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Canada's oceans
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Pathways of Effects National Guidelines

Illustrating the links between human activity and its potential impact on aquatic ecosystems

Canada

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This report may be cited as:
Government of Canada. 2012.
Pathways of Effects National Guidelines.
Fisheries and Oceans Canada. 32 pp.

PDF – English
Cat. No. Fs23-581/2012E-PDF
ISBN 978-1-100-20993-7

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Acronym list

AOI	Area of Interest
BMP	Best Management Practice
CEAA	Canadian Environmental Assessment Agency
CSAS	Canadian Science Advisory Secretariat
CMA	Coastal Management Area
DFO	Fisheries and Oceans Canada
DPSIR	Driving forces-Pressures-State-Impacts-Responses
ERA	Ecological Risk Analysis
EOAR	Ecosystem Overview and Assessment Report
EBM	Ecosystem-based Management
EA	Environmental Assessment
EPA	Environmental Protection Agency (United States)
EEA	European Environmental Agency
IOM	Integrated Oceans Management
LOMA	large Ocean Management Area
MPA	Marine Protected Area (generic)
OECD	Organisation for Economic Co-operation and Development
PoE	Pathway of Effect
PoENWG	Pathway of Effect National Working Group
REA	Regional Environmental Assessment
SECOA	Social, Economic and Cultural Overview and Assessment
UNEP	United Nations Environment Program
VEC	Valued Ecosystem Component

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PREFACE

The following Pathways of Effect National Guidelines are intended to help ocean management practitioners to apply Pathways of Effect (PoEs) for the implementation of Integrated Management (IM) and Ecosystem-based Management (EBM) within Canada's coastal regions and oceans. Developed by a Fisheries and Oceans Canada (DFO) Pathways of Effect National Working Group (PoE-NWG) for planners and decision-makers within DFO, these guidelines may also be useful for the identification, assessment and management of the potential impacts of human activities on aquatic ecosystems and their resources.

Using these guidelines

Sections 1 and **2** provide the *regulatory context* in which PoE models are developed and position the models within the larger practice of *ecosystem-based management*.

Section 3 describes the *benefits* of using such models and details the *core elements of PoE design*.

Section 4 outlines the *ecological unit* considerations for the use of PoEs in the IM context and defines the *three current categories* of models in use at DFO.

Section 5 provides *step-by-step instructions* on how to develop a PoE model – from the identification of participants and selection of endpoints, to the identification of ecological impacts and scientific validation.

1. INTRODUCTION

Ocean planners and environmental managers work to maintain marine ecosystem health, ensuring that significant or valued ecosystem components (VECs) and services are not compromised by human activities. But how do they describe and measure the complex and multi-faceted relationships between human activities and their potential impacts upon aquatic ecosystems? One widely used approach is a modeling tool known as a **Pathways of Effect** – or PoE.

Knowledge and expertise about PoE development at DFO evolved from traditional fish management advice to broader application within EBM, using various PoE model types. This 'ever green' document describes the role of PoEs within broader planning processes, the types of PoE models currently in use, their potential applications, and a step-by-step process for their development.

2. ECOSYSTEM-BASED MANAGEMENT (EBM)

The Government of Canada, through the *Oceans Act* (1997), is committed to the integrated management of human activities in or affecting Canada's marine ecosystems. Integrated management is implemented through an ecosystem approach—or Ecosystem-based Management (EBM).

EBM considers the marine ecosystem health in the management of human activities that affect marine and coastal areas, and includes land-based activities. The approach ensures that significant ecosystem components and goods and services, such as fish habitat and water quality, are not significantly impacted by human activities and are maintained at appropriate temporal and spatial scales over time. The concept has been incorporated into numerous international agreements, and many other countries are also in the process of implementing EBM approaches (Curtin and Prellezo, 2010). EBM overcomes the limitations of the traditional sector-by-sector or species-by-species approach to resource management by providing a framework for the identification and assessment of the cumulative impacts that *multiple* human activities may have on an ecosystem.

EBM requires comprehensive information about aquatic ecosystems and their potential pressures and impacts. Within DFO, knowledge compiled to date relates to ecosystems and the social, cultural and economic use of marine areas. Several reports and guides to support EBM implementation have been developed through expert workshops[1]:

- "Delineation of Marine Ecoregions Workshop." Canadian Science Advisory Secretariat Proceedings Series 2004/016.
- "Guidelines on Evaluating Ecosystem Overviews and Assessments reports (EOARs): Necessary Documentation." Canadian Science Advisory Secretariat SAR 2005/026.
- "Identification of Ecologically and Biologically Significant Areas." Canadian Science Advisory Secretariat Ecosystem Status Report 2004/006.
- "Identification of Ecologically Significant Species and Community Properties." Canadian Science Advisory Secretariat SAR 2006-041.
- "Guidance on Identifying Conservation Priorities and Phrasing Conservation Objectives for Large Ocean Management Areas." Canadian Science Advisory Secretariat Report SAR 2007/010.
- Social, Economical and Cultural Overview and Assessment (SECOA) reports.

These reports/guides provide a firm foundation for understanding ecosystems in general, as well as significant ecological components and areas within Canada's marine environment. In some circumstances, this work has led to the identification of conceptual conservation objectives (and eventually clear operational objectives) for ecosystems—the first steps toward the implementation of IM/EBM. It has also increased understanding of potential sector-based

[1] http://www.dfo-mpo.gc.ca/csas-sccs/index.htm

and cumulative impacts of human activities on coastal and marine ecosystems, and is the basis for assessing ecosystems' health.

3. PATHWAYS OF EFFECT MODELS

3.1 Role of PoEs

In addition to the reports and guides described in the previous section, managers and regulators also need tools, such as environmental and risk assessment processes, to identify management priorities. PoEs can guide these processes by providing the necessary science-based foundation for decision-making (as highlighted in the draft IM/EBM process framework in **Table 1)**.

PoEs are also effective communication tools that inform, educate, involve and engage ocean users, governments, and other affected and interested parties.

1. INITIATE THE PLANNING PROCESS
• Delineate area • Identify key interests • Establish vision and broad objectives
2. CHARACTERIZE AND ASSESS ECOSYSTEMS
• Ecosystem overviews • Socio-economic overviews • Ecologically & Biologically Significant Areas & Species
• Vulnerability analysis • Pathways of Effects models (PoEs) • Risk assessment
3. IDENTIFY MANAGEMENT GAP & ECOSYSTEM SERVICES
• Conduct policy and regulatory gap analysis • Evaluate ecosystem goods and services
4. SET OBJECTIVES/TARGETS AND INDICATORS
• Set operational objectives with targets and limits • Identify indicators
5. IDENTIFY MANAGEMENT OPTIONS
• Identify and assess management options (e.g. MPA, Fisheries closures, MEQ standards)
6. DEVELOP PLAN, GUIDANCE & ADVICE
• Develop operational guidance and specific advice
7. MONITOR, EVALUATE AND REPORT
• Monitor, assess and report on the status of ecosystems and pressures. Assess effectiveness of management measures

Table 1: Draft **Integrated Management / Ecosystem-based Management planning process**

3.2 What is a PoE model?

A PoE model is a conceptual representation of fact-based relationships between human activities and their associated sub-activities, the pressures and the environmental effects or impacts they may have on a specific ecological or biological endpoint.[2] The alteration of the endpoint may have consequences on ecosystem goods and services, and ultimately the socio-cultural and economic activities and values that rely upon these goods and services. **Figure 1a** illustrates the elements in a PoE model.

