

Shadow relief of 3D model of the coral mounds/
reefs in Hola outside Vesterålen (5 metre grid).

PRACTICAL USE OF NEW KNOWLEDGE

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Redfish are comfortable among corals. Norwegian fishermen know this and call the reefs “Uer stø” meaning something like redfish hang-out.

It may be scientifically and academically interesting to map the seabed, but ultimately it is the application of the new knowledge that demonstrates whether the results are useful and worth the effort. We may obtain spectacular topographic seascape maps and beautiful images of corals and other benthic fauna, but if the knowledge is not used by governmental agencies and private players, it will be of limited value. Or to say it use the English idiom: “The proof of the pudding is in the eating”.

13.1 USE OF NEW KNOWLEDGE IN THE MANAGEMENT OF MARINE RESOURCES

"MAREANO is a result of our constant search for new knowledge. We want more detailed knowledge of an important part of Norwegian territory – a part of the kingdom of Norway that is not visible to the naked eye. So many exciting things can be hidden down there. What ends up in the sea ultimately falls to the bottom, so the seabed is like a historical library. The sediments tell the story of past climate changes, the development of species and transportation of contaminants. MAREANO will systematically collect data on the seabed for both animate and inanimate aspects. Traditionally, we have harvested the living, renewable resources from the sea – mainly fish. Today, we also extract what earlier times have left us in the form of oil and gas deep down in the seabed. Historical data will be used as a basis for future management." Quote from the opening of the 2006 MAREANO User Conference by the Minister of Fisheries and Coastal Affairs.

Natural resource management is largely a matter of managing human activity to prevent it from inflicting excessive damage on nature. In order to do this, we need to know the nature of the areas that are exposed to human activity, and how rare and vulnerable they are to the environmental change it is these activities represents. The management for the Norwegian seas state that MAREANO will be a main knowledge contributor and expectations are high for MAREANO to provide the basis for an improved marine resource management.

The MAREANO mapping programme has given us increased knowledge of ecologically important benthic habitats, such as coral reefs and sponge areas. Additionally, data from MAREANO has provided us with a better basis for evaluating the extent and importance of human effects. So far, mapping results have been used to evaluate which marine habitats in the Norwegian Sea, the Barents Sea and off Lofoten should be defined as "endangered"

Figure 2. MAREANO has delivered information on the distribution of vulnerable habitats as input to the revision of the management plans for the Barents Sea and the Norwegian Sea. The figure shows predicted distribution of habitats classified as vulnerable according to the Oslo-Paris convention.

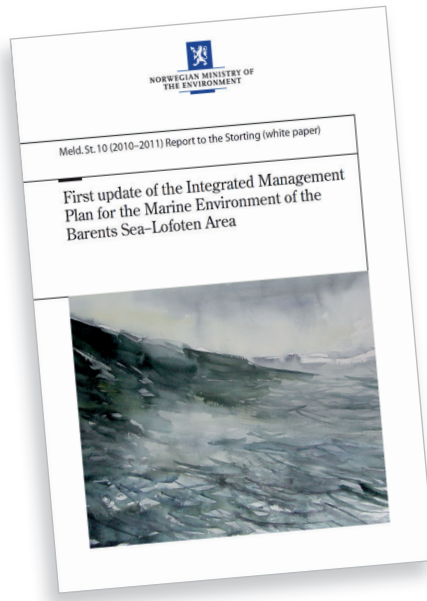
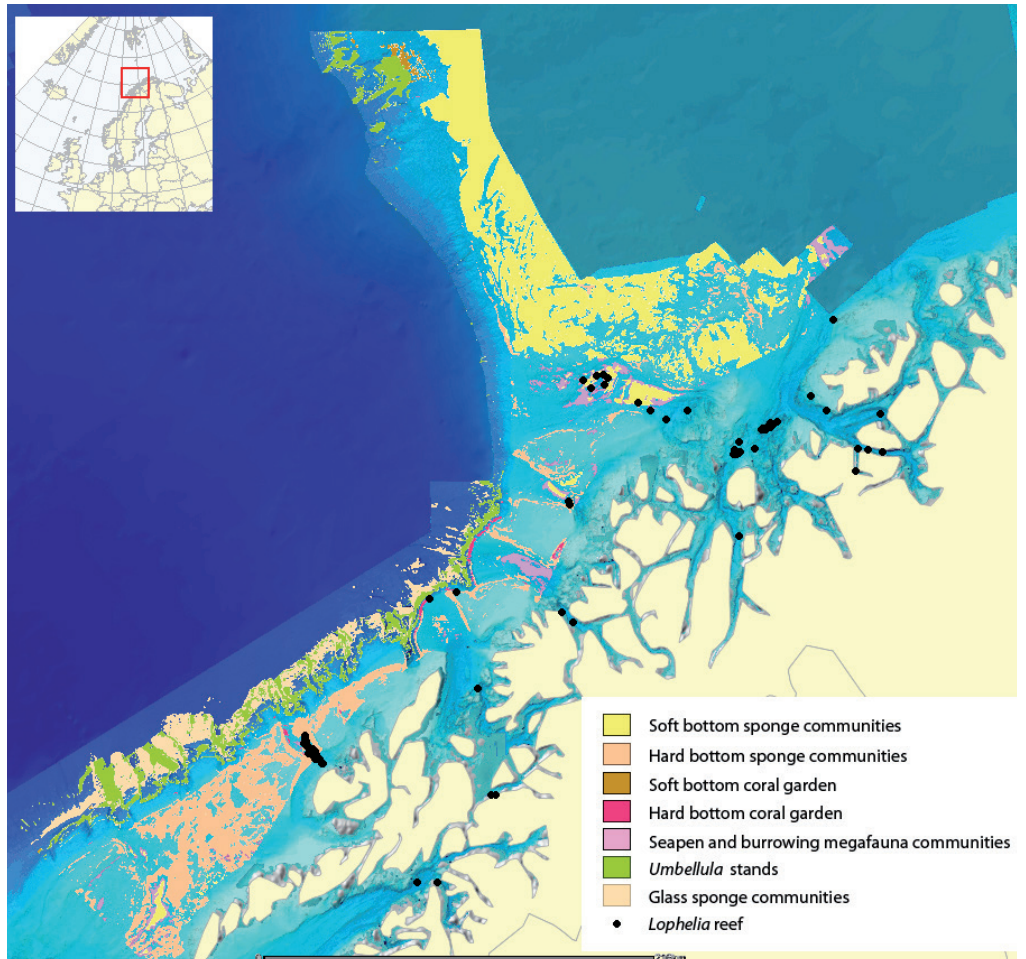


