TECHNICAL REPORT

NORWEGIAN MARITIME DIRECTORATE

EVALUATION OF THE NORWEGIAN PART OF THE BARENTS SEA AND THE NORTHERN PART OF THE NORWEGIAN SEA AS PARTICULAR SENSITIVE SEA AREA (PSSA)

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DET NORSKE VERITAS

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TECHNICAL REPORT

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Approved by: Peter Bjerager Head of Section	Organisational unit: Environmental and Technical Solutions (MONNO 312)
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DET NORSKE VERITAS AS
Maritime Technology and Production Centre
Technical Solutions
Veritasveien 1
1322 Høvik
Norway
Tel: +47 67 57 99 00
Fax: +47 67 57 99 11
http://www.dnv.com
Org. No: NO 945 748 931 MVA

Summary:

The shallow depths and influx of warm Atlantic water from the south and nutrient rich waters from the north makes the ecosystems of the Barents Sea area among the most productive in the world. These marine ecosystems are characterised by simple food webs sustaining large stocks of few key species at each trophic level. These features make the systems dynamically unstable compared to ecosystems with higher biodiversity.

The Norwegian Government aims to protect the Norwegian coast of the Barents Sea and the northern part of the Norwegian Sea against threats to the environment. The pressure on establishing petroleum activities is increasing resulting in increased maritime traffic and potentially increases of risk of environmental impact. Import of nuclear waste to Russia is planned from Western Europe and it is at the moment unclear if this will be transported by sea via Norwegian waters and the Barents Sea. Shipping traffic in the Barents Sea and along the Norwegian coast is expected to increase, resulting in a higher risk of accidents and associated pollution. Further the potential of opening the Northern sea route to Asia represents a potential increase in maritime operations in the area.

As part of the evaluation of protection mechanisms from potential impact from maritime operations, the Norwegian part of the Norwegian Sea and the Barents Sea has been assessed in accordance to the IMO Guidelines for Particularly Sensitive Sea Areas.

The following document holds a description of the environmental resources, maritime activity and risk potential in the area posed by present and future international maritime operations.

Further the report proposes designation of PSSA in the area including a traffic separation scheme as a protective measure.

Report No.: 2004-0226	Subject Group:	
Report title: Evaluation of the Norwegian part of the Barents Sea and the northern part of the Norwegian Sea as Particular Sensitive Sea Area (PSSA)		
Work carried out by: Hanna Lee Behrens, Egil Dragsund, Peter Hoffmann, Stephan Kjellstrøm, Kari Skogen		
Work verified by: Aage Bjørn Andersen		
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Maritime Activity

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1 SUMMARY

1.1. Background

The shallow depths and influx of warm Atlantic water from the south and nutrient rich waters from the north makes the ecosystems of the Barents Sea and the north east part of the Norwegian Sea among the most productive in the world. These marine ecosystems are characterised by large stocks with few key species at each trophic level, making the systems more vulnerable to anthropogenic impact compared to ecosystems in boreal and tropical regions with a higher number of key species.

The Norwegian Government aims to protect the Norwegian coast of the Barents Sea and the northern part of the Norwegian Sea against threats to the environment (/8/). The pressure on establishing petroleum activities is increasing resulting in increased maritime traffic and potentially increases of risk of environmental impact. Import of nuclear waste to Russia is planned from Western Europe and it is at the moment unclear if this will be transported by sea via Norwegian waters and the Barents Sea. Shipping traffic in the Barents Sea and along the Norwegian coast is expected to increase, resulting in a higher risk of accidents and associated pollution. As part of the evaluation of protection mechanisms from potential impact from maritime operations, the Norwegian part of the Norwegian Sea and the Barents Sea has been assessed in accordance to the IMO Guidelines for Particularly Sensitive Sea Areas (Resolution A.927(22)), ref /4/.

The objective of this project has been to evaluate the Norwegian part of the Barents Sea and the northern part of the Norwegian Sea as a Particularly Sensitive Sea Area in accordance with IMOs Guidelines considering available information on environmental issues and maritime activity. The project has also identified protective measures that can be applied to reduce the risk of harm to the environment.

The Assembly resolution A.927(22) adopted on 29th November 2001 (Guidelines for the Designation of Special Areas under MARPOL 73/78 and guidelines for the Identification of Particularly Sensitive Sea Area) (ref /4/) is divided into two parts;

- Annex 1: a new guideline for the Designation of Special Areas under MARPOL 73/78.
- Annex 2: a new guideline for the Identification of Particularly Sensitive Sea Area (PSSA).

A PSSA is an area that needs protection through action by IMO because of its significance for recognized ecological, socio-economic, or scientific reasons and because it may be vulnerable to damage by international shipping activities.

Identification of any PSSA and the adoption of associated protective measures require consideration of three components:

1) the particular environmental conditions of the area to be identified,
2) the vulnerability of such area to damage by international maritime activities, and
3) the availability of associated protective measures within the competence of IMO to address risks from the shipping activities.

Member Governments wishing to have the IMO designate a PSSA should submit an application to the MEPC based on the outlined criteria and proposed associated protective measures. Where two or more Governments have common interest in a particular area, they should formulate a co-ordinated proposal, and the proposal should contain integrated measures and procedures for co-operation between the jurisdictions of the proposing Member Governments.

The work on evaluating the northern Norwegian Sea and the Barents Sea as a PSSA should be seen in connection with the ongoing work on an overall administrative and action plan for the Barents Sea area. This includes assessment of petroleum activities, maritime operations and identification of vulnerable ecological areas.

1.2 Proposed designated PSSA in the Norwegian part of the Barents Sea and the northern part of the Norwegian Sea

The area considered for the purpose of protection as PSSA is the Norwegian part of the northern Norwegian Sea and the Barents Sea as presented in Figure 1.1.

The oceanographic conditions in the Barents Sea and the connecting Norwegian Sea and the ice edge ecosystem are regarded as essential features to the marine ecosystems of the Barents Sea. It is concluded that to a large extent the special characteristics of the Barents Sea and the northern part of the Norwegian Sea meet the criteria for designation of PSSA status according to IMO Res.A.927(22), ref /4/.

Within the Barents Sea, the ice edge ecosystem, with the plankton community is a driving force of the ecosystems. The border of the ice edge however, fluctuates in geographical extension through the year and from year to year. Further the coastlines of Svalbard, Bjørnøya and Norway support populations of seabirds and marine mammals of national and international value. The oceanographic conditions provide feeding areas of marine fish species holding key roles in the ecosystem and having importance as exploitable resources.

Figure 1.2 presents areas in the Barents Sea and the northern part of the Norwegian Sea that have been identified as especially valuable according to defined criteria (/29/).

Based upon general knowledge of the Barents Sea and the northern part of the Norwegian Sea, the area fulfils most of the criteria addressed by IMO for PSSA status. This includes criteria related to ecological, social, cultural, economical, scientific and educational criteria. The maritime activity in the area is at present small compared to other areas. However, due to the vulnerability of the area, maritime operations do pose a relatively high environmental risk. Further the traffic intensity is expected to increase due to increased petroleum activity in the Norwegian sector as well as increased traffic from northern Russia.

Table 1.1 gives a summary of the general fulfilment of the north east Norwegian Sea and the Barents Sea area to the criteria of PSSA status according to IMO resolution A.927(22), ref /4/.

Figure 1.1. Sea areas around Norway. The area assessed for the purpose of PSSA protection is indicated in red hachure.

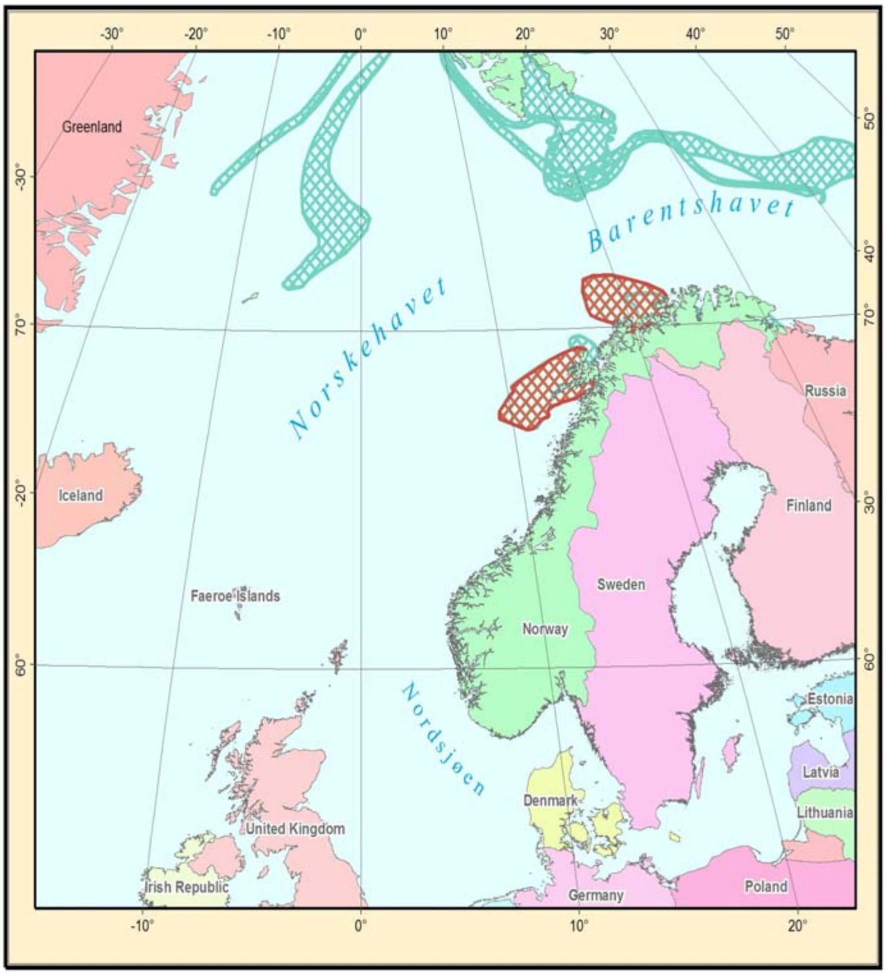


Figure 1.2. Especially valuable areas (green hachured areas) and prioritised valuable areas (red hachured areas) in the Barents Sea and the northern part of the Norwegian Sea. Source: /29/.

Table 1.1 Summary of the fulfilment of the north east part of the Norwegian sea and the Barents Sea area to the criteria of PSSA status according to IMO resolution A.927(22), ref /4/.

Criteria in Res. A. 720(17)	Compliance to criteria
Oceanographical conditions (wrt §5 of Res a.927(22))	The ocean currents increase the risk of damage to the sea from discharges caused by accident or regular operations. Because of the current system in the Barents Sea the discharge will follow the current system along the coast or to the very sensitive area in the north. The ice-edge ecosystem is typical for the Barents Sea, and regarded as very sensitive for impact specifically oil spills. The occurrence of ice is further known to affect the contingency actions. The establishment of continuous and discontinuous gyres between different water masses and over the bank areas within the Barents Sea are features essential to the plankton growth and hence important fish, marine mammals and seabirds living upon planktonic organisms. The northern Barents Sea holds sea ice all through the year. In some years the ice extends far south in the Barents Sea during winter. The connection to the Atlantic water masses in the Norwegian Sea which transports plankton rich water into the Barents Sea is regarded as essential to the plankton ecosystems of this sea
Ecological conditions (wrt §4 of Res a.927(22))	The ecosystems of the Barents Sea are among the most productive in the world due to the shallow areas and influx of warm water from the south and nutrient rich water from the north caused by melting of ice revealing nutrient waters. Fish, seabirds and marine mammals are represented in high numbers within the Barents Sea. The north east part of the Norwegian Sea also poses important spawning areas of ecologically important species. Parts of the Barents Sea is characterised by having the largest areas of near-pristine wilderness in Europe. Most of the marine and substantial parts of the terrestrial ecosystems are intact, with undisturbed habitats and vegetation, and viable, un-harvested populations of fish, birds and mammals. The area are protected or proposed protected at international level due to the existence of vulnerable populations of seabirds and marine mammals. Areas are also protected or proposed protected to preserve relatively pristine ecosystems. Within the Barents Sea there are populations of seabirds, fish and marine mammals feeding upon plankton or plankton feeders, regarded as of international conservation value. Many of these species are given to be vulnerable according to stock sizes. The plankton communities located along the ice edge in the Barents Sea and within gyres over shallow bank areas are crucial for the ecosystem in the area. The ecological features of the Barents Sea and north east Norwegian sea is essential for the ecological features along the coastline representing strong ecological interactions between the sea and the coast. In the Arctic area there is an influx of energy from the sea to the land which maintains and develops the ecosystem on land and islands.
Socio-economic conditions (wrt §4 of Res a.927(22))	The Barents Sea has some of the world's largest fish stocks. More than 50% of all fishermen in Norway live in the northern part of Norway. The

	employment along the coast has always been and is still related to fishery industry. Further growth of aquaculture is also an important basis for the development along the coast in the northern part of Norway. The numerous fishing villages in the area signify the importance of this development, both as cultural-historical documentation and as a natural business activity. Tourism is also very important and increasing and is strongly related to the sea and coastal areas. The environmental resources represented by the sea and the coastal area and the interrelations thereof are major preconditions for the value of the area, economically as well as cultural. Thus, economic growth and exploitation of these resources are critical and may pose a threat to the vulnerable marine environment.
Scientific conditions (wrt §4 of Res a.927(22))	The Barents Sea area is highly valuable as scientific and environmental reference areas and important in climatic processes and indicators of globally important changes (atmosphere-sea-ice-ocean).
Vessel traffic(wrt §5 of Res a.927(22))	Vessel traffic was earlier dominated by fishing vessels with local distribution of bunker oil with small coastal tankers as the most important environmental risk. The traffic is located in near shore areas. However fisheries also occur in the central part of the Barents Sea along the continental edge. Increased Russian export of crude oil and heavy fuel oil has caused a significant growth in tanker traffic the last three years. More than 200 vessels transited the area in 2003. This traffic is expected to increase to more than 600 tankers in 2015 with average size going up from less than 50 000 dwt in 2002 to more than 150 000 dwt. The Russian traffic is located close to the Norwegian coastline and passes through areas with high density of fishing vessels. Export of oil and gas from the Norwegian sector of the Barents Sea and Norwegian Sea will cause a further growth in tanker traffic from 2006. Production scenarios developed by the Ministry for Oil and Energy indicate that between 400 and 700 crude and gas tankers will be involved in this export in 2015. In addition cruise traffic and general cargo is expected to grow by 5- 10 % in the next 10 – 20 years.
Other considerations (wrt §5 of Res a.927(22))	
- Reception facilities	Waste reception facilities are established in major ports of Norway and are reported to provide sufficient facilities for waste reception.
- Influence by other sources	In comparison with most other areas of the world, the Barents Sea remains a "clean" environment. It should be noted though that the Barents Sea is also affected by long distance transport of pollutants causing concern of the environment.
- Implemented management regime	Norway has a thorough and long term policy on marine environmental protection internationally (through ratification of MARPOL annexes, OSPAR, AMAP, the Bonn agreement, the Copenhagen agreement, bilaterally agreements with Russia) as well as nationally. The concern about the Barents Sea area is specifically addressed in the Report to the Storting No. 12 Protecting the Riches of the Seas /8/. The management regime includes extensive development and maintenance of a pollution prevention and contingency regime, routing regime within the territorial waters (12 nm) and establishment of waste reception facilities and implementation of regulation for delivery of waste in port /11/.

Table 1.2 lists criteria met for the proposed designated PSSA. The proposed PSSA (north east Norwegian Sea PSSA) is encompassed by the areas of Tromsøflaket and the area Lofoten – Røstbanken - Vesterålen. The other 2 areas identified as being of high value (the Polar Front and the Ice Edge) is not expected to be impacted by international maritime operations to the same extent and hence they are not part of the proposed PSSA.

The proposed PSSA is presented in Figure 1.3 and is located in the north east part of the Norwegian Sea.

The extension of the proposed designated as a PSSA is given by the area bounded by a line connecting the following geographical positions and the main land of Norway:

1)	Lat: 66° 30'	Long: 13° 0' (eastward extension is the main land of Norway)
2)	Lat: 67° 21'	Long: 8° 56'
3)	Lat: 71° 32'	Long: 17° 41'
4)	Lat: 71° 34'	Long: 20° 41'
5)	Lat: 71° 0'	Long: 24° 0' (eastward extension is the main land of Norway)

A traffic separation scheme is proposed outside the two vulnerable areas of Tromsøflaket and Lofoton – Røst – Vesterålen. The two areas are identified within the buffer zone where the proposed routing is established.

<u>Traffic separation scheme position 1</u>

The routing position 1 is positioned west of the vulnerable area of Lofoten – Røstbanken – Vesterålen but within the buffer zone of the proposed PSSA.

The area is defined by the following positions:

Northern position:	Lat: 067° 25' 09.9134"	Long: 008° 52' 35.2160"
Southern position:	Lat: 067° 22' 12.0457"	Long: 008° 49' 15.5641"

Shortest distance from land is 60 nm

<u>Traffic separation scheme position 2</u>

The routing position 2 is positioned west of the vulnerable area of Tromsøflaket but within the buffer zone of the proposed PSSA.

The area is defined by the following positions:

Eastern position:	Lat: 071° 36' 27.8804"	Long: 017° 46' 37.0912"
Bend:	Lat: 071° 36' 20.8834"	Long: 017° 36' 40.4430"
Southern position:	Lat: 071° 33' 53.3737"	Long: 017° 30' 03.8083"

Shortest distance from land is 80 nm.

An additional traffic separation scheme is proposed 20 nm north of Nordkapp to ensure that the traffic directed to and from the traffic separation regime within the PSSA is undertaken in a safe manner.

Traffic separation scheme position 3

An additional traffic separation scheme is proposed 20 nm north of Nordkapp to ensure that the traffic directed to and from the traffic separation regime within the PSSA is undertaken in a safe manner.

The area is defined by the following positions:

Eastern position:	Lat: 071° 32' 42.1939"	Long: 025° 42' 56.7185"
Western position:	Lat: 071° 32' 53.8656"	Long: 025° 32' 48.8003"

Shortest distance from land is 20 nm.

Table 1.2. IMO Resolution A.927(22) (ref /4/ criteria met by the area proposed as PSSA (north east Norwegian Sea PSSA) in the north east Norwegian Sea and the Barents Sea.

Criteria in Res. A. 720(17)	Area specific compliance to criteria
Ecological conditions (wrt §4 of Res a.927(22))	
Uniqueness	Fulfilled by other areas of the Barents Sea
Critical habitat	Fulfilled by the area proposed designated as PSSA.
Dependency	Fulfilled by other areas of the Barents Sea
Representativeness	Fulfilled by the area proposed designated as PSSA.
Diversity	Fulfilled by the area proposed designated as PSSA.
Productivity	Fulfilled by the area proposed designated as PSSA.
Spawning / breeding ground	Fulfilled by the area proposed designated as PSSA.
Naturalness	Fulfilled by the area proposed designated as PSSA.
Integrity	Fulfilled by other areas of the Barents Sea
Vulnerability	Fulfilled by the area proposed designated as PSSA.
Biogeographical importance	Fulfilled by other areas of the Barents Sea
Socio-economic conditions (wrt §4 of Res a.927(22))	
Economic	Fulfilled by the area proposed designated as PSSA.
Recreation	Fulfilled by the area proposed designated as PSSA.
Human dependency	Fulfilled by the area proposed designated as PSSA.
Scientific conditions (wrt §4 of Res a.927(22))	Fulfilled by the area proposed designated as PSSA.
Vessel traffic(wrt §5 of Res a.927(22))	
Operational factors	Fulfilled by the area proposed designated as PSSA.
Vessel types	Fulfilled by the area proposed designated as PSSA.
Traffic characteristics	Fulfilled by the area proposed designated as PSSA.
Harmful substances carried	Fulfilled by the area proposed designated as PSSA.