Figure 1a: PoE main elements

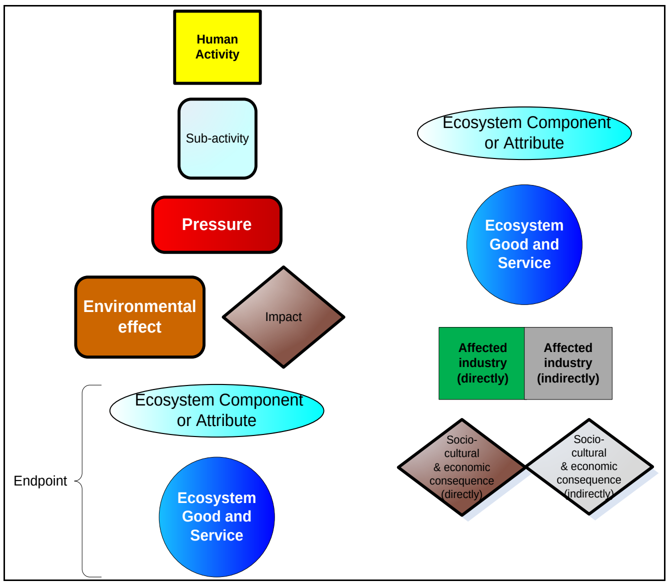


Figure 1b: Example

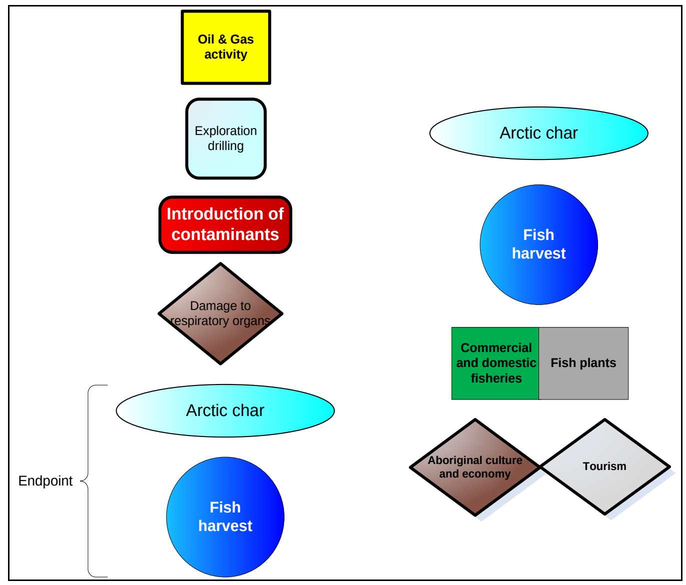


Figure 1b provides a concrete example of what PoE elements represent and the relationships among them. The human activity, oil and gas, and one of its sub-activities, exploration drilling, may potentially introduce heavy metal contaminants in the water column via the discharge of mud and/or cuttings. One of the resulting impacts may be damage to the respiratory organs of fish such as Arctic char (endpoint). If the Arctic char population in the vicinity of the contaminated water column is affected, then the ecosystem may not be able to provide the fish biomass necessary for harvesting purposes. In turn, direct consequences on commercial and domestic Arctic char fisheries and indirect consequences on fish processing plants may occur.

PoE models consist of **diagrams** like those in Figure 1, as well as **a narrative** that describes the relationships among the elements along with the rationale for their selection.

[2] The term endpoint is used to define the ecosystem component/function that needs protection (EPA, 1998).

3.3 Benefits of a PoE model

The benefits of using a PoE model are numerous. In particular, PoEs can inform decision-makers by:

1. Illustrating potential impacts:
   - linking human activities and ecological components to ecosystem services and social, cultural and economic values (endpoints);
   - aiding strategic management planning related to cumulative effects that arise from activities in a place-based context;
   - serving as a check list for potential effects when reviewing the design/mitigation of a particular sector's activities in a regulatory or an environmental assessment context; and
   - helping managers to understand an issue fully and identify key areas where mitigation to break or minimize the pathway may be most effective.

2. Supporting communication:
   - with the public, managers, practitioners, regulators and affected parties;
   - with project proponents (particularly with regards to potential effects of a proposed project, as well as the information and monitoring required for project reviews and ongoing evaluation); and
   - with stakeholders (facilitation of participation through a transparent, structured and scientifically validated review process).

3. Facilitating the identification of gaps and needs:
   - policy and regulatory gaps:
     - identification of requirements for new policy, regulatory and non-regulatory measures;
     - identification of responsible authorities who should be involved in decision-making processes due to their specific mandates for the proposed activities or potentially affected ecological and/or social, cultural and economic values in area of interest; and
   - research needs (e.g., areas of limited or unknown effects on ecosystem components).

4. Providing additional benefits:
   - creating bridges between aquatic terrestrial, marine and coastal management by illustrating impacts of land-based activities on marine environments.

