20. Integrated ecosystem-based management of the Barents Sea – Lofoten area

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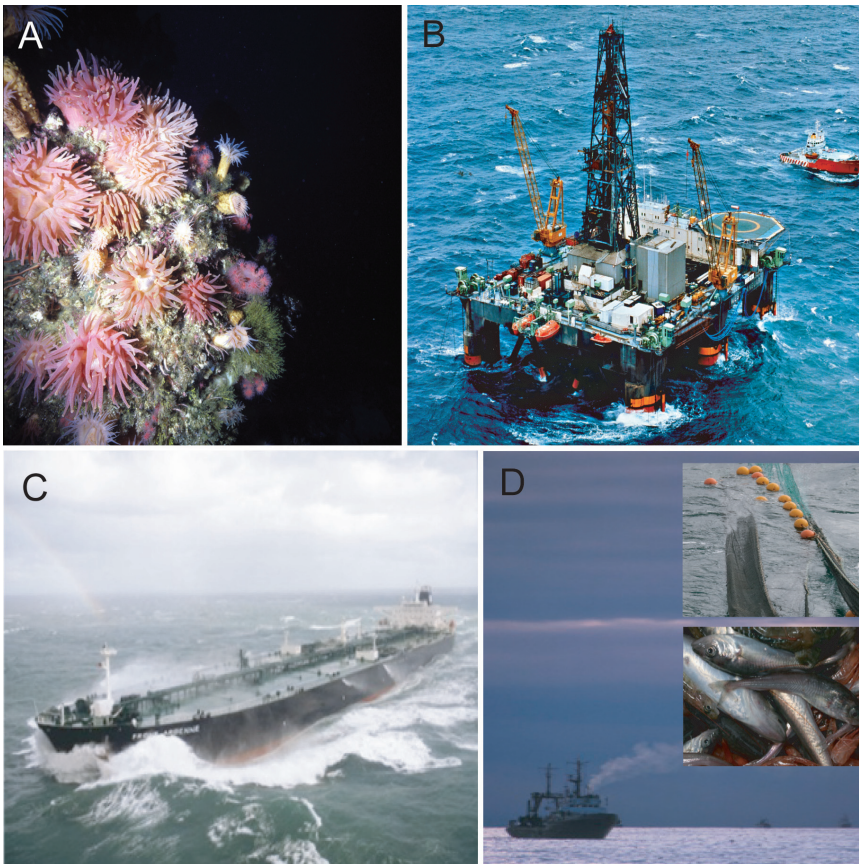
Management of the marine environment has developed greatly during the 20th century. Many destructive practices, such as dumping toxic waste, have been stopped or limited. Norway manages the Barents Sea–Lofoten area within the framework of international law, including the international conventions to which Norway is a party. There are common national goals, but also clear division of responsibility between different authorities (sectors). For example, the Ministry of the Environ-



The purpose of the Barents Sea Management Plan is to provide a framework for the sustainable use of natural resources and goods derived from the Barents Sea–Lofoten area, while maintaining the structure, function and productivity of the ecosystems in the area.
A. Hard bottom benthos includes many slow-growing organisms which are sensitive to human activity.
B. Oil drilling activity in arctic areas presents many challenges, sea-ice and winter darkness, for example.
C. Transport of oil in the Barents Sea requires vessels with ice-strengthened hulls and good navigation skills.
D. During 1987 up to 50 Russian fish-trawlers (large picture) were trawling simultaneously for Atlantic cod at the Bjørnøya fishing bank for several weeks.
Photos: Bjørn Gulliksen (A), Diamond Offshore Drilling LTD (B), Frontline (C) and Geir Johnsen (D).

ment has the main responsibility for national goals, management systems and performance monitoring in the field of environmental policy, the Ministry of Fisheries and Coastal Affairs is responsible for the management of living marine resources and for Government policy regarding the fishing industry, the aquaculture industry, seafood safety, fish health and welfare, maritime safety, maritime transport and the emergency response system for acute pollution and the Ministry of Petroleum and Energy is responsible for the management of Norway's petroleum resources. In the last two decades attention has shifted from single-sector rules and regulation to multisectoral approaches. This integrated mind-set, coupled with a precautionary approach, has led to the development of an Ecosystem Approach to management (EA, see Box 20.1), especially with respect to fisheries activities. The UN has played a key role in EA development – the Johannesburg declaration of 2002 calls for EA management of all marine ecosystems by 2010.

In the inaugural declaration of the Norwegian government that came into power in the autumn of 2001, an ecosystem-based plan for the Barents Sea was promised. The Barents Sea - Lofoten area was (and still is) seen as a promising area for oil/gas development, but it has historically been (and still is) a rich fisheries region. These competing interests dictated that a thorough knowledge-base was needed for the political deliberations as to the future of the area. This, together with a desire by the government to follow UN agreements, was the main driving force(s) for instigating the development of the "Barents Sea Management Plan".

A multi-sector basis for decision making lies at the core of the EA approach, correspondingly the Barents Sea Plan was developed jointly by the Ministries of the Environment, Foreign Affairs, Fisheries and Coastal Affairs, and Petroleum and Energy, with the Ministry of Environment acting as the Secretariat. Analytical work started in 2002, and was carried out by government directorates and institutions under the four Ministries. The plan was presented to Parliament as a government white-paper in March 2005 and was ratified by Parliament in June 2006.

Scope of the plan

The national plan covers the Norwegian Economic Zone and the fisheries protection zone around Svalbard (Figure 20.1); it is limited to the east by the border with Russia, and to the south by the 1 nautical mile offshore border. The area included in the plan extends south-west to include the Lofoten area, and west past the continental shelf break. (Areas closer than 1 n.m. to shore are managed according to the EU Water Management Directive.) Within the area of the plan, foundations for integrated management of all human activities are to be constructed in order to ensure the continued health and safety of the entire marine ecosystem and the human communities dependent on it.

The plan was set in place in 2006. It will be regularly revised to take into account new knowledge and changing situations. Thus, regulations in the plan are flexible to the extent that it is expected that they will be revised as new and better knowledge becomes available, or when physical changes to the environment necessitate change.

Satisfactory management of the Barents Sea will also involve close international cooperation, particularly between Norway and Russia. The management plan described here ap-

plies to Norwegian waters and not to the entire Barents Sea. Internationally, the Barents Sea has been identified as a Large Marine Ecosystem (LME). The Government of Norway will therefore seek close cooperation with Russia to ensure an integrated management regime for the entire Barents Sea. The plan includes proposals for strengthening cooperation between Norway and Russia, particularly through the new Norwegian-Russian working group on the marine environment which is operating under the Joint Norwegian-Russian Commission on Environmental Protection.