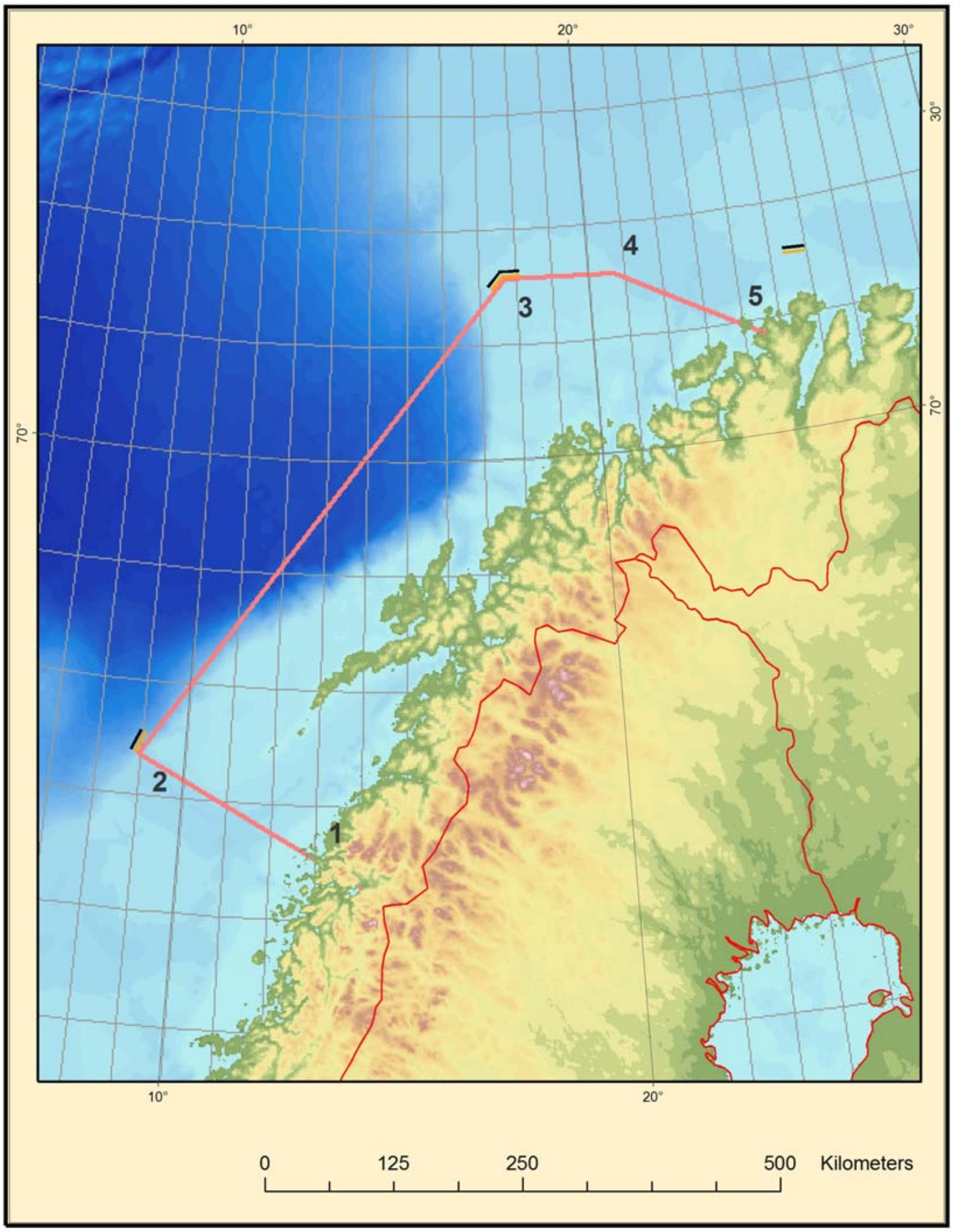


Figure 1.3. North east Norwegian Sea PSSA. Area proposed designated as PSSA in northern Norwegian Sea and the Barents Sea, indicated by a red line. Proposed traffic separation scheme is given in black and yellow.

2 INTRODUCTION

2.1 Background

The shallow depths and influx of warm Atlantic water from the south and nutrient rich waters from the north makes the ecosystems of the Barents Sea area among the most productive in the world. These marine ecosystems are characterised by simple food webs sustaining large stocks of few key species at each trophic level. These features make the systems dynamically unstable compared to ecosystems with higher biodiversity. The most important feature is the spring bloom of primary producers concentrated along the ice edge. It creates a food base for higher trophic levels, represented by fish, seabirds and mammals. Fish, seabirds and marine mammals are represented in high numbers within the region, many of which are regarded as internationally important. Several areas on Svalbard, in the Barents Sea and on the Norwegian coast are already protected or proposed protected.

The Norwegian Government aims to protect the Norwegian coast of the Barents Sea and the northern part of the Norwegian Sea against threats to the environment. The pressure on establishing petroleum activities is increasing resulting in increased maritime traffic and potentially increases of risk of environmental impact. Import of nuclear waste to Russia is planned from Western Europe and it is at the moment unclear if this will be transported by sea via Norwegian waters and the Barents Sea. Shipping traffic in the Barents Sea and along the Norwegian coast is expected to increase, resulting in a higher risk of accidents and associated pollution. The concern related to future maritime operations in the Barents Sea is also addressed in the Report to the Storting No. 12 Protecting the Riches of the Seas /8/.

As part of the evaluation of protection mechanisms from potential impact from maritime operations, the Norwegian part of the Norwegian Sea and the Barents Sea has been assessed in accordance to the IMO Guidelines for Particularly Sensitive Sea Areas (/4/).

2.2 Objective

The objective of the report is to evaluate the Norwegian part of the northern Norwegian Sea and the Barents Sea as a Particularly Sensitive Sea Area (PSSA) in accordance with IMOs Guidelines for the identification and designation of Particularly Sensitive Sea Area (/4/) considering existing available information on environmental issues and maritime activity.

2.3 The area of assessment

The area of assessment for the purpose of protection as PSSA includes the Norwegian part of the northern Norwegian Sea and the Barents Sea. The northern part of the Norwegian Sea includes the Lofoten area and northwards to the Barents Sea (ref. Figure 1.1).

3 CHARACTERISTICS OF THE ECOLOGICAL, SOCIO-ECONOMIC AND SCIENTIFIC SITUATION IN THE AREA

3.1 Topography

The Barents Sea is one of the widest shelf areas in the world with a mean depth of 230 m. The Barents Sea covers an area from the deep Norwegian Sea in the west, with depths of more than 2500 m, to the coast of Novaya Zemlya in the east and from the coast of Norway and Russia in the south to Svalbard and Franz Josef Land in the north. Latitudinal extension is approximately 70°N to 83°N. Longitudinal extension is approximately 15°E to 70°E. The total surface area of the Barents Sea amounts to approximately 1.4 millions km^2 and represents 7% of the total surface area of the Arctic Ocean. There are several trenches and depressions in the Barents Sea, the most important being Storfjord Trench (Storfjordrenna) and Bear Island Trench (Bjørnøyrenna) branching into the Norwegian Sea in the western part of the Barents Sea.

The continental shelf of the northern part of the Norwegian Sea is narrow and south-west of Tromsøflaket, at the entrance to the Barents Sea, the width is only 20-30 km. The continental shelf is sloping into the Norwegian Sea Basin, where water depth of more than 3 000 m can be found.

The bottom topography has a large influence regarding distribution and movement of the water masses. Further the bottom topography is decisive regarding sediment quality and hence organisms communities. The northward movement of water masses and the sloping shelf results in a large up welling area along the entrance to the Barents Sea.

The bottom topography of the Barents Sea and the northern part of the Norwegian Sea is given in figure 3.1.

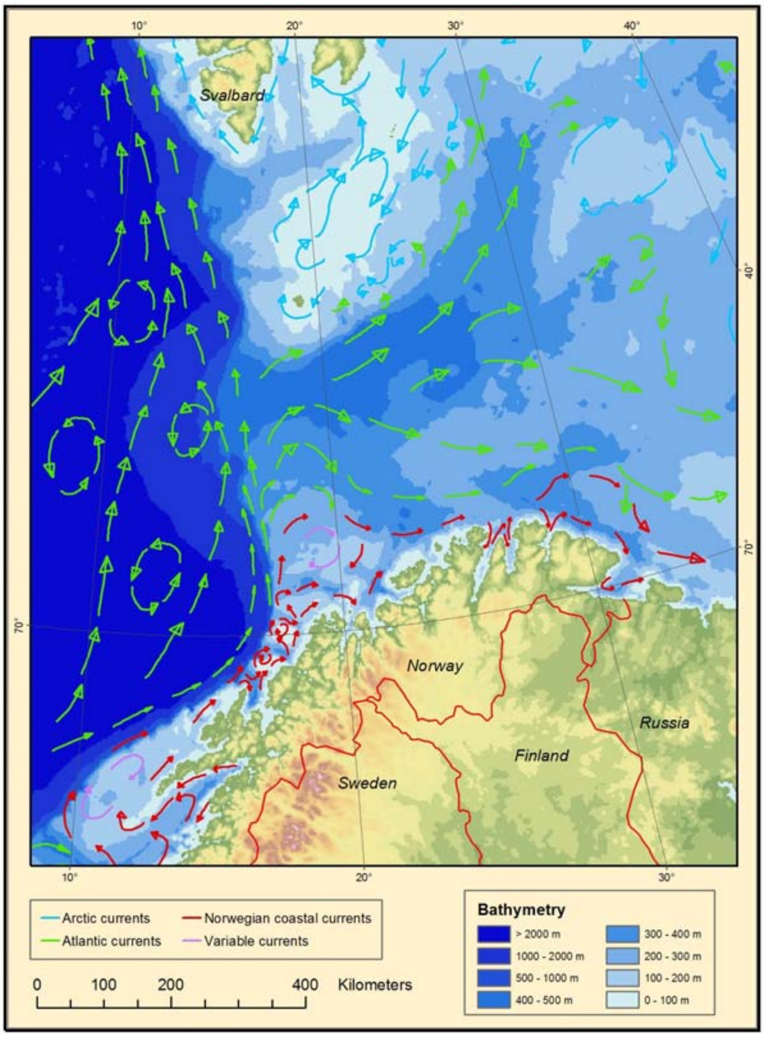


Figure 3.1 Bottom topography and the current system of the Norwegian part of the northern Norwegian Sea and the Barents Sea.

3.2 Oceanography

3.2.1 Current system

The current system of the Barents Sea and the northern part of the Norwegian Sea is presented in figure 3.1. The two major currents flowing into the Barents Sea from west are the Norwegian Coastal Current and the Atlantic Current. The Norwegian Coastal Current is confined to the coast, but several meanders and gyres can be found branching out from the coast, especially in the area from Tromsøflaket to North Cape. The Norwegian Coastal Current continues eastwards north of the Kola Peninsula and eventually into the Kara Sea.

The Atlantic Current follows the continental shelf between Lofoten and Svalbard and branches at the Bjørnøyrenna. One branch turns eastwards into the North Cape Current while the main current continues northwards along the continental slope west of Svalbard.

In the northern part of the Barents Sea, surface water is flowing westwards from the Arctic Ocean in the Makarov Current between Franz Josef Land and Novaya Zemlya, and continues into the Persey Current and the Central Current in the central parts of the Barents Sea.

3.2.2 Water masses

The water masses of the northern Norwegian Sea and the Barents Sea are complex and of different origin. The three major water masses are Coastal water, Atlantic water and Arctic water.

The coastal water is found in the southern part of the Barents Sea. Its origin can be traced back to Skagerrak and the Baltic Sea. As it flows northwards the water in the coastal current is mixed with river run-off and is characterised by a relative high temperature and low salinity.

The central part of the Barents Sea is considered as an important mixing area between relatively warm (temperature ~ 3°C, salinity > 35 psu – practical salinity unit) Atlantic water masses, which are nutrient scarce, and Arctic water masses, which are cool and nutritious (temperature < 0°C, salinity ~34.3-34.8 psu.) due to melting of sea ice revealing nutrient rich water. The mixing zone (also called the Polar Front) between these two water masses provides good conditions for high primary production, which is basis for the large fish stocks.

The Arctic water mass is found in the northern part of the Barents Sea, entering from the Arctic Ocean. In the winter, during ice formation, cold, saline water is formed from the salt brines emerging from the ice. The salinity can be as high as 35.25 psu and a temperature between the freezing point (-1.88°C) and 0°C.

3.3 Ecological characteristics

The Norwegian Sea extends from 62°N and northwards and borders in east the Barents Sea along the continental slope. The Barents Sea is the central sea of the European Arctic and is surrounded by the western Kara Sea, the eastern Greenland Sea, and the north-eastern part of the Norwegian Sea. The ecosystems of these seas are among the most productive in the world due to:

- banks in shallow areas which cause considerable vertical blending without lowering the light regime for high primary production.
- massive influx of warm water which blend due to strong wind and currents in the southern parts of the Barents Sea.
- massive influx of Arctic water from the Norwegian Sea, in particular north of Bjørnøya, which brings nutrient-rich water from ice covered areas during ice melting

Together with abundant solar energy (24 hours daylight during summer in the Barents Sea), these water masses support a large production of new biomass during spring and summer.

Many species of the northern and Arctic areas have a low growth rate, live longer, have a low reproductively and are key elements in the energy flux. The marine ecosystems of the Arctic region are characterised by large stocks of a few key species at each trophic level /5/, while the ecosystems of the more boreal regions have a higher number of species at each trophic level. The production is generally high all over in the shallow Barents Sea as well as in the shallow areas of the Norwegian Sea (e.g. Haltenbanken and Vøringplatået). The coastline of the Barents Sea and the islands within it are strongly linked to the marine ecosystems and they improve the productivity and diversity of the terrestrial ecosystems in these areas. The food chains are normally short but in Arctic ecosystems these short food chains can often be strong and robust with respect to natural impact. However, anthropogenic impact can cause large impacts /5/. Variation in the influx of warm water causes irregular variations in the primary production and the survival and production of key species in the food webs. The consequences may at times be dramatic, in particular for species at higher trophic levels (seabirds and mammals) and hence makes them vulnerable to anthropogenic impact. In the Arctic region there is a characteristic energy influx from the sea to the coastal areas. Hence the ecological features of the sea area are not only a precondition for the higher trophic levels in the sea but also for the ecology of the costal terrestrial areas as well.

3.3.1 Primary production

Phytoplankton are the primary producers of the ocean and utilise solar energy and inorganic nutrients to create organic matter (biomass) through photosynthesis. Phytoplankton forms the basis of the marine food chain, as they are food for zooplankton, and through them also for most higher marine organisms. The most important feature of the primary producers is the spring bloom. The bloom is caused by the combination of stable surface layer of nutrient rich water with low salinity.

Along the continental shelf and north of 62°N the spring bloom generally starts in April. The main factors controlling this bloom are interactions between different water masses (e.g. Atlantic water and coastal water), wind and local hydrographical conditions. The stable water layer prevents mixing into deeper waters with poorer conditions for phytoplankton production, e.g. reduced solar energy. The production increases exponentially until nutrients are consumed and the herbivorous zooplankton has increased in number (/20/, /21/, /22/). About 60 % of the annual primary production is associated with the spring bloom (/23/).

The Barents Sea area contains several hundred species of phytoplankton, the primary producers of the sea. They form the basis of the marine food chain in the Barents Sea as food for secondary producers (e.g. zooplankton) and through these also for higher marine organisms. The dominating phytoplankton group is represented by diatoms. Diatoms are very important during the spring bloom and their number may reach several billion cells per cubic meter of the sea water. Another important group of phytoplankton in the Barents Sea is the naked flagellates. The third group is the dinoflagellates. Many of the species are heterotrophic, which means they feed on organic material and thus act as animals (/5/).
The primary production in the Barents Sea is driven by different factors over the bank areas, open water, the ice edge and along the polar front.
Vertical mixing of the water column in combination with available light are the most important processes controlling the growth of phytoplankton. During winter, surface cooling combined with wind stress causes deep mixing that brings nutrients up into the surface water where they are available for the phytoplankton during the spring bloom. Where stratification is already present the spring bloom will usually start when the light level is sufficient.

The ice-edge ecosystem is typical for the Barents Sea. During spring and summer the ice retreats revealing nutrient rich water. This seasonal retreat is vital to the biological production in the area which is caused by the combination of a stable top layer (due to melting ice), nutrient rich water with low salinity from the melting ice and sufficient and continuous sunlight during the summer months. These are optimal conditions for phytoplankton blooming and correspondingly high secondary production. This is known as the "ice-edge effect". This ice-edge effect occurs earlier than general spring blooms in open arctic waters. The ice-edge bloom is a dynamic process which follows the ice edge as it recedes, and stops in late summer when the melting of the ice comes to an end or light becomes a limiting factor. It creates an early food base for zooplankton, fish, seabirds and mammals, all of which concentrate at the ice-edge during this period (ref: /5/).
The Barents Sea is divided into a northern and southern part by the Polar Front (the bordering area between Atlantic water and Arctic water) where relatively warm, saline Atlantic water descends under the cold but less saline Arctic water. North of the Polar Front, the water column in the upper twenty-meters is stabilised by melting ice triggering the spring bloom. The spring bloom north of the Polar Front can start as early as in April, 6 – 8 weeks earlier than in open waters (Norwegian Polar Institute, comm.). The stratification of the water column is too strong to be eroded by wind and this pronounced pycnocline remains at 25 – 35 m depths for the remaining part of the growth season. During the spring bloom the production increases exponentially until nutrients are consumed and the herbivorous zooplankton has increased in number. Consequently, primary productivity after the spring bloom is small and mainly regenerative leading to a low-productivity ecosystem (/18/,/19/, /20/, /21/).
South of the Polar Front several processes and in particular wind-induced mixing ensure the supply of new nutrients to the photic layer. In this area the spring bloom generally starts in April / May and ends in May / June. However, several blooms through the growth season leading to a high productivity ecosystem follow this bloom. Both model studies and observations demonstrate that the Atlantic waters south of the Polar Front are the most productive waters in the Barents Sea. This primary production is distributed more or less evenly over large areas in contrast to the production north of the Polar Front, which is concentrated into a narrow band (20 – 50 km wide) following the ice edge (/19/, /22/, /23/).

3.3.2 Secondary production

Zooplankton is major link between the phytoplankton and the higher organisms in the food web. They form a very heterogeneous group of animals and in size, they range from a few micrometers to several centimetres. Some species only exist as plankton during their juvenile stages, while others are planktonic during their whole life cycle. The zooplankton community in the Barents Sea is characterised by a few dominant species.

Crustaceans form the most important group of zooplankton, among which the copepods of the genus *Calanus* play a key role in the Arctic ecosystems. The *Calanus finmarchicus* is by far the most important contributor to the biomass of the Barents Sea area. It has a unique position as the main food source for important fish species as herring, capelin, mackerel and other plankton feeders. *Calanus glacialis* is the dominant contributor to zooplankton biomass in the Arctic region of the Barents Sea, and *Calanus hyperboreus* is the most abundant *Calanus* species in the Polar Front. Krill is another group of crustaceans playing a significant role in the pelagic ecosystems as food for both fish and marine mammals. They appear in large schools and continuous layers, often remaining at deeper levels in the day and ascending at night. The amphipods are represented by few pelagic species in the area (ref: /5/).

In the Barents Sea the total zooplankton biomass varies considerably, both seasonally and between years. Zooplankton production is governed by phytoplankton production and the grazing of the zooplankton by predators (ref: /5/).

3.3.3 Marine fish

The Barents Sea is and important areas for fisheries and is exploited for both fish area well as shellfish and crustaceans. The area holds some of the world’s largest and most important fish stocks. The stocks of capelin (Atlantic subspecies), north-east Arctic cod and Atlanto-Scandinavian herring (the Norwegian spring spawning sub stock) are the largest and most important stocks ecologically and economically. The main spawning grounds and nursing areas of these species are found along the Norwegian coast in the Norwegian Sea and the Barents Sea. North-east Arctic cod and capelin do also have spawning areas along the Icelandic coast. Other important fish species of the region are polar cod, redfish, halibut, haddock, saithe, ling and tusk, the two latter mainly in the Norwegian Sea. Many species that spawn along the Norwegian coast such as herring, cod, saithe, and redfish spend parts of the lifecycle within the Barents Sea. The current system results in a northward transport of spawning products into the fjords and the Barents Sea, giving the juveniles good feeding conditions.