Figure 1. First update of the Integrated Management Plan for the Marine environment of the Barents Sea and Lofoten area. Meld. St. 10 (2010-2011) Report to the Storting.

The Barents Sea-Lofoten management plan area. The red dashed line shows the delimitation line in Barents Sea between Norway and Russia agreed on in 2010.



or "vulnerable" (figure 2). New knowledge from MAREANO was an important factor in the 2010 update of the scientific basis for the Management Plan for the Barents Sea. MAREANO has delivered new information about trawl tracks, seabed pollution and the distribution of vulnerable habitats, such as corals. This knowledge allows for a better and safer regulation of human activity in the mapped areas. The Management Forum for Norwegian Waters and the Monitoring Group are bodies established by the authorities to coordinate work on the Management Plans for the Norwegian seas.

Knowledge of the seabed is difficult to obtain and data collection is expensive. Consequently, our knowledge of physical and biological aspects of the seabed is very limited and traditionally, data collection has been performed more or less blindly. Now, however, the MAREANO mapping provides us with detailed information about seabed structures before we start collection biological, chemical and geological data. MAREANO's extensive video documentation (see chapter 2) enables us to see the actual conditions and how the fauna lives in its natural environment. This is new and exciting knowledge for scientists and managers alike. We have discovered new species and have been able to observe life down to 2700 m. We have documented areas with vulnerable species and habitats and have seen traces of human activity, mainly in the form of trawler trails and seabed pollution. For managers to know whether new species have established in or disappeared from an area due to factors such as climate change, ocean acidification, pollution or other human effects, we need detailed knowledge of its natural condition. The MAREANO mapping has allowed us to update the distribution of more than 100 species and record several new species in Norwegian waters. This is most likely due to better knowledge of the benthic fauna in the mapped areas rather than an actual change in their distribution.

Through mapping and assessment of biotopes and habitats, mainly on the continental shelf, but also in the coastal zone, MAREANO has improved the knowledge basis for an ecosystem-based management. This is an important and necessary prerequisite for an integrated management that depend largely on knowledge of biodiversity and habitat distribution. It is particularly important to have high quality mapping data that describes habitats, as well as natural resources, for the

