

Canada's Ecoregion Determination Approach

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Necessity for National Ecoregion Determination

- Canada's Ocean Strategy calls for a new **integrated management approach** that takes into consideration the impacts to our oceans stemming from all sectors of activity.
- To make integrated management possible, **ecosystem objectives adapted to distinct ocean areas** are needed.
- The highest hierarchical level of organisation for such areas for management is termed the "**ecoregion**".
- After ecosystem objectives are established for ecoregions, human activities will be managed such that these objectives are met.
- Adopting this approach to management requires that **ecoregions be defined on a consistent basis nationally**.

Ecoregion Definition

- This presentation summarises the results of a Canadian national ecoregion workshop held in 2004 (Powles et al. 2004).
- The definition of ecoregion used was that of Harper et al. (1993): **"a part of a larger marine area (ecoprovince) characterized by continental shelf-scale regions that reflect regional variations in salinity, marine flora and fauna, and productivity."**

- The workshop **brought together specialists** from DFO and from outside the Department, with expertise in geology, physical, chemical and biological oceanography, and marine biology (including fishery science).
- The workshop **reviewed a number of previous initiatives to define marine ecoregions** for Canada by other departments or groups. Each of these was based on a logical approach which was appropriate for its intended purpose, and the utility of these approaches for DFO was assessed. It was ultimately decided to develop DFO's own approach.

Other Approaches Considered

Other approaches that were considered either:

1. did not identify ecoregions **at a scale** corresponding to the definition above,
2. did not provide a good basis for **setting ecosystem objectives** as required for DFO's integrated management approach, or
3. did not capture a **marine ecoregion pattern** required for setting overall ecosystem objectives.

Result: DFO did its own analysis, summarised here.

Defining Criteria

Criteria used in defining marine ecoregions fell into three categories:

1. **Geological properties**, including the degree of enclosure, bathymetry and surficial geology.
2. **Physical oceanographic properties**, including ice cover, freshwater influence, water temperature, water masses, currents, and mixing/stratification.
3. **Biological properties**, including primary productivity, species distributions, population structure and assemblages/communities.
4. Specific properties were only considered in defining ecoregions in a particular ocean area if data were available throughout that ocean area.

- Information from all three categories was overlaid simultaneously rather than hierarchically in an attempt to develop an ecological picture based on a wide range of criteria.
- This approach could not yield consensus on all boundaries due to the conflicting nature of some of the patterns.
- Thus, some boundaries were chosen based on the best possible arrangement for the purpose of the exercise, rather than through consistency among all criteria.
- Boundaries between ecoregions are accordingly not considered firmly fixed, and modifications arising from additional data may later be made, recognizing that the position of such boundaries will always be somewhat arbitrary.

Ecological Structuring

- Ecological structuring exists in the sea at a **hierarchy of scales**. While we sought large ecoregions which suited our definition, instances where “substructure” exists within a defined ecoregion were recognised, and this substructure was described for some of the ecoregions identified.
- It was concluded that **coastal areas (including fjords or bays)** should be considered as “substructure” rather than as ecoregion boundaries.

- Also, although Canada's ecoregion maps show the ecoregions ending at the edge of Canada's Exclusive Economic Zone (EEZ), all those **ecoregions adjacent to a Canadian boundary** are recognised to extend into adjacent waters.
- The workshop was not mandated to define the outer boundaries of these ecoregions in non-Canadian waters, nor did it include appropriate expertise to do this.
- It would be useful to define all outer ecoregion boundaries though, and to **encourage collaborative and complementary management** by the relevant national management authorities in transboundary ecoregions.

- The workshop sought **areas of homogeneity in properties** (which would represent the "core" of ecoregions) and **areas of rapid change or discontinuities in properties** (which would represent boundaries of ecoregions).
- Specialists were asked to bring information to the workshop on maps which could be displayed. One base map was provided for each of the three oceans, and **patterns contributed by specialists were sketched onto transparencies of these base maps. Maps of the various properties were overlain and compared.** The final output was sketch maps of ecoregions for each of the three oceans. Boundaries were not determined exactly.

Ocean Properties Considered

Ocean properties considered at the workshop are described in the following. Information on all of these properties was not available for all parts of Canada's oceans. Parameters used to determine each identified ecoregion are described.

Geological properties

1) *Degree of enclosure*

Distinct basins were considered as a basis for ecoregions, as long as these were on a large scale. Information was obtained from the interpretation of large-scale charts of the Canadian coastline.

2) *Bathymetry*

Patterns in bathymetry as represented by depth contours were considered as a basis for ecoregions. These were obtained from large-scale charts of the Canadian continental shelf and slope. Depth is one of the key ecological variables in the ocean at all scales and the focus here was on an ecoregion scale. Topographically "flat" places were considered as homogeneous with respect to depth, and thus within an ecoregion, while topographically "steep" areas were considered as discontinuities or boundaries.