Capelin is the main plankton feeder in the Barents Sea, and is a key species on which other fish, seabirds and mammals feed. Hence capelin holds an important ecological position as an intermediate link in the food web and alterations of the capelin stock (over-exploitation, reduced food supply, natural fluctuations) may dramatically influence the ecosystems of the Barents Sea. In early spring, the mature capelin migrates southward to the Norwegian coast of the Barents Sea and the northern part of the Norwegian Sea to spawn. The spawning locations vary greatly, some years the spawning is concentrated as far west as Lofoten, while other years it can occur along the coast of Finnmark and the Kola Peninsula. The hatching occurs in early summer and drift north-eastward into the central Barents Sea. The juveniles over winter in the polar front region and migrates northward during the next summer following the high production along the ice edge. Figure 3.2 presents the distribution of capelin larvae in 2000 and capelin fry in 2002 and figure 3.3 presents the population fluctuations of capelin in the Barents Sea from 1970 to 2000.

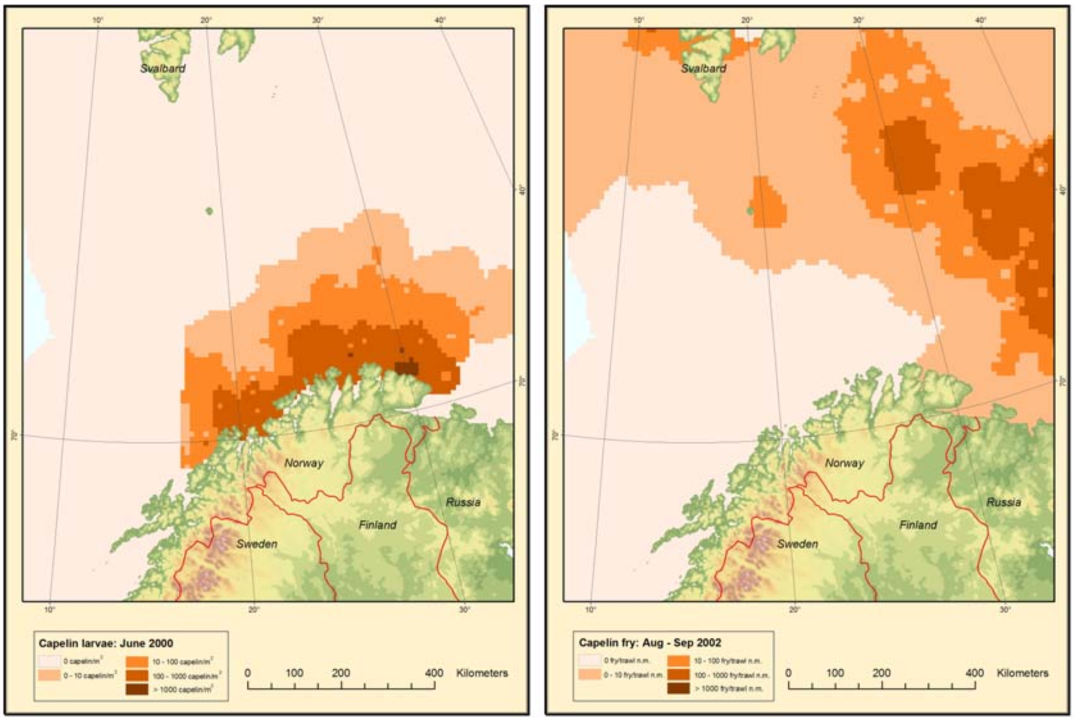


Figure 3.2 Distribution of capelin larvae in 2000 and capelin fry in 2002 in the Barents Sea and the northern part of the Norwegian Sea. Source: /5/.

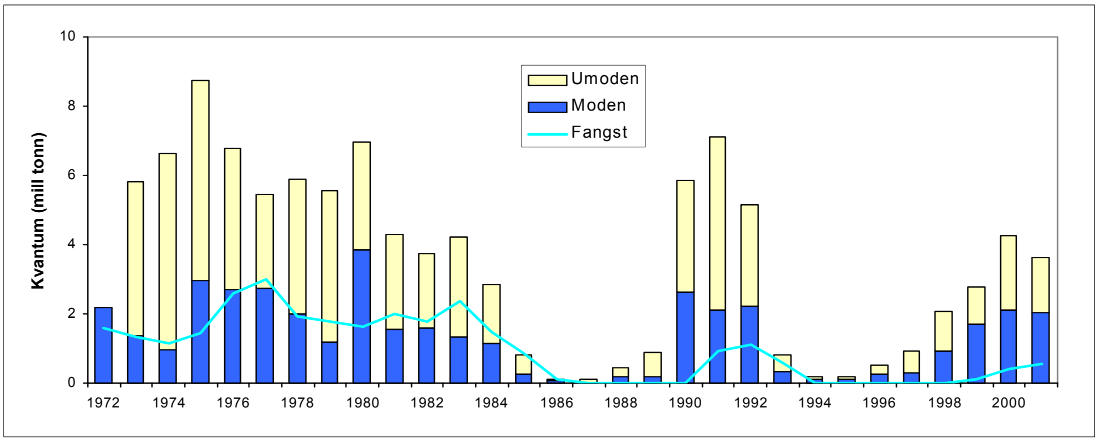


Figure 3.3 The population of capelin in the Barents Sea from 1970 to 2000 presented as mature (blue) and immature (yellow) stock. Catch is given as a light blue line. Source: /5/.

As capelin in the Barents Sea, Norwegian spring-spawning herring (subspecies of Atlanto-Scandinavian herring) has also an important ecological position in the marine ecosystems of the Norwegian Sea and the north-east Atlantic, and is potentially the largest fish-stock in the north-east Atlantic. It spawns along the Norwegian Shelf in February-March and the larvae drift northward with the coastal current into the Barents Sea, as indicated in figure 3.4. Immature Norwegian spring-spawning herring spends two to three years in the Barents Sea before migrating into the Norwegian Sea to join the mature stock.

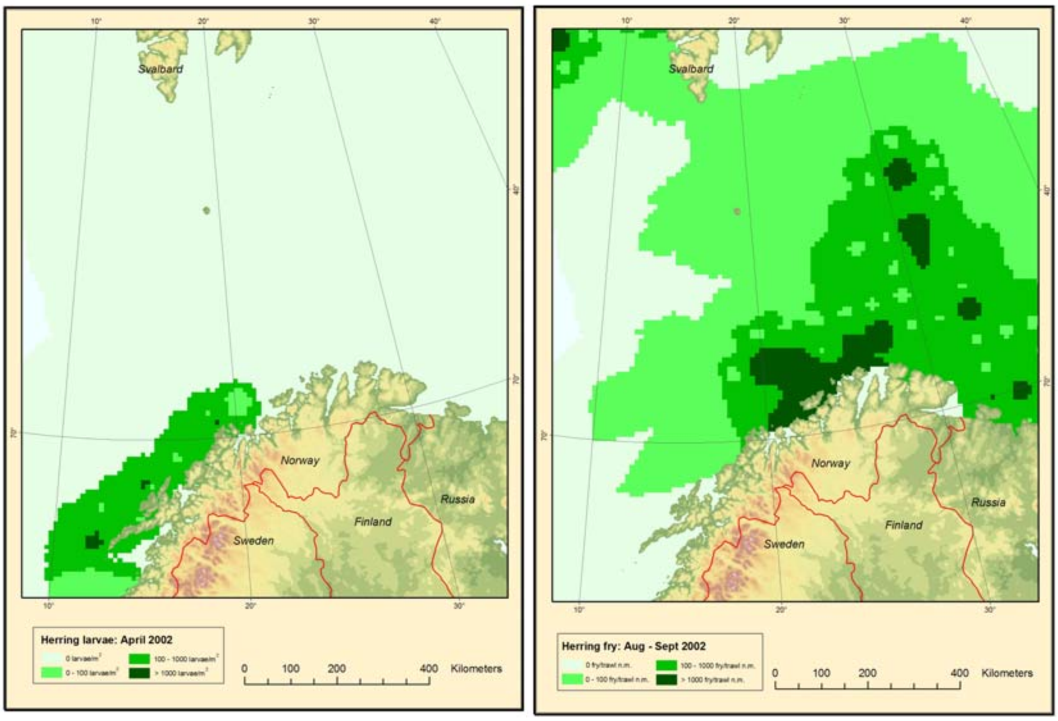


Figure 3.4 Distribution of Norwegian spring-spawning herring larvae and fry in 2002 in the Barents Sea and the northern part of the Norwegian Sea. Source: /5/.

During the 1950s and 1960s the stock size of mature Norwegian spring spawning herring declined gradually from about 13 million ton to a minimum after the collapse in the late 1960s, as indicated in figure 3.5. After the collapse, the feeding area shifted to the continental shelf and the Norwegian fjords became wintering areas. In the early 1990s the Norwegian spring-spawning herring reoccupied the Norwegian Sea as its main feeding area and the spawning population started to increase (ref: /5/).

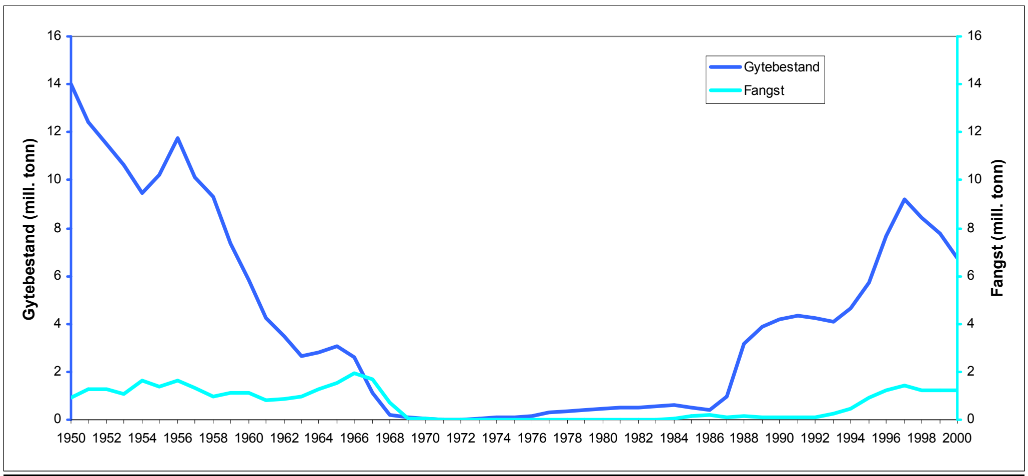


Figure 3.5 The population of mature Norwegian spring-spawning herring from 1950 to 2000. Source: /5/.

The North-east Arctic cod is potentially the largest stock of cod in the world. Spawning occurs in March and April along the coast of mid and northern Norway, and mainly in the Lofoten area. Three months after spawning, the juveniles are found in the south-western Barents Sea and particularly in high concentration over the bank of Tromsøflaket, as illustrated in figure 3.6. Five months after spawning they are spread in the entire Atlantic water masses of the Barents Sea and particularly over the narrow shelf off the coast of West Spitsbergen.

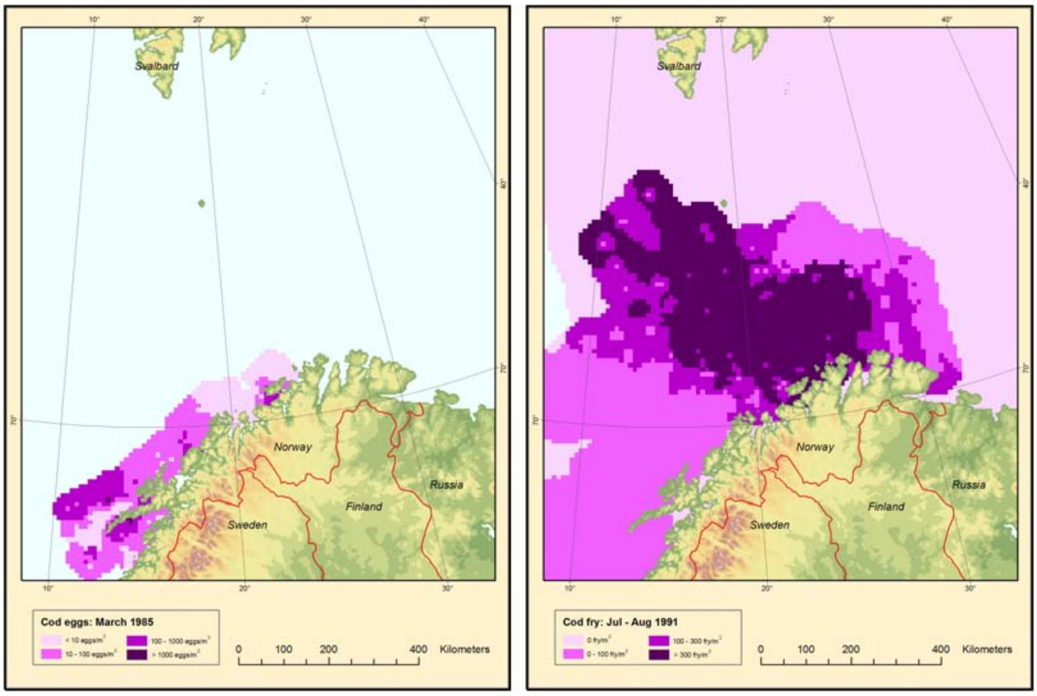


Figure 3.6 Distribution of North-east Arctic cod eggs in 1985 and North-east Arctic cod fry in 1991 in the Barents Sea and the northern part of the Norwegian Sea. Source: /5/.

The stock biomass of North-east Arctic cod has fluctuated considerably over the last 50 years, as illustrated in figure 3.7. The stock biomass is closely linked to recruitment, food basis and climate (ref: /5/).

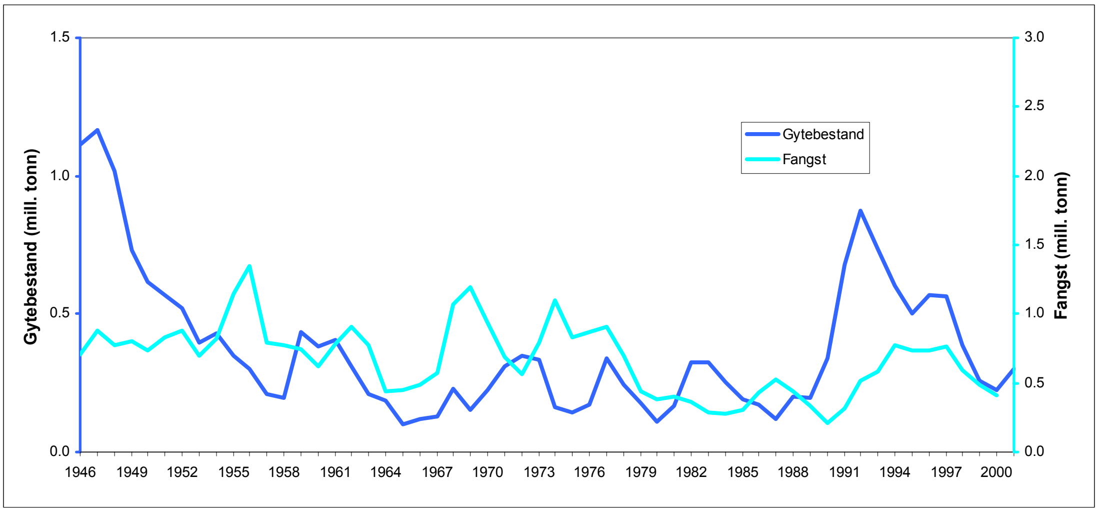


Figure 3.7 The spawning population (dark blue) and catch (light blue) of North-east Arctic cod from 1946 to 2000. Source: /5/.

3.3.4 Seabirds

The Norwegian territorial sea area from 62°N and northwards including the Barents Sea is regarded as important breeding and wintering area of seabirds on international level, considering both number of individuals and conservation value. The main groups of seabirds within the area to be considered are alcids, marine ducks, cormorants/shag, gulls, terns, skuas, loons, fulmars and storm petrels. As part of a scheme for nation-wide monitoring of seabirds and waterfowl in Norway, a monitoring system for breeding and wintering populations have been established.

About 3 - 4 million pairs of seabirds breed in Norway of which a majority are located in the northern part of the country, holding the 21 largest bird cliffs, as illustrated in figure 3.8. Most of the seabird species show a decline in population size from 1960, especially among alcids. Alcids have low reproduction capacity (on average one chick pr. year), high age at sexual maturity and long duration of life. These characteristics make them capable of resistance against single years with reproduction failure, but highly vulnerable towards impacts on mature individuals. Examples of species that have declined due to impacts on mature individuals are puffin and common guillemots. Most of the alcids, gulls and fulmars nest in large colonies on cliffs or rocky terrain. Terns, geese and ducks near the coast or on islands. Outside the breeding period, alcids typically spend most of their time diving, swimming or resting on the sea surface, while fulmars, storm petrels, skuas, gulls and terns spend more time in flight, roaming over large areas. In the breeding period alcids spend more time on land incubating eggs and caring for young, and flying between the feeding areas in open sea (banks and up welling areas) and the colony than they do other parts of the year. In contrast fulmars, gulls and skuas may spend more time feeding on water to supply their young with food. All together a major part of the marine seabirds in the area is highly dependent upon the sea for feeding and resting area.

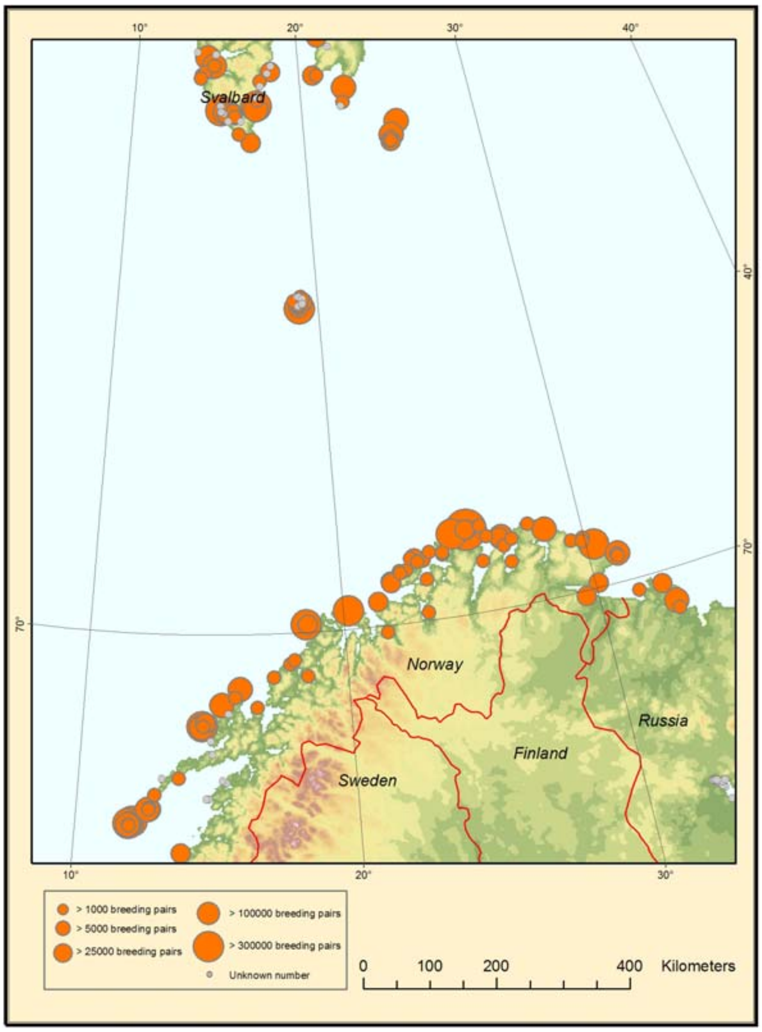


Figure 3.8 Distribution of breeding seabirds (with more then 1000 pairs) in the Barents Sea and the northern part of the Norwegian Sea. Source: /5/.

The coastal areas of Norway sustain large areas of importance to wintering seabirds of international conservation value, e.g. Varangerfjord and the outer part of Lofoten. Regular monitoring of wintering populations in this area indicates that seabirds of special interest with respect to wintering are cormorants (two subspecies), divers, loons and marine ducks. Norway is stated to have special responsibility in preserving species within these groups of seabirds. The coastal areas of Norway are important as feeding and resting area for millions of wader's migration from southern Europe and Africa to breeding areas in northern Norway and Svalbard. River deltas, wetlands and shallow sea areas are especially attractive for this purpose. Important areas are located along the coastline and fjords in the counties of Troms and Finnmark. Areas of international value to be mentioned are the sea area outside the county of Troms and in the Varangerfjord in the county of Finnmark.