3.4 PoE design

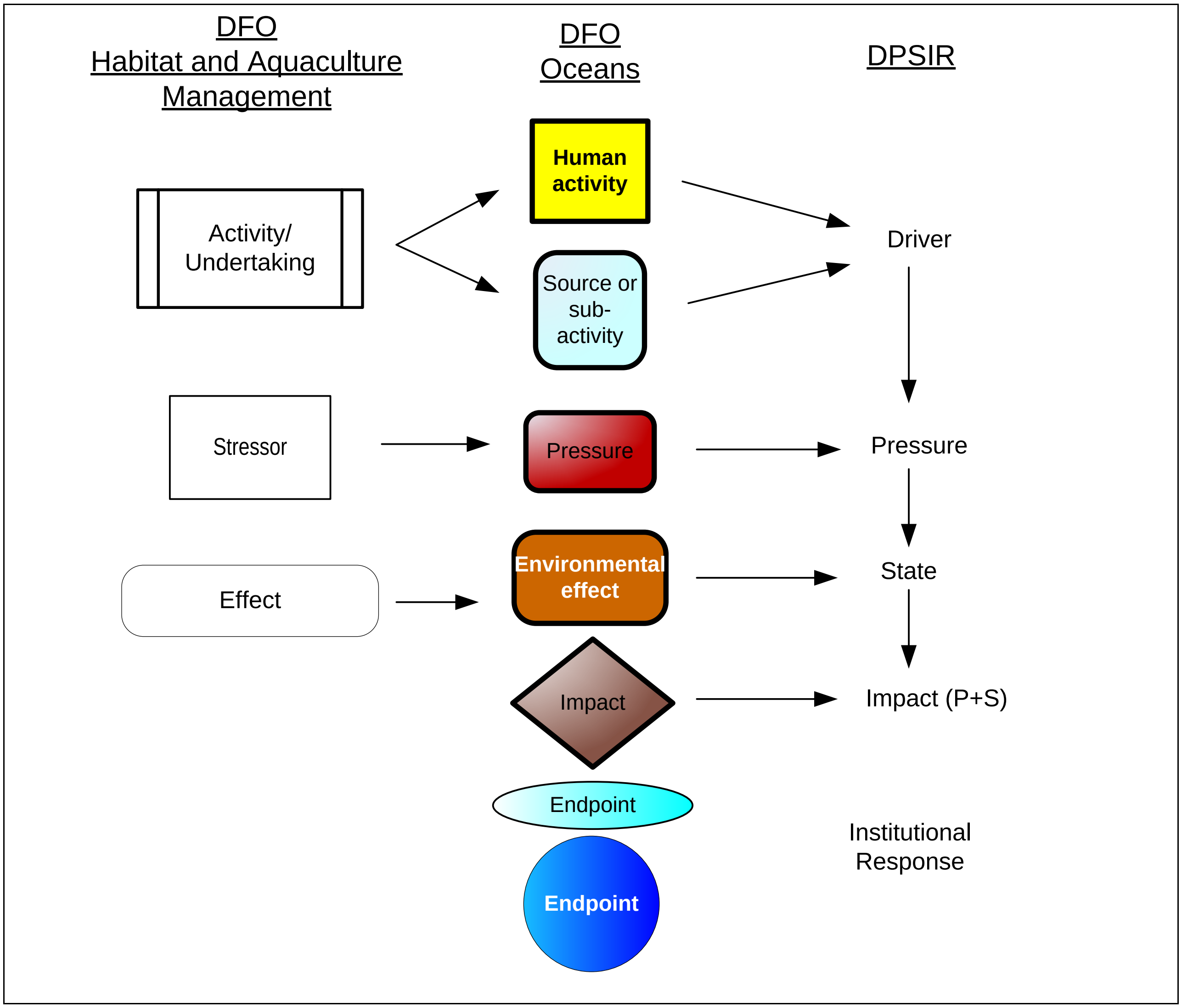
Figure 2 (following page) illustrates the various terminologies, labels and layouts used in conceptual modelling. On the left, DFO's Habitat and Aquaculture Management programs use a PoE terminology composed of three main elements. Oceans programming – in the centre – uses a more detailed terminology. This is closely linked to the international driving forces-pressures-state-impacts-responses (DPSIR) nomenclature that is illustrated on the right. Depending on the origin of the model, different terminology may be used.

The DPSIR framework, an extension of the Organisation for Economic Co-operation and Development's 1999 Pressure State Response framework, was originally developed by the United Nations Environment Program (UNEP) and adopted by the European Environmental Agency (EEA) to assess and manage environmental problems. It is a general framework for organizing information about the state of the environment, and assumes cause-effect or correlative relationships between interacting components of social, economic and environmental system. These include:

- **D**riving forces of environmental change (e.g., industrial production);
- **P**ressures on the environment (e.g., discharges of waste water);
- **S**tate of the environment (e.g., water quality in rivers and lakes);
- **I**mpacts on population, economy, ecosystems (e.g., water unsuitable for drinking);
- **R**esponse of the society (e.g., watershed protection).

The PoE approach outlined in this document is consistent with the DPSIR framework. However, the driver element of the DPSIR is further divided into two elements: human activity and sub-activities. This adds specificity to the type of activity that may cause pressures. Endpoints are also added in the DFO Oceans PoEs because they structure/align the assessment to address management concerns. Compared with DPSIR, DFO PoEs do not include institutional responses to a pressure (e.g., code of practice, mitigation measure, best management practice (BMP), regulation or others), although these may be identified later in the management process.

Figure 2: Examples of PoE design, terminology and labels used in conceptual modeling



4. TYPES OF PoE MODELS

The type of PoE model used, and therefore its complexity, will differ depending on the **geographical unit** or scale at which the model is built and the degree of detail to be included. The geographical or spatial unit can be as broad as a bioregion or as small as a marine protected area (MPA), a single estuary or a species-specific habitat.

Three categories of PoE models exist within DFO to address different analysis goals and objectives:

- Holistic models;
- Endpoint models; and
- Activity/action and sector-based models.

