Theme session N

Seabed habitat mapping: from observation to management

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Theme Purpose

In our planning and management of the terrestrial environment, we take for granted the availability of high quality maps of terrain and land cover provided by, for instance, satellite images. Yet for decades, human activities at sea have been developed and planned with only a scant understanding of the nature of seabed and the distribution of its biological resources. This draw on space and resources is now coupled with an increasing demand for seabed surveys and status assessments to meet national and European maritime policy requirements for nature conservation and ecosystem-based marine spatial planning. Effective delivery on such policy targets needs a sound understanding of the properties and distribution of seabed habitats (including their biology) and the pressures upon them from human activities. However, the prospect of having full coverage, high resolution seabed habitat maps for European seas is still many years, perhaps decades, away. To improve on this situation, several research projects on the observation, mapping and assessment of seabed habitats at different spatial scales are currently underway. This theme session was intended to provide a snapshot overview of the latest developments, including technical advances in observation and mapping, applications to predictive modelling and the use of habitat maps for management purposes.

Across a range of marine ecosystems, this session presented papers on seabed habitat mapping covering at least one of the following topics: (a) Improvement of our understanding of the distribution and extent of marine species and habitats, (b) Examples of how habitat mapping may contribute to ecosystem quality assessment, environmental monitoring and ecosystem-based marine spatial planning, (c) Guidance for spatially explicit prioritization and problem identification, (d) Assessment of changes in marine habitats as a result of human activity, (e) Development of standards and protocols that help improve compatibility between maps and data, (f) Assessing and improving map accuracy and confidence, and (g) Data sharing initiatives that ease access to geospatial information for end-users.

During the session, a total of 22 oral presentations were given, with an additional two poster presentations. Based upon resemblance, oral presentations had been grouped into the subthemes (1) technicalities, (2) applications and (3) management. The overall attendance throughout the session was high, with an estimated average of 60 participants. Unfortunately, only little time (15 min) had been allocated to a final discussion. Apart from that, discussion rounds were active, with much participation from the session attendees.

Technicalities

The first part of the session was allocated to topics related to the observation and modelling of seabed habitats. As demonstrated throughout this thematic slot, there was distinct interest in trying to develop practical methods for baseline characterizations, habitat classification and monitoring designs in support of marine conservation and resource management. Examples provided largely focused on biological aspects of habitat mapping rather than the observation of geophysical or biogeochemical properties of sediments. Several authors presented papers that involved targeted multibeam surveys, video imagery and remote sensing in different marine ecosystems, including high energy coastal environments (N:12), tidal flats (N:15) and subtropical to cold water coral reefs (N:12, N:15, N:27). These regional observations were often performed in combination with statistical modelling to predict species distribution based on environmental surrogates, typically physical and topographic parameters such as temperature, salinity, depth and slope. Some authors demonstrated how these methods could be applied to even larger scales by considering habitat properties and environmental variability of entire marginal seas (N:05, N:07, N:11). Caution however is needed as two papers were presented on map accuracy and the effect of scale. One showed that the identification of error sources and the spatial representation of uncertainty in seabed habitat maps can be improved by combining common error metrics with approaches used in terrestrial land cover mapping (N:01). The other paper (N:10) reminded us that awareness of small-scale heterogeneity is highly important in seabed habitat mapping and high data resolution essentially when it comes to surrogacy-based interpretations of point-based biological sampling designs.

Applications

One way forward in using habitat maps to their full potential is a continued effort to find, quantify and explain relationships between abiotic and biotic parameters to predict the distribution of habitats and species at various temporal and spatial scales. A snapshot overview of different approaches provided the second part of the session. Three presentations on national and international habitat mapping programs (N:02, N:08, N:22) served as a good introduction, highlighting the need for high-quality measurements and baseline datasets on substrata, biological, geophysical and (bio)geochemical parameters as well as human pressures to map and classify habitat features, biotopes and risk exposure at management scales. Subsequent presentations focused on applications to the assessment of single species (N:14), multispecies (N:09) and benthic communities (N:03, N:23) within different advisory frameworks. These papers employed diverse statistical modelling techniques, including generalized additive models (GAM) and regression trees to show the probability of species occurrences in areas that have not been surveyed. While such methods seem appropriate to accounting for a wide variety of ecological and environmental factors to predict spatial and temporal variations, and are promising for providing cost-effective information to management, it was not clear how uncertainty associated with the different steps of map production (i.e. data collection, surrogacy testing, predictive modelling) could be included. Further, discussion regarding the availability and interoperability of data revealed that there is a need to put more effort in standardization and provision of infrastructures for the dissemination of data and map products.