The Barents Sea has a high production of biomass and supports large populations of seabirds of international value during breeding period. Many species migrate southward in autumn and winter in warmer areas, while other species as guillemots and kittiwake stay all year within the region. Seabirds are regarded as the key component in transporting nutrients from the sea to land. This can best be seen below bird cliffs on the Arctic islands (Bjørnøya and Svalbard) where the vegetation is richer than in surrounding areas.

Table 3.1 and table 3.2 show the estimated stocks for selected seabird species international, national, in the Barents region and on Svalbard.

Table 3.1 Estimated international and national stocks of selected seabird species in the Barents region and on Svalbard. The estimates are given as individuals. Source: /26/.

English name	Latin	International	National	Barents region	Lofoten-Grense Jacobselv (mainland)	Svalbard	% of the international stock in the Barents region
Red-throated diver	*Gavia stellata*	75 000	1 200	100	90	Unknown	0,13
Great northern diver	*Gavia immer*	5 000	1 200	30	30	4	0,60
White-billed diver	*Gavia adamsii*	1 000	750	300	300	0	30,00
Red-necked grebe	*Podiceps grisegena*	100 000	2 500	50	50	0	0,05
Northern fulmar	*Fulmarus glacialis*	2 210 000	1 013 000	1 001 000	1 000	1 000 000	45,29
Storm-petrel	*Hydrobates pelagicus*	270 000	11 000	11 000	10 000	0	4,07
Leach`s Storm-petrel	*Oceanodroma leucorhoa*	25 000	1 100	1 100	1 000	0	4,40
Northern Gannet	*Sula bassana*	600 000	8 000	6 000	6 000	0	1,00
Great Cormorant	*Phalacrocorax carbo*	120 000	48 000	16 000	10 000	0	13,33
Shag	*Phalacrocorax aristotel*	250 000	30 000	18 000	12 500	0	7,20
Grey Heron	*Ardea cinerea*	400 000	15 000	200	200	0	0,05
Graylag Goose	*Anser anser*	325 000	17 000	6 000	5 000	0	1,85
Pink-footed Goose	*Anser brachyrhynchus*	259 000	37 000	37 000	37 000	37 000	14,29
Brent Goose	*Branta bernicla*	5 000	5 000	5 000	0	5 000	100,00
Barnacle Goose	*Branta leucopsis*	15 000	23 500	23 500	23 500	23 500	156,67
Shell duck	*Tadorna tadorna*	300 000	7 000	1 500	1 500	0	0,50
Long-tailed Duck	*Clangula hyemalis*	4 600 000	100 000	35 000	30 000	Unknown	0,76
Eider	*Somateria mollissima*	1 735 000	410 000	220 000	175 000	50 000	12,68
King Eider	*Somateria spectabilis*	300 000	85 000	85 000	50 000	3 750	28,33
Black Scoter	*Melanitta nigra*	1 600 000	4 000	200		0	0,01
White-winged Scoter	*Melanitta fusca*	1 000 000	30 000	16 000	14 000	0	1,60
Steller`s Eider	*Polysticta stelleri*	30 000	15 000	30 000	15 000	0	100,00
Goosander	*Mergus merganser*	104 000	40 000	30 000	30 000	0	28,85
Red-breasted Merganser	*Mergus serrator*	200 000	40 000	20 000	16 000		10,00
Purple Sandpiper	*Calidris maritima*	50 500	15 000	10 000	9 000	Unknown	19,80
Great Skua	*Stercorarius skua*	28 000	700	710	700	650	2,54
Arctic Skua	*Stercorarius parasiticus*	140 000	17 000	64 000	10 000	2 000	45,71
Ivory Gull	*Pagophila eburnea*	5 000	1 200	4 000	0	1 200	80,00
Common Gull	*Larus canus*	1 650 000	300 000	57 000	3 000	10	3,45
Herring Gull	*Larus argentatus*	2 700 000	350 000	250 000	200 000	0	9,26
Lesser black-backed Gull	*Larus fuscus*	30 000	1 500	2 000	200	0	6,67
Great Black-backed Gull	*Larus marinus*	480 000	75 000	66 000	35 000	200	13,75
Glaucous Gull	*Larus hyperboreus*	200 000	11 000	24 000	2 000	11 000	12,00
Kittiwake	*Rissa tridactyla*	8 400 000	1 750 000	1 800 000	900 000	540 000	21,43
Sabine's Gull	*Larus sabini*	Unknown	6	8	0	6	Unknown
Common Tern	*Sterna hirundo*	780 000	30 000	5 000	3 000	0	0,64
Arctic Tern	*Sterna paradisaea*	1 000 000	95 000	260 000	20 000	20 000	26,00
Little Auk	*Alle alle*	13 000 000	2 000 000	2 600 000	2 600 000	2 000 000	20,00
Razorbill	*Alca torda*	985 000	60 000	60 000	54 000	200	6,09
Brünnich's Guillemot	*Uria lomvia*	14 000 000	1 300 000	3 500 000	3 000	1 700 000	25,00
Guillemot	*Uria aalge*	3 000 000	95 000	280 000	25 000	200 000	9,33
Black Guillemot	*Cepphus grylle*	400 000	100 000	140 000	45 000	40 000	35,00
Puffin	*Fratercula arctica*	10 600 000	4 020 000	4 000 000	3 800 000	20 000	37,74

Table 3.2. Estimated international and national stock status of selected seabird species in the Barents region and on Svalbard. Source: /26/

English name	Latin	Restitution	Stock-trend (mainland)	Stock-trend (Svalbard)	Red-list status (mainland)	Red-list status (Svalbard)
Red-throated Diver	*Gavia stellata*	medium	-	-	DC	-
Great northern Diver	*Gavia immer*	medium	-	-	-	R
White-billed Diver	*Gavia adamsii*	medium	-	stable	VSV	-
Red-necked Grebe	*Podiceps grisegena*	medium	positive	stable	-	-
Northern Fulmar	*Fulmarus glacialis*	small	stable	stable	-	-
Storm-petrel	*Hydrobates pelagicus*	small	-	stable	-	-
Leach`s Storm-petrel	*Oceanodroma leucorhoa*	small	-	stable	-	-
Northern Gannet	*Sula bassana*	large	positive	stable	-	-
Great Cormorant	*Phalacrocorax carbo*	large	positive	stable	-	-
Shag	*Phalacrocorax aristotelis*	large	positive	stable	-	-
Grey Heron	*Ardea cinerea*	large	positive	stable	-	-
Graylag Goose	*Anser anser*	large	positive	stable	-	-
Pink-footed Goose	*Anser brachyrhynchus*	large	-	-	-	-
Brent Goose	*Branta bernicla*	large	stable	stable	V	V
Barnacle Goose	*Branta leucopsis*	large	stable	stable	-	-
Shell duck	*Tadorna tadorna*	large	positive	stable	-	-
Greater Scaup	*Aythya marila*	medium	-	stable	DM	-
Long-tailed Duck	*Clangula hyemalis*	medium	negative	-	DM	-
Eider	*Somateria mollissima*	medium	stable	stable	-	-
King Eider	*Somateria spectabilis*	medium	-	-	VSV	-
Black Scoter	*Melanitta nigra*	medium	stable	stable	DM	-
White-winged Scoter	*Melanitta fusca*	medium	negative	stable	DM	-
Steller`s Eider	*Polysticta stelleri*	small	stable	stable	V	V
Goosander	*Mergus merganser*	large	-	stable	-	-
Red-breasted Merganser	*Mergus serrator*	large	-	stable	-	-
Purple Sandpiper	*Calidris maritima*	large	stable	-	-	-
Great Skua	*Stercorarius skua*	medium	positive	positive	-	-
Arctic Skua	*Stercorarius parasiticus*	medium	stable	-	-	-
Ivory Gull	*Pagophila eburnea*	small	stable	-	-	DM
Common Gull	*Larus canus*	large	stable	stable	-	-
Herring Gull	*Larus argentatus*	medium	stable	stable	-	-
Lesser black-backed Gull	*Larus fuscus fuscus*	medium	negative	stable	E	-
Great Black-backed Gull	*Larus marinus*	medium	stable	stable	-	-
Glaucous Gull	*Larus hyperboreus*	medium	stable	stable	-	-
Kittiwake	*Rissa tridactyla*	large	negative	-	-	-
Sabine's Gull	*Larus sabini*	small	stable	-	-	R
Common Tern	*Sterna hirundo*	medium	stable	stable	-	-
Arctic Tern	*Sterna paradisaea*	medium	negative	stable	-	-
Little Auk	*Alle alle*	small	stable	-	VV	-
Razorbill	*Alca torda*	small	-	-	VV	R
Brünnich's Guillemot	*Uria lomvia*	small	negative	stable	VSV	-
Guillemot	*Uria aalge*	small	stable	stable	V	V
Black Guillemot	*Cepphus grylle*	medium	negative	-	DM	-
Puffin	*Fratercula arctica*	small	stable	-	DC	-

3.3.5 Marine mammals

The Barents Sea is also important for many marine mammals where the seals dominate in number and the whales in biomass. The group of marine mammals of the region include whales, seals, walrus and polar bear. White-beaked dolphin, killer whale, harbour porpoise, narwhale, beluga, sperm whale, beaked whale, blue whale, fin whale, minke whale, humpback whale, bowhead whale, walrus, grey seal, ringed seal, bearded seal, harp seal, harbour seal and hooded seal can all be found regularly in the Barents Sea. Killer whale, fin whale, humpback whale and minke whale migrate northward and into the Barents Sea in the summer driven by the large amount of food (plankton and fish). After summer these species migrate southward to more temperate climate (ref: /5/).

The seals in the area include the harp seal, which is pelagic, the ringed and bearded seal, which are coastal and strictly Arctic, and the harbour and grey seal, which are coastal and sub-Arctic. In general, harbour seals favour intertidal sandbanks in estuaries and around sandy coasts, but in Norway there is only one colony resident in a sandbank area, in the Tana river estuary in Finnmark county. The harbour seal whelps in May and July, and moulting takes place in the period from September to October. Harbour seals inhabiting the Barents Sea area are the world's northernmost population and are mainly found along the coast of Finnmark and Kola and in Svalbard. Due to this fact and that it has a very limited geographical distribution it represent a unique opportunity for different comparative studies and should therefore be considered of the highest conservation value, both nationally and internationally

As opposed to the harbour seal, the grey seal seems to prefer the outlying skerries throughout the year. The whelping period seems to differ between the western and eastern parts of the northern Norway and lasts from October to January. Moulting of adult females takes place in January/February whereas the males moult in March/April. The population of grey seals in Troms and Finnmark can be considered to have national conservation value.

Polar bear is common in the southern and eastern areas of Svalbard, travelling on firm packed ice and in the drift ice. The bears migrate south-westwards with the expanding winter ice during late fall and winter and follow the retreating ice north-eastward during spring and summer. Polar bears of the region are mainly located on Storfjorden, Svalbard, Hopen, Franz Josef Land, Novaya Zemlya and in the Kara Sea. The Barents Sea population is considered as of international conservation value.

Table 3.3 presents the population sizes of internationally important marine mammals in Norwegian waters, including the Barents Sea of which some species should be given special attention.

Table 3.3. Population size of marine mammals in Norwegian waters including the Barents Sea. Source: /5/. Figures indicated by * is based on the /6/.

Species	Norwegian population	Barents Sea area
Harbour porpoise	95 000	11 000
Harbour seal	6 700	1 800[1]
Bearded seal	10 000 – 100 000 (1,3 - 13%)*[6]	10 000 – 100 000 (100%)*[5]
Grey seal	> 3 000*	> 500*
Ringed seal	-	-
Harp seal	-	1 700 000[4]
White whale	10 000 – 100 000*	10 000 – 100 000 (100%)*[5]
White-beaked dolphin	132 000	50 000
Humpback whale	1 000	210
Minke whale	118 300	46 800
Atlantic walrus	-	2000[2]
Polar bear[3]	3 000-5 000	3 000- 5 000

1) Including Svalbard.
2) Atlantic walrus in the area around Svalbard
3) Polar bears on Svalbard, East Greenland and western Soviet Arctic belong to one population estimated to 3 000 – 5 000 individuals. Of these are around 3 000 expected to inhabit Svalbard
4) 1.7 million Harp seal spend the wintertime in Østisen.
5) Figures in parentheses indicate percentage of national Norwegian population.
6) Figures in parentheses indicate percentage of international population.
* Figures from Barents Icewater Programme (/6/).
- Indicates that figures are uncertain / not given.

3.3.6 Coastal zone

The Norwegian coastal area is by Brattegard & Holthe (1995) divided into sub-regions based on the distribution of benthic algae and invertebrates, and fishes. The coastal zone from 62°N and northwards including the county of Troms is located within the "West Norwegian Sub-region" and is further part of the coastal area of Norway which has the highest diversity of species within this region. In general this sub-region have a high number of species with a southern distribution, the number of species with these characteristics reduces northwards. The coast of Finnmark belongs to the Finnmark sub-region. This sub-region is characterised by a rich flora and fauna of species known to have a southern distribution in the outer coastal area, while the inner parts have more Arctic species and a reduced diversity.

The landscape along the northern coast of Norway is characterised by exposed outer coast and sheltered inner coast and deep fjords (especially in the county of Finnmark). As a result the coastline within the area also show large variations, where kelp forests, rocky shore, seaweed banks, sandy shores, salt marshes/clay-silt shores and gravely/stony shores are represented with characteristic flora.

Salt marshes and clay-silt shores are very productive as feeding areas for many seabird species and nursing areas for fish. The flora is usually dominated by a low number of species with high coverage. The plants are essential for binding the substrate. The sea shores within this region are represented with various types of botanical interests. Several of the locations within the area to be evaluated are assigned a high conservation value and are vulnerable to oil pollution.

3.3.7 Protected areas

Protection of resources or areas is according to national legislation established to attend the interest between man and nature and preserve the quality of nature for the next generations. The largest protected areas within the area to be considered are found on Svalbard. On the Norwegian mainland, most of the protected areas consist of inland treeless mountain areas. The major gaps in the Norwegian protected areas are found on the mainland and are among others coastal and fjord systems. Along the Norwegian coast, many smaller areas are protected or partly protected (seasonal protection, e.g. breeding areas for seabirds). It should be noted that the majority of these areas are protected due their importance as seabird sanctuaries. Along the Norwegian coast several marine areas are proposed protected. Some 3/4 of these areas are located north of 62°N (Brattegard & Holthe (1995)). Several of these areas extend into the water to ensure protection of the sub littoral zone. It should be noted that the geographical position and extension of the marine areas are proposals and are given in general terms.

3.4 Social, cultural and economical characteristics

3.4.1 Economic benefit

Fisheries

The fish resources of the Barents Sea are of high value nationally as well as internationally and are hence important for both national as well as international fisheries. The Barents Sea is the only area that contributes with an equivalent amount as the North Sea, which stands for about 5 % of the world's total catch, and 20-30 % of the catches in the North Atlantic.

The total stocks of important species in Norwegian waters have decreased dramatically compared to stock levels from 1940-1950. This is the case for herring, cod, saithe, haddock, capelin and mackerel. The decrease is mainly caused by exploitation and for some species severe overexploitation. The population trends of cod, saithe and capelin do all show a general decrease from 1970 to 1988 - 1990, after which all stocks have increased but are still low compared to the stock level in 1970 (/15/). Table 3.4 and 3.5 present the volume of fish delivered (tonnes) and value (NOK) respectively for landings from the Lofoten- Barents Sea area.

Although the stock level has decreased the total export in both volume and in monetary terms increased from 1991 to 2000, with a small decrease following in 2002 (/12/).

Table 3.4: Fish delivered in tonnes in 1990, 1993, 1997 and 2000. Source: /15/.

Species	Fishing gear	Year 1990	1993	1997	2000
Haddock	Conventional	14 746	27 294	46 716	24 897
	Seine fisheries	61	16	7	1
	Trawl	2 825	9 163	44 565	13 490
	Other	19			0
Total Haddock		**17 651**	**36 473**	**91 288**	**38 388**
Capelin	Seine fisheries		316 103		252 556
	Trawl		87 047		30 071
Total Capelin		**0**	**403 150**	**0**	**282 627**
Prawn	Trawl	30 939	23 961	18 349	52 655
Total Prawn		**30 939**	**23 961**	**18 349**	**52 655**
Saithe	Conventional	18 559	26 842	34 355	45 988
	Seine fisheries	16 863	31 117	42 676	23 757
	Trawl	25 009	35 156	33 677	33 525
	Other				1
Total Saithe		**60 431**	**93 115**	**110 708**	**103 271**
Herring	Conventional	465	1 174	296	0
	Seine fisheries	24 084	131 114	624 248	549 827
	Trawl	655	5 792	72 972	67 655
Total Herring		**25 204**	**138 080**	**697 516**	**617 482**
Cod	Conventional	71 698	167 169	243 046	137 587
	Seine fisheries	18	105	148	26
	Trawl	28 139	81 152	131 321	65 112
	Other	308	2	0	5
Total Cod		**100 163**	**248 428**	**374 515**	**202 730**
Other species	Conventional	35 575	43 204	39 225	37 510
	Seine fisheries	4 866	3 063	337	1 830
	Trawl	47 757	23 496	18 890	18 198
	Other	5 213	8 408	299	125
Total other species		**93 411**	**78 171**	**58 751**	**57 663**
TOTAL		**327 799**	**1 021 378**	**1 351 127**	**1 354 816**

Table 3.5: The value of fish delivered in 1000 NOK in 1990, 1993, 1997 and 2000. Source: /15/.

Species	Fishing gear	Year			
		1990	1993	1997	2000*
Haddock	Conventional	137 776	180 704	304 801	288 401
	Seine fisheries	504	105	35	5
	Trawl	27 256	68 443	268 901	168 776
	Other	211			1
Total Haddock		**165 747**	**249 252**	**573 737**	**457 183**
Capelin	Seine fisheries		241 429		301 029
	Trawl		33 601		24 167
Total Capelin		**0**	**275 030**	**0**	**325 196**
Prawn	Trawl	618 915	277 988	261 477	681 857
Total Prawn		**618 915**	**277 988**	**261 477**	**681 857**
Saithe	Conventional	100 350	100 960	147 518	213 958
	Seine fisheries	56 647	74 026	102 037	67 031
	Trawl	123 510	132 753	175 027	161 957
	Other				4
Total Saithe		**280 507**	**307 739**	**424 582**	**442 950**
Herring	Conventional	1 158	1 801	507	1
	Seine fisheries	77 386	213 557	1 212 140	1 050 160
	Trawl	2 201	6 721	105 139	103 114
Total Herring		**80 745**	**222 079**	**1 317 786**	**1 153 275**
Cod	Conventional	854 733	1 454 176	1 868 339	1 897 929
	Seine fisheries	283	920	1 205	337
	Trawl	312 839	677 422	1 063 184	887 260
	Other	3 796	15	3	75
Total Cod		**1 171 651**	**2 132 533**	**2 932 731**	**2 785 601**
Other species	Conventional	278 425	297 295	288 597	385 892
	Seine fisheries	11 957	8 185	736	1 652
	Trawl	346 709	170 314	139 438	136 957
	Other	49 432	72 632	15 614	561
Total other species		**686 523**	**548 426**	**444 385**	**525 062**
TOTAL		**3 004 088**	**4 013 047**	**5 954 698**	**6 371 124**

* Temporary figure.

Table 3.6 presents the total quota in the Barents Sea in the years 1991, 1993, 1997 and 2002 for cod, haddock, saithe, capelin and herring assigned to Norway, Russia and other countries.

Table 3.6 The total quota in the Barents Sea of cod, haddock, saithe, capelin and herring in 1991, 1993, 1997 and 2002. Source: /14, 15/.