Development of the Plan

The plan was developed through a broad, multi-faceted process involving a host of government directorates and institutions, with the Institute of Marine Research and the Norwegian Polar Institute leading several of the assessments and analyses. Figure 20.3 gives a brief overview of the process

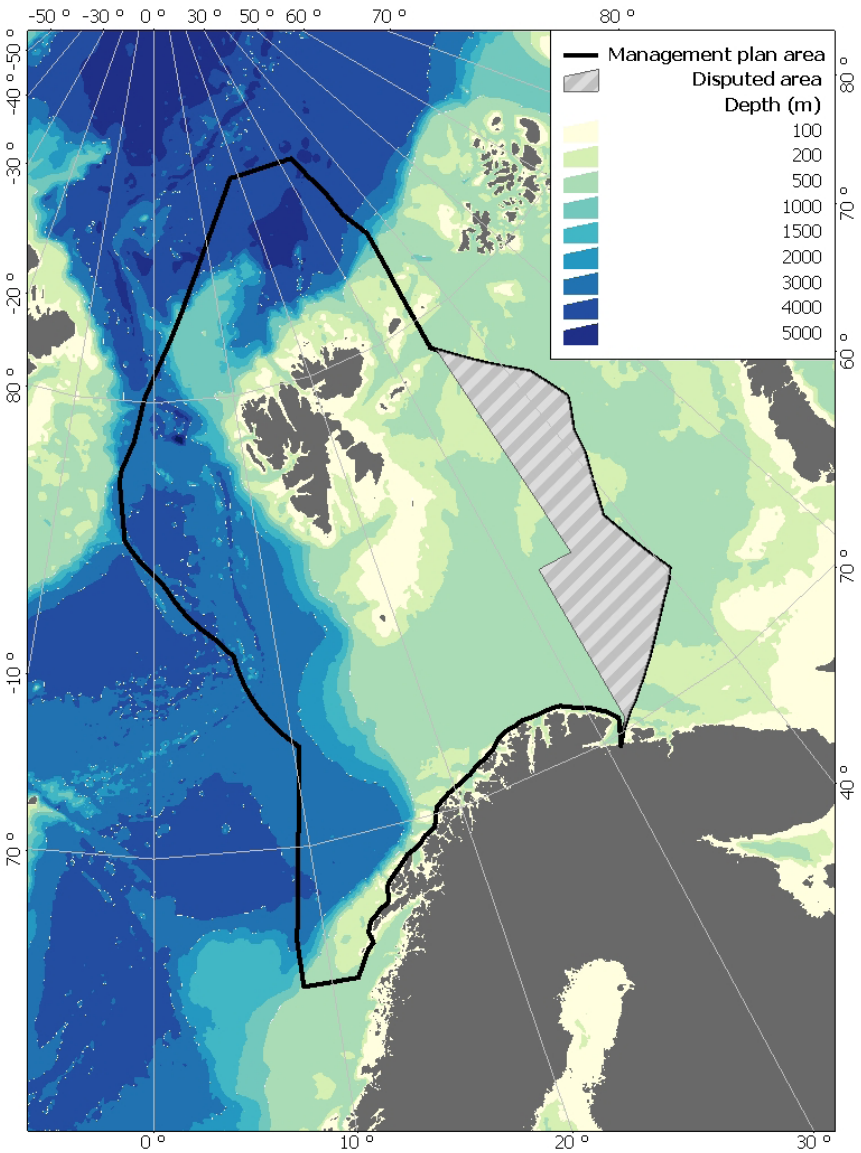


Figure 20.1.
The geographic area for the Norwegian Barents Sea Management Plan (limits marked by the black line) and an area of internationally overlapping claims (grey hatched).

involved in the development of the plan. A key challenge faced throughout the plan's development was to achieve truly integrated cooperation across sector-barriers at both the ministerial level and the level of directorates and institutions. Success also depended on having input from interested user groups regarding how specific sectors were to be managed, or how assessments of impacts on that sector were going to be made in relation to the well-being of the ecosystem. This was a very difficult process that required a considerable amount of time, but in the end it succeeded, and cooperation was achieved between the participating ministries, directorates, institutes and interested parties.

Ratification of the Plan

New aims

The management plan provides a foundation for co-existence between industries as well as measures for addressing the main challenges related to pollution and the maintenance of biodiversity (Box 20.2). However, ecosystem-based management calls for cooperation across sectors, with respect to monitoring, mapping and research. Three permanent working groups have been established to facilitate action on the Management Plan: 1) an advisory group to assist in coordination of the system proposed by the Government of Norway for monitoring the state of the environment; 2) a forum on environmental risk management that will focus on acute pollution in the area, which will provide input to environmental risk assessments; and 3) a management forum, which is responsible for the coordination and overall implementation of scientific aspects of ecosystem-based management.

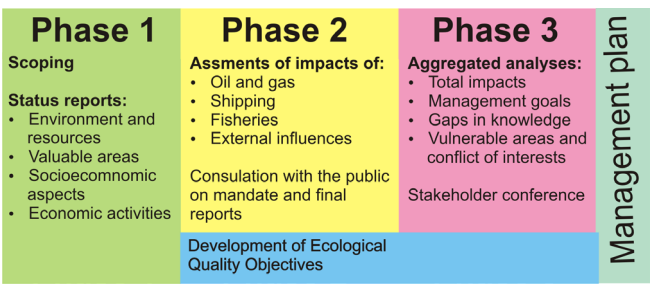


Figure 20.2. Development of the management plan from 2002 to 2006. The work was led jointly by four Ministries, while the analyses and assessments were carried out by Government Directorates and institutes.

The different groups have a broad membership, with representatives from the relevant governmental institutions with responsibility for, and expertise in, the various sectors. But, the groups also draw on expertise from other sources as necessary. The groups report to the Barents Sea Management Plan Steering Group headed by the Ministry of Environment, in which all relevant Ministries are members. In order to make sure that that the various business, industry, environmental organizations and native peoples groups (Sami) have input to the implementation of the plan, a Reference Group has been established. This group will help ensure "transparency" in all activities linked to the management system.

New knowledge needed

Large and challenging knowledge gaps need to be filled to enable the design and long-term implementation of scientifically sound and adequate monitoring of essential elements of the Barents Sea ecosystem (Figure 20.3). An important part of the management plan process has been to identify these gaps and to give priority to them according to a defined set of criteria.

