Approaches to biogeographic classification of the world's oceans

Marjo Vierros
United Nations University
Institute of Advanced Studies

This presentation will cover

- International policy developments of importance to bioregionalisation
- Existing global biogeographic classifications
- Common issues in biogeographic classification
  - Objectives
  - Data considerations
  - Scale considerations
  - Classification systems
  - Some final observations

International policy developments and bioregionalisation

- Continuing decline in biodiversity and under-protection of oceans
- Increasing recognition of the need to protect areas representative of the full range of biodiversity in the context of ecosystem approach
- **World Summit on Sustainable Development:**
  - Develop and facilitate the use of diverse approaches and tools, including the ecosystem approach, the elimination of destructive fishing practices, the establishment of marine protected areas consistent with international law and based on scientific information, including **representative networks by 2012**
- **Convention on Biological Diversity:**
  - WSSD 2012 target and 2010 target to reduce rate of biodiversity loss
  - At least 10% of each of the world ecological regions effectively conserved by 2010
  - Particularly vulnerable marine and coastal ecosystems, such as tropical and cold water coral reefs, seamounts, hydrothermal vents, mangroves, seagrasses, spawning grounds and other vulnerable marine habitats effectively protected

International policy developments and bioregionalisation

- International **expert workshops and bodies** developing global biogeographic classification systems and criteria for selecting areas in need of protection, particularly focused on the high seas:
  - Mexico hosted a workshop in January 2007 to define a set of basic principles and framework for the recognition and classification of coherent biogeographic regions of the high seas
  - CBD Expert Workshop on Criteria and Biogeographic Classification Systems in October 2007 (Azores, Portugal)
  - CBD Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA-13) February 2008
  - UN Informal Working Group on Biodiversity in areas beyond national jurisdiction, New York, early 2008
  - CBD 9th Conference of the Parties, Germany, May 2008

Global data layers

- Because of these on-going initiatives there has been an effort to compile **global GIS data**. Some of these data may be of relevance for the Southern Ocean, for example:
  - Species richness and distribution of marine reptiles
  - Species richness of pelagic seabirds
  - Species richness of marine mammals
  - Species richness of exploited marine invertebrates
  - Species richness of exploited marine fishes
  - Seamount distribution

Existing global bioregionalisations

- Relatively few comprehensive global biogeographic classification systems exist due to paucity of data on this scale
- First classification originates from 1953 (Ekman)
- Some existing bioregionalisations include:
  - The Longhurst classification
  - Large Marine Ecosystems (LMEs)
  - Marine Ecoregions of the World (MEOW)
  - Biogeographic criteria for the classification of open and deep ocean areas (on-going expert process resulting from Mexico workshop)

Existing global bioregionalisations

- Will focus mainly on:
  - Marine Ecoregions of the World (MEOW)
  - Biogeographic criteria for the classification of open and deep ocean areas (Mexico workshop)
- These two classifications were developed specifically to inform and support international marine policy and integrated coastal and oceans management
- The international efforts might inform CCAMLR Southern Ocean classification (ex. Availability of global data, complementarity with global systems at higher hierarchies)
- The CCAMLR work can inform and assist international efforts (ex. Improved global classification, improved methods)

Marine Ecoregions of the World (MEOW)

- Based on review and synthesis of existing biogeographic boundaries
- Covers coastal areas and continental shelves, but not high seas

Subantarctic Islands

- Macquarie Island
- Heard and Macdonald Islands
- Kerguelen Islands
- Crozet Islands
- Prince Edward Islands
- Bouvet Island
- Peter the First Island

Scotia Sea

- South Sandwich Islands
- South Georgia
- South Orkney Islands
- South Shetland Islands
- Antarctic Peninsula

Continental High Antarctic

- East Antarctic Wilkes Land
- East Antarctic Enderby Land
- East Antarctic Dronning Maud Land
- Weddell Sea
- Amundsen/Bellingshausen Sea
- Ross Sea

