance to ensure that readers can see clearly the conclusions on what human activities and impacts are of greatest concern, in the context of the inherent variances and uncertainties brought out in the Ecosystem Overview and Assessment. As an analogy this part of the assessment can be likened to dragging a magnet through the parts of the ecosystem components that have not already been identified as important on a priori grounds. As a result of this part of the assessment additional ecosystem components may be flagged as warranting special attention from managers, either because they turn out to be highly likely to be affected by one or more human activities or because they are particularly reliable indicators that a particular human activity is perturbing the ecosystem possibly more than expected.

As with the Ecosystem Overview Documents, the issue of scale in space and time is crucial to ensuring that an ecosystem assessment is meaningful. Here, too, focused work on increasing our understanding of the most effective ways to incorporate different scales of different ecosystem structures, processes, and human activities might yield significant benefits. For now, it is even more important to heed the considerations about scale presented in the Ecosystem Overview Section; report on the scale of interactions which arise in the assessment, and take care to relate structures, processes, and human activities on the scales at which they actually interact.

## CONCLUSIONS AND ADVICE

The two Ecosystem Overview and Assessment documents which have been reviewed were developed through different processes, and had different formats and organisational structures. In fact, different parts of the Overview and Assessment from each of the two ecosystems were prepared in somewhat different ways. In one case, no single document or set of documents was intended to constitute a complete Ecosystem Overview or a complete Ecosystem Assessment. Ways to improve all the documents were identified through constructive but critical review, and revisions will increase the similarity among the documents somewhat. Beyond that, it is premature to give highly prescriptive guidance on details of how the Ecosystem Overview and Assessment documents should be prepared and organised.

Notwithstanding what remains to be learned about how to prepare maximally useful Ecosystem Overviews and Assessments, the considerations in the Guidance provided above should play a



strong role in collecting the information, analysing it and interpreting it for these documents. Technology is nearly ready, in fact, for at least the Ecosystem Overview to become a living electronic document, with the status and trends of various ecosystem components updated as rapidly as new information comes available. This will pose new challenges to users, and create the need for yet an additional layer of information about the sources and date of origin of different parts of the virtual overview document. The assessment step is particularly important to repeat periodically, in a comprehensive manner, and to report out in a new document. The tabulations of activity by pressure and pressure by state, may form the core of the common factual foundation specified in the section on the Purposes of the Document, and provide an effective basis for the subsequent steps in integrated planning and management.

## SOURCES OF INFORMATION

Breeze, H., D.G. Fenton, R.J. Rutherford, and M.A. Silva. 2002. The Scotian Shelf: An ecological overview for ocean planning. Can. Tech. Rep. Fish. Aquat. Sci. 2393: x + 259 pp. Available on WAVES website: [www.dfo-mpo.gc.ca/Library/263134.pdf](http://www.dfo-mpo.gc.ca/Library/263134.pdf)

Coffen-Smout, S., R.G. Halliday, G. Herbert, T. Potter, and N. Witherspoon. 2001. Ocean Activities and Ecosystem Issues on the Eastern Scotian Shelf: An Assessment of Current Capabilities to Address Ecosystem Objectives. DFO Can. Sci. Advis. Sec. Res. Doc. 2001/095. Available on the CSAS website: [www.dfo-mpo.gc.ca/csas/Csas/DocREC/2001/RES2001\\_095e.pdf](http://www.dfo-mpo.gc.ca/csas/Csas/DocREC/2001/RES2001_095e.pdf)

DFO. 2003. State of the Eastern Scotian Shelf Ecosystem. DFO Can. Sci. Advis. Sec. Ecosystem Status Rep. 2003/004. Available on CSAS website: [www.dfo-mpo.gc.ca/csas/Csas/status/2003/ESR2003\\_004\\_E.pdf](http://www.dfo-mpo.gc.ca/csas/Csas/status/2003/ESR2003_004_E.pdf)

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