Knowledge gaps were grouped into three categories, monitoring, research and mapping needs, and they were also classified as existing or new activities. Some of the prioritised gaps regarding monitoring activities were: (geophysics) horizontal distribution of Atlantic and Arctic water masses; (biology/ecology) an introduced/alien species registration system, time trends in population estimates of key stone

species and temporal variation in diet composition of important species, bottom fauna and habitats; and establishing long-term monitoring of pollutants in biota and the environment. Some research priorities were also highlighted in the plan. In the field of geophysics/climate- identification of good quality climate indicators, establishment and maintenance of long time series, and the integration and development of surface satellite data for monitoring of environmental status were seen as top priorities. Top priority ecological studies for the Barents Sea area include studies of primary production, energy transfer and trophic ecology in plankton, ice flora and fauna at all trophic levels, development of indicators for non-commercial fish species of key ecological importance and estimation of critical threshold values for herring biomass. Additionally research is clearly also required regarding the impacts of IUU-fishing, and the effects of pollutants in arctic ecosystems. Mapping "gaps" were also identified in the plan. For climate assessment work, it is important that the HINDCAST historical weather archive be updated on a finer geographic scale. Sea bottom data (topography, sediment quality, flora and fauna) and mapping of migration patterns of important populations and species would enhance our knowledge base for the Barents Sea area. Mapping of species in ballast water and on ship hulls is required to develop a target list for potential species introductions. Better mapping of human activities, including documentation using remote sensing methods (for example ship traffic), would also be a major step forward.

All the identified gaps were discussed at a public meeting in Tromsø in May 2005. It was pointed out that it would be important to find good procedures for handling scientific uncertainty and that development of improved and more robust monitoring methodology would be vital in light of a probable long-term scenario with limited

Figure 20.3.
The Barents Sea is a productive ecosystem. Its primary production supports zooplankton, which in turn is grazed by other species further up the food chain. There is a need for better knowledge about energy flow and interactions between species if we are to develop a sound management regime.
Photo: Nils Øien.

resources available. The identified knowledge gaps are diverse and complex, and during the process there was a unanimous call for the development and implementation of good procedures for how the management process will identify new knowledge gaps and how these should be included, given priority and finally filled.

Area-based management

For areas identified as particularly valuable and vulnerable, special caution will be required and special considerations will apply to the assessments of standards for, and restrictions on, activities (Box 20.3). In these areas activities should be conducted in such a way that all ecological functions and biodiversity are maintained i.e. the structure, productivity and dynamics of the system not threatened. In addition, a network of marine protected areas will be established in Norwegian waters from the south to the north end of the Plan's area, before 2012, in order to maintain biodiversity and keep certain areas more or less undisturbed to facilitate research and monitoring. A plan for marine protected areas has been drawn up, but the final selection of areas must still be decided by the Ministry of the Environment, in cooperation with the Ministries of Fisheries and Coastal Affairs, Trade and Industry, and Petroleum and Energy. The Nature Conservation Act provides the legal basis for permanent and general protection of areas against all activities that have an impact on the environment and natural resources.

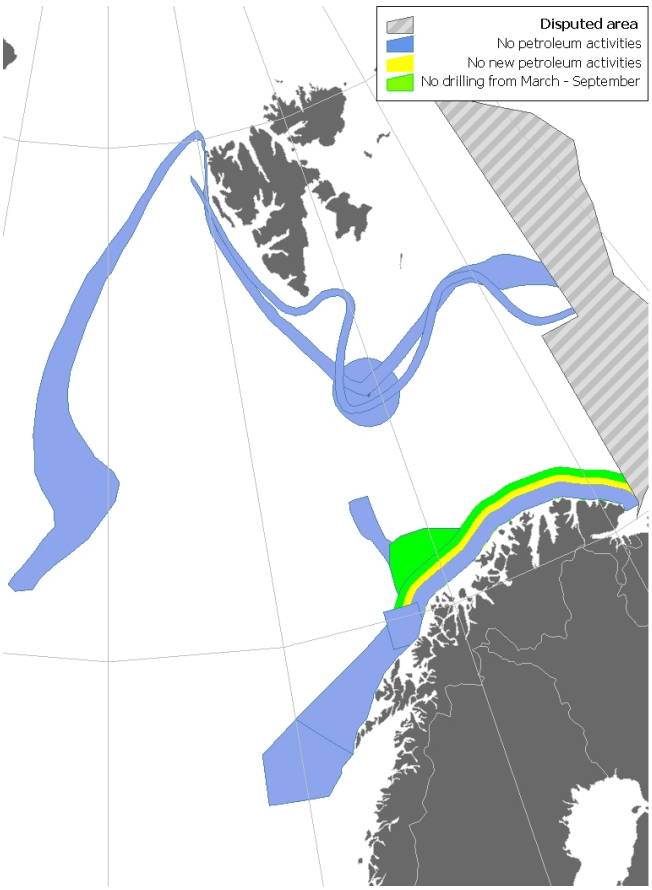


Figure 20.4. Framework for petroleum activities in the Barents Sea - Lofoten area for the period 2006-2010.

An example of area-based management which has been established is the framework for petroleum activities based on an evaluation of particularly valuable and vulnerable areas and an assessment of the risk of acute oil pollution (see Figure 20.4). In some areas no petroleum activity will be permitted at all, while in others areas no new activity will be permitted. In some areas seasonal restrictions will be applied (such as closure between 1 March and 31 August). Based on new knowledge gained through research, monitoring and other ongoing activities this framework will be re-evaluated every time the management plan is updated.

Another example of a geographically-based management regime is the mandatory routing and traffic separation scheme for maritime transport, which restricts ship traffic to an area about 30 nautical miles from the coast in order to reduce the risk of acute oil pollution from ships. This is still close enough to be within the coverage area of a special system for traffic surveillance and control (the Coastal Administration's AIS

system), but at the same time it is far enough out to allow a certain amount of response time in case of an oil spill. Fishery and petroleum activities can occur within the area covered by the routing and traffic scheme, but special rules for these activities will be drawn up for these areas of overlap.

A third example involving area-based management is temporary or permanent closure of areas to certain types of fishing gear, motivated by a particular type of benthic community, underwater cultural heritage, or unwanted changes in commercial fish stock sizes and the size and age structure of these stocks etc. Two marine protected areas have been established within this framework, under fisheries legislation, in order to protect coral reefs from damage caused by bottom trawling in the Barents Sea – Lofoten Area.

Species management

Norway has signed a number of agreements and conventions on species protection and management, e.g. the Convention on Biological Diversity (CBD), the Convention on Trade in Endangered Species of Wild Animals (CITES), the Convention on the Conservation of Migratory Species of Wild Animals (CMS), the Agreement governing the North Atlantic Marine Mammal Commission (NAMMCO), the Agreement on the Conservation of Polar Bears and their Habitats. The Government of Norway has established a set of objectives for species management in the Barents Sea - Lofoten area that fit with the obligations in these various agreements. These species objectives are listed in the white paper on the management plan (Report No. 8 (2005-2006) to the Parliament). They include: naturally occurring species will exist in viable populations and genetic diversity will be maintained; harvested species will be managed within safe biological limits so that their spawning stocks have good reproductive capacity; species that are essential to the structure, functioning, productivity and dynamics of ecosystems will be managed in such a way that they are able to maintain their role as key species in the ecosystem concerned; populations of endangered and vulnerable species and species for which Norway has a special responsibility will be maintained or restored to viable levels and unintentional negative pressures on such species as a result of activity in the Barents Sea - Lofoten area will be reduced as much as possible by 2010. Additionally, the introduction of alien species through human activity will be avoided. These objectives will only be achievable if several ministries, directorates, research institutions, and industry work together.