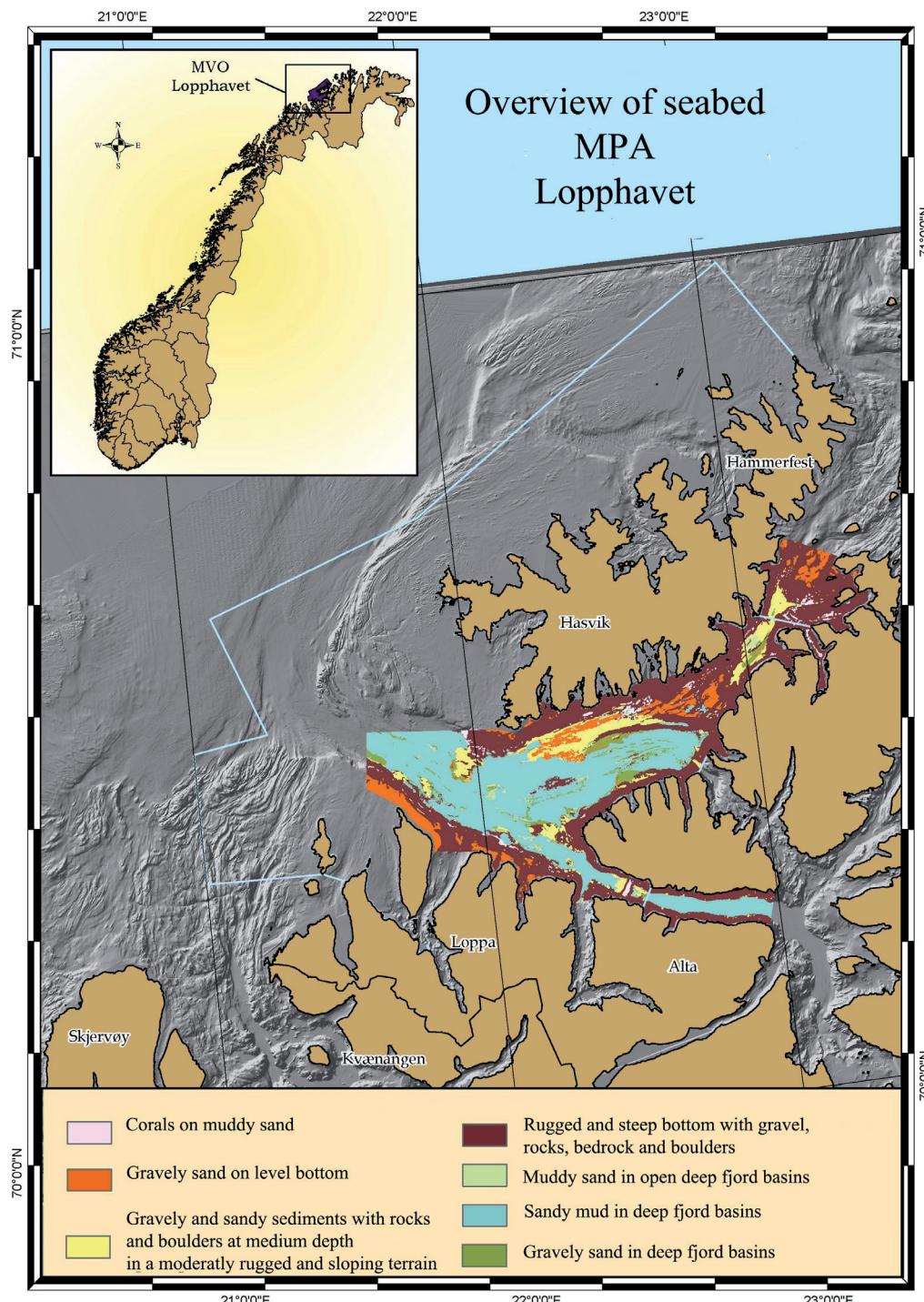


Figure 3. Habitats in the Stjærnsund–Sørøysund area. Areas in white indicate occurrences of corals. Large occurrences of sponges have been documented on gravelly sand in shallow and inner parts of Sørøysund.

management of fisheries, the oil industry and shipping traffic.

The mapping also provides important input to the work on marine protected areas, where there is a great need for knowledge on marine biodiversity and habitat distribution. This

knowledge is necessary in order to choose what areas best represent the habitats and natural wealth we wish to protect. Improved knowledge about the nature of our extensive waters also uncovers natural wealth we did not know of. One example is Norway's large and