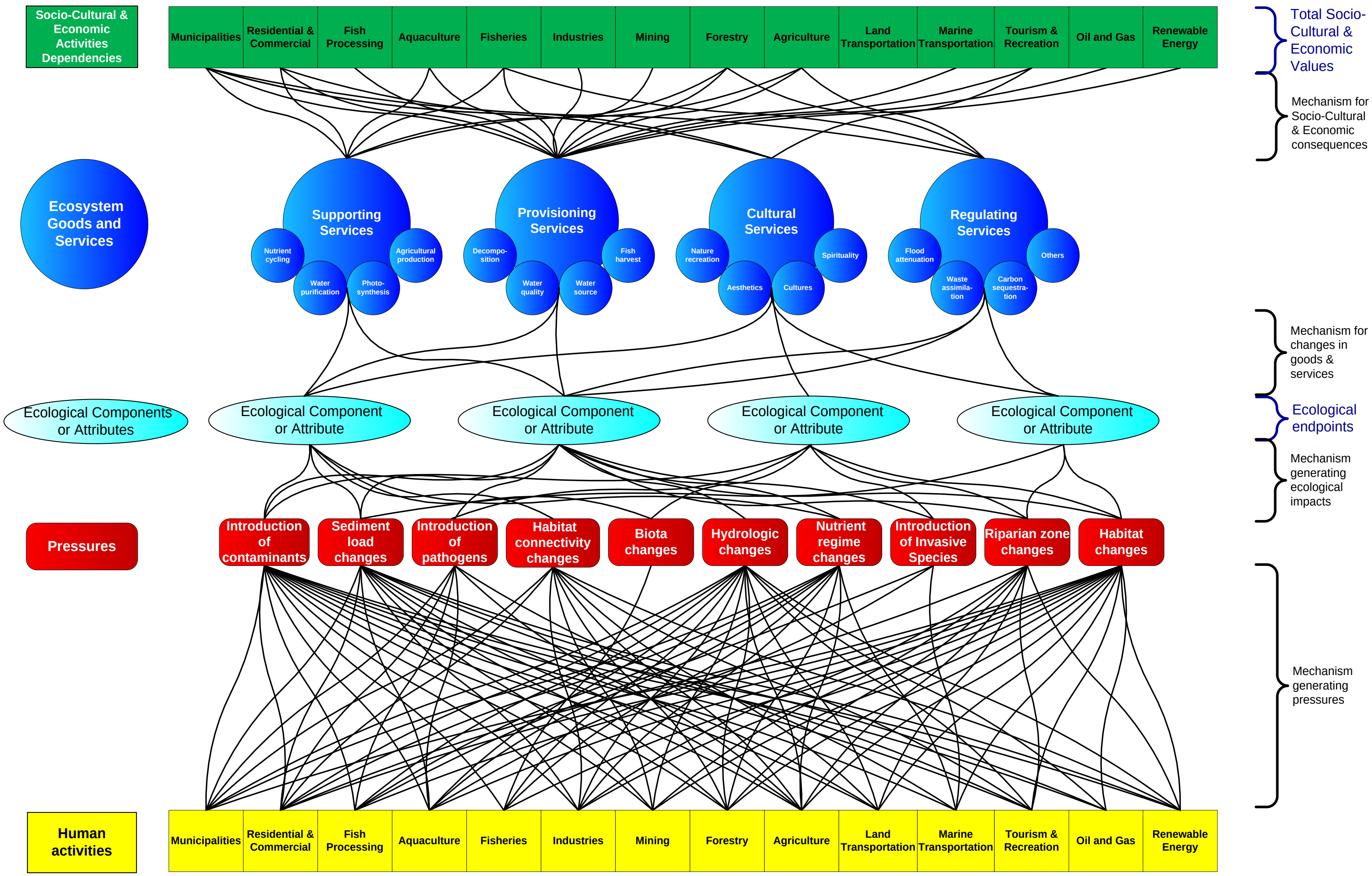
4.1 Holistic models

The holistic PoE model is the starting point for IM and provides a foundation for future detailed PoE development. A holistic model is a high-level one that illustrates all human activities taking place in the same spatial unit and that could collectively create cumulative impacts on the ecosystem. The holistic model is designed to be read from the bottom up, whereas subsequent model types are read from the top down.

Holistic models are effective planning tools for the management of a particular spatial unit to ensure appropriate measures are taken to avoid detrimental effects. They can help identify: a) the legal authorities responsible for managing activities that result in/create a specific pressure (e.g., nutrient loading); b) the existing management responses to that pressure (e.g., municipal laws); and c) gaps in legislation, policies and regulations (e.g., no existing regulation on fertilizer).

The holistic model example provided in **Figure 3** illustrates the multitude of pathways between all human activities (e.g., agriculture, fisheries); potential pressures (physical, chemical and biological stressors) stemming from these activities (e.g., nutrient regime changes, biota changes); and their impacts on endpoints (ecosystem components or attributes such as spawning ground) and aquatic ecosystem goods and services (e.g., water quality, fish harvest). The model depicts the socio-cultural and economic activities that rely upon those goods and services. The model is built to be circular in nature, in that the human activities and the socio-cultural and economic activities, dependencies or values are both the initiators and the objects of the environmental changes.

Figure 3: Example of a holistic PoE model

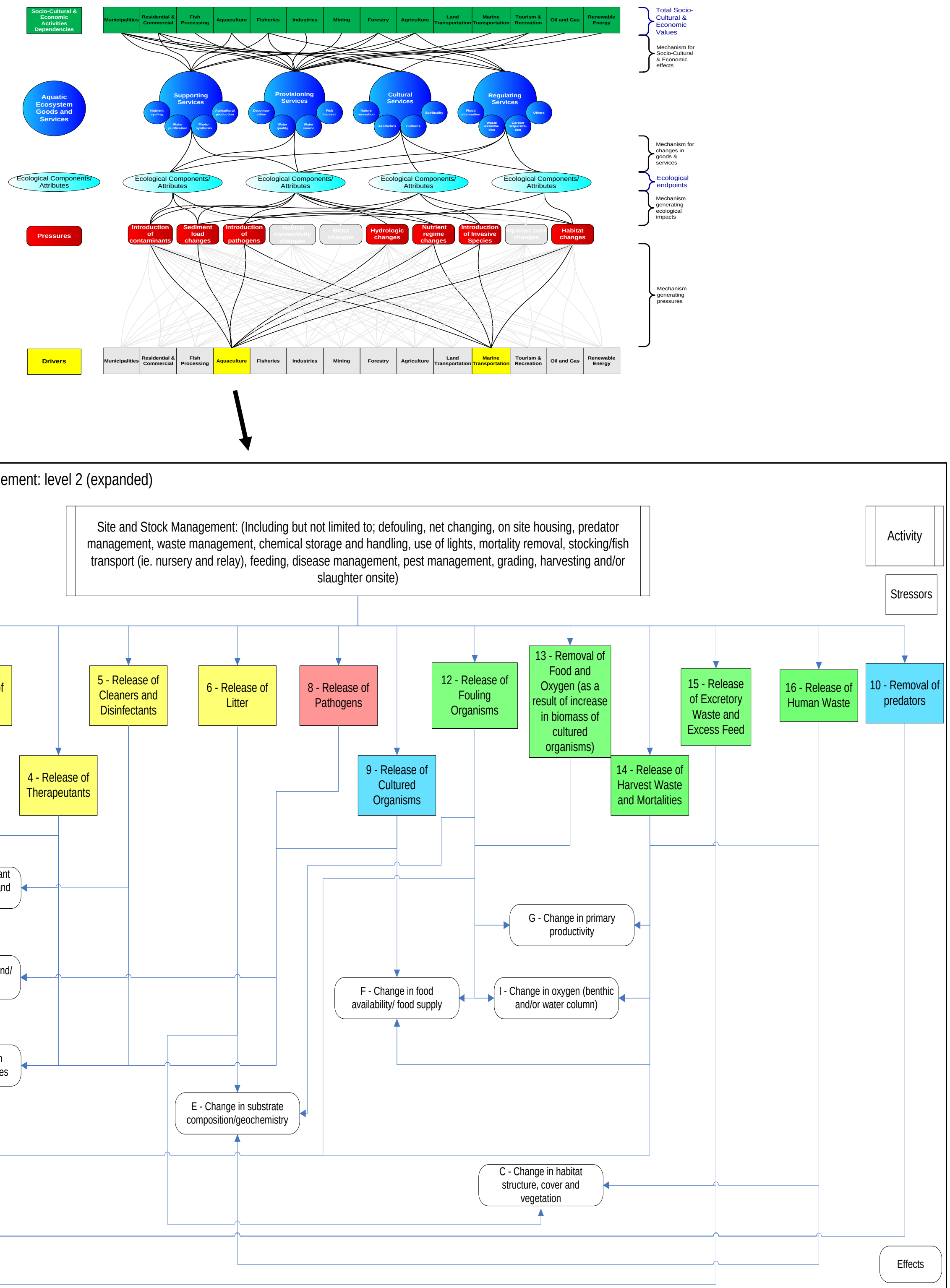


4.2 Endpoint PoE models

Once the holistic model is complete, one or more endpoint models can be developed. Endpoint models are more detailed than holistic PoEs as they illustrate all potential impacts on selected endpoints (the ecosystem components, functions or social, cultural or economic values that need to be maintained or protected). Endpoints are directly linked to specific objectives as derived from legislative mandates (e.g., *Species at Risk Act* recovery objectives) or international agreements (e.g., MPA network objectives that conform to Convention on Biological Diversity guidance). Alternatively, they may be linked to management or conservation objectives (e.g., conservation objectives for Ecologically and Biologically Significant Areas (EBSAs)). Other endpoints may be derived from special socio-economic or cultural objectives (e.g., protection of clams and salmon that are important sources of food, income and cultural activities for Pacific Coast First Nations (GESAMP, 2008). Objectives need to be defined prior to the development of an endpoint PoE.

Figure 4 is an example of a comprehensive PoE linked to a holistic model that provides significant detail regarding the pressures and impacts generated by specific sectors, activities or actions.