Sector-based actions

Even though the management plan has been agreed upon across the different sectors, there is a sectoral responsibility for increasing knowledge about effects (and how to reduce these) of different pressures on the Barents Sea ecosystem. Additionally, there are implementation and enforcement issues regarding the regulations and laws, including time limitation, volume limitation, equipment restrictions and other demands upon fisheries technology. Some examples are described below.

Fisheries have substantially impacts on the ecosystem in the Barents Sea. The fishery authorities' responsibility is to continue to develop an ecosystem-based management regime for harvesting biological production, bring down the considerable illegal, unreported and unregulated fishing (IUU fishing), rebuild fish stocks that have been severely depleted, increase general knowledge regarding the distribution and ecology of relevant species, reduce

by-catches and damage to benthic communities by fishing gear, develop selective fishing gear such as sorting grids etc. In Norway, the Institute of Marine Research (IMR), and the Directorate for Fisheries are the most important advisors for the Minister of Fisheries. The aim of research and management advice provided by IMR is to ensure that Norway's marine resources are harvested in a sustainable way. The activities of the Directorate for Fisheries includes implementing political decisions, processing applications and appeals and conducting monitoring and control of fishing activities. The Norwegian Coastguard carries out inspections of fishing vessels.

Comprehensive legislation and control and enforcement procedures ensure that the impacts of petroleum, as well as any other industries, activities on the environment are dealt with satisfactorily. Several authorities are involved including: the Ministry of Petroleum and Energy (process plans for development and operation of a field, plans for installation and operation, and plans for decommissioning, issue production licences etc.); the Norwegian Pollution Control Authority (issue guidelines for environmental monitoring); the Norwegian Petroleum Directorate (issue drilling permits, coordinate approval procedures); Petroleum Safety Norway; the Norwegian Board of Health, etc. The last three actors in this list above have to approve the health, safety and environmental aspects of all petroleum-related activities. The decision to open an area for petroleum activity is made by Parliament, which may also be involved at later steps in the process, depending on the size of the project. The Petroleum Act and international law provide premises for decisions at all stages of petroleum operations. This includes the requirement for analyses of impacts on other activities and environmental impact assessments which are distributed broadly for public comment.

Maritime transport is, to a large extent, regulated by international laws, which function as a framework for how Norway can regulate maritime transport within Norwegian waters. The International Maritime Organization (IMO) has adopted a number of global conventions to protect the marine environment from negative impacts of marine transport and to ensure safe and efficient transport, e.g. the International Convention for the Safety of Life at Sea (SOLAS), the International Convention for the Prevention of Pollution from Ships (MARPOL), the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), etc. More specifically these conventions deal with various forms of certification as well as oil pollution damage, harmful anti-fouling systems, ships ballast water and sediment, transport of hazardous and noxious substances etc. The Coastal Administration has operational responsibility for governmental emergency response systems for acute pollution as well as the responsibility for ensuring that damage-reducing measures implemented by other bodies are adequate. The Norwegian Maritime Directorate acts as an advisor to the Coastal Administration on acute pollution together with an advisory group consisting of members with environmental, fisheries and marine-engineering expertise set up under the leadership of the Coastal Administration. The Norwegian Maritime Directorate is also responsible for ensuring compliance with regulations and standards for ships.

Ecosystem indicators

Appropriate management must include a means to evaluate the state of the

ecosystem, i.e. ecological quality, at any given time. In order to do so in the Barents Sea region a set of indicators have been identified (EcoQs; Figure 20.5). An indicator is a variable that provides specific information about a particular part of the ecosystem. Indicators will be used to assess to what degree management goals have been reached and whether trends in the ecosystem are favourable. Relevance to ecosystem management, relevance in relation to Norway's international obligations, feasibility in practice, and the "role" of a given species/parameter in the ecosystem were some of the criteria used in the selection of criteria. The indicators can be grouped into those that reveal something about the physical state of the water bodies in the Barents Sea and the production of phytoplankton and zooplankton, indicators for components of the ecosystem that live on this production, for example indicators for benthic fauna and benthic habitats, fish stocks and fisheries, seals and whales, and seabirds, but also indictors for vulnerable, endangered and introduced species as well as indicators for pollution levels. A satisfactory evaluation of the condition of a parameter for management decisions is only possible when indicators are combined with background information, such as distributions maps for various species, information about ecology etc. One challenge in monitoring impacts of various activities/environmental changes etc. is to distinguish between the effects of human activity and natural fluctuations in the ecosystem. For some of the indicators reference values have been established, as well as action threshold at which new measures should be considered to return balance to the system. Reference values correspond to the ecological quality expected in a similar, but more or less undisturbed ecosystem, adjusted for natural variation and development trends. Precautionary reference values are used for harvestable stocks. The action threshold is the point at which a change in an indicator (in relation to the reference value) is so great that new measures must be considered to halt negative trends in the parameter indicator values. Based on the chosen indicators, a monitoring system has been established. The management plan emphasizes that the system must be dynamic so that is can be updated in the light of new knowledge in a timely manner. Furthermore, additional ongoing monitoring in the Barents Sea will also be used in the evaluation of the state of the ecosystem.