Species	Country	Year 1991	1993	1997	2002
Cod	Norway	128 500	256 200	399 000	195 550
	Russia	108 500	227 000	387 000	183 550
	Other	18 000	56 800	104 000	55 900
	Total	**255 000**	**540 000**	**890 000**	**435 000**
Haddock	Norway	14 500	35 000	104 000	46 300
	Russia	12 500	31 500	96 000	34 300
	Other	1 000	5 000	10 000	4 400
	Total	**28 000**	**71 500**	**210 000**	**85 000**
Saithe (north for 62oN)	Norway	97 000	127 000	118 500	152 000
	Other	3 000	5 000	5 000	10 000
	Total	**100 000**	**132 000**	**123 500**	**162 000**
Capelin	Norway	510 000	0	0	390 000
	Other	340 000	0	0	260 000
	Total	**850 000**	**0**	**0**	**650 000**
Herring	Norway	65 000	168 000	855 000	484 500
	Other	20 000	32 000	645 000	366 500
	Total	**85 000**	**200 000**	**1 500 000**	**851 000**

In 2002 about 10 000 individuals living in the counties of Nordland, Troms and Finnmark where listed in the fishery register of the Norwegian Fishery Directorate. Approximately 70 % of these had fishery as their main occupation. In total they constituted approximately 50% of all fishermen in Norway (/31/).

Aquaculture

The aquaculture industry is of great importance in Norway and is still an increasing industry. The economically most important species is the Atlantic Salmon (*Salmo salar*), of which 436 736 tonnes were reared in 2000 (/14/). The amount of reared salmon and trout in 2001 was for Nordland (northern part), Finnmark and Troms counties 86 554 tonnes and had a value of 1.6 billion NOK.

In 2001 590 persons worked within the aquaculture industry in the Nordland (northern part), Finnmark and Troms counties. One man-labour year in the aquaculture industry generate 3-4 man-labour year in derivative activity and hence is regarded as an important industrial activity of the coastal areas of Norway (/14/).

Table 3.7 presents numbers of the different types of licenses and locations in the Barents Sea and the northern part of the Norwegian Sea (Nordland (north), Finnmark and Troms).

Table 3.7. Number and type of aquaculture licences and locations in Nordland (north), Troms and Finnmark. Source: /14/.

Species				Nordland	Troms	Finnmark
Salmon/trout		Adult fish	licences	38	70	70
			locations	74	162	94
		Fingerling [5]	installations	10	20	4
Marine fish	Cod [1]	Adult fish	licences	11	12	11
		Fry	licences	4	6	0
	Halibut [2]	Adult fish	licences	12	1	0
		Fry	licences	0	1	0
Shellfish	Mussel		licences	16	80	58 [3]
	Sea urchin		licences	0	0	9 [4]
	Iceland scallop		licences	2	8	1
	Oyster		licences	0	2	0

1) **Some of the licences also allow other marine species (saithe, catfish and hake)**

2) **Some of the licences also allow turbot and sole.**

3) **Some of these licences are small and temporary test-licences.**

4) **Including one licence for crab.**

5) **Includes only commercial licences.**

Figure 3.9 presents the aquaculture locations in the Barents Sea and the northern part of the Norwegian Sea (Source: /46/).

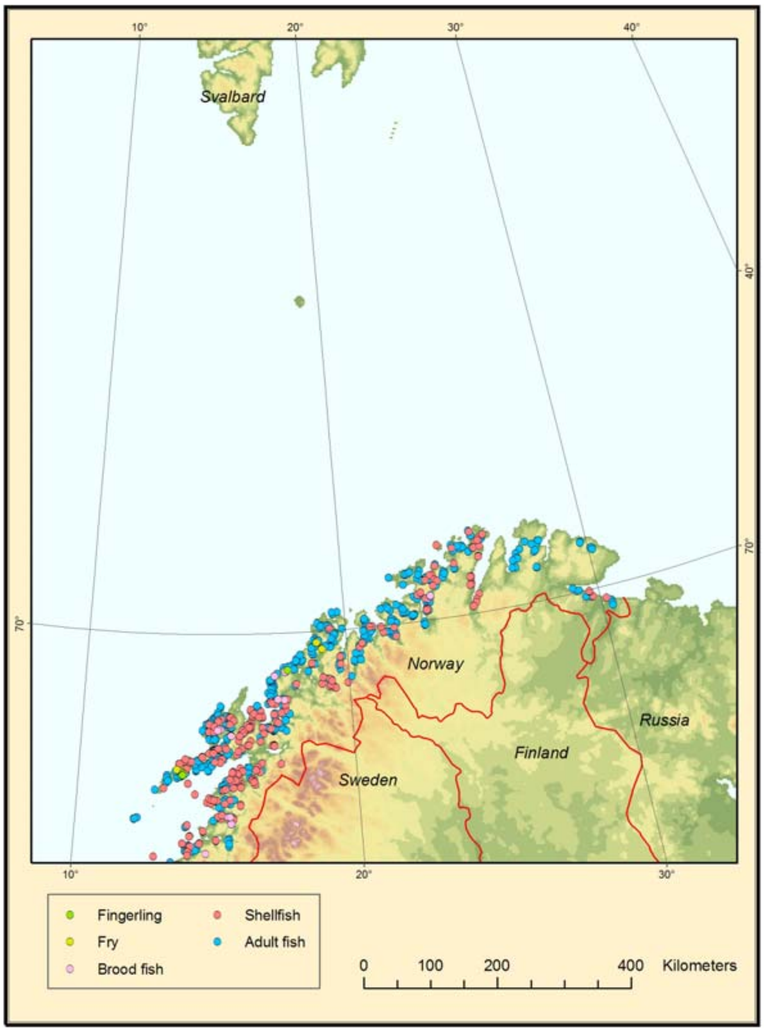


Figure 3.9. Aquaculture locations in the northern part of Nordland, Troms and Finnmark. Source: /46/.

3.4.2 Recreation

Recreation activities in Norway are closely connected to the experience of nature, and this applies to both local recreation and tourism. Through the public property law, the public is ensured the right to free access to outlying field. However, this law does not limit the owner's ability to change the use of the area to home fields, thus preventing the public's ability to use the area as recreation area. For this reason, public authorities have protected several areas for recreational purposes.

For the county of Finnmark mapping and protection of recreational areas has to a little extent been performed. This is partly due to the fact that the county is in governmental ownership. However, due to the characteristics of the nature, most of the coastline is defined to be a recreational area. The experience of outdoor recreation in this area is very closely related to the coastal area and the bird cliffs. Some coastal areas in the county of Troms are protected for the purpose of touring and hiking, bathing, boating, fishing and camping.

Tourism
As for local recreation, tourism in the north of Norway is dependent on the experience of pure and clean environment. Most of the tourism activities in the area are connected to the sea and the coast and associated wildlife.

Cruises in northern Norway and to Svalbard
In the summer season several cruise vessels of different nationalities sail along the Norwegian coast. Usual destinations for the cruises in the northern Norway are Tromsø, Gravdal, Hammerfest and Honningsvåg. In addition, a number of cruises go further north, to the Svalbard region. The ships can sail anywhere, without any need to follow given routes or report their route to the authorities. In spite of this, the Coast Guard usually receives a sailing route in April/May from ships sailing in Norwegian waters the following summer. This is the same information they send when they order a pilot. The ships generally sail in the archipelago along the coast of northern Norway and therefore they usually have a pilot on board. The season lasts from June to the end of August.

The cruises towards Svalbard are in general leaving Tromsø, and enters the waters around Svalbard via Bjørnøya either on the way northward or on the return to Tromsø. The usual route for the cruises is to Longyearbyen/Isfjorden and along the West Coast to Magdalenafjorden. Larger cruise vessels are operating in the area, and about 40 000 cruise passengers visited Svalbard in 2001. In the period 1995 to 2000 around 20 000 to 25 000 cruise passengers visited Svalbard each year (/30/). Number of landing areas has also increased the last years. These areas are however not fully documented.

3.4.3 Human dependency
Approximately 50% of all fishermen in Norway live in the northern part of Norway (/31/). The employment along the coast has always been and is still closely connected and related to the fishing industry. Further growth of aquaculture is also an important basis for the development along the coast in the northern part of Norway. Few other places so far north have a population similar to that of the northern part of Norway. The numerous fishing villages in the area emphasises the value of this development, both as cultural-historical documentation and as a natural business activity.

3.5 Scientific and educational characteristics

3.5.1 Research, baseline and monitoring studies & Education
The Barents Sea area is highly valuable as scientific and environmental reference areas and important in climatic processes and indicators of globally important changes (atmosphere-sea-ice-ocean).

The Norwegian Polar Institute is Norway's central institution for research, environmental monitoring and mapping of the polar regions of the Arctic and the Antarctic. The Institute is the Norwegian authorities' consultant and supplier of knowledge, and contributes to the best possible administration of Norwegian polar areas. Through active participation in national and international bodies, the Polar Institute is central when it comes to protecting national interests in matters of research and the environment. Approximately 120 man-years are employed at the Institute in Tromsø and Svalbard. The institute organises and equip large expeditions in the Arctic region (as well as the Antarctic region) and operates both the research station at Ny-Ålesund as well as the research vessel Lance. The research station at Ny-Ålesund was defined as large scale research facility under the EU research cooperation in 1997 (ref, /47/ - Polar Institute homepage).

The universities of Tromsø and Svalbard are basing their courses on the Arctic environment having the Barents Sea and Svalbard as an important feature of these studies. The /48/, of fishery science has during the years established strong connections to research bodies internationally this including Russia, Japan, USA and Africa. The college has further established an international master programme with extensive exchange of students (http://www.nfh.uit.no/).

Institute of Marine Research (IMR) is Norway's largest research institution. Its main areas of interest include marine resources, marine environment and aquaculture. The main objective of IMR is to provide scientific advice to government agencies, industry and other civic institutions on issues relating to marine science. IMR is the research branch of the Ministry of Fisheries. IMR has more than 500 employees which makes it one of the largest research institutes in the world in this area. Hence, the institute is an international leader in several areas of marine research. The core areas of research at the Institute of Marine Research are marine resources, marine environment, and aquaculture. IMR carries out its monitoring activities by means of fixed oceanographic stations and data acquisition techniques, primarily utilising the Institute's own vessels. A core task of the IMR is to provide, maintain, develop and evaluate time-series of environmental and stock variables in order to be able to provide good, timely advice. The regular time-series forms the basic data for the development of models of the marine climate, fish stocks, marine mammals and the state of the health of the ocean. They also provide essential data for the Institute's research activities. (ref. /49/, http://www.imr.no/).

3.6 Summing up environmentally valuable areas

In the Barents Sea and the northern part of the Norwegian Sea 18 geographical areas have been identified as especially valuable with respect to a predefined set of criteria (Table 4.8). The criteria are produced by major environmental scientific institutions in Norway and are presented by the Institute of Marine Research and the Norwegian Polar institute (/29/). The criteria encompass the same elements as the criteria for PSSA status on oceanographic, ecological, scientific and socio-economic conditions given in IMO resolution A.927(22), ref /4/.

Table 3.8 Criteria for evaluation of marine nature- and culture value (/29/).

Special important criteria	○ Production of biomass	○ High biological production ○ High concentration of species
	○ Bio-diversity	○ High diversity ○ Area of unique / rare species ○ Special habitats ○ Border areas
Complementary criteria	○ Representation of biogeographically-zones, habitats, species and cultural heritage in the area	○ Preserve unique and characteristic representation
	○ Connection between marine and terrestrial environment	○ Level of impact between systems
	○ Rarity	○
	○ Uniqueness	○
	○ Economic criteria	○ Tourism ○ Exploitation
	○ Social and cultural criteria	○ Recreation ○ Ethical value ○ Historical value
	○ Scientific criteria	○ Scientific interesting specie/ecosystem ○ Reference area
	○ Educational criteria	○ Ecological ○ Geological ○ Historical ○ Interactions
	○ Availability	○

In most cases the areas identified have been found to meet one of the two most important criteria (production of biomass and bio-diversity), while other areas comply with complementary criteria. The areas are described below and presented in figure 3.10.

Tysfjorden – Ofotfjorden

The fjords in inner Vestfjorden are important for herring in winter, and also for the connected populations of killer whale, and fisheries. A local population of lobster is also present in Tysfjorden.

Lofoten – Røstbanken – Vesterålen

The area of Lofoten – Røstbanken – Vesterålen is an important wintering area for herring, sea birds and killer whale, spawning area in spring, and as a nursing and/feeding area for fish, sea birds and sea mammals in summer. It is a key area for commercially and ecologically extremely important fish stocks (as cod, haddock and herring). The most vulnerable stages of the life cycle of these stocks are concentrated within a relatively confined area. It is the most important spawning area identified for Arctic cod and haddock and an important spawning ground for herring at Røstbanken. Young herring spend the winter at the continental slope west of Røst – Vesterålen. Lofoten is also important for the production of copepods, especially along the coast, and in retention whirls in fjords and bays. At the edge of the continental shelf large areas of coral reefs are present, some of which are protected against bottom trawling. In addition there are significant concentrations of sea mammals and sea birds and the area is rich in bio-diversity in general. The high biodiversity is a result of valuable and rich benthic fauna and flora in addition to fish, sea mammals and seabirds. Hence, the area represents a high value for different parts of the ecosystem all through the year.

The islands of Røst, Værøy and Bleiksøy have large colonies of nesting birds, amongst other the common guillemot, puffin, black guillemot and eider duck, in addition to several species of cormorant and ducks. Many species spend the winter in the Lofoten – Vesterålen area, and geese are increasingly utilising the area for resting during spring migration.

The area is regarded as a key area of the most important renewable resources and of the coastal areas the one of highest value.

Bleiksdjupet – Andfjorden

The area has a wide range of natural habitats, ranging from shallow water areas to great ocean depths. Bleiksdjupet and Andfjorden are coral reef habitats, and are of great importance as feeding grounds for sperm whales migrating to the Norwegian region.

Balsfjorden

Balsfjorden has its own populations of capelin and herring, and constitutes in many ways its own eco-system. Balsfjorden is therefore important for research, both by Norwegian and international research institutions.

Lopphavet

Lopphavet is a bio-geographical border area between southern and northern arctic species and is therefore important as a reference area for monitoring any changes in the geographical propagation of these. The area has deep sea trenches and coral reefs important as nursing grounds for many fish species. The island of Loppa has an important sea bird colony.

Tromsøflaket:

Tromsøflaket is a bank area on the edge of the continental shelf. In summer Tromsøflaket is a gathering area for larvae and spawn of commercially important fish stocks (cod, haddock, herring, capelin) spawning along the coast in winter/spring. Fish spawn of herring, cod and haddock drift in the Atlantic current to Tromsøflaket where they are collected in large retention whirls in July. This is the most important retention area for cod- and haddock spawn in the area. This signifies that a large proportion of the annual hatch of cod and haddock passes through the area each summer. The northern part of the area is also an important spawning ground for smaller catfish. In addition, the north-west part of the area, which is rich in currents, is a well-known area for sponge, regarded as important for young individuals of many fish species. It is presumed that large colonies of corals, habitats known to have high biodiversity, are present at the edge of the area.

The area is important for several species of fish and is rich in bio-diversity. It is probably important for birds nesting, migrating or spending the winter, although one lacks data for birds in the open sea.

Porsangerfjorden

Porsangerfjorden is a cold water fjord, where the inner parts are unique in their topography, oceanography and ecology. Porsangerfjorden has the only populations of Arctic cod, polar sea-snail and northern eel-cusk along the mainland coast. In addition, eleven species of invertebrates have been identified, and the area is thus unique in a regional and national context. The inner parts of the fjord are important feeding and resting grounds for wading birds and ducks.

Inner Varangerfjord

This is the area in Norway where the highest elements of Siberian bottom-dwelling organisms occur. A total of 44 species of invertebrates are found in this fjord only. The north side of the fjord is an important winter habitat for several species of duck, including Stellers eider which is the rarest of diving ducks in the world, and an estimated 5-10 % of the world population spends the winter in Varangerfjord. The King Crab, migrated from the Kola Peninsula, might have a potential for fishing and therefore presents an economic resource.

The Polar front

The polar front, where Atlantic and Arctic water meets, extends through the Barents Sea from Novaya Zemlya to Bjørnøya, and northwards along the western coast of Svalbard. The polar front changes with season, depending on where the warm Atlantic currents and the cooler polar waters meet, but generally it follows the topography of the ocean floor, especially along the western edge.

An increased primary production of biomass makes the polar front an important feeding area. The polar front is a natural and dynamic bio-geographical borderline, and therefore it is rich in bio-diversity. The meeting water masses result in an increased biological production and are therefore an attractive feeding area for several levels of the food chain. The polar front is the basis for, amongst other, large sea bird colonies in the area Bjørnøya – Storfjorden – Hopen, where Bjørnøya contains some of the largest nesting colonies in the Barents region and in the North Atlantic. It is also a border area for some species not comfortable in some water column strata, for instance some crayfish and fish species. Several of the species present are of national / international preservation value, and / or are on the red list, under special responsibility, key species or indicator species. Examples of these are Brünnich's guillemot, common guillemot and kittiwake. It is an interesting area scientifically, and several research and monitoring programs are ongoing in the area.

The ice edge

The edge of the polar ice cap is special in that it moves from its southernmost latitude of Bjørnøya to its northernmost latitude north of Spitsbergen throughout the year. The ice is most permanently present east of Spitsbergen.

In spring and summer the melting ice creates a stable, although quite shallow, surface layer. As long as sufficient nutrients are present in the water, this layer is beneficial for the primary production of biomass. A short term, intensive production takes place within a zone 20-50 km from the ice edge. The edge of the polar ice cap is therefore an important feeding area, and the population density of many species is high. Seabirds and marine mammals, including the Polar bear, take advantage of the primary production. The ice edge is further the border for any species dependent on the ice cover in parts or the whole of its life cycle. Several of the species in the area are of national and/or international importance, are red listed under special protections, key species or indicator species. Examples are Arctic cod, Brünnich's guillemot, the little auk, black guillemot, ivory gull, several species of seal, walrus, polar bear and species of whale.

The ice edge is a scientifically important area with several research and monitoring programmes and educational institutions use the area frequently. Through the years many ships have been shipwrecked in the area offering an opportunity for exploration.

The Spitsbergen bank

Due to advantageous physical conditions the annual primary production over the Spitsbergen bank is possibly the highest in the Barents Sea and is of vital importance for the regional eco-system. The area is of importance with respect to feeding and growth of several species of fish. It is also an important area for the many large sea bird colonies in the area. Occurrences of Iceland scallop are also found here. A large proportion of the primary production extends to the sea floor, which is reflected in the large benthic biomass present.

The Storfjord area, including Hopen

Storfjorden has the best known coastal polynya, and in addition a semi-permanent polynya is present at Edgeøya. This is one of the areas in the Barents Sea where bottom water is formed. The area around Hopen has a great biomass of capelin. Some 45 % of the total population of Brünnich's guillemot is found here, and several important nesting cliffs exist, such as the Kovalskij cliffs, the Stelling cliff and Hopen. Tusenøyane is a key area for Brent goose. The western and southern parts of Edgeøya and Tusenøyane are important for ducks, polar bears and walrus. Areas of strong currents have distinctive biota. Storfjorden is suggested as a "climatic indicator" due to its physical and biological diversity. Areas important for cultural heritage are also found here.

Nordaustlandet – Kvitøya – Kong Karls Land

Knowledge of the area is sparse, especially regarding the fjords of Nordaustlandet. At the same time these areas are unspoilt and can be important as reference areas. Parts of the area are at times difficult to reach due to the presence of ice. An increased Atlantic influence will probably be seen in certain parts of the area. Large glacial fronts are found due to the heavy ice cover. The area is an important birthing and resting area for seal and walrus. Kong Karls Land is the most important breeding area for Polar bear in this part of the Arctic. An area of smaller nesting cliffs constituting important key biotopes, and the area is an important spawning ground for Arctic cod, which is a key species. The area is part of North East Svalbard nature reservation, which is on UNESCO's list of biosphere reserves.

Kongsfjorden

This area is the best known eco system on Svalbard due to the fact that Ny-Ålesund has long been a centre for national and international research. Several species have been studied over a long period. In this respect the area is important in a global setting. The fjord has also been studied closely with respect to glaciological processes. Several groups of coastal birds are dependent on the area, and the fjord is important for the prawn fisheries. It is also an important cultural site.

Magdalenafjorden

The inner parts of the fjord have a cold water basin with a special fauna and a clear glacial front. The fjord is important for the cruise industry. Any detrimental effects of this traffic should be studied closely.

Widjefjorden

The Widjefjord is a long fjord suitable for studies of longitudinal gradients. It has a cold water basin, and is less affected by human activities than Kongsfjorden and Magdalenafjorden.