Figure 4: Example of a holistic model with common pressures generated by aquaculture and marine transportation sectors, and associated detailed PoE for aquaculture



There are three types of endpoint models, depending on the objective of the analysis:

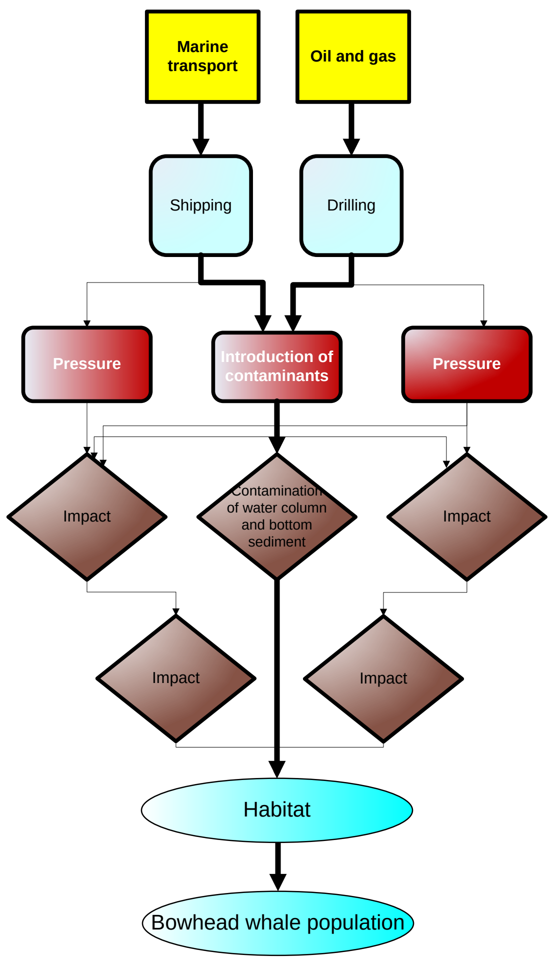
- Species-based model;
- Pressure-based model;
- Socio-cultural and economic-based model.

4.2.1 Species-based model

In a species-based model, the endpoint can be an ecologically significant species, a species at risk or other species of management concern. This type of model identifies the pathways between human activities, their sub-activities, the pressures and the potential cumulative impacts on an ecosystem component/attribute that a species depends upon for survival or recovery.

Figure 5 illustrates the specific relationships among two human activities (marine transport and oil and gas), their sub-activities (shipping and drilling), the pressures (introduction of contaminants, etc.) and the potential impacts (contamination of water column and bottom sediment, etc.) on the habitat and ultimately on the bowhead whale population**.**

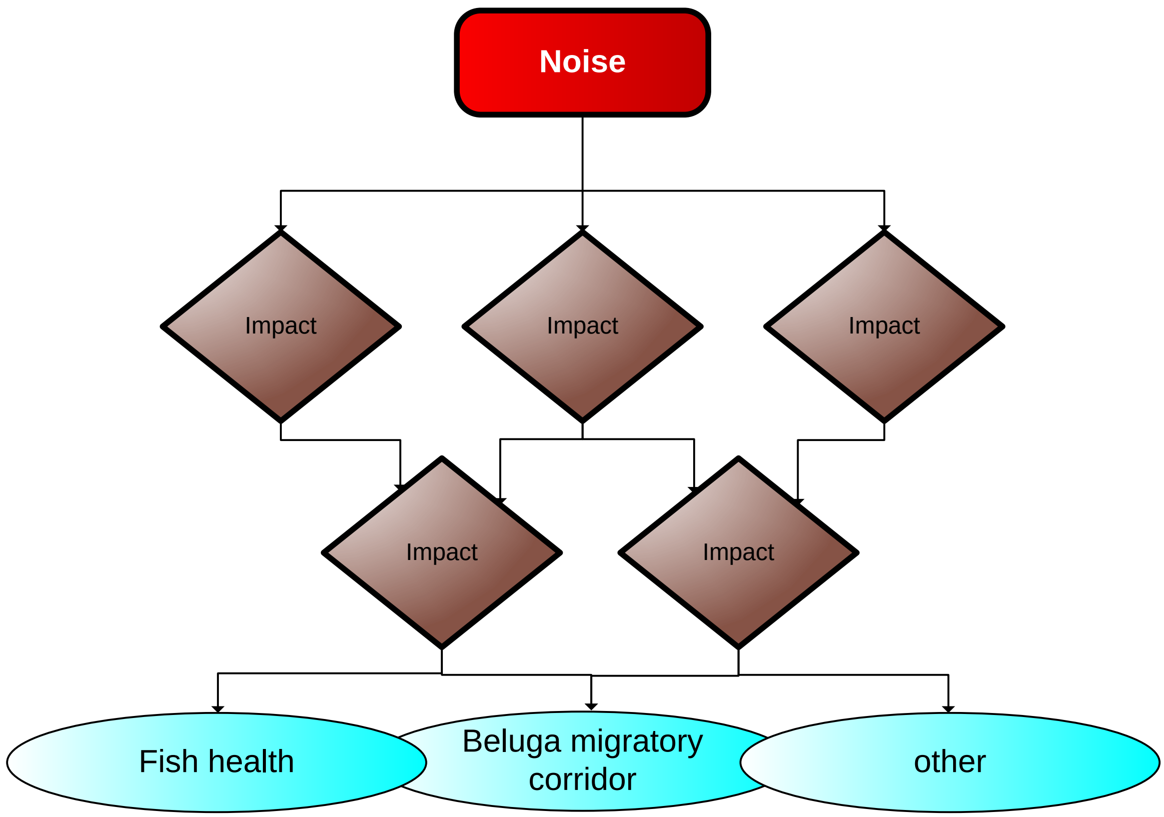
Figure 5: Example of a species-based model



4.2.2. Pressure-based model

The pressure-based model **in Figure 6** illustrates the pathways from one pressure (e.g., noise) to one or more measurable endpoints (e.g., beluga whale migration corridor, fish health). Such a model shows how a single pressure may affect many endpoints and how the mitigation of this pressure would contribute to the protection of multiple ecosystem components and functions. The combination of several pressure-based models can also illustrate the cumulative effects of various pressures on specific ecological components.