Subantarctic New Zealand

- Bounty and Antipodes Islands
- Campbell IslandAuckland Island

Marine Ecoregions of the World (MEOW)

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

Biogeographic criteria for the classification of open and deep ocean areas

- From Mexico expert workshop - still work in progress
- Covers open and deep ocean areas

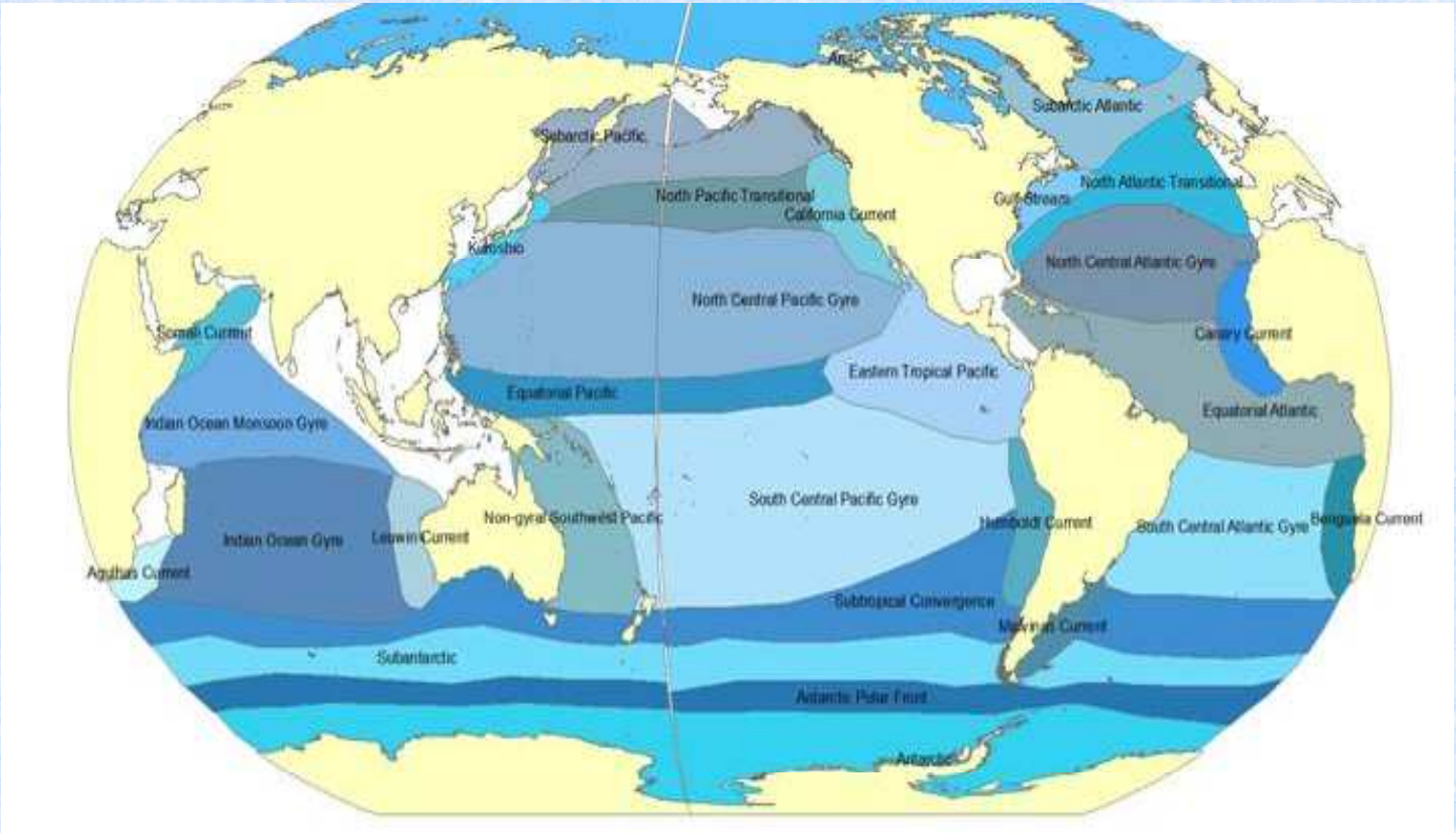
Pelagic areas:

- Antarctic
- Antarctic Polar Front
- Subantarctic

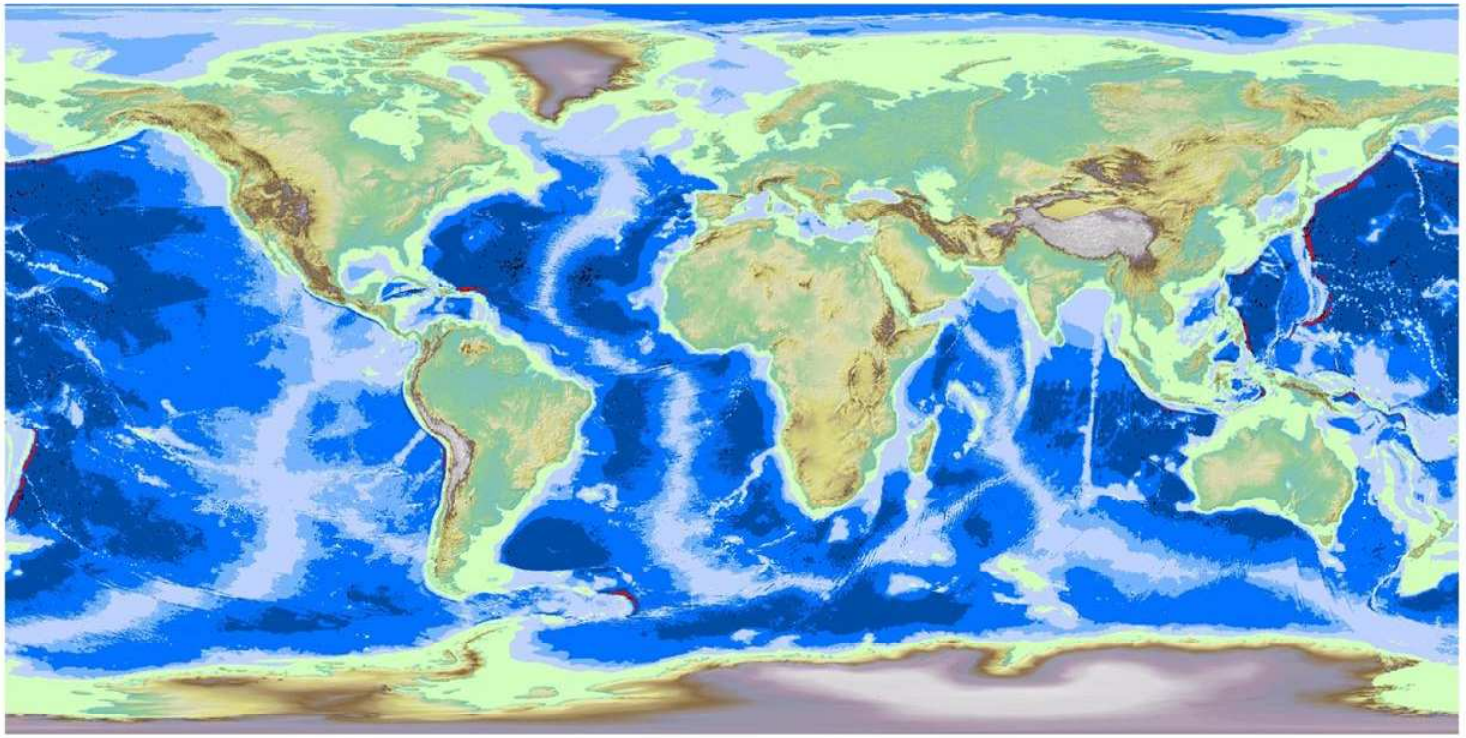
Benthic areas (*This classification is still in progress, but will consider the following factors*):

