

MarBEF Theme 1: Global Patterns of Marine Biodiversity across Ecosystems

Central role of large-scale biodiversity data

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Climate change is a central discussion topic among scientists and the general public. The analysis of long-term datasets and the modelling of future climate events are occupying the minds of thousands of researchers. Global warming and the mitigation of its effects is in the focus of present and future European policy as well as the development of appropriate science-based strategies to cope with changing climate conditions.

In the context of the climate change discussion, the importance of biological, physical and/or chemical data is easy to convey. What is receiving less attention are the many steps involved in collecting the information needed to produce the high-quality data required for these large-scale and long-term analyses. This involves, for instance:

1. Appropriate sampling strategies and protocols
2. Sample analysis/measurement
3. Correct data analysis and data storage and management.

The vital importance of creating good-quality and comparable datasets is particularly true today where many European projects involve intensive collaborations of a great number of different European and, indeed, international research institutes on a large geographical scale. MarBEF, being one of the collaborative Networks of Excellence, has made great strides in the field of biodiversity, particularly in the establishment of a European baseline of biodiversity. In order to achieve this goal, great efforts have been made in compiling existing data and assuring the integrity and comparability of these joint datasets.

Single datasets usually lack the spatial coverage necessary to allow the pan-European comparisons central to the work and mission of MarBEF. Such large-scale comparisons can, however, be accomplished using the wealth of data available in individual databases held by partner institutes. Combining datasets presents a wonderful opportunity to tackle the big questions, but it is an opportunity that is hard won. Existing datasets are gathered for a variety of purposes and sampling strategies differ between countries, institutes and research projects. Sampling protocols can be standardized at institute and even state level (for example, the Standard Operating Procedures of the UK Centre for Environment, Fisheries and Aquaculture Science, or the Norwegian Government's protocol for oil- and gas-field monitoring used across the Norwegian Continental Shelf) or regionally as

part of monitoring activities within, for example, AMAP, HELCOM or OSPAR. However, mostly such standardization still does not occur on a scale large enough to permit direct comparisons across Europe. Moreover, several long-term monitoring programmes have been shut down for various reasons in recent years, making temporal comparisons more difficult. A number of other issues affect dataset comparability, including gear used, whether colonial or juvenile taxa are sampled, whether taxa are quantified or simply recorded as present, which organism groups are surveyed and the level of taxonomic resolution applied. Some incompatibility problems are less easy to solve than others. For example, datasets with mismatched counts (abundance per 0.1 m² vs abundance per 0.5 m²) could, with caveats, be translated into a common currency, but surveys using different sampling gears (e.g. 0.5 mm vs 1 mm-mesh sieves) sample different parts of the assemblage and should not be directly compared.

The difficulties resulting from the use of different sampling gear is even more obvious when using historical records dating back more than one hundred (benthos and plankton), or even several hundred, years (fish). Much of this data has been made available electronically within MarBEF and methods are under development to better allow the comparing of historical and recent biodiversity data.

MarBEF has made great leaps in the process of bringing diverse datasets together, including data on meiofauna (MANUELA) as well as macrobenthic fauna and flora, phytoplankton (Macroben, LargeNet) and fish (MarFish). Soft bottoms and rocky shores in shallow and coastal areas are covered as well as the open water and the deep sea. The MacroBen and LargeNet databases, for example, contain 62 and 43

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separate datasets respectively, covering a diverse range of habitats and taxonomic groups. The databases contain meta-data allowing protocols to be compared and tools enabling data extraction based on specific search criteria. They are also linked to the European Register of Marine Species (ERMS), bypassing the difficulty of comparing studies subject to taxonomic discrepancies.

Compiling these datasets has allowed Theme 1 participants to examine a number of important issues related to, among others, latitudinal patterns in species richness and zoogeographical boundaries. The Macroben database has been completed and – with LargeNet scheduled to release a final version in October – the path is open to a range of exciting opportunities for large-scale marine studies and assessments.