Prince Karls Forland

This area hosts the only occurrence of the common / harbour seal on Svalbard, which constitutes the northernmost colony of this species. As the population is small it is prone to external influence. Important sea bird nesting areas and geese and eider duck colonies are found here. The whole of Prince Karls Forland is part of Forlandet national park.

Bjørnøya and vicinity

Bjørnøya has some of the largest nesting colonies in Europe, especially of Brünnich's guillemot and common guillemot. As these populations are quite isolated, they make good indicators of changes of the environment. Studies are ongoing of nesting grounds, benthic communities, and the sea floor fauna. Studies have found that the area is special in that it has extensive areas of shallow water, strong currents, a dominantly hard sea floor, absence of glacial action, some sea ice scouring, and mixing of Arctic and Atlantic waters, resulting in a bottom fauna with few species but high biomass, including a large kelp forest. Bjørnøya, including coastal waters within 4 nautical miles, have recently been declared a nature reservation.

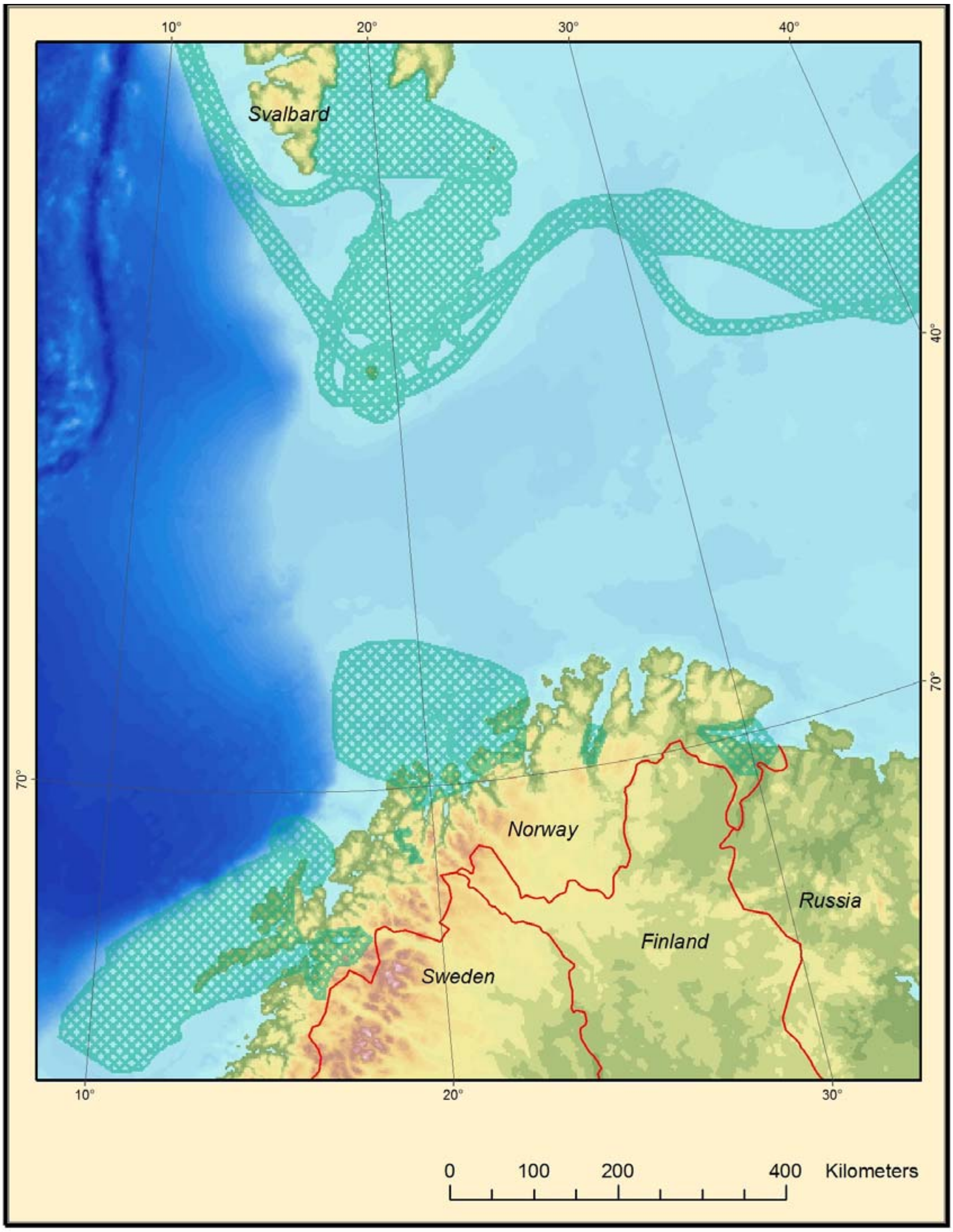


Figure 3.10: Geographical areas in the Barents Sea and the northern part of the Norwegian Sea identified as especially valuable with respect to defined criteria. (Source: /29/).

4 ECOLOGICAL, SOCIO-ECONOMICS AND SCIENTIFIC CRITERIA FOR THE IDENTIFICATION OF THE AREA

In order to be identified as a PSSA, the area has to meet at least one of the ecological, socio-economics and scientific criteria listed in section 4 in the IMO-Guideline and should be at risk from international shipping activities.

The following section describes in which way the area of assessment i.e. the northern part of the Norwegian Sea and the Barents Sea satisfies the specific ecological, socio-economic and scientific criteria given in the IMO Guideline not taking into account risk exposed from shipping activity.

4.1 Ecological criteria

4.1.1 Uniqueness or rarity

The biological production is higher and the animal life is richer in the Barents Sea area compared to other sea areas at the same latitude. The reason is the combination of climate, current system and topographic variation. Due to this the Barents Sea can not be compared with any other marine area in the world. For further reference, see section 3.1 and 3.2.

4.1.2 Representativeness

The Barents Sea is especially representative regarding seabird societies and is one of the most important seabirds regions in the world. The region is regarded as a seabird breeding and wintering area of international importance considering both number of individuals and value of conservation. Important breeding areas for several bird species are located along the Norwegian coast, on Spitsbergen, Novaya Zemlya and the Russian coast. 17 of the 41 largest seabird colonies (with more then 1000 pairs) from Røst and northward are classified as "Important Bird Areas" by Birdlife International. About 3-4 million pairs of seabirds breed in Norway and the majority breeds within the northern part of the country and the area consists of some of Norway's largest bird cliffs, reference is made to section 3.3.4.

4.1.3 Productivity

The ecosystems of the Barents Sea are among the most productive in the world due to the shallow areas and influx of warm water from the south and nutrient rich water from the north. Fish, seabirds and marine mammals are represented in high numbers within the Barents Sea.

More than half of the primary production in the area is "new production". This is possible because of the light condition in the area during summer and the nutrient rich water. The primary production forms the basis of the marine food chain in the Barents Sea, reference is made to section 3.3.1 and 3.3.2.

4.1.4 Spawning and breeding grounds

The Barents Sea has a relatively low number of fish species, but among these are some of the world's largest fish stocks. The stocks of capelin, north-east Arctic cod, Atlanto-Scandinavian herring and haddock are the largest and most important stocks ecologically and economically.

The main spawning grounds and nursing areas of these species are found along the Norwegian coast in the Norwegian Sea and the Barents Sea. Many species that spawn along the Norwegian coast spend parts of the lifecycle within the Barents Sea. The current system results in northward transport of spawning products into fjords and the Barents Sea, giving the juveniles favourable feeding conditions, reference is made to section 3.3.3.

4.1.5 Naturalness

The Barents Sea is characterised by having the largest areas of near-pristine wilderness in Europe, as represented by Svalbard and Bjørnøya. Most of the marine and substantial parts of the terrestrial ecosystems are intact, with undisturbed habitats and vegetation, and viable, un-harvested population of fish, birds and mammals. Such qualities that are of global importance, are becoming exceedingly rare elsewhere, and contribute to making the environment in the region valuable to all of Europe, reference is made to section 3. The costal areas of Norway in the area of the assessment do not pose the same level of naturalness as the northern areas of the Barents Sea. However, they still represent a high level of naturalness and are important for the sustainability of the ecosystems in the area.

4.1.6 Integrity

The ecosystem in the Barents Sea is driven by ecological processes which are dependent on single components functional place in the system. The Barents Sea has a large ecological integrity. If some components in this system are damaged or distorted, the effect may impact the whole system, reference is made to section 3.

4.1.7 Bio-geographic importance

The continental shelves and the inner waters of the northern North Sea is a part of the northeast Atlantic Boreal Region. No other Boreal Region goes so far north. The southern part of the Barents Sea has common border with the Artic Bio-geographic Region. In the border between different bio-geographic regions, it is in general expected a higher number of species because of the overlap between geographical extremity for species from both regions.

In a bio-geographic relation, the area from Lopphavet and east to Sørøysundet, Stjernesundet and Rognsundet are mentioned as very interesting because of the significant changes in the Norwegian marine fauna and flora with a notable decrease in number of species. Lopphavet represents the crossing between West-Norwegian sub-province and the Finnmark sub-province, and is one of the areas along the coast which is recommended high priority from the Directorate for Nature Management reference is made to section 3.

4.2 Social, cultural and economic criteria

4.2.1 Economic benefit

Fishing

The fish resources of the Barents Sea are of high value nationally as well as internationally and are therefore of importance for both national as well as international fisheries. The stocks of

capelin (Atlantic subspecies), north-east Arctic cod and Atlanto-Scandinavian herring are the largest and most important stocks ecologically and economically.
The Barents Sea is the only area that contributes with an equivalent amount as the North Sea, which accounts for some 5 % of the world's total catch, and 20-30 % of the catches in the North Atlantic. The value of fish delivered from the Barents Sea was in 2000 around 6.3 billion NOK, reference is made to section 3.3.3 and 3.4.1.

Aquaculture

The aquaculture industry is of great importance in Norway and is still an increasing industry. The amount of farmed salmon and trout in 2001 was for Nordland (north), Troms and Finnmark counties 86 554 tonnes and had a value of 1.6 billion NOK, reference is made to section 3.4.1.

4.2.2 Recreation

The tourism activity in the Norwegian part of the Barents Sea takes mainly place along the Norwegian northwest coast and towards Svalbard. In the summer season several cruise vessels of different nationalities sail along the Norwegian coast and towards Svalbard. Tourism/Cruises are a relatively new but well established industry in the northern areas and have steadily increased the last 10-15 years. The activity is mainly located near the shore / ice edge with the aim at presenting dramatic, "untouched" natural resources and the ultimate experience. Svalbard is a very famous place for recreation activities due to the "untouched" nature (reference is made to section 3.4.2).

4.2.3 Human dependency

In 2002 about 10 000 individuals living in the counties of Nordland, Troms and Finnmark where listed in the fishery register in Norway. In total they constituted approximately 50% of all fishermen in Norway. Around 70 % of these have fishery as their main occupation (ref. section 3.4.1). The employment along the coast has always been and is still related to the fishing industry. Further growth of aquaculture farming is also an important basis for the development along the coast in the northern part of Norway. The numerous fishing villages in the area emphasises the value of this development, both as cultural-historical documentation and as a natural business activity, reference is made to section 3.4.3.

4.3 Scientific and educational criteria

The Barents Sea area is highly valuable as scientific and environmental reference area and important in climatic processes and indicators of globally important changes (atmosphere-sea-ice-ocean), reference is made to section 3.5. Several research institutions have substantial activity in area and some have the Barents Sea as their main research area.

4.4 Summing up PSSA criteria fulfilment

4.4.1 Especially valuable areas in the Barents Sea and the northern part of the Norwegian Sea

The Institute of Marine Research and the Polar Institute (/29/) have identified 18 areas in the Barents Sea and the northern part of the Norwegian Sea that are especially valuable (figure 3.10). All areas meet one or more of the defined criteria for PSSA status. Of these however, four areas are by IMR & NP (/29/) identified as the most important for production of biomass and bio-diversity and also have a high score according to the IMO criteria. These are:

1) Lofoten – Røstbanken – Vesterålen

2) Tromsøflaket

3) The Polar front

4) The ice edge

Any negative influence on these areas can cause severe and long term detrimental effects on the whole region of Lofoten – Barents Sea (/29/). Figure 4.1 presents the geographical extension of these areas.

The overall fulfilment of the area of consideration to the IMO criteria is given in table 4.1. Table 4.2 lists criteria met for each of the 4 areas given by IMR & NP (/29/).

Table 4.1. Summary of the fulfilment of the Barents Sea – Lofoten area to the criteria of PSSA status according to IMO Resolution A.927(22), ref /4/.

Criteria in Res. A. 720(17)	General compliance to criteria
Ecological conditions (wrt §4 of Res a.927(22))	The ecosystems of the Barents Sea are among the most productive in the world due to the shallow areas and influx of warm water from the south and nutrient rich water from the north. Fish, seabirds and marine mammals are represented in high numbers within the Barents Sea. The Barents Sea is characterised by having the largest areas of near-pristine wilderness in Europe. Most of the marine and substantial parts of the terrestrial ecosystems are intact, with undisturbed habitats and vegetation, and viable, un-harvested populations of fish, birds and mammals. The area holds protected or proposed protected at international level due to the existence of vulnerable populations of seabirds and marine mammals. Areas are also protected or proposed protected to preserve relatively pristine ecosystems. Within the Barents Sea there are populations of seabirds, fish and marine mammals feeding upon plankton or plankton feeders, regarded as of international conservation value. Many of these species are given to be vulnerable according to stock sizes. The plankton communities located along the ice edge in the Barents Sea and within gyres over shallow bank areas are hence crucial for the ecosystem in the area.
Socio-economic	The Barents Sea has some of the world's largest fish stocks. More than

conditions (wrt §4 of Res a.927(22))	50% of all fishermen in Norway live in the northern part of Norway. The employment along the coast has always been and is still related to fishery industry. Further growth of aquaculture is also an important basis for the development along the coast in the northern part of Norway. The numerous fishing villages in the area tell a lot about the importance of this development, both as cultural-historical documentation and as a natural business activity. Tourism is also very important and increasing.
Scientific conditions (wrt §4 of Res a.927(22))	The Barents Sea area is highly valuable as scientific and environmental reference areas and important in climatic processes and indicators of globally important changes (atmosphere-sea-ice-ocean).
Vessel traffic(wrt §5 of Res a.927(22))	Vessel traffic was earlier dominated by fishing vessels with local distribution of bunker oil with small coastal tankers as the most important environmental risk. The traffic is located in near shore areas. However fisheries also occur in the central part of the Barents Sea along the continental edge. Increased Russian export of crude oil and heavy fuel oil has caused a significant growth in tanker traffic the last three years. More than 200 vessels transited the area in 2003. This traffic is expected to increase to more than 600 tankers in 2015 with average size going up from less than 50 000 dwt in 2002 to more than 150 000 dwt. The Russian traffic is located close to the Norwegian coastline and passes through areas with high density of fishing vessels. Export of oil and gas from the Norwegian sector of the Barents Sea and Norwegian Sea will cause a further growth in tanker traffic from 2006. Production scenarios developed by the Ministry for Oil and Energy indicate that between 400 and 700 crude and gas tankers will be involved in this export in 2015. In addition cruise traffic and general cargo is expected to grow by 5- 10 % in the next 10 – 20 years.
Oceanographical conditions (wrt §5 of Res a.927(22))	The ocean currents increase the risk of damage to the sea from discharges caused by accident or regular operations. Because of the current system in the Barents Sea the discharge will follow the current system along the coast or to the very sensitive area in the north. The ice-edge ecosystem is typical for the Barents Sea, and regarded as very sensitive for impact specifically oil spills. The occurrence of ice is further known to affect the contingency actions.

Table 4.2. IMO Resolution A.927(22) (ref /4/) criteria met by area identified as of high value within the Barents Sea – Lofoten area.

Criteria in Res. A. 720(17)	Area specific compliance to criteria
Ecological conditions (wrt §4 of Res a.927(22))	
Uniqueness	The Polar front The ice edge
Critical habitat	Lofoten – Røstbanken – Vesterålen Tromsøflaket The Polar front The ice edge

Dependency	The Polar front The ice edge
Representativeness	Lofoten – Røstbanken – Vesterålen Tromsøflaket The Polar front The ice edge
Diversity	Lofoten – Røstbanken – Vesterålen Tromsøflaket The Polar front The ice edge
Productivity	Lofoten – Røstbanken – Vesterålen Tromsøflaket The Polar front The ice edge
Spawning / breeding ground	Lofoten – Røstbanken – Vesterålen Tromsøflaket
Naturalness	Lofoten – Røstbanken – Vesterålen Tromsøflaket The Polar front The ice edge
Integrity	The Polar front The ice edge
Vulnerability	Lofoten – Røstbanken – Vesterålen Tromsøflaket The Polar front The ice edge
Biogeographical importance	The Polar front The ice edge
Socio-economic conditions (wrt §4 of Res a.927(22))	
Economic	Lofoten – Røstbanken – Vesterålen Tromsøflaket
Recreation	Lofoten – Røstbanken - Vesterålen
Human dependency	Lofoten – Røstbanken – Vesterålen Tromsøflaket
Scientific conditions (wrt §4 of Res	Lofoten – Røstbanken – Vesterålen

a.927(22))	Tromsøflaket The Polar front The ice edge
Vessel traffic(wrt §5 of Res a.927(22))	
Operational factors	Fulfilled by the area proposed as PSSA.
Vessel types	Fulfilled by the area proposed as PSSA.
Traffic characteristics	Fulfilled by the area proposed as PSSA.
Harmful substances carried	Fulfilled by the area proposed as PSSA.

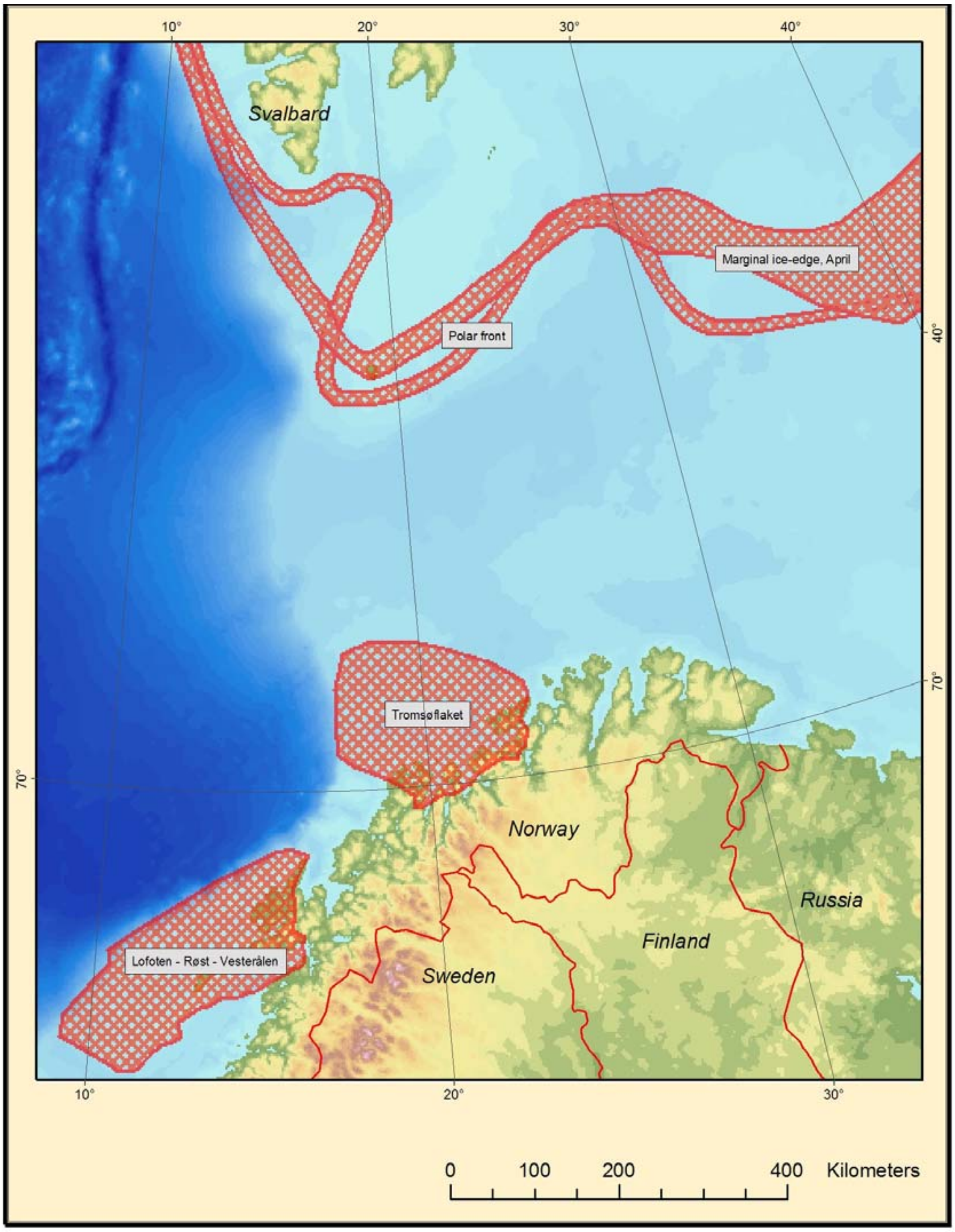


Figure 4.1: Prioritised valuable areas in the Barents Sea and the northern part of the Norwegian Sea. (Source: /29/)

5 CHARACTERISTICS OF THE MARITIME ACTIVITIES IN THE AREA

5.1 Vessel traffic today

The maritime activity in the northern Norwegian Sea and the Barents Sea area consists of:

- transport of wet bulk related to local distribution of fuel and hydrocarbon export from Russia (assumed to increase in the future)
- transport of dry bulk, general cargo and containers (assumed to increase in the future)
- fisheries (assumed to remain stable)
- cruise vessels / passenger vessels - tourism, including whale watching, (assumed to increase in the future)
- transport of vessels for scrapping (assumed to increase in the future)
- icebreakers and tugs (although small in the Norwegian part of the Barents Sea it is assumed to increase due to overall increase in maritime traffic)
- research and other vessels (assumed to remain stable)

Major navigation routes are located east – west along the Norwegian coast and north – south between Norway and Svalbard along the continental shelf as given in Figure 5.1.