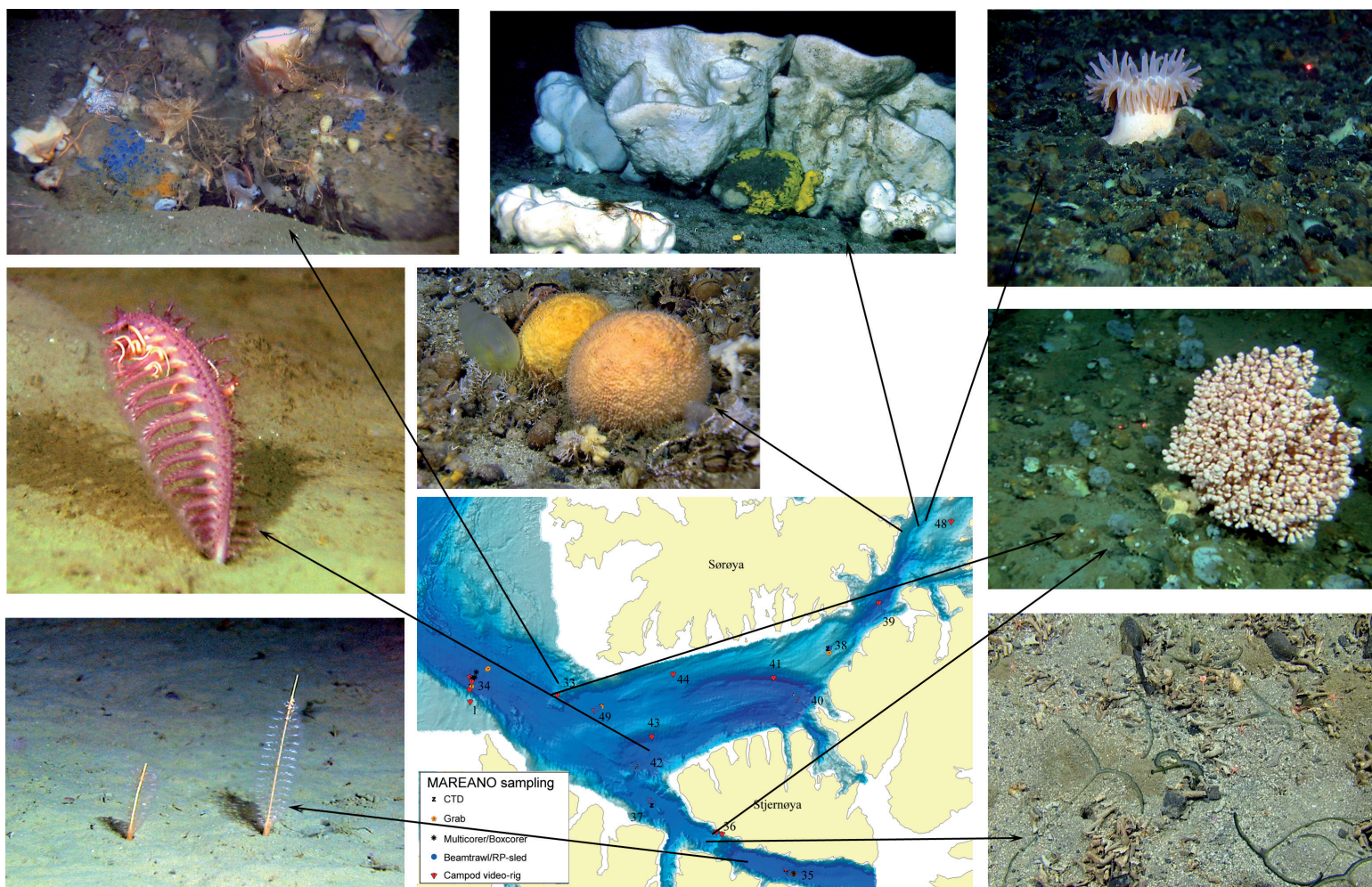


Figure 4. Examples of vulnerable and endangered habitats in Lophhavet. In the deeper parts of the fjord basins we found sea pens; and in Sørøysundet, where currents are strong, there is a marvellous sponge area. On underwater ridges and headlands, there are coral reefs and coral forests.

important cold coral reefs, which – up until a few decades ago – were relatively unknown. Additionally, MAREANO has mapped some of the areas involved in the National Plan for Marine Protected Areas. During periods of bad weather, MAREANO has mapped coastal areas such as the Stjernsund–Sørøysund area in Lophhavet and the Andfjord transect. Mapped coastal areas are presented in chapter 2, figure 4. Habitats and biotopes in the Stjernsund–Sørøysund area are shown in figures 2 and 3.

On the MAREANO website – www.mareano.no – you can combine topics such as vulnerable habitats, petroleum activity and fishing intensity in one map, which will show where to find possible areas of conflict (see chapter 10). This information may be used by managers or in advice provided to relevant ministries on possible effects of oil and fishing activity, shipping and long-distance transportation of pollution in various marine areas. In this way, MAREANO

contributes to the integrated management of the marine environment.

Advice related to human activity at sea and the establishment of marine protected areas, are mainly presented in the form of reports to various management projects and programme groups. Scientists also have regular meetings with oil companies to discuss planned pipelines and other installations in relation to areas of vulnerable natural wealth, such as coral reefs. MAREANO has contributed with data and advice to the project “identify valuable areas” led by the Norwegian Environment Agency (see below) and has participated in the development of *Nature Types in Norway* led by the Norwegian Biodiversity Information Centre. Internationally, mapping results are used (via working groups) in advice primarily to the International Council for the Exploration of the Sea (ICES) and the Commission for Protecting and Conserving the North-East Atlantic and its Resources (OSPAR).