Figure 6: Example of a pressure-based model (generic)

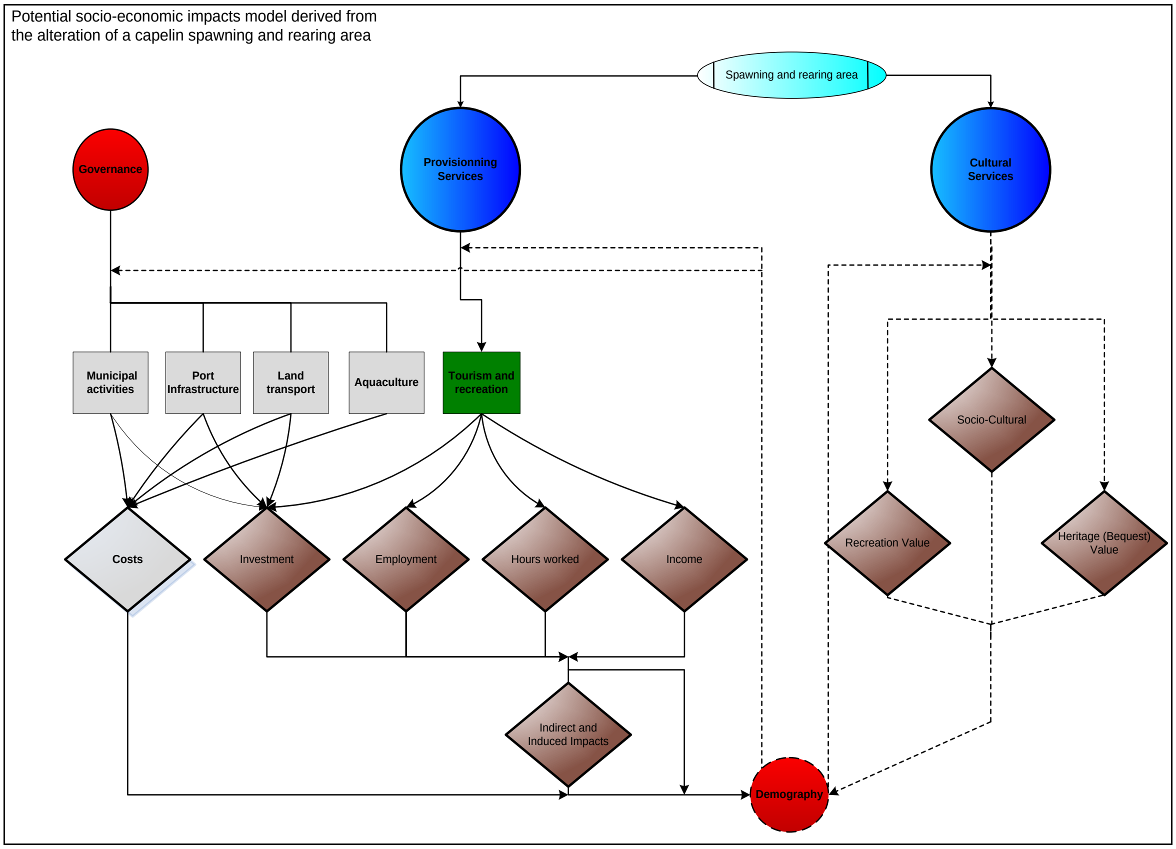


4.2.3 Socio-cultural and economic-based model

A socio-cultural and economic-based model illustrates the potential consequences of an altered ecological component or the loss of an ecosystem goods or service on a specific social, cultural or economic user (e.g., industry).

Figure 7 shows the linkages between a measurable endpoint (e.g., capelin spawning and rearing area) and the potential impacts on ecosystem goods and services (e.g., provisioning and cultural services) which may eventually affect economic activities (e.g., tourism) and cultural values (e.g., recreational), and ultimately social demographics. Some activities and values can be impacted directly—for example, by losing capelin spawning ground, there would be less capelin for marine mammals and the whale watching industry would become less lucrative (leading to loss of jobs). Alternatively, impacts may be indirect – for example, a regulation that forbids the building of a retaining wall on a coastal beach could affect, in turn, other economic sectors such as transportation (e.g., relocation of a road).

Figure 7: Example of a socio-cultural and economic model



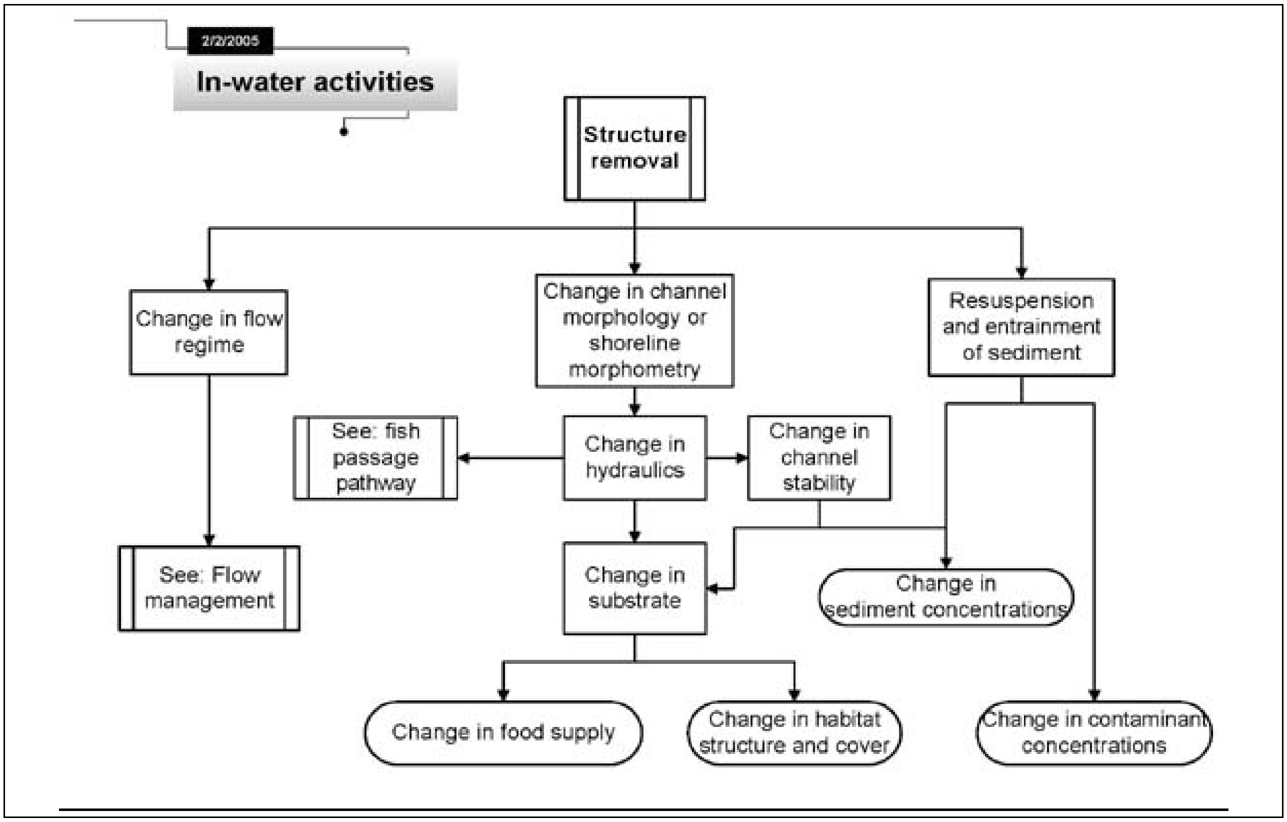
4.3 Activity/action and sector-based models

Activity/action models and sector-based models are two types of PoEs that form the building blocks of a holistic model. They may be used individually or in combination with other such models (e.g., to review environmental assessment proposals).