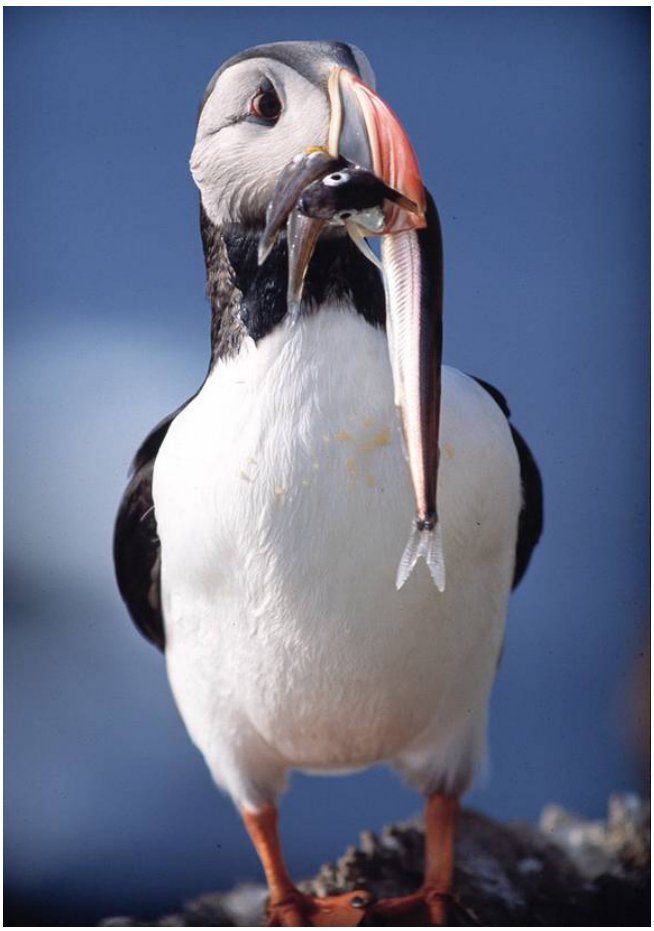


Figure 20.5. The Atlantic puffin (*Fratercula arctica*) is an indicator of the availability of small pelagic fish. Photo: Rob Barrett.

The plan calls for yearly reports on the state of the ecosystem in order to

achieve the aim of ensuring the health of the ecosystem. An Advisory Group on Monitoring of the Barents Sea has been appointed by the Norwegian Government to commence this ongoing task. The group is lead by the Institute of Marine Research in Bergen and is comprised of all parties currently conducting monitoring activities in the Barents Sea in order to achieve an integrated and coordinated monitoring effort, and to cooperate in annual reporting on the state of the ecosystem. The new ecological quality objectives will be assessed and reported by this group.

Risk evaluation

There will always be risk connected to petroleum activities and maritime transport in the Barents Sea. Maritime transport contributes considerably more to the overall risk of acute oil pollution than the industrial activities extracting oil and gas in the management plan area. However, in spite of an expected increase in the volume of maritime transport by 2020, implementation of measures such as minimum sailing distance from the coast, traffic separation schemes and vessel traffic service centres are expected to reduce the risk of oil spills associated with maritime transport by half from 2003 to 2020.

Based on risk identification and understanding possible accident scenarios and their consequences, appropriate emergency response systems can be put in place. Based on an evaluation of whether there is an adequate basis for decision-making or not, possible actions to reduce uncertainty etc., risk-based decisions are taken. Models and risk analysis are being used as tools to estimate risk. These models focus on different aspects of risk, e.g. the probability of accidental discharges, the probability of oil contamination, the risk of damage and the risk of potential damage-related costs. However, it is important to be aware of the pros, cons and limitations of these tools. Risk will also change over time due to: Changes in the volume of ship traffic; measures being put into place; lessons learned from accidents; new technology etc.

Updating the management plan

A follow-up system will be established for the management plan to ensure that it is up-dated as needed, e.g. in the light of new findings emerging through monitoring and research. Updating is necessary on a regular basis. The permanent working groups will give advice and produce annual reports which will be used for this purpose. By 2009, a status report compiling all of the results obtained through research, monitoring, surveys and other scientific activities relevant to the goals of the management plan will be produced; this process will be repeated at regular intervals after this time. There will be a preliminary update of the plan in 2010, and a more thorough update of the whole management plan in 2020 with a time frame up to 2040.

Regional cooperation

Norway and Russia have shared stewardship and responsibility of the Barents Sea for an extended period. In order for the Norwegian plan to be effective, agreement with Russia must be reached on ecosystem-based management for the whole Barents Sea. Both countries have an implicit interest in cooperation regarding management, and have co-operated successfully for the past 50 years within the fisheries sector. Other sectors have followed up on this success, and recent developments within at the Joint Fisheries and Joint Environmental Commission meetings show that cooperation on ecosystem-based management is becoming a reality.

Norway is a member of the International Council for the Exploration of the Sea (ICES), which provides scientific advice on the state of and outlook for fish stocks. Annual negotiations regarding total allowable catches are based on recommendations from ICES. Since 1957 there has been formal research cooperation between Norway and Russia, including coordination of research cruises and joint ecosystem surveys as well as co-operation regarding practical aspects of management and enforcement issues. Fish stocks are harvested within, as well as outside, Norwegian and Russian jurisdiction within the Barents Sea region. The North East Atlantic Fisheries Commission (NEAFC) has the primary responsibility for coordinating the regulation of fisheries for stocks that migrate between different countries' exclusive economic zones and stocks that occupy international waters. One measure implemented by NEAFC is a comprehensive system for satellite tracking of fishing vessels in the Northeast Atlantic.

International comparisons

The UN Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992, marked a step towards a new view of the need for precautionary approaches and a more ecosystem-based management regime for resources – in a larger international context. The Biodiversity Convention[1] (1992) was a result of that meeting, and several other conventions and agreements followed in the next few years, including the UN Agreement on fishing in the open sea[2] (1995), which is based on the United Nations Convention on the Law of the Sea (UNCLOS; 1982) and the FAO Code of Conduct for Responsible Fisheries (1995).

Many countries and international organizations are now making an effort to achieve an ecosystem-based approach to management. A common denominator is the importance of ecological quality objectives accompanied by a set of indicators, regional management plans, and broad participation. However, the integrated management of resources and activities in the different countries' waters is still being developed and a good deal remains to be done before a more ecosystem-based approach will become general practice. Norway, Canada and Australia have probably made the most progress with respect to developing regional management plans as part of integrated ecosystem-based management efforts.

The EU has ecosystem-based management as its goal for European Waters. The requirement for the European Commission to develop a marine strategy is founded in the EU's Sixth Environment Programme which was adopted in 2002. The European Commission has submitted a Communication to the Council and the European Parliament. Four working groups have been set up for the purpose of preparing a basis for the strategy. Eleven ecoregions have been recognized within the EU, one of which is the Barents Sea. Ecological objectives are to be developed for all areas. The Barents Sea Ecoregion also coincides with one of 64 "Large Marine Ecosystems" (LME[3, 4]), defined in several international and national programs, whose goals are sustainable use of resources and preservation of the environment. ICES and OSPAR (The Oslo-Paris Convention for the Protection of the Marine Environment of the North East Atlantic) employ different divisions of the region; ICES employs several sub-areas to cover

[1] The Convention on Biological Diversity (CBD)
[2] Agreement for the implementation of provisions of the UNCLOS (UNFA)
[3] Large Marine Ecosystems (LME) (http://www.fao.org/figis/servlet/topic?fid=3440)
[4] http://www.seaaroundus.org/gislme/map/viewer.htm

what the EU has defined as the Barents Sea ecoregion and OSPAR regards it as part of a larger area.