13.2 SUSTAINABLE DEVELOPMENT AND SUSTAINABLE USE

Sustainable development is founded on three pillars; one financial, one social and one environmental. Of these three, the environment is in a unique position, because transgressing nature’s tolerance limits may have irreversible effects, and because a sound environment is a prerequisite for long-term financial and social needs. The principle of sustainable use is expressed in the Norwegian Constitution.

Principles of environmental law are laid down in the Biodiversity Act (see § 7 of the Biodiversity Act). Particularly important is the principle that governmental decisions concerning biodiversity must be based on scientific knowledge of stock status, habitat distribution and ecological status, as well as effects of human activity.

Where knowledge of the effects of a government regulation on the environment is insufficient, measures must be taken to avoid any possible damage to biodiversity. If there is a risk of serious or irreversible damage to biodiversity, that is in itself sufficient to postpone or avoid passing a resolution.

It is also a requirement that the overall impact on the ecosystem must be taken into account when considering possible effects of human activities. Thus, government agencies must consider the combined effects on the ecosystem before passing a resolution.

The principles of knowledge-based management, the precautionary approach and the consideration of combined effects all guide maritime governance and thus will contribute to a knowledge-based management of biodiversity. Naturally, there is a great need for knowledge on habitats, species, how species interact and how vulnerable they are to various impacts. An ocean of knowledge is still required and MAREANO data, along with research and other marine mapping, is absolutely necessary to enable the authorities to pass regulations consistent with sustainable development.

13.3 ENVIRONMENTAL VALUE AND VULNERABILITY

The development project on environmental value and vulnerability, *Valuation of Marine Areas*, started in 2008. The overall aim of this project is to contribute to ensuring that human activity in Norwegian seas adapts to the characteristics of these areas, and that decisions made about human activity are based on the best possible knowledge.

The objective of the project is to develop a system for assessing environmental value and vulnerability, at the same time as knowledge is being generated, and to present the results to managers and other stakeholders. The system is available on havmiljo.no. Knowledge on species and habitats, and thus data collected by MAREANO and SEAPOP, will be important contributions to the system.

Havmiljo.no will be an important provider of knowledge to marine managers, as well as the general public. The project was introduced in the Management Plan for the Barents Sea and has been developed to include Norwegian seas in general. The method must also be seen in relation to the international development of marine area valuation.

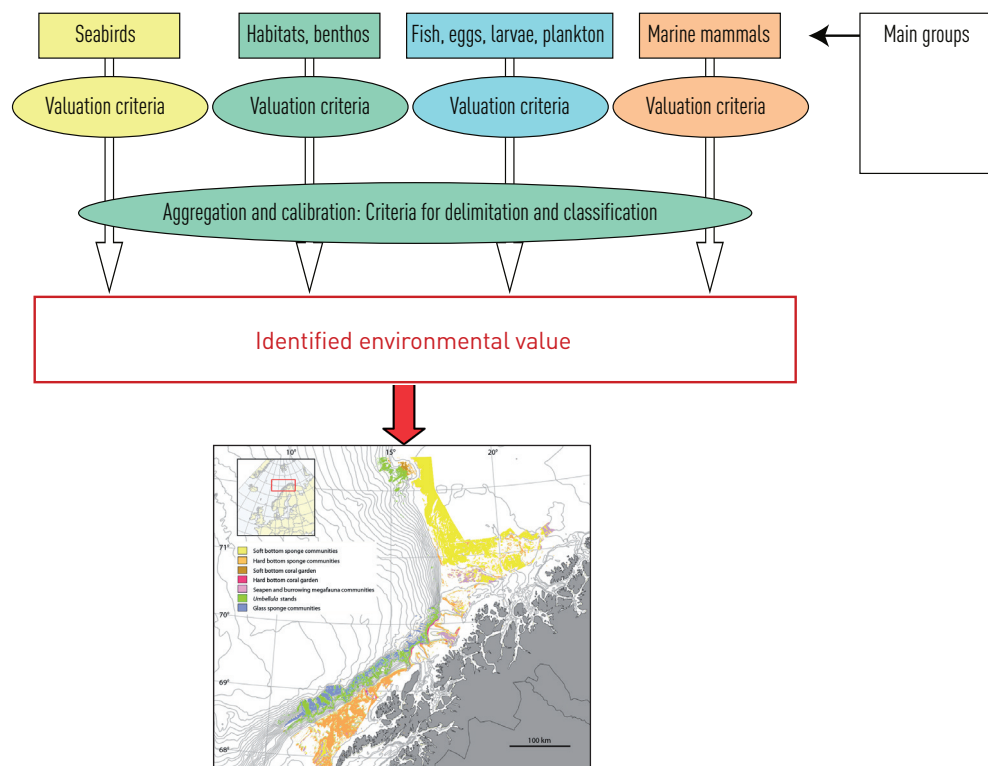


Figure 5. The various components of a system for environmental valuation.