3) *Surficial Geology*

Patterns in surficial geology on the shelf and slope were considered as a criterion. They provided an additional parameter which was useful to resolve lack of congruence between patterns in other biophysical properties. Major discontinuities can be particularly useful in seeking boundaries between ecoregions.

Physical oceanographic properties

The objective was to delineate regions that are generally distinct based on their **overall physical oceanographic properties**, not necessarily based on the details of each parameter.

1) Ice cover

The difference between maximum and minimum ice cover was used to determine seasonal ice areas; minimum extent is the permanent ice areas.

2) Freshwater influence

Summer conditions were considered most relevant since it is usually the time of maximum freshwater influence.

3) Water Temperature

Charts of summer surface temperatures averaged over 10 years or more at large scale were used.

4) Water masses

Four broad water mass types were considered useful: oceanic, shelf, estuarine, and slope.

5) Currents

Four types of current regimes were considered useful: areas of well-defined mean current, of well-defined seasonal current, of weak current, and of strong tidal current.

6) Mixing/stratification

Considered the spatial distribution of areas well stratified in summer.

Biological properties

1) Primary productivity

Surface distribution of chlorophyll from remote sensing and averaged over the years for which data exist was considered useful. For the Atlantic Ocean, four parameters -- the magnitude of the maximum bloom, the time of onset of the bloom, the time of the maximum bloom and the duration of the bloom -- were used to create a composite map of spring primary production.

2) Species distributions

Distributions of key species can provide useful information on ecoregions. Information on density (from surveys, suitably averaged over years), and secondarily on presence and absence, was used. Species for which there was good information included demersal fish and invertebrates from RV surveys (mainly Atlantic); a few key species were picked which are characteristic of specific conditions, such as seabirds and marine mammals.