Management activities focussed on the North Sea, performed through various Norwegian ministerial conferences, have been valuable for promoting an ecosystem approach to management; they have been formulating ecological quality objectives for quite a long time. The OSPAR Commission, made up of representatives from 15 nations and the European Commission, following guidelines given in Declarations and Statements from Ministerial Conferences, administers the OSPAR Convention. The OSPAR Commission relies on an ecosystem approach with respect to the management of human activities.

The EU Water Framework Directive is intended to ensure the overall management of water within one nautical mile of the coast of individual nations. The basic principle of this Directive is that fresh water, coastal water and groundwater must be of good quality. By 2015, the amount of water and the physical state of the water, i.e. the chemical and biological conditions of the water body, must not deviate too much from conditions that would have existed if the water body had not been affected by human activities. The EEA agreement obliges Norway to introduce this Directive nationally.

In 1997, Canada adopted the Canadian Oceans Act. This was a turning point towards a more ecosystem-based and integrated management of Canadian waters and entails assessing the effect of every activity in the entire ecosystem and not just isolated activities on target species. A number of initiatives have followed this first major step. For example, Canada's Oceans Strategy was published in 2002 and Canada's Ocean Action Plan had an initial phase that ran from 2005 to 2007. A national coordinating body has been set up to ensure the best possible practices for integrated management. An initiative has been established to develop a scientific basis for defining boundaries of ecoregions. An effort is also being made to determine environmental quality standards.

Australia's Oceans Policy, which requires the development of regional management plans for Australian marine waters, was launched in 1998. The South-East Regional Marine Plan, adopted in 2004, was the first step. In addition, reports on the state of the national environment have been published every fifth year since 1996. A set of indicators has been selected to follow the state of the environment, the effects of human activities on the environment and the management of the areas. Moreover, some local areas have special monitoring programmes and plans for preservation. One example is the Great Barrier Reef (UN World Heritage Area).

Antarctic ecosystem-based management (CCAMLR)

As early as 1984, CCAMLR[5] began to plan a programme to monitor selected marine values in the Southern Oceans near Antarctica. Great emphasis is placed on monitoring both the fisheries (the species that are harvested, and harvesting strategies, etc.) and "dependent species" (natural predators of the harvested species). The monitoring activities are based on a voluntary system where relevant members of CCAMLR report monitoring data that is conducted at set sites, using standard methodologies, to the Secretariat. The WG-EMM[6] assesses the results annually.

[5] The Commission for the Conservation of Antarctic Marine Living Resources
[6] Working Group on Ecosystem Monitoring and Management

Box 20.1. What is ecosystem-based management?

The concept of "ecosystem-based management" (EBM) has become very popular among politicians and managers, but there still seems to be no generally accepted definition of the concept. One representative definition, from the west coast of Canada, is:

…an adaptive approach to managing human activities that seeks to ensure the coexistence of healthy, fully functioning ecosystems and human communities. The intent is to maintain those spatial and temporal characteristics of ecosystems such that component species and ecological processes can be sustained, and human wellbeing supported and improved.[7]

Sustainable use and human wellbeing are frequently used arguments for EBM, and EBM is clearly a management concept, not a scientific concept. It is also clear from this definition and others that EBM means management of human activities in the ecosystem, not management of the whole ecosystem. Knowledge about ecosystem functions and about the extent of human activities and influences is critical to good management, and scientific data about changes in the different components of the ecosystem is essential for any functional management plan.

Ideally EBM should take into account, at least, the following elements:

- long-term changes and short term fluctuations in the physical parts of the ecosystem (climate)
- changes in primary and secondary production
- changes in the abundance and composition of harvested populations
- effects of harvesting on dependent populations
- by-catches and other effects of harvesting on non-targeted populations and on the physical environment
- effects of local and long-distance pollution on ecosystem components and on the useability of products harvested
- dependence of local human communities on harvesting and other services from the ecosystem
- existing harvesting practices
- existing and future human uses of the ecosystem (e.g. fisheries, tourism, shipping, petroleum) and the related direct and cumulative effects
- existing legal systems and management practice regulating human activities in the ecosystems
- national and international jurisdictions
- availability of information

In practice, EBM will have to be adapted in different ways to different ecosystems because: the physical and biological parts of the ecosystems are different; the human activities in the ecosystems are different; existing legal systems and management practices are different; and availability of information is different for various areas.

[7] This definition is included in several agreements in April 2001 between the Province of British Columbia, First Nations governments from the Central and North Coasts and Haida Gwaii, local governments and non-government interests (http://www.citbc.org/ebm.html).

Box 20.2. Human impacts today and in the future

Traditionally, the primary users of the northern seas, including the Barents Sea, have been the fishing and maritime transport industries. However, this situation is changing radically (Box 20.2 Figure 1). There is growing activity in new fields such as oil and gas extraction, transport of oil – mainly from Russia – cruise traffic along the coast and around Svalbard, and marine bioprospecting. Such activities must be regulated and coordinated with more traditional activities, and a balance must be struck between the various interests involved (Box 20.2 Figure 1).

Fisheries

The Barents Sea is one of the world's most important fishing areas. Fishing of Northeast Atlantic cod, Northeast Atlantic haddock, capelin, herring, tusk, ling, wolf-fish, deep-sea red fish and Northeast Atlantic Greenland halibut and shrimp trawling have been carried out in the Barents Sea and Svalbard region for extended periods of time and these fisheries continue today. The largest catches are for Northeast Atlantic cod and capelin, but catch sizes vary. A major problem in managing the Barents Sea fisheries is that fishing quotas are often set at levels that are higher than those recommended by scientists performing the stock assessments. Furthermore, the dimensions of dumping of unprofitable species or size classes (e.g. young cod and haddock) are unknown. Ghost fishing also contributes to unregistered harvest. In addition, some commercial fish species (e.g. Northeast Atlantic Greenland halibut and deep-sea red fish) are taken as by-catch in other fisheries. Over-harvest of various biological resources affects not only those species directly, but also has potentially negative consequences for the ecosystems in which these "resources" are integral parts. In addition benthic communities may be damaged or disturbed by trawls and other demersal gear types. By-catches of seabirds and marine mammals in fishing gear can also be a problem in certain areas and at certain times of year.

Hunting

The minke whale is the only marine mammal species hunted in the management plan area at a commercial level. Some seals (common, grey, bearded and ringed) are harvested at small scales, by local hunters and residents in the settlements of Svalbard and northern Norway. The commercial hunting grounds for harp and hooded seals lie outside the plan area.