A first set of hypotheses has been tested using the Macroben data, and the results will be published as a series of multi-author papers in a Marine Ecology Progress Series (MEPS) Theme Section (“MarBEF database: large-scale patterns of European benthos”) in the coming months.

Another collaboration across responsive mode projects has gained better insight into the importance of deep-sea diversity and has provided scientific evidence that the conservation of deep-sea biodiversity is a priority for sustainable functioning of the world’s oceans (Danovaro *et al.*, 2008). In compiling long-term data on biodiversity in Arctic fjords, main drivers of variability in biodiversity could be identified which may be reconstructed over decadal or centennial time-scales (Renaud *et al.*, 2007).

Many more scientific papers based on MarBEF data have been published in the past few years and are listed on the MarBEF website. An overview paper and large-scale comparison across different taxonomic groups and habitats based on MarBEF datasets is under way. For all these comparisons a range of state-of-the-art statistical methods were applied after their suitability had been discussed and tested – another common approach within MarBEF Theme 1.

Species richness is one of the simplest and most important descriptors of biological diversity. Counting the number of species in a sample is straightforward, but extending this to the number of species in an area or region is a completely different matter. Even the most intense marine studies can sample only a tiny fraction of an area and, in these circumstances, richness values must be extrapolated. With a number of techniques available, the options for estimating a region’s total richness can be bewildering. Working with a colleague from the NERC Centre for Population Biology at Imperial College, London, a sub-group of the LargeNet RMP has been comparing richness estimation techniques and has discovered that many of the methods available, developed largely in terrestrial habitats, may not be appropriate for some marine systems. Presently, the group is developing an estimation technique that accounts for this inherent heterogeneity, and initial tests (using intertidal invertebrates on Helgoland’s rocky shores) show it to be surprisingly accurate in predicting total species richness.

Ultimately, our aim is to compare species richness around Europe and identify hotspots, coldspots or areas of potential conservation concern. It is not difficult to see how it is incredibly important to have confidence in the tools we use to make these large-scale comparisons. MarBEF is at the forefront of developing and testing such techniques. By developing a framework for which method can be used safely in a given context, the network is going to provide essential tools for the management of the marine environment.

An upcoming challenge is the emergence of entirely new types of data such as genetic data and taxonomic image material. Images, in particular, often do not even seem to be regarded as data at all, even though they play a vital role in the establishment/documentation of a marine biodiversity baseline in Europe. The latter is, after all, absolutely necessary for achieving such ambitious targets as that of halting biodiversity loss by 2010. High-resolution, high-quality images can nowadays be produced covering different species groups and size ranges. In order to apply this information on a larger geographic scale, it is

not the variety of methods and protocols available that is causing problems but the fact that general concepts/protocols regarding a quality-controlled record do not seem to have been established yet. This is a challenging task for the future.

Molecular tools also have only been used and managed in database systems for a relatively short time and it is therefore vital that for large-scale comparisons tight quality control mechanisms are put in place to ensure the comparability of data generated by the different sources.

In order to improve and better understand marine biodiversity patterns, MarBEF Theme 1 has taken the stewardship for compiling and safeguarding data from the partners in the network and from external sources. This has resulted in unique meta-databases covering European marine biodiversity. Based on this data, first distributional maps have been made, and spatial and temporal comparisons performed, as indicated above. The MarBEF databases could also serve as a tool in the ongoing discussions regarding the setting up of Marine Protected Areas in Europe. However, this requires additional analyses beyond the scope of MarBEF.

The meta-databases established within MarBEF as well as the expertise gathered in recent years are vital to support present and European policy and its implementation. By establishing mechanisms, protocols and improved methodologies, MarBEF is facilitating the much-needed large-scale collaborations to address challenging questions, e.g. in regard to loss of biodiversity or climate change. However, to be able to make use of this knowledge in the future, a mode has to be developed to maintain and sustain the MarBEF databases as well as the established research network. The process has been started in the past months in dialogue with other European Networks of Excellence as well as with MARS, the European network of Marine Stations and Institutes.

References

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