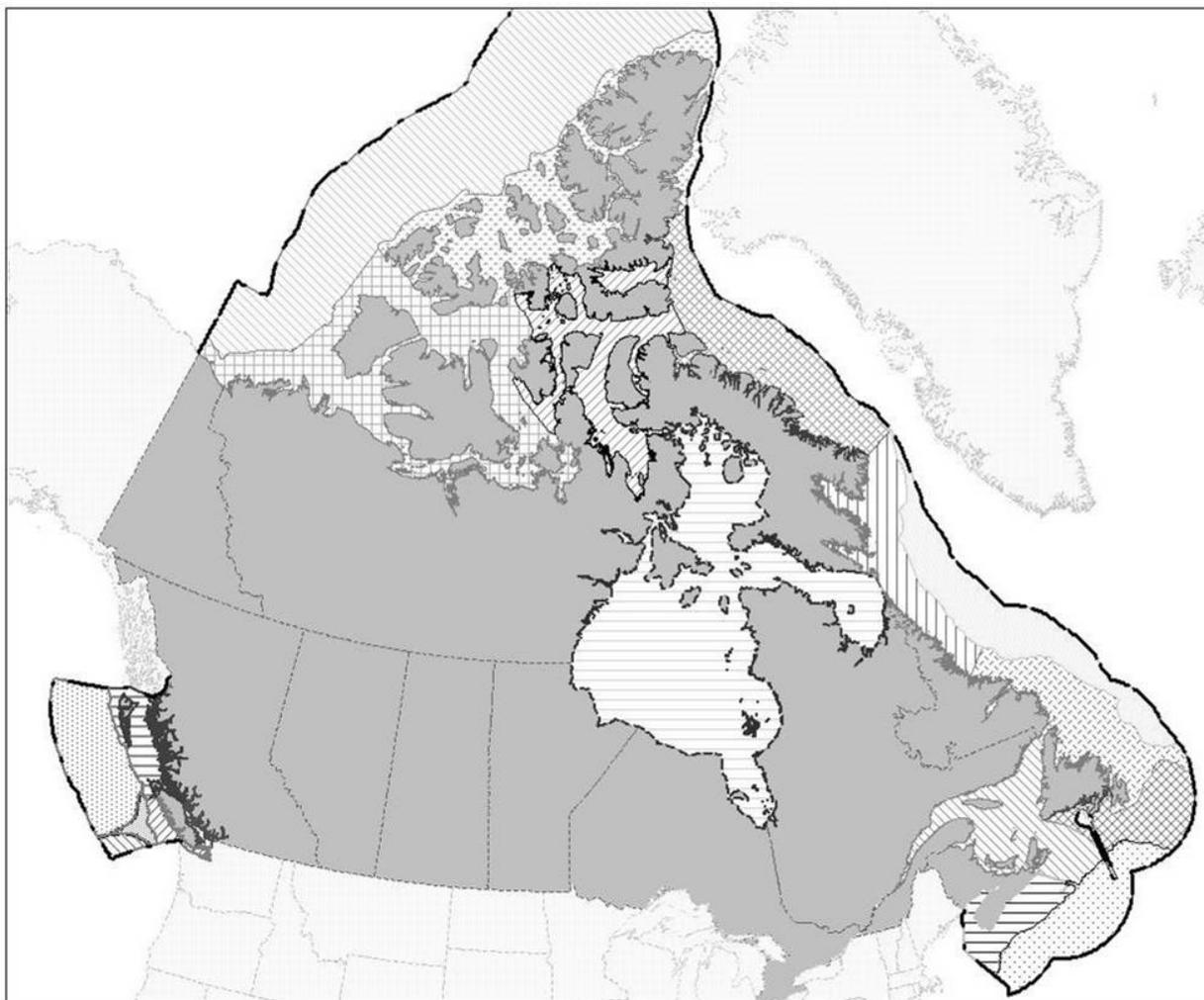
3) Population structure

Distribution of well-known populations below the species level was useful.

4) Assemblages/communities

Distribution of species assemblages from previously published groundfish assemblage analyses from the East Coast was useful.

Figure 5. Canada's Marine Ecoregions
Figure 5. Écorégions marines du Canada



Ecoregions / Écorégions

Arctic - Arctique

(6)

- Hudson Complex
Complexe de la baie d'Hudson
- Arctic Basin
Bassin arctique
- Lancaster Sound
Détroit de Lancaster
- Baffin Bay - Davis Strait
Baie de Baffin - Détroit de Davis
- High Arctic Archipelago
Archipel du Grand Nord
- Beaufort-Amundsen-Viscount Melville-Queen Maud /
Beaufort-Amundsen-Vicomte Melville-Reine Maud

Atlantic - Atlantique

(7)

- Gulf of St. Lawrence -
Eastern Scotian Shelf
Golfe du Saint-Laurent -
Est du Plateau néo-écossais
- Western Scotian Shelf -
Gulf of Maine
Ouest du Plateau néo-écossais -
Golfe du Maine
- Northern Grand Banks -
Southern Labrador
Nord des Grand Bancs -
Sud du Labrador
- Southern Grand Banks -
South Newfoundland
Sud des Grand Bancs -
Sud de Terre-Neuve
- Labrador Sea
Mer du Labrador
- Northern Labrador
Nord du Labrador
- Gulf Stream / Gulf Stream

Pacific - Pacifique

(4)

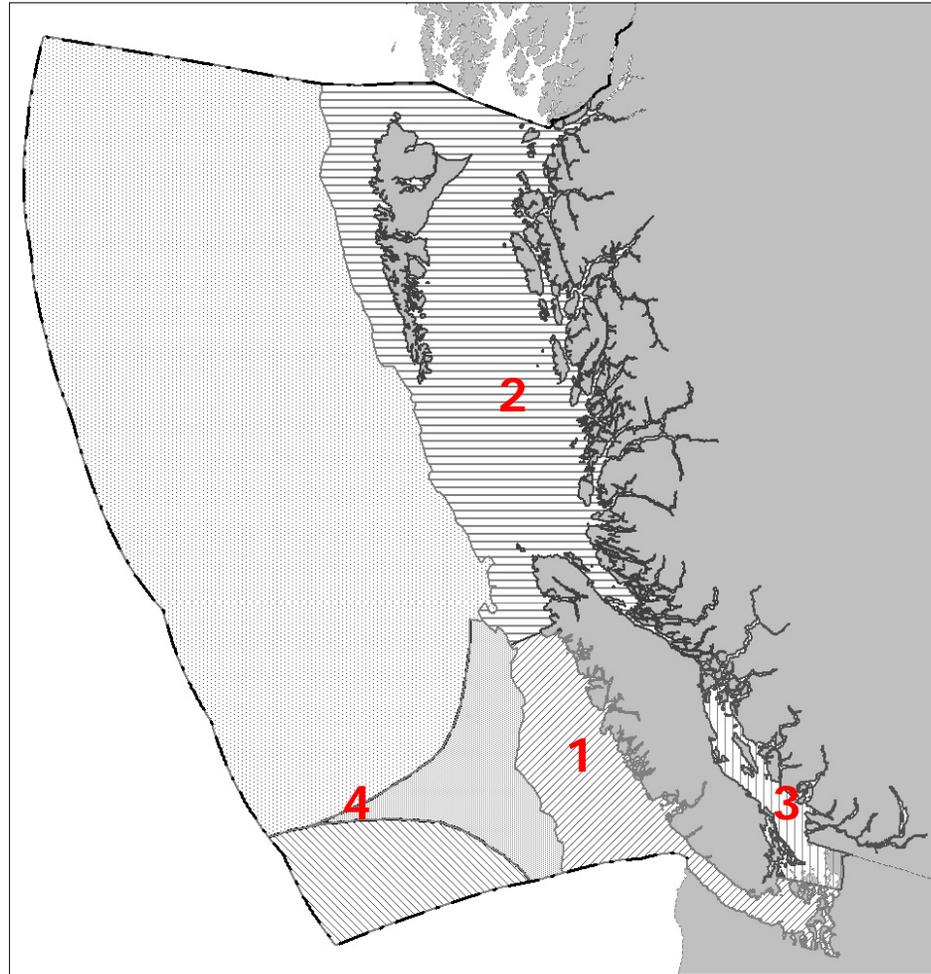
- Southern Shelf - West Coast
of Vancouver Island
Plateau du Sud - Côte ouest
de l'île de Vancouver
- Northern Shelf
Plateau du Nord
- Strait of Georgia
Détroit de Georgia
- Offshore and Subdivisions/
Large et subdivisions**
- a. Transition zone
Zone de transition
- b. Alaska Gyre
Gyre de l'Alaska
- c. California Gyre
Gyre de Californie