Petroleum exploitation

Seismic surveys and exploration drilling for oil and gas began in the Barents Sea-Lofoten area in 1980. Prior to the work beginning on the Management Plan, 65 exploration and appraisal wells had been drilled in the area. Mainly gas has been discovered, but also some oil. There is no year-round petroleum activity in the area, but the gas and condensate field "Snøhvit" north-west of Hammerfest began full-scale production in 2007. The parliamentary paper on the Barents Sea Management Plan summarized the general negative effects the oil and gas industry can have on the environment through operational discharges of chemicals and oil to the sea, mechanical disturbance of the seabed, effects of seismic surveys on fish and marine mammals and emissions of NOx, VOCs and CO2 to air. However, the conclusion was that given the strict standards that apply to petroleum activities in the Barents Sea, discharges to the sea and mechanical disturbances of the seabed are not expected to have significant environmental impacts. That only leaves possible negative effects of larger accidental oil spills. The Barents Sea north of 74° 30' is not open for prospecting operations.

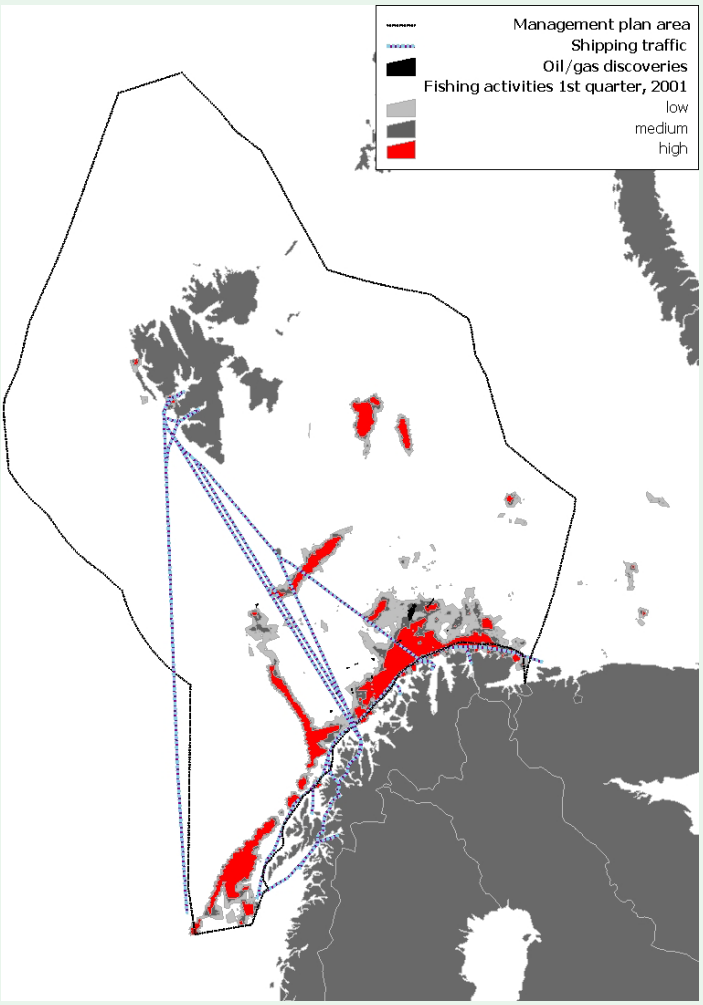


Figure 20.2.1.
Human activities in the Barents Sea - Lofoten region.

Maritime transport

Fishing vessels, tankers and bulk carriers, other cargo vessels and passenger ships, can have adverse impacts on the environment through operational discharges to water and air, releases of pollutants from anti-fouling systems, noise, introduction of alien species via ballast water or life-forms attached to hulls and local discharges from zinc anodes in ballast tanks. In addition, increased maritime transport will increase the risk of accidental spills of oil and chemicals. From 2002 to 2020, it is estimated that the total distance sailed will rise by 27.7% for cargo ships, 22.7% for passenger ships and 9.4% for fishing vessels.

Tourism

Though tourism is likely to have its greatest effects on land, marine systems can also be impacted via effects on important seabird nesting areas, moulting and birthing sites for seals, etc. Cultural remains associated with old marine hunting sites are often located in the same areas targeted today by the marine tourist visitations. According to the office of the Governor of Svalbard, the total number of landing sites outside the settlements and Isfjorden has increased from 56 in 1996 to 168 in 2007 and the number of persons visiting land-sites has increased from about 20 000-25 000 in 1996 to more than 90 000 in 2007.

Other external pressures

In addition to the above mentioned pressures, the environment in the Barents Sea-Lofoten area is also affected by activities from outside the area such as climate change, long-range trans-boundary pollution, pollution originating in neighbouring areas and alien species.

Box 20.3. Valuable and vulnerable areas

In the Barents Sea Management Plan several areas are identified as particularly valuable and vulnerable (Box 20.3 Figure 1). Vulnerability was assessed with respect to specific environmental pressures such as oil pollution, fluctuation in food supply and physical damage within the plan area. When assessing vulnerability, the type of impact and duration of its activity or effects needs to be considered. Differentiating between natural and human-induced pressures on the environment can be difficult. Furthermore, an area is usually not equally vulnerable all year round and all species in an area will not be equally vulnerable towards a specific environmental pressure. Vulnerability can be measured at individual, population, community and ecosystem levels. The most important criteria for selecting vulnerable areas were:

- whether it supports high production and high concentration of species
- whether it includes a large proportion of endangered or vulnerable habitats
- whether it is a key area for species for which Norway has a special responsibility or for endangered or vulnerable species
- whether it supports internationally or nationally important populations of certain species all year round or at specific times of the year

Negative pressures in these areas will in some cases affect a great deal of a population or a great deal of the ecosystem and might persist for many years.

The entire Barents Sea is regarded as productive compared to many other oceans areas, but there can be large temporal and spatial variability. Areas with high primary production are attractive grazing areas for zooplankton which itself is food for species at higher trophic levels, resulting in high concentrations of organisms at some times of the year in some areas. Thus, the number of individuals within an area will influence the assessment of vulnerability with respect to possible oil spills, disturbances due to tourism etc. Species able to escape unfavourable conditions will be least affected. Animals with feathers and hair are more vulnerable to oil spills than whales and adult fish. Furthermore, the more time seabirds spend at sea while seeking food or moulting, the more vulnerable an animal is to oil spills. Diet variability and the degree of specialization of a species is also a significant factor in its vulnerability to a particular perturbation. Most seabird species are top predators, and changes in their behaviour or population dynamics may reflect changes in climate and/or lower levels in the ecosystem. Some fish species are more closely associated with specific environmental factors than others. Key spawning and nursery areas for some species are located in a region that is sensitive to environmental change. Sessile animals will be vulnerable with respect to climate change, pollution and certain types of fishing operations, particularly trawling, which can have direct effects on the seabed, by damaging and disturbing benthic communities, resuspending particles and shifting sediments.

