Canada's Approach to Ecosystem-Based Management

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Ecosystem-based Management (EBM)

Under the overarching objective of conservation of species and habitat, EBM is the implementation of defined objectives related to monitoring and maintaining ecosystem features:

- biodiversity,
- productivity, and the
- physical and chemical properties of the ecosystem.

Oceans Act

- Canada enacted the *Oceans Act* in 1997, which outlined a new approach to managing oceans and their resources based on the premises that:
  - oceans must be managed as a collaborative effort amongst all stakeholders that use the oceans, and
  - new management tools and approaches are required.

- This *Act* has changed the legislative basis for ocean management and managers are now required to consider the impacts of all human activities on Canada's ecosystems in marine resource management plans.

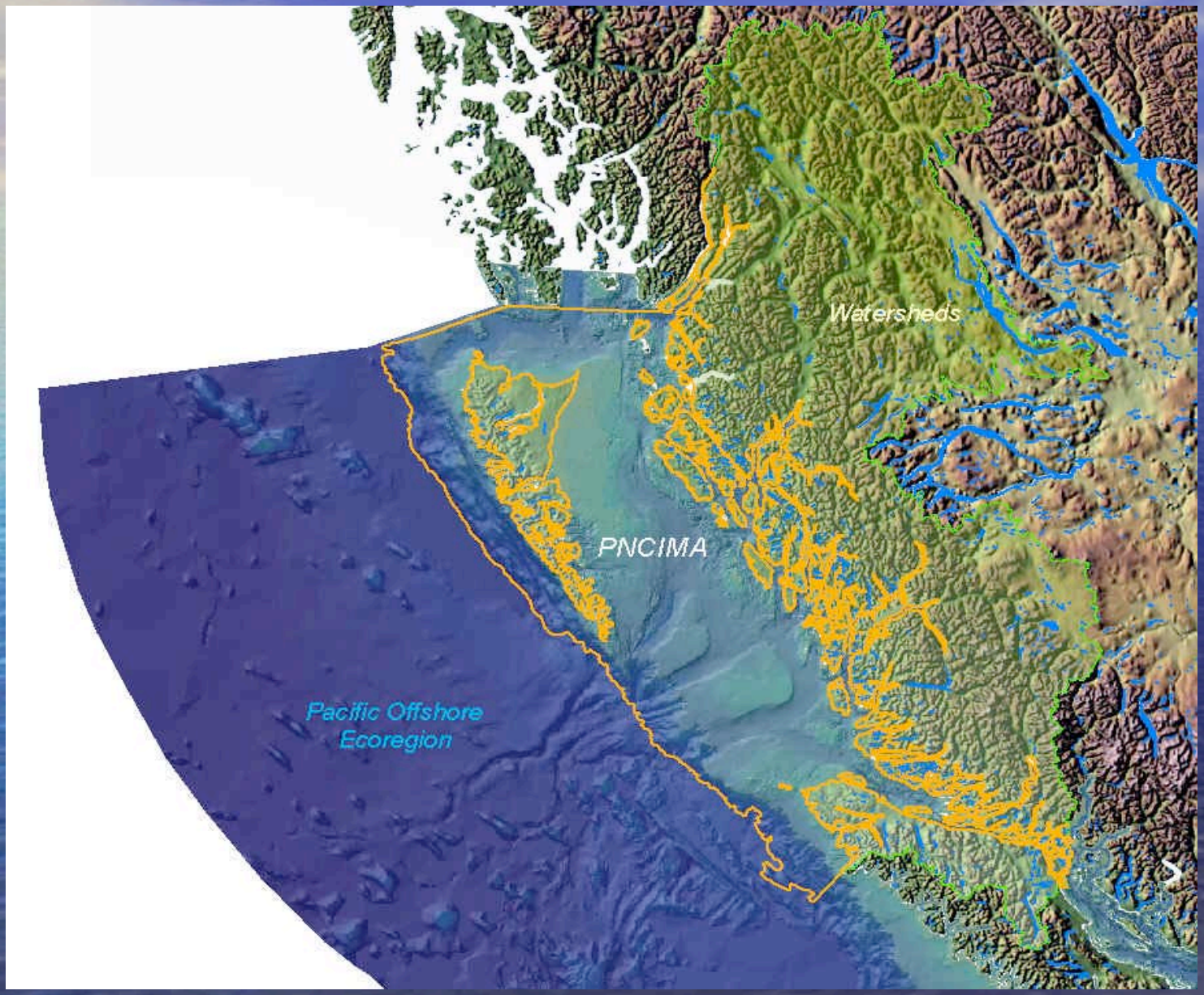
Canadian EBM Approach