1. Depth zones:
   - Upper bathyal
   - Lower bathyal
   - Abyssal
   - Hadal
2. Hydrographic settings:
   - Water mass
   - Transport pathways
3. Geomorphology:
   - Trenches and troughs
   - Abyssal basins
   - Topographic highs (seamounts, ridges, plateaus, islands)
   - Slopes
   - Shelves
4. Chemosynthetic ecosystems:
   - Vents
   - Seeps
   - Whale falls

Classification of pelagic areas



Bathymetric map of the ocean, contoured to illustrate major geomorphological features



Common issues in biogeographic classification

- The most successful classifications have had clear **objectives** (ex. Fisheries management, selection of representative biodiversity areas, marine mammal management)
- These objectives inform the selection of the **most meaningful data for the purpose**, the scale of data and the weighting of the data
- For example, the open and deep ocean classification (Mexico workshop) excluded any information that did not relate to representative areas (ex. Areas of high biodiversity, unique areas, threatened areas).

Types of data used

- Most biogeographic classifications use either:
  - Biological data (species taxonomic), or
  - Ecological/physiognomic (data relating to physical features and processes, oceanographic processes, bathymetry, habitat/ecosystem type, sediment type, etc.)
  - Mixed data
- Most bioregionalisations have a species management purpose, so purely biological classifications have the advantage of focusing directly on the central property of interest
- However data are often insufficient in amount or coverage to achieve this, particularly on global and (often) regional scale
- On a large scale, physical features often control distribution of organisms, and there is a strong relationship between physical parameters, biological parameters and species (environmental data as a surrogate for biological distributions)

Common methods for biogeographic classification

- No universally agreed method
- **The ocean is fluid**: There are few sharp or absolute boundaries in ocean and conditions change over a variety of temporal scales
- Because of this, biogeographic classification commonly combines **qualitative information** (expert opinion and descriptive data) with **quantitative multivariate statistical analysis.** (Ex. LMEs, MEOW: expert driven, Longhurst classificaton: data driven)
- Even data-driven classifications require expert input (ex. Selection of data, validation of results)

Scale considerations

- The biogeographic units should be appropriate to reflect gradients of change
- The following might be kept in mind:
  - What is the realistic scale at which habitats change markedly?
  - What is the scale at which the relevant information is available?
  - What is a meaningful scale at which subsequent planning and management can be applied?
- Coastal areas are commonly more heterogeneous than areas further off-shore (ex. Great Barrier Reef Marine Park scale of 10s to 100s of km)

Classification systems

- Problem of 3-dimensionality in the oceans
- Often **parallel classifications** for pelagic and benthic environments particularly in deep waters (ex. Mexico workshop - open and deep ocean classification)
- Many classification systems are **hierarchical and nested**
  - A hierarchical system will allow multiscale analysis, with each level relevant to management from local to global scales
  - A hierarchical system may be easier to update (by adding information to the lower level hierarchies), and provide for compatibility with global systems (at higher level hierarchies)

Global hierarchical classifications

- Longhurst:
  - 4 biomes, 57 biogeochemical provinces
- Marine Ecoregions of the World:
  - 12 realms, 58 provinces and 229 ecoregions
- Deep and open ocean classification:
  - 1st iteration: provinces (29 pelagic, benthic not yet finalised). Will become a hierarchical classification, but spatial scale and number of levels not yet defined.

The need for periodic review of boundaries

- Bioregion boundaries may need to be reviewed periodically as new information becomes available (improved technology, new sampling efforts), or in light of climate change
- Most bioregional classifications have not dealt with the requirements of migratory species, spawning areas and other transient phenomena. Such issues may need to be addressed separately.

Thank you!