Classification and distribution modelling of deep-water biotopes and habitats – a foundation for offshore marine spatial management

Pål Buhl-Mortensen (1), Genoveva Gonzalez Mirelis (1) and Margaret Dolan (2)
(1) Institute of Marine Research, Bergen, Norway; (2) Geological Survey of Norway, Trondheim, Norway. Presenter contact details: paalbu@imr.no, Phone +47 55 23 85 99

Summary
The Norwegian seabed mapping project MAREANO has collected and analysed sea floor video records and sediment samples from the Barents Sea and the Norwegian Sea since 2005. MAREANO maps both conspicuous habitats and general biotopes. This is based on quantitative analyses and classification of megafauna composition recorded on video. Biological classes or biotopes are then modeled for their spatial distribution. Several approaches, both at analysis and classification stages used in the MAREANO programme are presented. Vulnerable biotopes are characterised by combinations of certain habitat-forming large sessile species and represents a “top-down” definition strategy, while the definition of general biotopes by classification of a great number of species represents a “bottom-up” approach. There are benefits and limitations associated with the different methods. These will be discussed with focus on the standardizing and naming of the classes of seabed biotopes in deep waters.

Introduction
The terms "habitat" and "biotope" are used almost synonymously for describing the environment associated with occurrence of certain species. We recognise the difference of these terms as "biotope" applying to the community's environment and "habitat," to the species' environment (Whittaker et al. 1973). Information about the spatial distribution of habitats and biotopes, in particular in the form of maps, is useful for managing human activities with potential negative impact. Classification of the seabed based only on the physical environment is often insufficient for capturing the variation in species composition. Classification of deep-water habitats can be based on pre-defined, classification schemes e.g. EUNIS, CMECS etc, or can rely on statistical methods where the composition of species is compared between locations and clear clusters are detected. Distribution patterns of biotopes can be observed at the landscape scale and are easier to map than single species. Many of the vulnerable deep-water biotopes are characterised by large, fragile species of sponges and corals. These are easily damaged by contact with fishing gear, especially bottom trawls.

Material and methods
Biotopes were identified through analysis of similarity in the species composition between samples (200 m long video sections from three different areas modeled separately) (Buhl-Mortensen et al. 2009; Elvenes et al. 2013). To display patterns of species composition, multivariate statistics (DCA) was applied to quantitative species data. At the next step k-means clustering was used to aid the identification biotope classes. Through these methods each sample was assigned the most appropriate biotope class and related to the physical environment (including terrain variables, sediment type and oceanographic properties). For modeling vulnerable biotopes we used another approach where the occurrence of selected characteristic species was the most important classification criterion. Seven vulnerable biotopes (in addition to cold-water coral reefs) were defined and modelled using Conditional Inference Forest (Gonzalez-Mirelis & Buhl-Mortensen 2015): 1) Soft bottom sponge
aggregations, 2) Hard bottom sponge gardens, 3) Cold water sponge communities, 4) Hard bottom coral gardens, 5) Soft bottom coral gardens, 6) Seapen and burrowing megafauna communities, 7) Umbellula communities, 8) Cold-water coral reefs. Probability maps of their likely occurrence were converted to binary maps using threshold values of abundance identified through analyses of their distribution patterns.

Results and discussion
MAREANO maps both conspicuous habitats, and general biotopes. The classes of both types occur in characteristic environments allowing for robust predictive modeling. It is a challenge to harmonize the general biotopes with the top-down defined habitat classes emphasizing bottom types. Application of such classifications represents a risk of “forcing” biotopes into irrelevant habitat classes, hiding the true biodiversity. Several methods have been used by the MAREANO program to map and predict biotopes and habitats. Similar maps from different methods indicate robust biological patterns consistent with the environmental variation covered by the predictors. Our results also indicate that vulnerable biotopes are identified through the classification of whole megafauna data sets. By including predictors based on new oceanographic models, at a higher resolution than previously available, the confidence of predicted biotopes increases. The main challenge for producing meaningful biotope maps across regions is harmonization of identified classes. Different solutions to this are discussed.

Figure 1. To the left: Modeled general biotopes in areas mapped by the MAREANO mapping project. To the right: Distribution of vulnerable habitats within the MAREANO mapping area, indicated from predictive modeling based on abundances of species characteristic for these habitats. Lophelia reefs (cold-water coral reefs) are represented as points based on observed occurrences rather than modeled areas.

References