As a consequence of the *Oceans Act*, since 1997, there have been a number of initiatives through which Canada's approach to EBM is beginning to emerge:

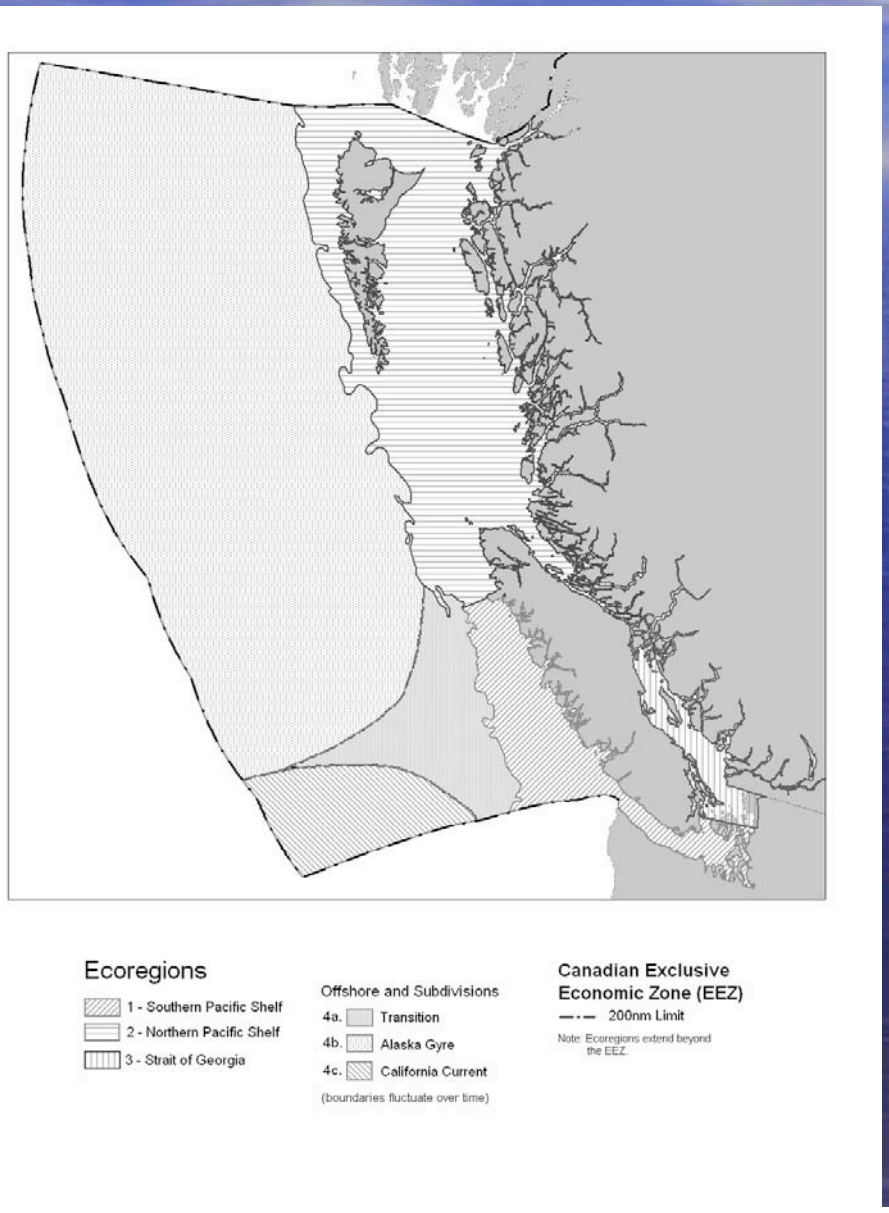
- In 1998, a pilot IM project was established in DFO's Maritimes Region to facilitate EBM on the Eastern Scotian Shelf (ESSIM), with a Strategic Planning Framework recently produced.
- In 2000, DFO's Pacific Region initiated a pilot IM project on the Central Coast (CCIM), which in 2004 was expanded to include the North Coast - Pacific North Coast IM area (PNCIMA).
- In 2002, the Canada Oceans Strategy was published, a key element of it being a nationally co-ordinated Integrated Management (IM) program.
- In support of the IM program, Fisheries and Oceans Canada (DFO) has established a national coordinating body, termed the Working Group on Ecosystem Objectives (WGEO), to facilitate the development of best practices for IM and to oversee regional pilot projects designed to test implementation of concepts.