Environmental Valuation

Environmental value describes the importance of a specific area for the ecosystem as a whole, and is based on how important habitats for birds, fish, benthic organisms / ecosystems and marine mammals are distributed over the year. The environmental value is identified and mapped.

The MAREANO data is essential when it comes to habitats and benthic fauna. Area

valuation for single species on the seabed is impractical, with the exception of habitat forming species such as corals and possibly sponges. MAREANO delivers maps and predicted habitats based on depth data, backscatter data, video transects and geological bottom samples. Detailed seabed data collected by MAREANO may be supplemented by data from IMR surveys in the same areas over the past five years.

Figure 6. A lively aggregation of saithe at Tromsøflaket, where fishing activity is intense.



13.4 KNOWLEDGE FOR FUTURE FISHERIES

"I have always believed that the ocean was flat, blue and monotonous. Now I know better," Dag Erlandsen writes in an editorial of *Fiskeribladet* in December 2009 after seeing the 3D maps of the continental shelf and slope off Vesterålen. "Down there I see redfish and Greenland halibut, I see a hungry monkfish lurking in the seaweed, I see a halibut, large and flat," he continues, suggesting that many species use the seascape purposefully – as spawning grounds, nursery grounds or habitats. A 3D map (figure 7) of tracking data from fishing vessels over 24 m, which have reported their movements to the Directorate of Fisheries since 2000, shows us something interesting. Most of the fishing activity is focused on the shelf edge, although some does occur on the shelf. Some areas have very little fishing activity, which is due to several factors: trawling is only authorised within specific areas to avoid trawling close to land; over generations, fishermen have learnt where the fish go, and when possible, this is

where they will harvest; moreover, fishermen have learnt, through bitter experience, where bottom conditions are not suitable for trawls and seines. In some places, glaciers that rested on the shelf more than 10,000 years ago have left large rocks and boulders that will tear the nets. Data collected by MAREANO provides new knowledge for a better targeted fishery, in order to avoid net damage and increase efficiency. Experience from Canada and Ireland indicates that detailed knowledge of the seabed helps to improve a fishery's energy efficiency, fuel consumption and economy, which again will reduce the fleet's emission of CO₂ and NO_x per kilo of fish. Additionally, accurate positioning of habitats, such as coral reefs and sponge areas, helps to avoid damage to these vulnerable ecosystems.

At Tromsøflaket, detailed depth data and sediment distribution maps were tested for a brief period in the summer of 2008. Skipper Pål Roaldsnes saw their obvious value both during planning and execution of fishing activity. "The greatest benefit was no doubt that they help fishermen to understand conditions on the seabed so that they can adjust their

fishing effort accordingly. We believe these maps will be of great importance for future fishing activity and for the management of fish resources," Roaldsnes concluded.

In 2010, the producers of electronic map plotting systems such as OLEX, MaxSea and others used by the fishing fleet, were invited to join an innovative collaboration financed by the Norwegian Seafood Research Fund (FHF). OLEX was the only company to participate. Up to now, detailed seabed information has only been available for use in office geographic information systems (GIS), and not for field users in the fishery and aquaculture industry. The project has successfully converted standard sediment and shaded relief bathymetry maps from the waters around Andøya Island to a format which can be used on the OLEX map plotting systems installed in many fishing and aquaculture vessels (figure 8). Additional maps are available from the coastal areas east of Andøya - the Astafjord area. Basic map themes such as bathymetry, sediment and backscatter are supplemented by specially made thematic maps aimed at the fishery and aquaculture industries, and local and regional management bodies. These thematic maps provide far more information about the seabed than standard electronic sea charts. For example the maps show where aquaculture installations can be safely anchored, where there is less likely to experience oxygen deficiency below aquaculture installations, and where cables and pipelines may be trenched into the seabed, avoiding interference with trawling and other fishing activities. All of these maps are now available as free downloadable files from the web pages of OLEX (www.olex.no).

Norwegian Seafood Research Fund (FHF) and Barentswatch (www.barentswatch.no) has financed the development of the service "FiskInfo" to provide information from Norwegian authorities directly to the fisherman's chartplotter. The service was launched February 2015 and information about fishing facilities, ice edge, installations on the seabed and planned and ongoing seismic activity is now distributed to Olex and MaxSea chartplotters. The MAREANO program is in dialogue with FiskInfo to have the most relevant products for fishermen distributed through this service. The most relevant products from MAREANO have been identified to be seabed terrain and sediment maps, and maps of corals and vulnerable habitats.