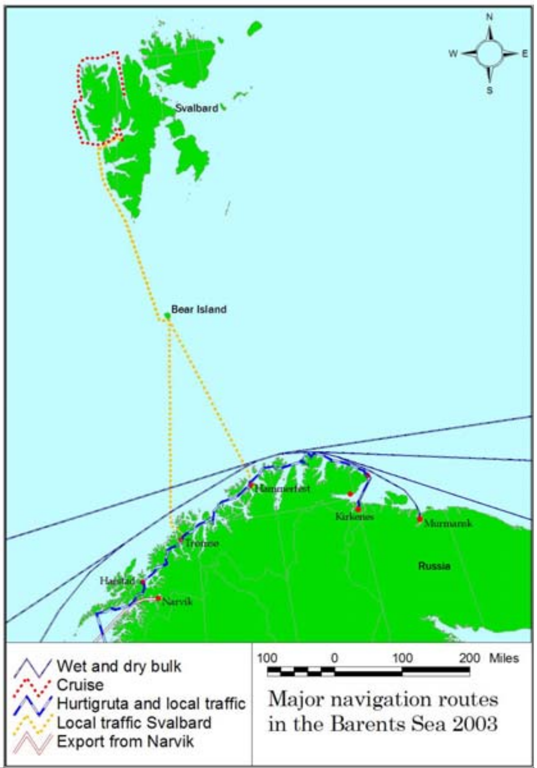


Figure 5.1 Major navigation routes in the Barents Sea area, 2003

5.1.1 National traffic

Quantified in sailed nautical miles the national traffic in 2003 along the Norwegian coast and Svalbard is mainly fishing vessels (Figure 5.2). Distance sailed by fishing vessels include fishing and transport activities. Passenger vessels include local ferries, high-speed crafts and cruise vessels. Local tankers are involved in local distribution of fuel and petroleum by small tankers (less than 10 000 dwt).

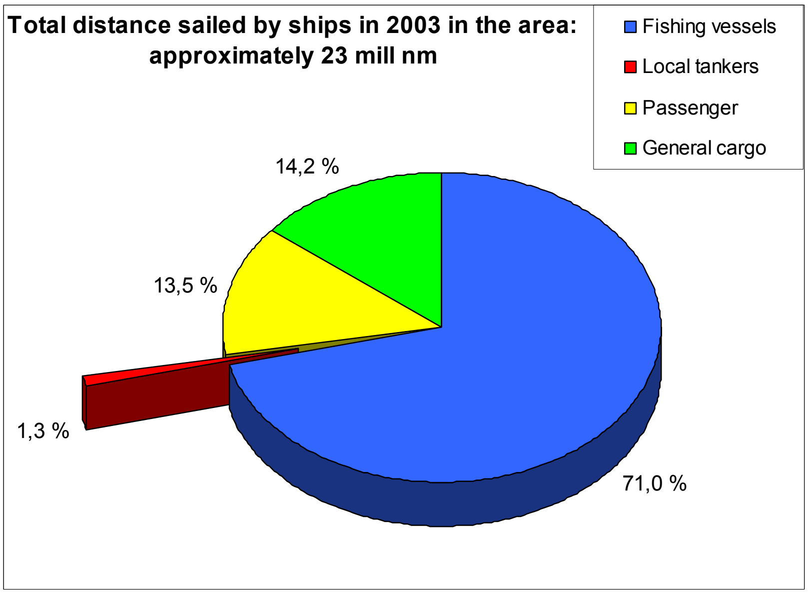


Figure 5.2 Number of nautical miles sailed by ship categories along the coast of northern Norway. Figures for fishing vessels include only ocean-going vessels (length > approximately 20 m). Figures generated based on data from /56/ and /51/.

All fishing vessels larger than 24 meter are tracked by satellite from 2000 sending their position, direction and speed to the Directorate of Fisheries. Figure 5.3 presents the number of vessels reported with speed less than 4.5 knots (assumed fishing) for each four quarters. Data includes vessels from EU, Russia, Iceland, the Faeroe Islands, Greenland and Poland when they are in the Norwegian economic zone.

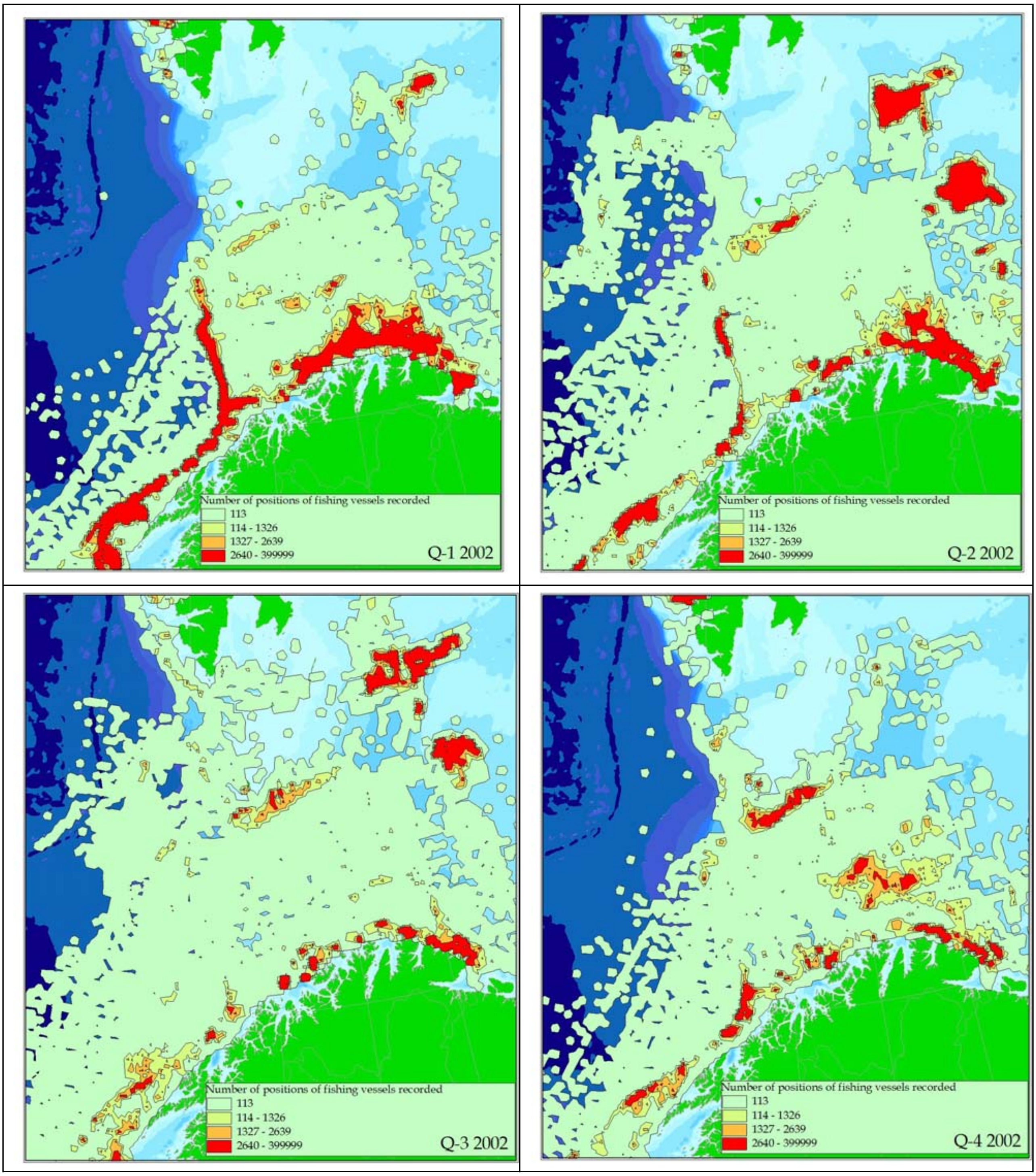


Figure 5.3 Distribution of fishing vessels in the Barents Sea in 2002. Map generated based upon data from Directorate of Fisheries /15/.

Major ports are Narvik with export of ore from Sweden and Tromsø (dry bulk and general cargo). Tromsø is the largest port measured in number of vessel calls (size > 1000 grt, Figure 5.4), while Narvik is by far the largest in cargo volume (Figure 5.5).

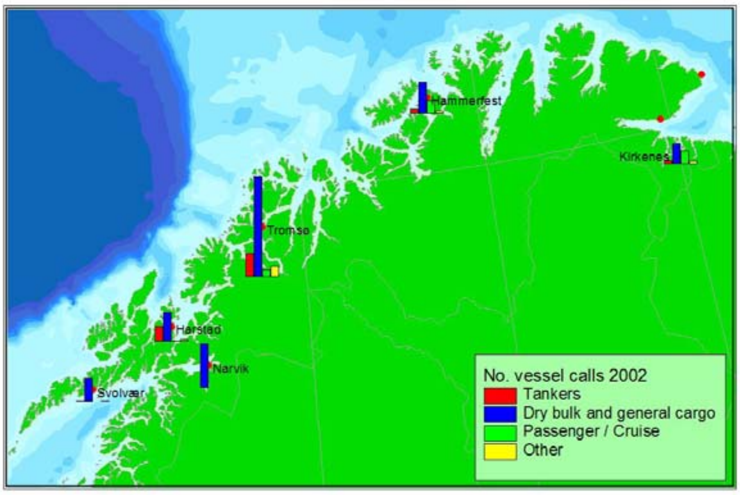


Figure 5.4 Number of calls of vessels (> 1000 grt) operated by Norwegian companies in 2002 (Statistics Norway, 2003) in major ports.

Harbour	No. Vessel calls 2002. All types of vessels larger than 1000 brt.
Longyearbyen	23
Kirkenes	229
Hammerfest	301
Tromsø	801
Harstad	260
Narvik	227
Svolvær	140

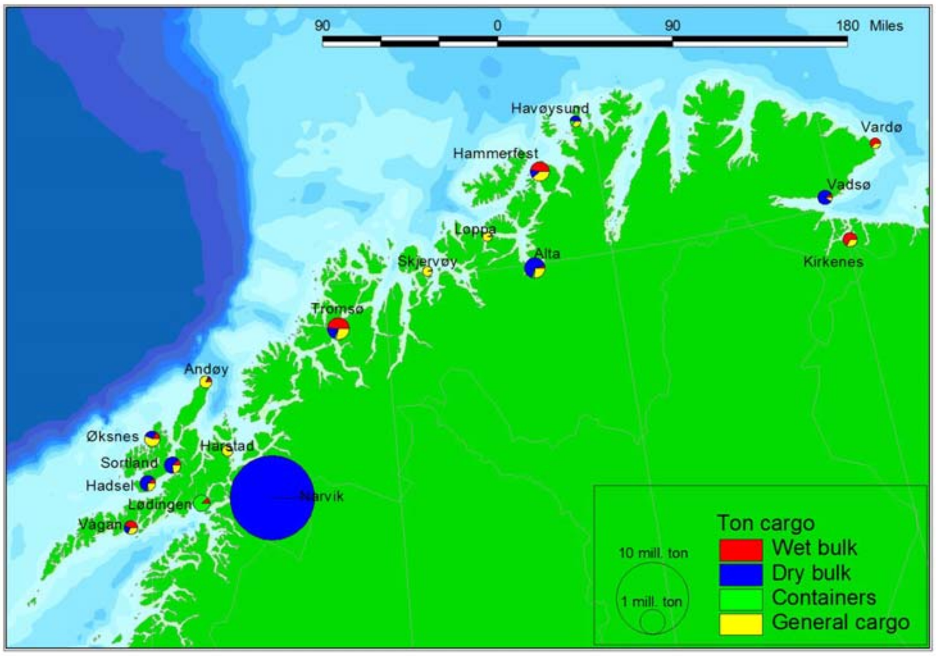


Figure 5.5 Tons of cargo from and to harbours in northern Norway, (Statistics Norway, 2003 and LKAB homepage)

Total dry bulk export from Norway is 38 mill. metric tons where approximately 13 mill tons is constituted by ore from Narvik exported by 240 vessel calls annually (average size approximately 50 000 dwt).

The Norwegian Coastal Voyage (Hurtigruta) is the most frequent cruise/passenger traffic in this area with daily calls to 10 harbours in the area.

Table 5.1 presents port of calls of main ship types in the counties of Nordland, Troms and Finnmark in 2001 by ship type. The port of calls of general cargo and fishing vessels constitute the major part of port of calls.

Table 5.1 Port call of international non-military vessels (2001). Source: /13/.

County	General cargo	Tanker	Passenger / Cruise	Fishing vessels	Other	Sum
Nordland	2 270	116	105	94	72	2 657
Troms	925	39	79	481	70	1 594
Finnmark	874	26	133	1 373	182	2 588
Sum	4 069	181	317	1 948	324	6 839

5.1.2 Traffic to Svalbard

Cruise traffic to Svalbard (Table 5.2) is expected to grow. In addition to calls of large cruise vessels there are 17 – 19 smaller local cruise vessels based in Longyearbyen. All cruise vessels visit several harbours (Barentsburg, Ny-Ålesund) and sites along the coast.

Table 5.2 Cruise traffic to Svalbard, Sysselmannen Svalbard, pers comm., 2003.

Year	International Cruise (no. calls)	Local cruise traffic (no. vessels)
2001	41	19
2002	33	17
2003	41	17

More than 90% of the traffic to Svalbard takes place during June, July and August. Total number of calls is approximately 350 mostly by smaller vessels. The largest vessels export coal for Store Norske.

5.1.3 International traffic

International traffic in the Barents Sea and northern part of the Norwegian Sea is mainly vessels going to and from Russian ports such as Murmansk, Arkhangelsk and Kandhalaksha. The last two years this traffic has been dominated by small tankers (15 000 – 30 000 dwt) exporting oil and fuel. This export is growing relatively fast causing an increase in the frequency of calls (Figure 5.6) as well as the average size of vessels (from approximately 25 000 dwt in 2001 to more than 50 000 dwt in 2003).

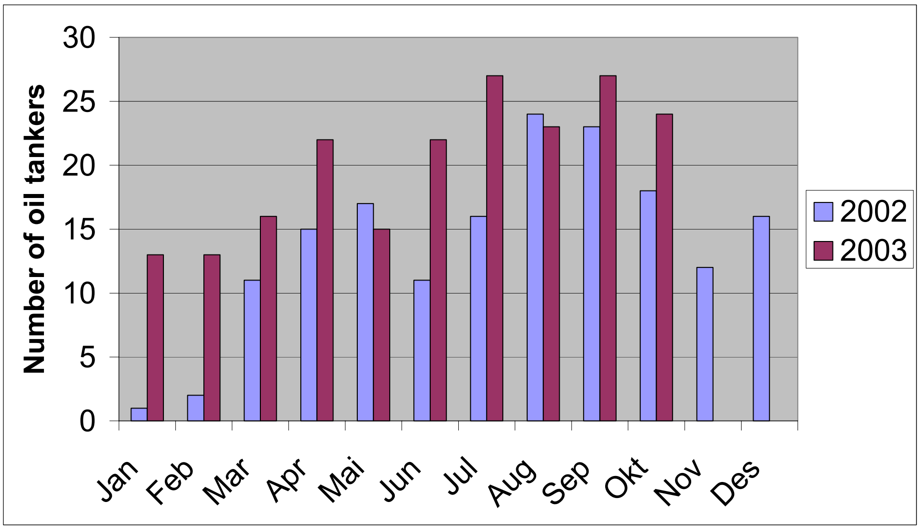


Figure 5.6. Number of tankers transporting oil from Russian ports in 2002 – 2003. Norwegian Navy, pers comm., 2003.

Names and data of ships involved in transport of oil in 2002 have been compiled by Norwegian Navy (Table 5.3).

Table 5.3 Age and size distribution of ships transporting oil from Murmansk and other northern Russian ports in 2002. Norwegian Navy, pers comm., 2003

Size (dwt)	Average year	Average size (dwt)	No. of ships	No. single hull	No. with ice class	No. double hull (1)
≤ 30.000	1994	18 192	30	10	14	5
> 30 000	1996	84 132	8	1	0	7

1 – Missing data for some ships

The petroleum volume transported in 2002 is presented in table 5.4.

Table 5.4 Volume of petroleum products transported from Russian ports in 2002 (/50/).

Port	Volume transported
Vitino	2.8 mill. tons
Archangelsk	2.0 mill tons
Varandey oil terminal	0.24 mill tons
Kolguev	0.12 mill tons
Murmansk	0.6 mill tons
Ob – Enisey area	0.1 mill tons gas/condensate

5.1.4 Seasonal variations

In areas of little or no ice coverage as the Norwegian part of the southern Barents Sea the shipping activity has a regular pattern with only minor seasonal variations. Seasonal variations are mainly caused by distribution of fishery resources (Figure 5.3) and prevailing ice conditions. Ice conditions are important for Russian oil export from the White Sea and Pechora-area, and for traffic to Svalbard. In the most ice-exposed areas, the shipping activity is regulated. However, operating experience has shown that ice and weather conditions are very variable from year to year as well as within season.

In many cases the use of icebreaker escort is necessary or instructed. A major part of maritime activities within and in and out of ice-infected areas is performed in the warmer period of June – October due to dense drifting ice and solid ice in November – April (Brude et al 1998 and Mikhailichenko & Ushakov 1992). This is expected to be the situation for the Russian sea areas including traffic in and out of this area. Hence transiting traffic to and from Russia through Norwegian Sea areas have varied accordingly.

5.1.5 Fisheries

Fisheries in the northern areas are mainly undertaken in the ice-free areas of the North East Atlantic, of which the Barents Sea represents an import source of exploitation and contribute to a considerable amount of the total global fisheries. The activity is dependent upon the availability and distribution of resources and shows large seasonal variations on a local scale.

A major part of the fishing fleet consists of smaller vessels (less than 30 metres) mainly active in near shore areas (Figure 5.7). Data on such fisheries are often not included in general statistics, but are known to contribute to a substantial part of emissions to air and waste generation. The larger vessels (larger than 30 metres) are mainly used in open water and are often included in national and international statistics.