Maps of CCIM and ESSIM

PNCIMA



Pacific Canada Ecoregions



Rationale for Integrated Management (IM)

- IM Planning requires that clear objectives are set, and for ecosystem-based planning, that ecosystem-level objectives are established. Under such an objectives-based framework for ocean management, all industries / activities within an area would accept and work within a framework of common objectives to conserve Canada's ecosystems.
- In June 2000, DFO's National Policy Committee (NPC) considered a framework for setting ecosystem objectives for integrated fisheries and oceans management. This framework proposed that a suite of objectives, indicators and associated reference points be developed for the maintenance of biodiversity, productivity and water quality within ecosystems of concern.
- Health and performance indicators are both needed

Conceptual and Operational Objective Definitions

Management goals need to be considered at both the conceptual and operational level:

- Conceptual objectives are stated in broad, general terms intended to be understandable by a general audience, and they tend to be valid for long time periods, i.e., are often government policy statements e.g., maintain productivity).

- Operational objectives are the strategies by which conceptual objectives are actually implemented, i.e., are measurable interpretations of conceptual objectives. In Canada, an operational objective is defined to consist of a verb (e.g., maintain), a specific measurable indicator (e.g., biomass), and a reference point (e.g., 50,000 t), thus allowing an action statement for management (e.g., maintain biomass of a given forage species greater than 50,000 t biomass).

Conceptual and Operational Objective Linkages

- Each conceptual objectives needs to be "unpacked" into a "tree" of conceptual sub-components, with branching to whatever level is considered necessary through a defined participatory and open process.

- Unpacking involves considering each conceptual sub-component level and determining whether or not a final operational objective can be stated at that level. In other words, can a measurable indicator and reference point be associated with that sub-objective? This requires an understanding of the knowledge and information that is available at different points in the unpacking process upon which indicators and reference points can be based. If information at a particular level is deemed suitable, then the unpacking process can stop there and an operational objective associated with that conceptual objective can be defined.

The link between qualitative, conceptual objectives and quantitative, operational objectives

What We Desire		*What We Can Measure*
Conceptual Objectives	**Operational Objective**	**Indicators**
Objective { objective { …	Maintain Productivity { Trophic Transfers { Forage Species { Target Escapement { (Maintain) Biomass	Consists of a Verb, Indicator and Reference Point e.g.,Maintain Biomass of age 3 herring > 50,000 t	Abundance of age 3 herring

Habitat Unpacking example

High-level Policy Objective (e.g. maintain components)

Next level of specificity: Biodiversity Conservation Objective (e.g. maintain habitat structure and complexity within bounds of natural variability)

Next level of specificity: Habitat Conservation Objective (e.g. maintain critical rare and sensitive habitats)

Operational Habitat Objective: Relate to Indicators, Ref. Points (e.g. maintain 100% of eelgrass habitat undisturbed)

Conceptual objectives:

- The best management decisions come from consideration of the interrelationships between cultural, social, economic and ecosystem parameters. Community involvement and buy-in is most likely with the inclusion of social and economic indicators. However, there is as yet no consensus in Canada for conceptual objectives in all four of the above dimensions; consensus to date within DFO has only been reached for conceptual objectives in the environmental dimension.