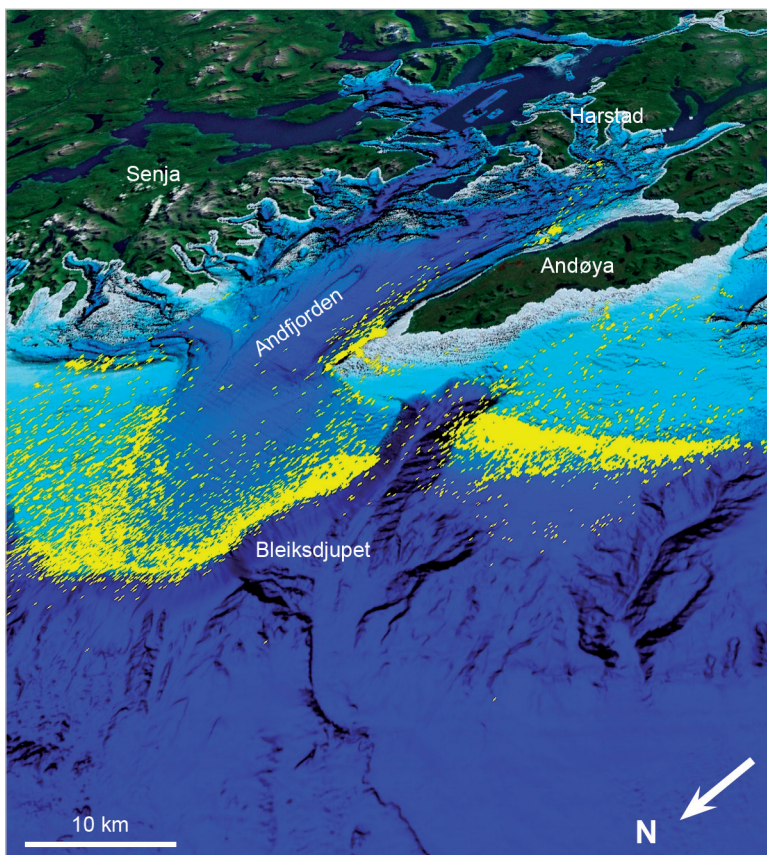
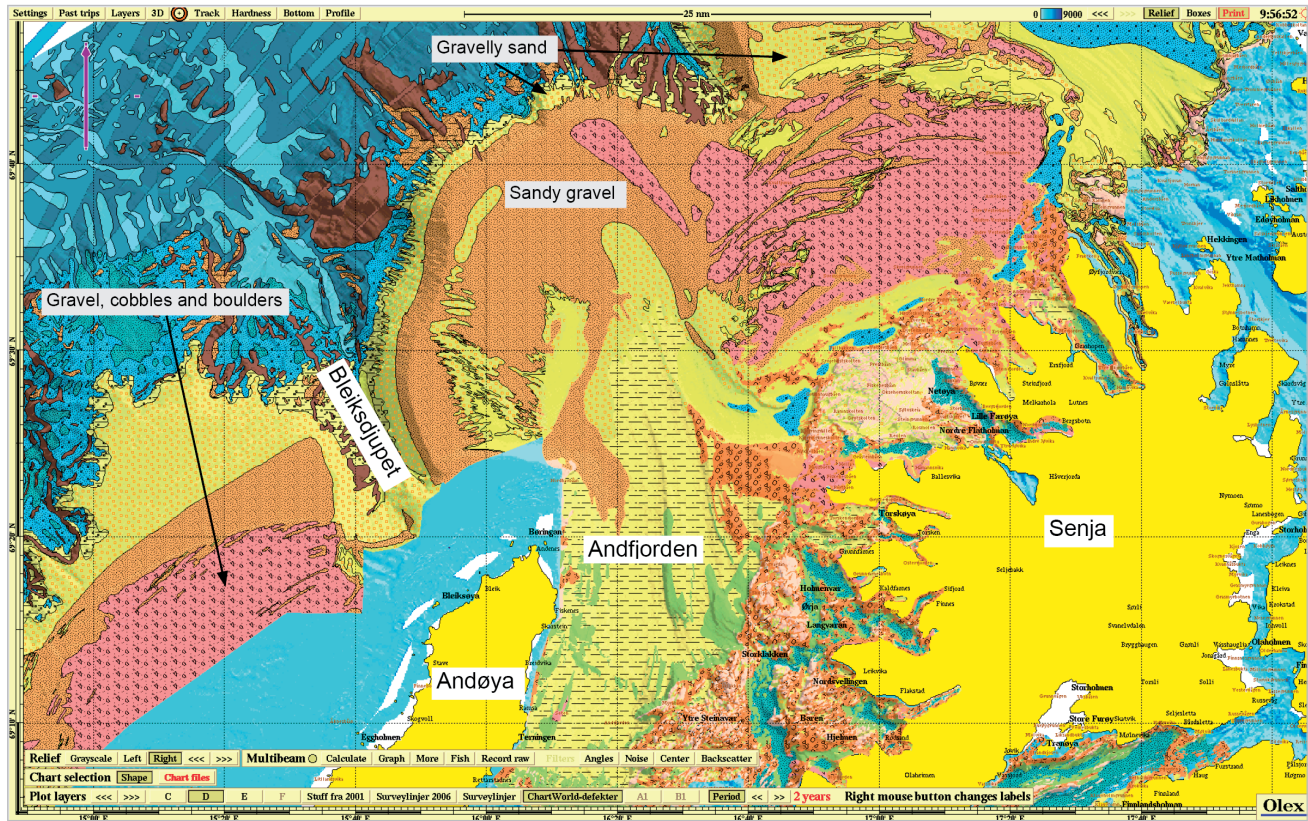


