Habitat mapping as a tool for conservation and sustainable use of marine resources: perspectives from the MAREANO Programme, Norway

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Summary
One of the main goals of marine spatial planning (MSP) is to promote a sustainable use of marine resources without putting biodiversity and habitats at risk. The objectives relating to marine biodiversity and habitats that are stated in the Biodiversity Convention, Habitat Directive and the Marine Strategy Framework Directive (MSFD) affirm that no species or habitats should be lost, and that the integrity of the sea floor should not be compromised by human activities. This has led to an increased request for a mapping approach that can assess the distribution and status of benthos including as many habitats as possible. We present mapping strategies based on literature together with perspectives from Norway's MAREANO mapping programme (www.mareano.no). A first and important step is to acquire high resolution bathymetry from multibeam echosounder surveys. With this information at hand video inspection along transects can provide information about how megafauna and surface sediments relate to topographical features. Classification of habitats/biotopes can be carried out through the analysis of the megafauna composition and its relation to environmental variables. From the identified habitats and biotopes information from a broad set of sampling gears are provided to get a more complete picture of the community composition. The approach here can be used to identify biologically valuable areas and assess health status for habitats/biotopes in a broad set of marine landscapes.

Introduction
The ICES Working Group of Marine Habitat Mapping (WGMHM) reviewed existing definitions of Habitat and developed the following working definition of the term: a recognizable space which can be distinguished by its abiotic characteristics and associated biological assemblage, operating at particular spatial and temporal scales (ICES 2005). Marine landscapes generally refer to the major features delimiting broad-scale habitats and each landscape will include different substrates that can be subdivided into smaller biotopes with specific fauna composition, functionality and production. MSP requires knowledge of the composition and distribution of benthic habitats with their related communities, the characteristics of a natural and healthy state of these communities, and the effects of different human activities (e.g. EC 2008; epbrs 2013; Steltzenmüller et al. 2013). It has been estimated that only 5–10% of the seafloor is mapped at a comparable resolution to similar studies on land (Wright and Heyman 2008). Furthermore, marine ecosystems are poorly described compared to their terrestrial counterparts. On land the proportion of unknown habitats has been estimated as 17% whilst for the marine realm it has been estimated as 40% (EC 2007). In recommendations from the European Platform for Biodiversity Research Strategy (epbrs 2013) it was emphasized that “a sound reporting based on scientific methods and knowledge is of major importance” and that it is recognized that “research is needed to substantially advance our knowledge of marine habitats and species in support of evidence-based policy and its implementation”. Management goals do not relate to any particular faunal group or size class of the benthic community, and it is well known that terms like habitat, biodiversity and ecosystem are concepts that depend upon the sampling methods and fauna studied (Costello 2009). This demand for a comprehensive mapping strategy for baseline surveys. Here we summarize some specific research needs and knowledge gaps relevant to habitat mapping together experiences from the seabed mapping programme MAREANO designed to provide information that can be used as a scientific basis for the regulation of human activities such as the petroleum industry and fisheries as part of Norway's obligations to national and international policy objectives.

Materials and Methods
The mapping conducted by MAREANO is designed to cover all parts and scales of the benthic community equally well with no organism group having a specific priority (Buhl-Mortensen et al. 2015). By using a variety of gears that can provide samples of a broad set of benthic organisms on many types of seabed, MAREANO offers insight into the species-diversity, biomass and production of benthic communities within various biotopes. This is a unique level of biological information for a mapping programme. As pointed out by Brown et al. (2011) all gears provide information on the small area of seafloor that they sample and it is difficult to derive an accurate representation of the broader spatial configuration of the seafloor biophysical characteristics. Furthermore, depending on the part of the benthic fauna that is studied the number and size of habitats/biotopes will differ and there is not one approach that can provide a solution that is universally applicable for all the
benthic fauna (e.g., Buhl-Mortensen et al. 2012a, 2012b; Pitcher et al. 2012). MAREANO has overcome this problem by letting the megafauna dictate the scale and number of biotopes in an area and then fill in data from other organisms sampled within the biotopes (Buhl-Mortensen et al. 2012a).

Results and discussion

What information is needed by management for marine spatial planning (MSP) and what implications this should have for the approach taken to seabed mapping? In accordance with the procedure for evaluation of spatially managed areas suggested by Steltzenmüller et al. (2013) the information required must correspond to management goals and operational objectives which we will argue in turn must have bearings on the chosen mapping strategy. Requirements of the European Marine Strategy Framework Directive (MSFD) (EC 2008) encompass the distribution and composition of bottom fauna on all scales as well as human pressures and related impacts. The goal for biodiversity management (MSFD, descriptor 1) is that: “...biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions. Must address four ecological levels: ecosystem, landscape, habitat/community and species.” (EC 2008). Good environmental status (GES) is achieved if there is no further loss of the diversity of genes, species and habitats/communities at ecologically relevant scales and when deteriorated components are restored to “target levels”. The management goal in the MSFD relates to “sea-floor integrity” stating that it should be “at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.” According to the MSFD this means that diversity and productivity are maintained and the uses do not cause adverse impacts to the natural ecosystem structure and functioning in both space and time, and recovery should be rapid and secure if a use ceases (EC 2008). Effective mapping and monitoring of benthic communities including habitat-forming organisms and their associated fauna require that the standard methodology (grab, 0.1 m²) useful only for small infauna benthos in soft sediments is supplemented and/or replaced by gears that can provide information from a wider range of sediment types and for megafauna and mobile organisms. Hard, topographically complex habitats are known from visual inspection to have biotic compositions that differ from sedimentary habitats (Kostylev et al. 2001; Pitcher et al. 2007). High resolution visual documentation is needed to assess the abundance and health status of long lived and habitat forming organisms, however, it is not sufficient to only record their presence, their health status and associated fauna also needs to be surveyed. Based on experience from MAREANO (> 1000 km of inspected sea bed that covers habitats between 50–2700 m depth) and recent monitoring by Fisher and Girard (2015) at Deepwater Horizon oil spill sites, we recommend visual monitoring of large and long lived organisms. This represents a cost effective approach to monitor the status of the whole benthic community in the same habitat when comprehensive baseline mapping has been conducted.

References