4.3.1 Activity or action-based models

Activity or action-based models illustrate the potential stressors and effects of a specific action (e.g., **Figure 8** illustrates the effects that the removal of an in-water structure may have on fish or fish habitat). Such models are used by DFO Habitat Program to evaluate development proposals in terms of the activities that are involved, the known cause-effect relationships, and the mechanisms by which stressors ultimately lead to effects in the aquatic environment (DFO, 2006). Each pathway represents an area where mitigation measures can be applied to reduce or eliminate a potential effect. When mitigation cannot be applied or fully address a stressor, the remaining effect is referred to as a "residual effect." To support habitat program practitioners, a series of PoE diagrams were developed for common activities associated with a broad range of development proposals. The purpose of these PoE templates is to enable habitat managers to have a common reference tool to highlight aquatic effects of specific concern.

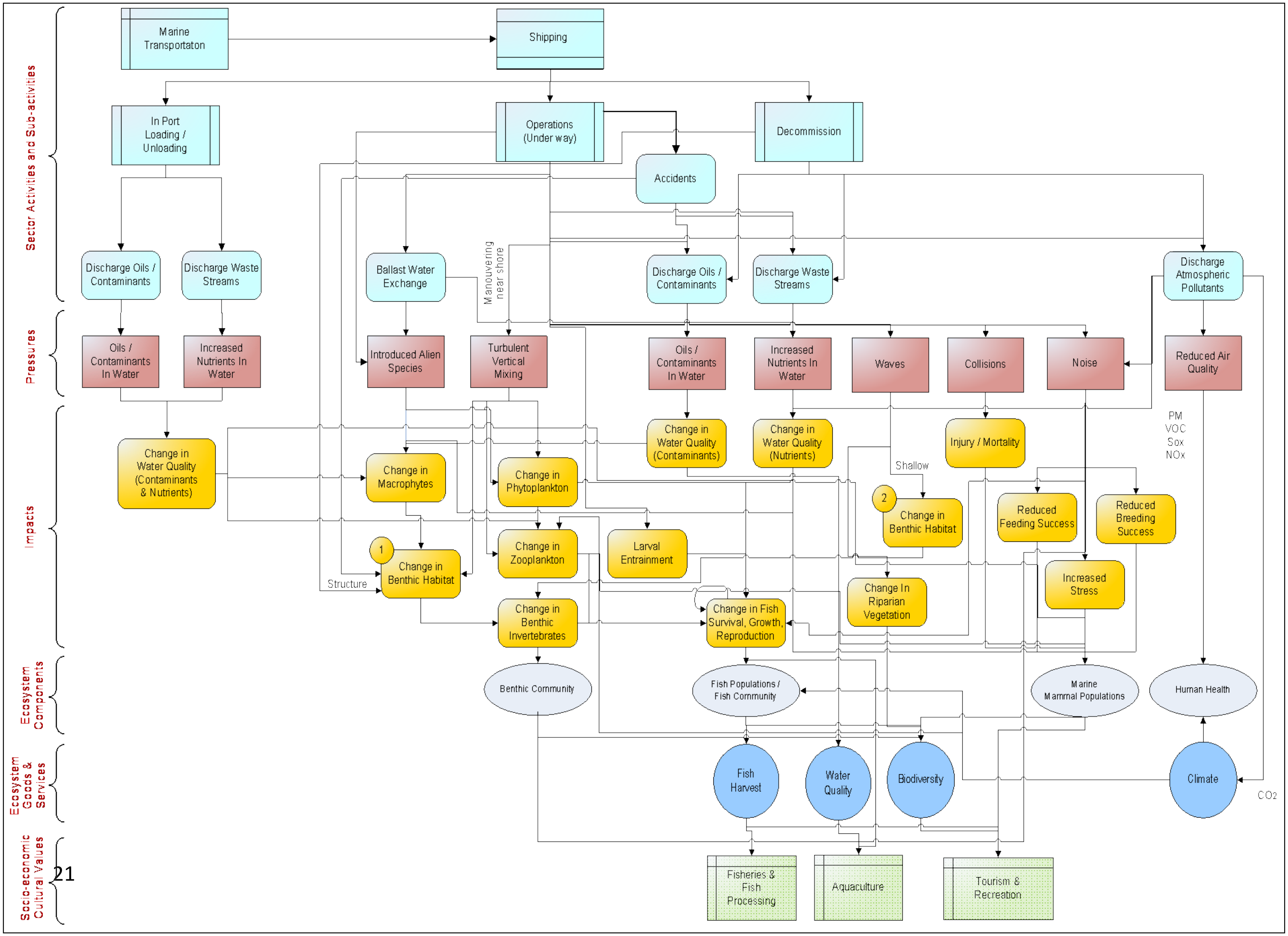
Figure 8: Example of an activity or action-based model



4.3.2 Sector-based models

Sector-based PoEs demonstrate the potential impacts derived from a specific sector, in order to inform IM and other planning processes in various spatial units. Sector-based models can be created for each sector operating within an area and can also be combined to identify cumulative effects. For example, **Figure 9** is a PoE of the marine transport sector that focuses on activities related to shipping. The sub-activities can generate several pressures (e.g., oils and contaminants; collision; noise). The pressures may cause changes in water quality (from contaminants), injury or mortality (from collision) and increased stress (from noise). In turn, all these impacts may harm ecosystem components, as well as the ecosystem goods and services these components provide to other socio-economic and cultural activities (such as fisheries, tourism and aquaculture).

Figure 9: Example of a sector-based model

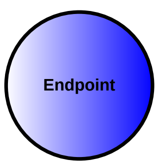


5. PoE DEVELOPMENT

A step-wise process is proposed for the development of any PoE. However, depending on the particular PoE model under development, different partners and affected parties will be involved according to their expertise, authority and management responsibilities. Models can be developed during workshops, by a smaller group of experts or by a consultant. If a holistic model is developed in a workshop, a broad range of participants with different backgrounds, skills and interests will usually be involved. For an endpoint model, more specialized expertise is required. The type of participants involved in developing PoEs will also depend on the geographic unit, the type of drivers, pressures and selected endpoints. The participants may be involved at all or any stages, including the selection of ecological components, the identification of potential pressures and impacts generated by human activities, the provision of advice, and during scientific validation. Involving experts from various regulatory agencies and industry from the beginning fosters acceptance of the resulting model and builds support for the entire planning process.

5.1 PoE components

Identification of measurable endpoints



The first step involves identification of the PoE components described in **Section 3**, starting with identification of specific, measurable endpoint(s) that will structure the rest of the PoE development process. The endpoints are equivalent to environmental/state indicators since both are used to measure and track changes over time with respect to the objective. Measurable endpoints will also help to 'operationalize' the objectives.

Measurable endpoints have to be practical and well-defined. They should be easily understood both by the public and decision-makers, yet meaningful to environmental, social, cultural and economic scientists. Measurable endpoints include both an ecological entity (e.g., eelgrass) and a measurable attribute (e.g., distribution). They provide direction for the assessment and are the basis for the development of questions, predictions, models and analyses. Measurable endpoints are selected based on their relevance to the management objectives, their importance in the ecosystem and their susceptibility to pressures (EPA, 1998).

The identification of measurable endpoints can be challenging. It requires the translation of abstract environmental, social, cultural and economic management objectives into specific well-defined attributes of the system. The rationale behind this linkage should be documented.

