Biogeographic Classification - Marine

DEFINITION

The biogeographic classification process aims to partition a large area into spatially distinct (geographical) regions. Each region will contain a combination of species, habitats and physical features that are sufficiently unique or distinct from their surroundings at a given scale. Biogeographic classifications frequently include the definition of a set of principles or features, and a framework for the recognition and classification of coherent biogeographic regions. It is hypothesised that these basic principles should allow the delineation of separate areas that have recognisably different and predictable taxonomic compositions.

Linking regions with oceanographic processes or geological structures may suggest mechanisms by which taxonomic compositions could have arisen and be maintained. They therefore promote the understanding of where taxa are distributed, along with factors influencing their spatial distributions.

By marking the boundaries of ecological and oceanographic features and attempting to define ecological communities, biogeographic classifications are thus a useful tool to support the management and conservation of the marine environment.

EXAMPLES OF MARINE BIOGEOGRAPHIC CLASSIFICATIONS

LARGE MARINE ECOSYSTEMS (LMES)

LMEs delineation was stimulated by the 1982 United Nations Law of the Sea Convention (UNCLOS), which granted coastal states sovereign rights to explore, manage and conserve the natural rights of their exclusive economic zones. The aim was to define large areas of the coastal ocean (> 200,000 km^2) [1] that encompassed the fisheries stocks being exploited by coastal states. Furthermore, it aimed to overcome the sector-by-sector approach to marine resource management and provide a basis for the integrated management of ocean resources within a defined geographical area. The LMEs approach complements the Regional Seas Programme of UN Environment.

The 64 LMEs have been delineated based on four criteria [1]:

1. Bathymetry (e.g. sea bottom depth and topography)

2. Hydrography (e.g. temperature, salinity and currents)
3. Productivity (e.g. nutrients, zooplankton and oxygen)
4. Trophic linkages (e.g. plankton, demersal and pelagic surveys)

Examples of LMEs include the North Sea, Baltic Sea, Celtic-Biscay Shelf, Norwegian Sea and Mediterranean Sea.

MARINE ECOREGIONS AND PELAGIC PROVINCES OF THE WORLD

The Marine Ecoregions and Pelagic Provinces of the World biogeographic classification was developed by Spalding et al. [2], [3], largely as an alternative to the LME classification with a stronger biogeographic basis. The ecoregions and pelagic provinces are broadly aligned with each other and are non-overlapping. This dataset was developed to address the need for a detailed, biogeographic system to classify the oceans. It provides better spatial resolution than earlier global systems, but may also be cross-referenced to many regional biogeographic classifications.

GEOMORPHOLOGY OF THE OCEANS

The Geomorphology of the Oceans dataset was developed by Harris et al. [4], and represents a digital map of the global seafloor's geomorphic features. It includes 29 different geomorphic feature categories, such as submarine canyons, valleys or plateaus, as defined by the International Hydrographic Organisation and other sources [5]. It also provides global estimates of different characteristics of these features, such as their surface area, number and mean size.

The map was created to guide and improve global scale marine management decisions. For example, it is used to assess the representativeness of features within ocean basins, exclusive economic zones, as well as existing Marine Protected Areas (MPAs) or in Areas Beyond National Jurisdiction (ABNJ). The map can be used to inform various processes such as marine spatial planning, MPA design, research on benthic ecosystems and seafloor geology and economic valuations of marine resources [6].

METHODS

There are no universally agreed methods for establishing biogeographic classifications. The methods used will depend on the aims, objectives and scale of the desired classification. Biogeographic classifications often combine qualitative information (e.g. expert opinion and descriptive data) with quantitative multivariate statistical analysis. They tend to focus on coastal and shelf waters, i.e. where information is more readily available. There have also been attempts at classifying offshore areas, e.g. the pelagic provinces extend into the high seas [3].

Examples of approaches to the classification of marine environments include those listed below.

TAXONOMIC METHODS

For example, Briggs' [7] classification of coastal provinces is based on degree of endemism. Although broad global patterns of species groups and higher level taxa (or biological groupings) are well established, these are subject to change as alternative methods such as genetic analysis are applied. In the marine environment, where knowledge of the spatial coverage of marine species is patchy and there is strong sampling bias towards temperate coastal regions, taxonomic methods are frequently insufficient to fully classify the biodiversity of the ocean such that representative areas can be selected for protection.