Environmental Dimension

- **Conceptual Objectives:**
  - to conserve enough components (ecosystems, species, populations, etc.) so as to maintain the natural resilience of the ecosystem
  - to conserve each component of the ecosystem so that it can play its historical role in the foodweb (i.e., not cause any component of the ecosystem to be altered to such an extent that it ceases to play its identified historical role in a higher order component)
  - to conserve the physical and chemical properties of the ecosystem

Synopsis of Potential Components in Social & Cultural, Economic and Institutional Dimensions (from ESSIM)

Social and Cultural Dimension	Economic Dimension	Institutional Dimension
•Community Structure ➢Ocean access ➢Sharing ➢Resource allocation •Community Behaviour e.g. Code of Conduct ➢Best practices ➢Responsible use ➢Stewardship ➢Compliance ➢Safety & security	•Sector Valuation ➢Economic Costs / Benefits ➢Employment •Sector Resilience ➢Economic self-reliance ➢Pace of development	•Management approach ➢Degree to which international, national, regional & local requirements / responsibilities met ➢Decision-making e.g. collaborative, inclusive, transparent ➢Adaptability ➢Responsiveness •Acceptability of management approach e.g. co-management ➢Benefit for administrative cost •Achievement of management approach ➢Sufficiency of Institutional resources e.g. Commitment ➢Compliance with system

Control: Assessment Activities

- In most traditional fishery situations, only one or two indicators are normally considered (e.g spawning biomass and fishing mortality).
- in EBM, many indicators and associated reference points must be considered in decision making.
- Alternatives to traditional assessment frameworks need to be developed until our state of our knowledge improves.

Desired Assessment Framework Characteristics

An assessment framework that incorporates multiple indicators in a 'mechanistic-free' environment is a short-term option. An appropriate framework would:

- allow inclusion of technically-based indicators as well as those related to Traditional and Local Ecological Knowledge (TEK and LEK),
- involve dependence on a suite of indicators, rather than just a few, and so would be more likely to detect degradation of the ecosystem.
- tend to be conceptually simple, easy to teach, potentially inexpensive, and easy to communicate.

EBM Framework Examples

- The Index of Biotic Integrity (IBI) and the Traffic Light Approach (TLA) are two such 'mechanistic-free' methods that have been used in Canadian habitat (Karr 1981) and fishery situations (Caddy 1999, Halliday et al. 2001). Others also exist.
  - The IBI rates broadly-occurring indicators on a simple numerical scale (e.g. 1, 3 5) in comparison to values observed in reference areas.
  - The TLA rates indicators as good (green), satisfactory (yellow) or bad (red) through an expert opinion (Delphic) process.

What indicators are most relevant and appropriate?

- Geography-based (CCIM) and industry sector (aquaculture and groundfishing) (ESSIM) workshops have been convened to suggest appropriate operational indicators
- Lessons learned:
  - broad discipline-based participation is essential to avoid potential bias by discipline.
  - an on-going dialogue between managers and scientists to develop a common language and understanding of EBM is needed; otherwise, a 'cultural communications gap' may form that would impede progress towards IM.
  - objectives and indicators that might eventually be adopted should be practical and pragmatic, repeatable, cost-effective, and helpful for management.