Figure 7. 3D map of the seabed off Andøya, with tracking data from fishing vessels over 24 metres superimposed. Source tracking data: Directorate of fishery.

Figure 8. Screen dump from the electronic map plotting system OLEX, which is widely used by fishing vessels. The sediment map from MAREANO can now be used during active fishing to locate good fishing sites, and to avoid areas with obstacles.



13.5 THE PETROLEUM INDUSTRY'S NEED FOR GEOGRAPHICAL DATA

The petroleum industry has a great need for data from a wide range of sources, for the purpose of exploration, early field development, environmental risk analysis and more.

Oil and gas companies have struggled to gather and get an overview of all the data available from various government agencies. Consequently, seven operators on the Norwegian continental shelf agreed to develop and establish ArcticWeb (www.arcticweb.com) to simplify access to public data sources. The portal was launched in January 2010.

ArcticWeb offers access to data on the environment, geology, infrastructure, marine activity, meteorology and other information. Knowledge collected by MAREANO is part of the data made accessible via this portal. Information is presented to the users via search and map interfaces.

The portal does not necessarily offer direct access to the data, but provides an overview of what data is available for specific geographical locations and who owns it.

ArcticWeb has several similarities with the portal www.geonorge.no (Norge digitalt, described in chapter 12), with the exception that

ArcticWeb focuses on Norwegian continental shelf and their use by the petroleum industry. However, the portal may still be of use to other stakeholders operating in the marine zone.

The portal covers the entire Norwegian continental shelf but the long-term goal is to cover the whole Arctic region.

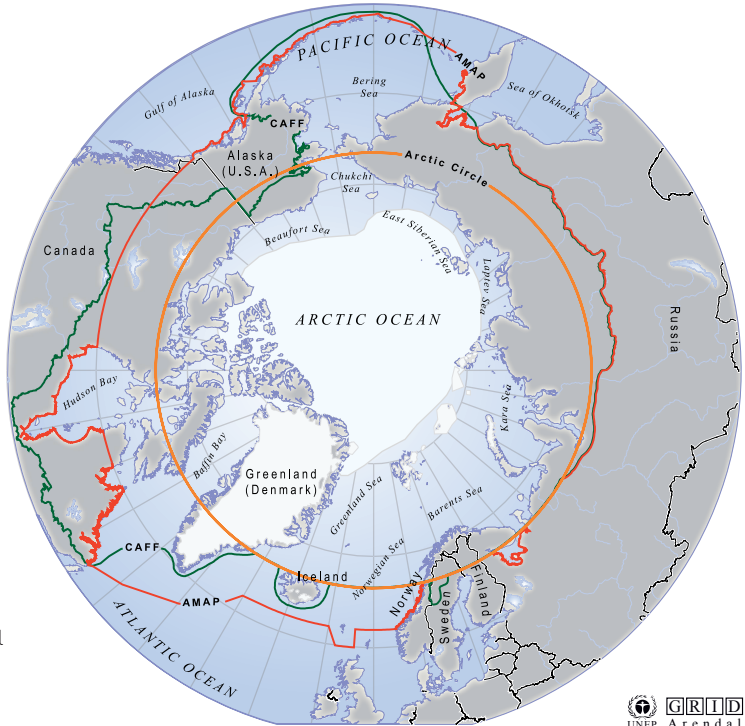


Figure 9. Areas that ArcticWeb plan to cover in the long run; 'AMAP area' (inside the red line) that is defined by the Arctic Council [Graphics from: Hugo Ahlenius, UNEP/GRID-Arendal, www.grida.no]