Management

The third and last slot of the session was allocated to papers focusing on the management perspective of seabed habitat mapping, including resource management and marine spatial planning, nature conservation and monitoring design. The first paper alluded to the challenge of producing meaningful (top–down defined) classification maps that can provide direction for management of both general biotopes and conspicuous habitats (N:21). Multiple visualizations generated from different classification methods offer the potential for identifying robust patterns consistent with environmental variation and thus, are especially promising to integrate different types of information at scales smaller than management units. To use such habitat and biotope maps directly in advice requires (at best) a close interaction between science and stakeholders. A good example of how sharing information between these groups can culminate in an improved knowledge base on habitat and species distribution was provided by a paper on North Sea herring spawning areas (N:17). Further, looking at fishing gear affect on benthic habitats, a paper on a risk-based approach illustrated that stakeholder involvement can be particularly important for scoring the consequence and spatial attributes of vulnerable habitats in data-deficient ecosystems (N:13). Other presentations expanded the scope to stock assessment (N:18) and coral conservation (N:06) encompassing live-stage specific definitions of essential habitats and long term monitoring of assemblage composition, respectively. Immediate discussion following these papers included that the need for aligning different and possibly conflicting priority settings related to map precision and inclusion of ecological information between policy, industry and science. This ought to be emphasized as a key component in the process of habitat mapping, and not as an add-on to mapping frameworks.

Session Discussion

The theme session ended with a brief (15 min) but intense discussion picking up issues that had been repeatedly raised throughout the presentations. Of particular interest was how to calculate and best present uncertainty in data and mapping products. The prospect of having a unified, all-encompassing confidence assessment would be ideal, incorporating uncertainty associated with data acquisition, description, analysis and classification. It was agreed that this is unlikely to be achieved with just one representation of map confidence but rather requires multiple visualizations of datasets with flexible querying protocols. It was also noted that demands on the representation, precision and reliability of maps are likely to differ between different users with decision-makers having more of a conservation tendency whereas the industry tends to have a more economic focus when weighing options. There is therefore a potential for mismatch between mapping approaches that serve different interests, perhaps owing to the implications of existing maritime legislations. In this regard, habitat mapping needs to increase links with stakeholders and policy to allow for broad perspectives when establishing targets and methods for integrating information into tactical and strategic management advice. From the discussion it was apparent, that we are currently lacking the necessary standards, protocols and tools to operationalize this information. We believe that our session provided some ways forward to this end. Perhaps most importantly, it highlighted the need to really engage with issues of data quality, harmonization, and dissemination, since policy decisions are being made with or without this information.

Conveners' own conclusion

The theme session dealt with issues in focus of the ICES strategic plan, in particular goal 3 and 4. One conclusion is that thorough assessments of data accuracy are needed

when it comes to the interpretation, merging and utilization of seabed habitat maps. This may require people involved in seabed habitat mapping to put more effort into documenting data and processes and adopting internationally agreed standards and protocols to ensure data compatibility and interoperability. Another conclusion is that there is a considerable amount of research regarding baseline characterization, biotope classification and predictive modelling of seabed habitats. However, our knowledge of habitats and biotopes in the marine environment is still poor compared to the terrestrial environment, whereas the availability of full-coverage, high resolution habitat maps is limited. Consequently, researchers focusing on the latter require access to knowledge and data platforms for the development of large-scale and harmonized products for use in management and advice. On the other hand, we observe that many tools and methods are already at hand that may be of usage in risk assessments and monitoring of ecosystem status.