WGEO Objectives

- Two, broad, overarching general goals for ecosystem-based management (EBM) were accepted:
  - the conservation of species and habitats, including those other ecosystem components that may not be utilized directly by humans (environmental dimension) and
  - the sustainability of human usage of environmental resources (human dimension)

- Discussion at the Dunsmuir workshop focused on objectives under the second, conservation, goal. Initial conceptual objectives relating to biodiversity, productivity and the physical and chemical properties of the ecosystem were developed:
  - to conserve enough components (ecosystems, species, populations, etc.) so as to maintain the natural resilience of the ecosystem
  - to conserve each component of the ecosystem so that it can play its historic role in the foodweb (i.e., not cause any component of the ecosystem to be altered to such an extent that it ceases to play its historical role in a higher order component)
  - to conserve the physical and chemical properties of the ecosystem

- The first conceptual objective has the following nested components:
  - to maintain communities within bounds of natural variability
  - to maintain species within bounds of natural variability
  - to maintain populations within bounds of natural variability

- The second conceptual objective relates to the productivity of the ecosystem, with nested components being:
  - to maintain primary production within historic bounds of natural variability
  - to maintain trophic structure so that individual species/stage can play their historical role in the foodweb
  - to maintain mean generation times of populations within bounds of natural variability

- The third conservation objective is intended to safeguard the physical and chemical structures within which the ecosystem resides, with nested components being:
  - to conserve critical landscape and bottomscape features
  - to conserve water column properties
  - to conserve water quality
  - to conserve biota quality

Halifax Workshop Output

- The following advice is NOT advised as best practice yet – and can't be advised as such until points have been tested and we know what REAL practice makes of them. But they are the consensus output of an expert meeting, and the best we could do with the information and expertise available (which was pretty high quality), in the timeframe in which we had to work.
- This workshop is the first evaluation of their utility.

Halifax Workshop – Guidelines for operationalising ecosystem objectives (EOs)

- When setting EOs and reference points, consider data and information from periods when, with current knowledge, the ecosystem would be considered healthy
- Existing data time series may limit artificially what we perceive are the natural state or bounds of natural variation
- Management actions intended to achieve individual ecosystem objectives need to be evaluated by managers with regard to the impacts of those actions on other ecosystem properties

- The cumulative effects of multiple activities, which may not be simply additive, need to be considered in setting EOs and in development management measures to achieve them.

- When setting EOs intended to address perceived problems, it is important to consider root causes, and not just symptoms.

- Ecosystems can show large, fairly abrupt, and sometimes unwelcome changes that are difficult to foresee. Monitoring needs to be vigilant for signs of such changes. Management needs to keep the risk of such changes in mind when setting and pursuing EOs, and be able to respond rapidly to signs of such changes.

Conceptual objective terms

1. Mean Generation Time
   - The dependence of reproductive potential (fecundity, maturity, whatever) on age needs to be considered, not just age structure of the population alone

2. Bounds of Natural Variability
   1. Differentiate "variability" from trend
   2. Seek cross-correlations of variation among species, and between species and both anthropogenic and environmental forcers.
   3. Consider best sources of information on lower frequency (i.e longer time period) components of variation. Try to keep variability within the bounds of the current regime. If the regime changes, EOs should also guide management to respond swiftly to signs of regime change.
   4. Sampling has to be representative in space of the expected variation, and will usually be best considered on scales of 10's of km or larger.

- Primary Productivity
  - Is not usually likely to be a source of specific operational management objectives
  -
- Historic role in the food web
  - not expected to be a basis for operational objectives in most circumstances
- Trophic structure
  - Much relevant data may be absent
  - Ensure that important fodder species (mid-trophic-level species used intensively by top predators when the fodder species is abundant) are not reduced below historically average values
  - EOs should not knowingly guide management to allow actions that substantially alter the ratio of different trophic levels in the food web or size classes in the size composition of the web
  - Guidelines should be applied on spatial scales large enough that population dynamics processes are likely to dominate over extrinsic factors such as migration.