Species that are highly specialized in their requirements (habitat, diet, nursery areas etc.) are more vulnerable than species that are generalists. Some of the endemic arctic animals in the Barents Sea area do have a narrow niche and are likely not very resistance to changes in their environment. Many are ice specialists. Some species such as the bowhead whale have slow life histories (late maturity, extreme longevity etc.) and do not recover easily from over-exploitation or perturbations, as has been showed during the last centuries; they are unlikely to respond well to increased predation rates from killer whales in a warming Arctic either. Management of the Barents Sea must take into account special protective measures for

such species. Thus, life history information; that is, how long they live, when they reach sexually maturity, and their reproductive rate are also useful for assessing vulnerability and designing conservation/protection plans when necessary. Additionally, almost regardless of which species is under consideration, an organism's vulnerability varies in accordance with age. Younger stages of an organism's lifecycle tend to be especially vulnerable. Many physiologically functions, immune functions, neural and enzyme systems etc. are developed during early life-stages. If one wants to protect important areas for individual species it is therefore important to know what represents breeding and birthing/hatching habitats and the habitat requirements of the youngest age classes. Whether a species spend its whole life in an area, or whether it migrates over vast areas also needs to be considered. A species is also often more vulnerable near the limits of its distribution.

Species that are currently low in abundance, declining, limited to a small geographic area etc. might be particularly vulnerable to perturbations from human activities or subject to detrimental effects from other environmental stressors. Species on the Norwegian National Red List (drawn up in accordance with international guidelines issued by the World Conservation Union, IUCN), thus warrant special consideration within the Barents Sea Monitoring Plan. They are already "flagged" as being at risk of extinction at least at the local level.

Special attention must also be paid to "keystone species", which play particularly important roles in ecosystems. The removal of these special pinnacle predators, or trophic-linking species, can seriously affected the whole ecosystem even if they are not particularly numerous, or large in terms of biomass.

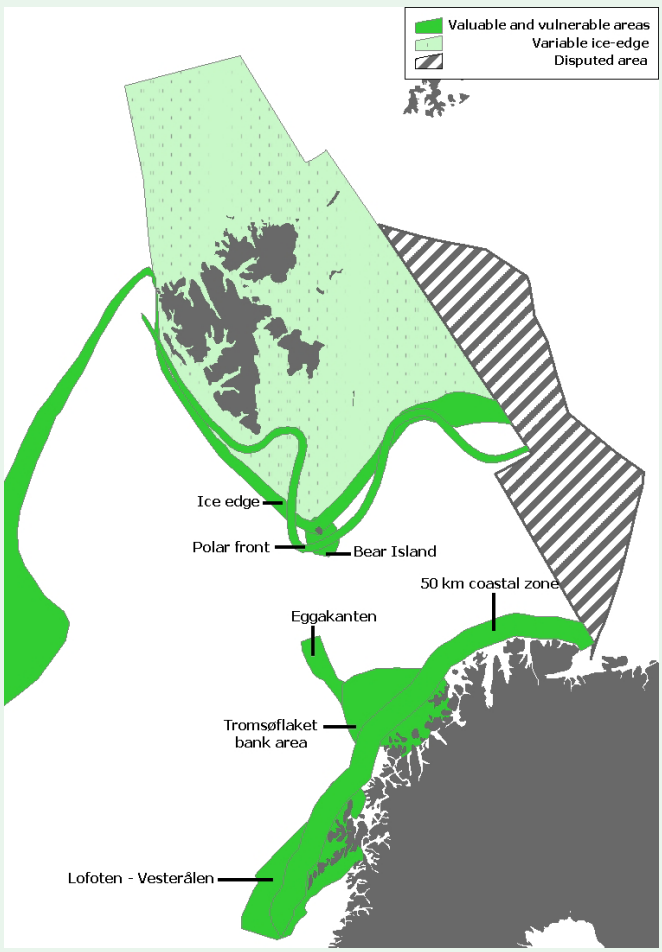


Figure 20.3.1
Particularly valuable and vulnerable areas in the Barents Sea - Lofoten Area.

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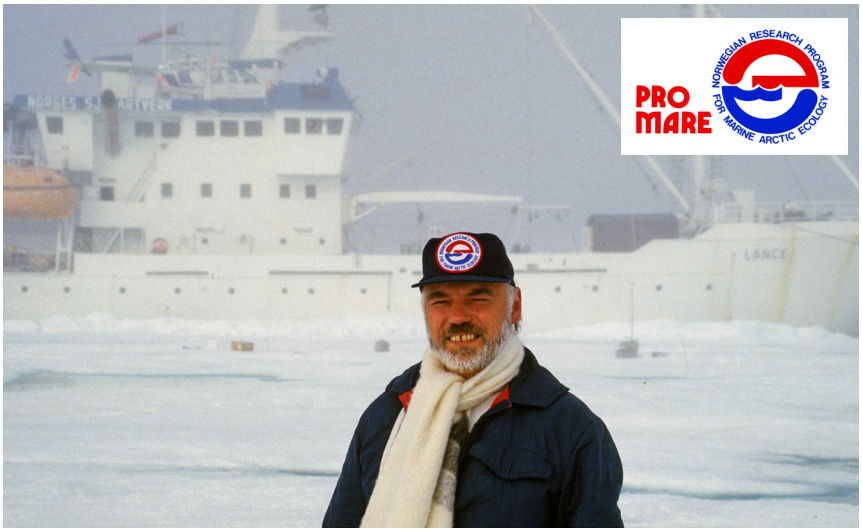

The Norwegian book about Pro Mare results (1991, 1994) was written to inform the public about the pelagic ecosystem within the Barents Sea. Pro Mare was in its time one of the most comprehensive research programmes to have been undertaken in arctic marine ecology. It had three major goals: 1) to increase our understanding of the functioning of arctic marine ecosystems, 2) to carry out long-term ecological research to improve the knowledge base for management of important commercial fish stocks while ensuring the survival of seabird and marine mammal populations and their sustainable exploitation, and 3) educating the next generation of marine polar scientists. The programme was funded by the Norwegian Fisheries Council, the Norwegian Research Council and the Ministry of Environment. Participating institutions including the universities of Bergen, Oslo, Trondheim (now the Norwegian University of Science and Technology) and Tromsø. The Institute of Marine Research and the Norwegian Polar Institute provided additional support. The Norwegian Coast Guard contributed ship time. The name Pro Mare was coined by Roald Sætre at IMR and the logo was designed by Jostein Kirkerud (NTNU) based on an idea by Egil Sakshaug (here photographed by Bjørn Gulliksen in front of "Lance" on her second Pro Mare cruise in 1984).