ECOLOGICAL GEOGRAPHY

For example, biomes and biogeochemical provinces [8]. Such classifications are typically more reliant on oceanographic, rather than taxonomic, information. As a result of the limited knowledge of the distribution of marine species, environmental data are often used as a proxy for biological distributions. At a large scale, there is often a strong relationship between physical features, biological features, and species communities.

POLITICAL OR GOVERNANCE MANAGEMENT REGIONS

These often follow delineations of sovereignty divisions between governing entities. Although useful as management units (especially for human activities such as fishing), classifications undertaken using political boundaries (or national jurisdictions) are unlikely to coincide with changes in species composition or ecosystem type.

PROBLEMS AND CONSIDERATIONS

Biogeographic classification systems are less developed in the high seas than in, for example, terrestrial, coastal and continental shelf areas. This is likely due to the lack of knowledge on high seas biodiversity and ecological geography, and the greater incentive to manage areas closer to shore that coincide with more traditional (and less remote) fishing grounds.

The scale at which to define biogeographic classifications is an important consideration and will vary with the particular aims of the process. For example, consideration should be taken of the scale at which data are available, the scale at which habitats or ecological communities change significantly, and also the scale at which any planning or management may be applied or may be most effective.

Undertaking biogeographic classifications in the marine environment is complicated by the three dimensional nature of this biome and the oceanographic and taxonomic differences between deep and shallow waters. For this reason, classifications are usually carried out separately for pelagic and benthic/demersal habitats.

There are few absolute boundaries in the sea, and defined boundaries may change over a variety of time scales. As new information becomes available, or habitats and species compositions are subject to change (for example through species invasions or the impact of climate change), boundaries may therefore need to be reviewed and altered accordingly. Biogeographic classifications also frequently fail to take account of transient phenomena, such as the requirements of migratory species or periodic spawning grounds.

MANAGEMENT

Biogeographic classification systems are widely viewed as essential tools for integrated ocean management, as they promote the understanding of how and where taxa are distributed and mark the boundaries between oceanographic regimes. Given that biogeographic regions are natural frameworks for marine zoning, this form of classification is increasingly used by regional fisheries management organizations [2]. Providing a way to classify areas and define the distribution of marine biodiversity facilitates the assessment of human impacts on the world's oceans. For example, the impact on a particular region might be particularly critical due to the presence of a geographically restricted species or habitat. Alternatively, a region might require management due to high fishing pressure or the interacting impacts of climate change and pollution.

GOVERNANCE AND POLICY

Classifications are often developed to inform and support marine policy and integrated coastal and ocean management. For example, the Convention on Biological Diversity (CBD) and the Ramsar Convention on Wetlands both recognise the need to protect areas that represent the full range of biodiversity, for which biogeographic classifications are a useful tool. This is particularly important in the ecosystem approach, which is based on the application of appropriate scientific methodologies focused on levels of biological organisation, and which encompass the essential processes, functions and interactions among organisms and their environment. For example, the World Summit on Sustainable Development [9] emphasised the need to develop and facilitate the use of diverse approaches and tools, including the ecosystem approach, to eliminate destructive fishing practices and establish marine protected areas consistent with international law and based on scientific information, including representative networks by 2012.

The Convention of Biological Diversity also aims to ensure effective conservation of a proportion of the world's ecological regions, with particular focus on Ecologically or Biologically Significant Areas (EBSAs). These are unique and vulnerable marine and coastal ecosystems, such as tropical and cold-water coral reefs, seamounts, hydrothermal vents, mangroves, seagrass beds, spawning grounds and other vulnerable marine habitats [10]. This work will be aided by the development, by international expert workshops and bodies, of biogeographic classifications and criteria for selecting areas in need of protection.

SPATIAL PLANNING

Biogeographic classification systems can also help businesses delimitate and distinguish ecological communities when planning and conducting their operations. Biogeographic classification systems may thus be used by businesses to assess, manage and reduce risk through environmental impact assessments and biodiversity action plans / environmental management plans.

They can also inform other types of spatial planning, such as Marine Protected Area designations, but informing conservation practitioners on the location of boundaries of ecological units and oceanographic features.

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Tools

Ocean Data Viewer A tool for easy access to a range of datasets that are important for the conservation of marine and coastal biodiversity. The data can be downloaded or viewed online.

Ocean+ Data A tool that provides an overview of a range of global marine and coastal datasets of biodiversity importance. The site allows users to filter by category, organisation and theme.

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