- Resilence
  - Although resilience of ecosystems is very important, it is not under direct management control and not directly measurable, although indirect measures do exist. Resilience measures are thus not recommended as something to be captured directly in ecosystem objectives
- Habitat
  - Structural habitat features may be usefully addressed in EOs, without having to demonstrate they serve an important biological function

- Where biological functions of structural habitat features are known, those should be given prominence in setting EOs
- Away from coastal influences, it is unlikely to be helpful to management to set EOs with regard to perturbations of natural characteristics of the water column
- Away from coastal influences, introduction of foreign materials, forces, and energies (including noise) to the water column may be addressed usefully by EOs to the extent that the introduced materials, forces, or energies pose a risk of detrimental effects on the ecosystems
- In areas where coastal influences on water column or seabed properties are expected to be prominent, EOs can and should address the likely impacts and important habitat features.

- In setting EOs for the physical and chemical properties, or pathogen levels, of water quality or substrates, levels of deleterious or bio-accumulating substances that may become a problem should be addressed explicitly.
- In addition to EOs for contaminant (defined broadly, to include *inter alia* endocrine disruptors, pathogens) levels in the water column, separate EOs can be set for levels of these substances in the tissues of organisms, which would reflect concerns for human consumption or for accumulation in the food chain. These EOs can be set without necessarily demonstrating deleterious population-level impacts of the substances on ecosystem components.

- Communities - it is necessary to have a clear and consistent description of the community at a scale specific for which the EO is expected to provide protection or benefits, and also as well at larger and smaller scales of relevant ecological processes.
  - EOs are most relevant for properties under direct management control and that can be easily measured.
  - To the extent that species exist and can be identified that are diagnostic of important community properties or are sensitive to perturbations of those properties, then the structural aspects of such communities are often best addressed through setting EOs for those species.
  - To the extent that spatial patterns exist and can be identified that are diagnostic of important community properties or are sensitive to perturbations of those properties, then the structural aspects of such communities are often best addressed through setting EOs that preserve the spatial pattern of the community, and particularly address preventing fragmentation

- There may be some utility for EOs intended to prevent major changes in the relative abundance or distribution of community components, if it can be ensured that the EOs can be clearly linked to management actions with known consequences.
- It is particularly important to coordinate the setting of EOs for communities with the setting of EOs for trophic structure.

- Species
  - It is legitimate to set EOs for all types of marine species regardless of their commercial value. SARA species warrant special attention.
  - When particular threats are known or expected to occur in an area for which EOs are being set, it is reasonable to set EOs for the species most vulnerable and sensitive to that threat.
  - It is legitimate and sometimes necessary to set EOs for different life history stages of a species, or for particularly important factors which contribute to a species' life history, such as migration routes or spawning aggregations.
  - Exotic or invasive species are not covered by the intrinsic value provision (1). Where the risk of detrimental impacts on native species or communities is considered high, EOs to manage exotics aggressively to deter their establishment are warranted.
  - EOs that set a high standard of scientific understanding for introductions and transfers are warranted.
  - If EOs are to be set for intentionally reducing a species' abundance significantly, the evidence of serious and widespread harm needs to be very strong, such as with harmful algal blooms. In such cases there also needs to be a good understanding of the consequence of the management actions taken to achieve the EO.

- Populations
  - Where experts identify population structure below the level of the species (e.g. genetic strain), the Guidelines for Species apply at those units as well.
  - Size, sex ratio, and possible age distribution within a population are important, and where particular threats to such properties are known or expected to occur, they should be covered by EOs, ie. additional to those EOs to do with abundance.

Caveats relative to this workshop

- DFO is still evaluating approaches to determine relevant EOs: it therefore should not be assumed that the approach being investigated at this regional workshop will be the approach finally utilised in either the CMAs mentioned or in the LOMA within which these CMAs are located. CMAs, by definition of IM in the national operation framework, need to be managed in harmony with objectives set at the LOMA scale, just as LOMAs need to be managed in harmony with objectives set at the Ecoregion scale.