Examples of ecological measurable endpoints:

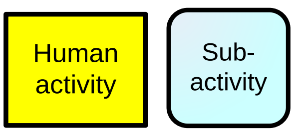
For species:

- Estuarine eelgrass habitat abundance and distribution;
- Fry survival;
- Area of spawning ground; and
- Benthic invertebrate diversity.

For ecosystems:

- Biodiversity/physical structure;
- Ecosystem structure maintained; and
- Carrying or adaptive capacity.

Identification of human activities and sub-activities



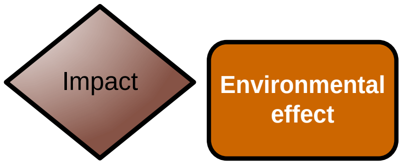
The next step of the process is the identification of the various human activities and sub-activities within the spatial unit that could potentially generate pressures and impacts on the selected endpoint(s).

Human activities (e.g., agriculture) and sub-activities (e.g., applying fertilizer) are entities or actions that are released or impose pressures on the environment. The sources of the pressures are the focus of management options. When multiple sources are identified, it may be beneficial to focus on those important sources that management measures can control.

Identification of pressures

The third step is the identification of one or more specific pressures that can potentially impact or have an environmental effect on the selected endpoint(s) within the study area (e.g., change in nutrient regime). Pressures are defined as any chemical, physical or biological entity that can cause an adverse effect on a measurable endpoint(s).

Identification of impacts/ environmental effects



The final step is identification of the potential impacts or environmental effects on the selected endpoint(s). An impact is a measurable change to an ecosystem component/function (e.g., loss of spawning habitat) as a result of human-induced pressures. An impact can be positive or negative.

The Canadian Environmental Assessment Act (2009) defines environmental effect (i.e., impact) as “any change that the project may cause in the environment (e.g., nutrient regime alteration)…”.

5.2 PoE validation

Once a PoE is developed, scientific review and validation of the model is needed to confirm what is known and what is not known about the relationships within the PoE. Validation may occur through formal or informal processes such as those outlined below.

Canadian Science Advisory Secretariat (CSAS) review process

CSAS processes provide quality control for information and advice on the pressure-impact linkages identified in PoEs, and identify knowledge gaps or areas of uncertainty. Scientific validation of PoE diagrams involves the review and documentation of existing data and research that confirm (or contradict) the linkages in the pathways.

Social, cultural and economic PoE models review process

In the absence of a formal process to assess social, cultural and economic PoEs, it is helpful to consult with academic experts (e.g., in the domains of economics, sociology, anthropology), depending on the subject matter.

6. CONCLUSION

Once PoE models are developed, they can lead to further steps in an ecological risk analysis, environmental assessment, or planning process. For example, a PoE can lead to:

- identification of pressure and state indicators needed for risk / environmental assessment;
- identification of scientific limits and management targets for the 'most at risk' ecological components/attributes; and
- identification of management gaps.

To that end, as the approach evolves and is refined, these 'living' guidelines will be updated accordingly. Over time, practitioners and managers will be able to access a comprehensive library of PoEs models as they are developed nationally and regionally. Once completed, these models will be available on DFO website: http://www.dfo-mpo.

GLOSSARY

Attribute:
Ecological attributes are those aspects of an aquatic assemblage or community that correspond to the structure and function of that assemblage or community for a given condition.

Cumulative impact:
The impact on the environment caused by a human activity which results in an incremental impact in combination with other past, present and reasonably foreseeable future human activities.

Ecological component:
Ecosystems consist of various non-living abiotic and living biotic components. The abiotic components of an ecosystem include various physical and chemical factors.

Ecological risk assessment:
The process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors.

Ecosystem:
The 2004 Convention on Biological Diversity defines the term ecosystem simply as a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit. The concept is applicable at any scale, from the planet as an ecosystem to a microscopic colony of organisms and its immediate surroundings.

Ecosystem based management (EBM):
Ecosystem-Based Management (EBM) is the management of human activities to ensure that marine ecosystems, their structure (e.g.,, biological diversity), function (e.g.,, productivity) and overall environmental quality (e.g.,, water and habitat quality) are not compromised and are maintained at appropriate temporal and spatial scales.

Ecosystem services:
Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as regulation of floods, drought, land degradation, and disease; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious and other nonmaterial benefits.

Endpoint:
The term endpoint is used to illustrate the ecosystem component/function and/or social, cultural or economic value that needs maintenance or protection.

Environmental effect:
An environmental effect represents changes to the state of the environment caused by natural or human-based actions.

Environmental indicator:
An environmental or a state indicator is a numerical value that helps provide insight into the state of the environment or human health. Indicators are developed based on quantitative measurements or statistics of environmental condition that are tracked over time.

Human activities:
Human activities, sources or sub-activities are entities or actions that are released or impose pressures on the environment.

Impact:
An impact is a measurable change to an ecosystem component/function. An impact can be positive or negative.

Limit reference point:
The *Limit reference point* is the stock level below which productivity is sufficiently impaired to cause serious harm to the resource but above the level where the risk ofextinction becomes a concern.

Measurable endpoint:
A measurable ecological, social, cultural or economic value that is related to the valued component chosen as the endpoint. A measurable endpoint establishes the link between an endpoint and the management or conservation objective identified by resource managers.

Pressure:
Any chemical, physical or biological entity that can cause an adverse effect on a measurable endpoint(s).

Pressure indicators:
Pressure indicators measure the factors that cause changes in the ecosystem.

Regional environmental assessment (REA):
Regional Strategic Environmental Assessment (R-SEA) is a process designed to systematically assess the potential environmental effects, including cumulative effects, of alternative strategic initiatives, policies, plans, or programs for a particular region.

Risk:
Risk refers to the uncertainty that surrounds future events and outcomes. It is the expression of the likelihood and impact of an event with the potential to influence the achievement of an organization's objectives.

Social, cultural or economic values:
Social, cultural or economic values (market or non-market) that can be affected by a change in an ecosystem component or function.

Social, cultural or economic dependencies:

Social and economic activities that rely on valued ecosystem components or ecosystem goods and services for their success.

Target:
A target is a clearly defined development goal that should be "SMART" (i.e., specific, measureable, achievable, realistic and time related).

Threshold:
A limit of change in an ecosystem component/attribute which if exceeded, requires a change in management for protecting the ecosystem component/attribute. A threshold is defined here as a point between alternate regimes in ecological or social-ecological systems. When a threshold along a controlling variable in a system is passed, the nature and extent of feedbacks change, such that there is a change in the direction in which the system moves. A shift occurs when internal processes of the system (e.g., rates of birth, mortality, growth, consumption, decomposition, leaching, etc.) have changed such that the variables that define the state of the system begin to change in a different direction, towards a different attractor. In some cases, crossing the threshold brings about a sudden, large and dramatic change in the responding variables, whilst in other cases the response in the state variables is continuous and more gradual.

Valued ecosystem component (VEC):
Any part of the environment that is considered important by a proponent, members of the public, scientists and governments. Importance may be determined on the basis of cultural values or scientific concerns.

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