Note: Pacific Offshore subdivisions boundaries fluctuate over time.
 Les limites des subdivisions de l'écorégion du large du Pacifique
 fluctuent dans le temps.

Canadian Exclusive Economic Zone (EEZ) **200nm Limit /**
Limite des 200 mn **Zone économique exclusive du Canada (ZÉE)**

Note: Ecoregions extend beyond the EEZ.
 Les écorégions s'étendent au-delà de la ZÉE

Figure 1. Pacific Ecoregions
Figure 1. Écorégions du Pacifique



Ecoregions / Écorégions

- 1. Southern Shelf - West Coast of Vancouver Island
Plateau du Sud - Côte ouest de l'île de Vancouver
- 2 - Northern Shelf
Plateau du Nord
- 3 - Strait of Georgia
Déroit de Georgia

- Offshore and Subdivisions/
Large et subdivisions
- 4a. Transition zone
Zone de transition
- 4b. Alaska Gyre
Gyre de l'Alaska
- 4c. California Gyre
Gyre de Californie

(boundaries fluctuate over time /
les limites fluctuent dans le temps)

Canadian Exclusive Economic Zone (EEZ)

200nm Limit /
Limite des 200 mn

Zone économique exclusive du Canada (ZÉE)

Note: Ecoregions extend beyond the EEZ /
Les écorégions s'étendent au-delà de la ZÉE

PACIFIC OCEAN

1. Strait of Georgia

Geological Properties: The Strait of Georgia is primarily defined by degree of enclosure.

Physical Oceanographic Properties: The region is bounded by strong tidal fronts to the north and south, and has significant freshwater influence coming from the Fraser River.

2. Southern Shelf – West coast of Vancouver Island

Geological Properties: The northern boundary of this ecoregion is the Brooks peninsula of the northwest coast of Vancouver Island, which extends almost to the 200 m contour and accordingly almost divides the continental shelf at this point. The southern boundary was not defined as this ecoregion extends into United States waters. The Strait of Juan de Fuca is a transition zone between the Strait of Georgia and the southern shelf.

Biological Properties: Brooks peninsula, at the northern boundary of this ecoregion, represents the northern distribution limit of many southern marine species and populations such as hake (*Merluccius productus*), pandalid shrimp and the southern resident killer whales (*Orcinus orca*).

3. Northern Shelf

Geological Properties: The Pacific northern shelf is bounded to the south by the Brooks Peninsula and extends northward into United States waters.

Physical Oceanographic Properties: The shallow water area east of Queen Charlotte Islands results in a warm water front and strong mixing and is a weak boundary within the ecoregion.

Biological Properties: Many species and populations of the northern shelf community (e.g., tanner crab (*Chionoectes bairdi*), Pacific cod (*Gadus macrocephalus*), northern resident killer whales, and the Steller sea lions (*Eumetopias jubatus*) do not have distributions extending southward past Brooks Peninsula. All major colonies (>10,000) of seabirds in British Columbia occur here.

4. Offshore

Geological properties: The Pacific offshore ecoregion is all that area seaward of the bottom of the continental slope, which is here defined as the line where the slope gradient becomes less than 2.7%.

Biological Properties: The shelf edge is an important boundary for seabirds.

Physical Oceanographic Properties: This ecoregion can be divided into **three subregions** defined by the splitting of the North Pacific current as it approaches the coast. This splitting results in part of the current going northward towards Alaska, and part going towards the southern U.S. This results in a **northern subregion (the Alaska Gyre)**, a **southern subregion (the California Gyre)**, and a **transition zone near the continental shelf boundary** at the fork. The locations for these subregions are not stable as they move northward and southward seasonally and interannually with shifts in the current. The Alaska gyre is associated with upwelling and the California gyre with downwelling.