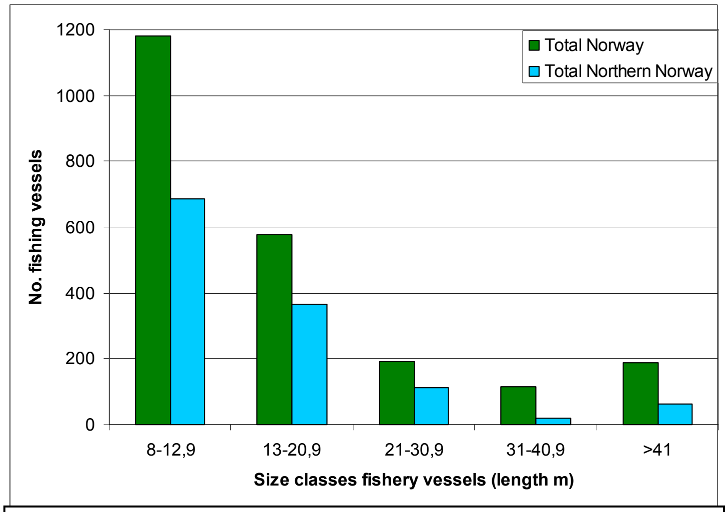


Figure 5.7 Size distribution of Norwegian fishery vessels. Source: /52/.

5.1.6 Tugs, Research and Icebreakers

Towage operations are supportive activities associated to beside that of escort also to manoeuvring, port operations, barge handling and occasionally towage of vessels for scrapping. At present the latter is not a major activity, however the activity is assumed to increase, among others due to the scrapping of military vessels in Russia. The experience in long distance towing varies and has in several cases resulted in losses, e.g. the *Murmansk* and *Boiky* outside the northern coast of Norway.

The Barents Sea area and its coastline are used for research purposes and vessels used for this purposes are mainly active in the "open sea" period. The activity is relatively small and does not amount to any volume compared to other maritime traffic.

The use of icebreakers is limited in the area due to favourable weather and ice conditions in the southern part of the Barents Sea allowing maritime activities in open water.

5.2 Expected future trends

Activities involving LNG/LPG*, seafood, cruise traffic and export of oil from Russia are expected to cause a growth in the ship traffic in the area considered. In the perspective of potential harm to the environment, transport involving hydrocarbons is considered the most important.

5.2.1 National traffic

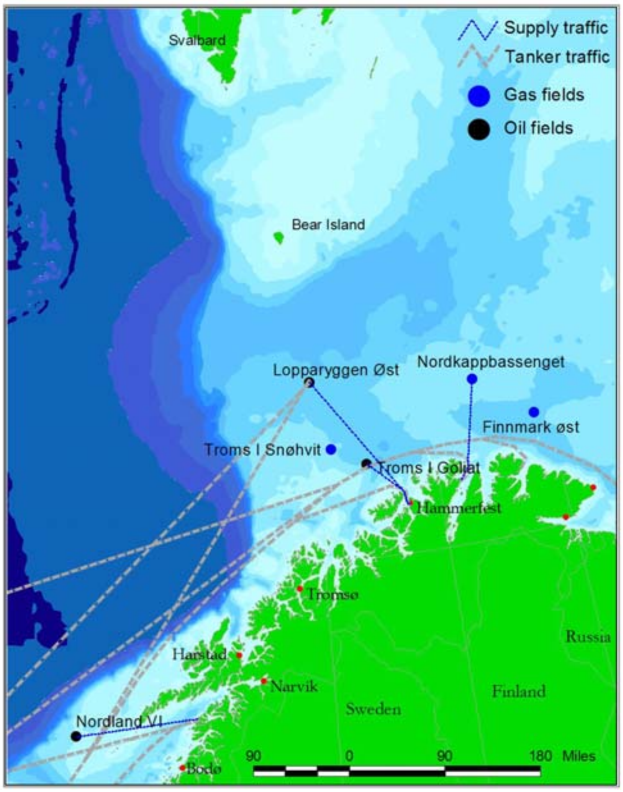
The production of LNG/LPG from the field Snøhvit outside Hammerfest is planned to start in 2006 causing approximately 90 calls at the coastal terminal annually. Hydrocarbons have been found, but are still not proved to be commercially exploitable at several locations within the area. The Government decided in 2003 to allow for further all-year petroleum activity in the Barents Seas south, except in certain especially valuable areas. The Government also decided not to continue further petroleum activities in the area Nordland VI outside Lofoten. This question will again be considered when the integrated management plan for the Barents Sea is completed.

Ship traffic in connection with export of petroleum is expected to increase from the Norwegian section of the Barents Sea as indicated in Figure 5..8 (only tankers). In addition there will be an increase in shipping due to contingency (standby) and supply vessels. Number of supply vessel calls to the fields is estimated to be between 50 and 150 annually.

Size distribution used in estimates is:

- Export oil tankers: 100 000 dwt, 170 000 dwt, 280 000 dwt
- Shuttle tanker 100 000 dwt
- LNG 135 000 dwt
- LPG/Condensate ship 28 000 dwt

* LNG: Liquid natural gas, LPG: Liquid petroleum gas



Field name	Type	Export harbour	Production
Snøhvit	LNG/LPG	Land	164 bill. Sm^3
Nordkapp-bassenget	LNG/LPG	Land	85 bill. Sm^3
Finnmark Øst	LNG/LPG	Land	100 bill. Sm^3
Nordland VI	Oil	Land	50 mill. Sm^3
Lopparygg en Øst	Oil	FPSO*	100 mill. Sm^3
Goliat	Oil	FPSO	10 mill. Sm^3

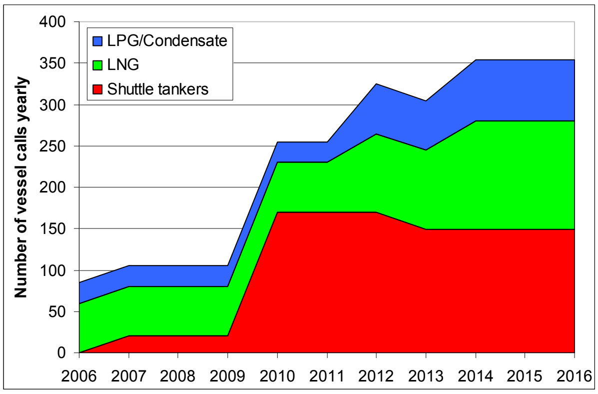


Figure 5.8 Oil and gas fields in Norwegian sector as identified by the Ministry of Oil and Energy in the *Medium activity* scenario (/55/)

The average fishing activity given as catch/year is expected to be stable and located more or less to the same areas as present. This is related to availability of fish stocks and the general natural variation as such. Number of fishing vessels has declined the last ten years and is assumed that this trend will continue to some extent. Fishing activity quantified in nautical miles is assumed to be either stable or be reduced down to 5%.

Tourism in general is an increasing business among others due to increased availability of targets, increased leisure time and improved economical status. The activity is expected to increase (5 – 10%) in the Barents Sea area in the future.

5.2.2 Russian export of oil

Russian oil export has increased by 10% annually the last 4 years and is now second largest in the world after Saudi Arabia. The growth will continue partly because of oil exploration in Timan – Pechora area and west Siberian. More than 200 oil- and gas fields were identified by the Russian Ministry of Transport in 2001 (/57/). Several studies (/50/, /51/, /53/) have estimated the

* FPSO: Floating Production, Storage and Offloading unit

annual production potential in this region to more than 110 million metric tons in less than 10 – 15 years depending on export capacity.

Up until 2001 most of the oil and fuel exported (1 – 2 million tons) came from ports in the White Sea which is shallow and where ice problem hamper export during winter. Oil was transported from oil fields on land to the ports by train. Small (10 000 – 30 000 dwt) ice classed tankers transported the oil to European ports.

New trends in 2002 and 2003 are expected to encompass the following actions:

- Oil from the small tankers coming from the White Sea will be transferred to larger tankers in Murmansk.
- Several export terminals will be established in the White Sea and the Timan/Pechora area.

Taroveysk is the largest oil field so far on Varandey and was started in 2000 with 4 mill tons as planned production rate in 2005. Export will be undertaken by ice classed tankers (20 000 dwt) to Murmansk or other ice free ports. According to Lukoil (http://www.lukoil.com) total export from Varandey is planned to be 12 mill tons/year. Oil produced in west Siberian is planned to be exported by pipeline to Murmansk. Capacity of the pipeline is, according to several sources, planned to be between 50 and 100 mill tons/year.

Production at the offshore oilfield of Prirazlomnoye in Pechora approximately 60 km from land will start in 2005 with plateau production around 8 mill tons/year (http://www.rosneft.ru/english/projects/index.html). Transport will be by shuttle tankers (40 000 – 60 000 dwt) to ice free ports in the Murmansk – Kirkenes area.

In addition to export of oil, there will probably be some export of gas and condensate by smaller vessels. Several large gas reservoirs have been found in the area where Schtockman is the largest. Most of the gas and condensate is planned exported by a pipeline to Europe through the Baltic Sea, but it is assumed that some export will be undertaken by ships.

In total the identified export potential of petroleum products in 2015 is quantified to be around 110 mill tons. It is assumed that the export will be split into

- 80 mill tons oil,
- 20 bill. Sm^3 gas and
- 1 mill Sm^3 LPG/condensate.

The most important export routes are by vessels from the Baltic Sea and the Black Sea (through the Bosporus Strait), and pipelines to Europe. The traffic in the Bosporus is now extremely heavy and most important future alternatives are by vessels from the Baltic Sea, the Barents Sea and the Adriatic Sea. New pipelines to Europe and Asia are also under consideration. Export from northern Russia to the east will be from other oil fields and will not reduce the export to the west through the Barents Sea.

Total traffic in 2015 is estimated to be 656 ships with size distribution as presented in Table 5.5.

Table 5.5 Assumed size distribution of tankers involved in export from Russia through the Barents Sea in 2015.

Ship type	No. ships
Oil tanker 100 000 dwt	320
Oil tanker 180 000 dwt	150
Oil tanker 280 000 dwt	86
LNG tanker 100 000 dwt	60
LPG/condensate 25 000 dwt	40
Total number of ships	**656**

5.3 Estimated traffic in 2015

Increased number of tankers and average size of tankers is the most important change in the traffic picture in 2015 (Table 5.6, Figure 5.9) compared to 2003 (Figure 5.2).

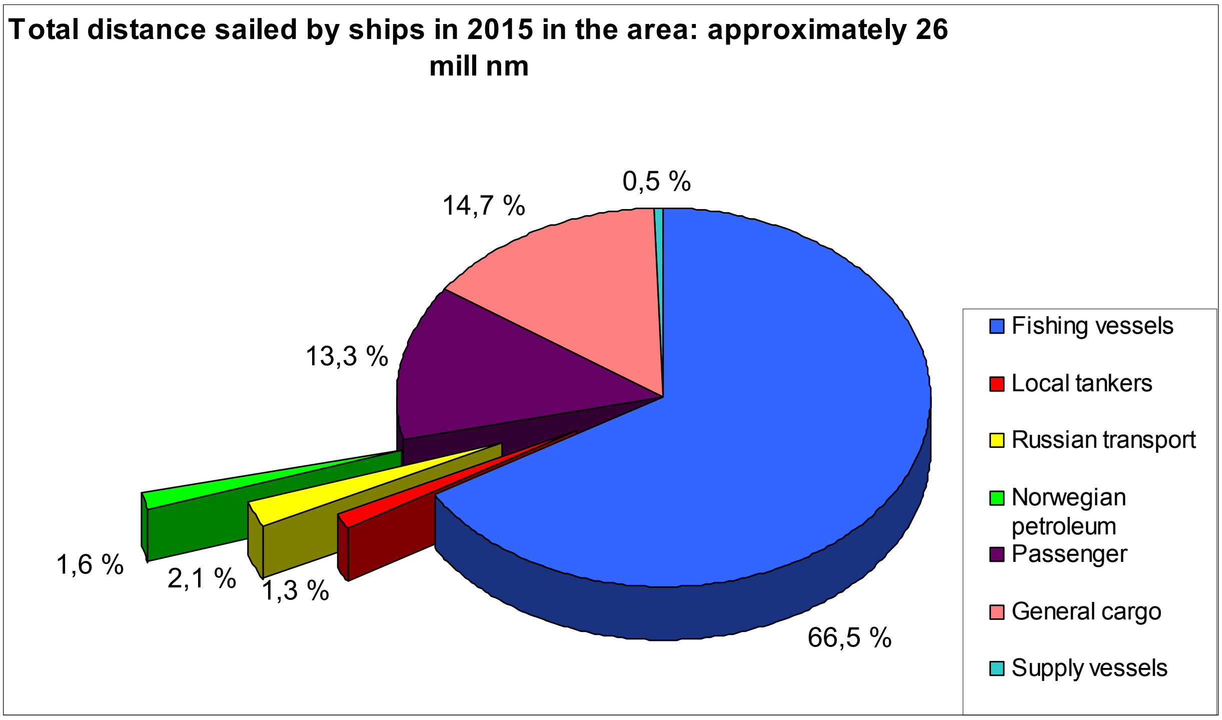


Figure 5.9 Sailed distance by categories of traffic in 2015. Figures generated based on data from /51/, /56/.

Table 5.6 Estimated traffic in the Barents Sea and northern Norwegian coast in 2015. - = No or small change compared to 2003.

Traffic category	Size (dwt) / Ship type	No. calls (2015)
Norwegian petroleum export	100 000 dwt	170
	200 000 dwt	63
	100 000 dwt LNG	130
	25 000 dwt LPG/condensate	53
Russian petroleum export	100 000 dwt	320
	180 000 dwt	150
	280 000 dwt	86
	100 000 dwt LNG	60
	25 000 dwt LPG/condensate	40
Supply vessels	Goliat oil	60
	Lopparyggen Øst (oil)	150
	Nordkappbassenget Gas	50
	Nordland VI Oil	150
Local distribution fuel	-	-
Fishing vessels	-	-
Local cargo Norway	-	-
Passenger	Ferries	-
	Cruise Norwegian coats	-
	Cruise Svalbard	-
	Local cruise Svalbard	-
	Speed crafts	-

6 RISK ASSESSMENT RELATED TO THE MARITIME ACTIVITIES IN THE AREA

6.1 Introduction

An assessment of the accidental risk of vessels trading in the Barents Sea and northern parts of the Norwegian Sea has been undertaken focussing on the traffic in connection with the potential new oil and gas fields in the Norwegian economical zone and the transiting traffic from Russia to the continent and the US. The methodology applied is according to the FSA (Formal Safety Assessment) methodology approved by the IMO. The risk is calculated for the year 2015 by which it is believed that the oil and gas fields will be operational.

The risk assessment includes risk related to crude oil transportation by tankers and bunkers oil for tankers in ballast and gas and supply vessels in terms of:

- frequency of accidents per year within the defined geographical area
- frequency of accidents with oil discharge per year, including amount (discharge rate and duration) of discharged crude oil and/or bunkers

6.1.1 Limitations and uncertainties

The risk assessment does not include unlawful acts such as terrorism, piracy, sabotage.

The risk assessment is carried out using models and generic statistics and should not be taken as an exact description of the vessel traffic risk, especially as some of the scenarios are modelled on the conservative side.

The traffic level in 2015 is uncertain and the level selected in this report is one of many possible scenarios. The risk is directly dependent of the level of traffic and will increase or decrease according to any changes in the traffic pattern.

The risk of the existing traffic has not been assessed, but results from existing reports have been described briefly.

6.1.2 Basic Assumptions

In order to carry out the risk assessment, a number of assumptions were made as described below.

Tankers for oil

- All tankers trading in the area will have double hull by 2015. Single hull tankers are to be phased out at the latest by 2015 according to IMO.
- 3 vessel sizes have been selected as suitable to reflect the future traffic in the area:
  VLCC: 283 000 dwt, average cargo tank capacity 20 000 tons
  Suezmax: 160 000 dwt, average cargo tank capacity 12 000 tons
  Aframax: 105 000 dwt, average cargo tank capacity 8 500 tons
- All tankers operate at an average of 4 000 hours per year at 12 knots

Other vessel traffic

- The storage capacity of a fuel oil tank is 2 000 tons. The fuel tanks are assumed always to be located in wing tanks and always to be full.

6.1.3 Abbreviation

The following abbreviations are used in the risk assessment description.

AIS	Automatic Identification System
ARPA	Automatic Radar Plotting Aids
CCT	Centre Cargo Tank
dwt	Dead weight ton
ECDIS	Electronic Chart Display and Information Systems
FSA	Formal Safety Assessment
GPS	Global Positioning System
LRFP	Lloyd's Register Fairplay
MARPOL	International Convention for the Prevention of Pollution from Vessels
nm	Nautical miles
VLCC	Very Large Crude oil Carrier
VTS	Vessel Traffic Services
WCT	Wing Cargo Tank

6.2 The current risk picture

The main focus of the risk assessment has been to quantify the risk associated with the traffic in 2015, i.e. including the increased traffic from Russia and from the potential new oil fields in the Norwegian economical zone.

A new assessment of the existing traffic has been performed. The following section gives a short presentation of the current risk picture (2002) in the area as given in /37/. The risk picture is based on the current traffic in the area, but excluding all tanker traffic already started to and from Russia. The risk picture as presented in /37/, is based on actual accident recordings over the period from 1991 – 2001. The numbers include vessels of all sizes. However, little is recorded regarding the severity of the given accidents.

The recorded accident data shows that in average 16.6 accidents have occurred annually along the Norwegian coast of the Barents Sea. The dominating accident type is grounding which amounts to over 70% of the incidents, followed by collision representing about 13% of the incidents. The accident consequences vary from minor damages (with little cost and environmental impact) to very severe damages (with loss of lives and environmental damage). The majority of the accidents have minor consequences.

The official pollution statistics as referred to in /37/ shows that there are in average 2.6 bunkers or diesel oil spills annually along the Norwegian coast of the Barents Sea. The spills are in volume less than 50 tons and are thus labelled as small spills. The spills are mainly evenly distributed along the coast, but there is a slight tendency for the spills to be in the southern most part of the area, as this area has a higher traffic density.

6.3 Risk reducing measures

In this section, risk reducing measures that are highly likely to be implemented by 2015 (and that has thus been included in the risk analysis) are described.

The risk reducing measures do only include measures that today are believed to be implemented (i.e. realistic measures). It is likely that new risk reducing measures are available and deemed realistic by 2015, but this has not been discussed nor included in this report.

6.3.1 Extension of territorial waters

The limit of the Norwegian territorial waters has been decided extended from 4 nm to 12 nm. The new boundaries entered into force by 1st January 2004.

In the Norwegian territorial waters, Norwegian regulations apply and therefore traffic lanes may be introduced. This results in a potential for imposing measures improving traffic control, e.g. by introducing mandatory ship lane systems forcing vessels further away from the coastline.

The increased limit of the territorial waters will not in itself have a risk reducing effect, but is vital for the effect of some of the options discussed later in this section, e.g. traffic separation and placement of tugs.

6.3.2 Electronic Chart Display and Information System

Electronic Chart Display and Information System (ECDIS) is a navigation aid that can be used instead of nautical paper charts and publications to plan and display the vessel’s route, plot and monitor positions throughout the intended voyage.

ECDIS is a real-time geographic information system. It is capable of continuously determining a vessel’s position in relation to land, charted objects, navigational aids, possible unseen hazards, and represents a new approach in maritime navigation. In daily navigational operations, it reduces the workload of the navigating officers compared to using paper charts. Route planning, monitoring and positioning are performed in a more convenient and continuously real time way, enabling the navigator to have a continuous overview of the situation.

ECDIS is a sophisticated electronic navigation system, which may be integrated with both the radar system and Automatic Identification System (AIS). ECDIS is thus a powerful navigational tool, which has proved to have a very good risk reducing effect.

ECDIS has been assessed and found to represent a direct risk reducing effect on power grounding /36/. Historical frequencies are mainly based on accidents with vessels without ECDIS, and the general trend today is for more and more vessels to have ECDIS applied. The effect is assessed to be 40% reduction of the likelihood for power grounding. It is also assumed that all vessels and especially tankers for oil of sizes relevant for this study will have implemented ECDIS by 2015. The effect has thus been applied for all vessels.

6.3.3 Automatic Identification System

An Automatic Identification System (AIS) is designed to send and receive information in relation to a vessel's identity (e.g. name, call sign, and dimensions), course (e.g. route, speed) and cargo. Current regulations demand the information to be presented into an AIS display. The most common type of installed display (minimum required) provides three lines of data consisting of basic information of a selected target (name, range and bearing). Additional information regarding the target can be provided by system. The AIS can be connected to the radar's ARPA function, and provide all the additional data into the radar display. By selecting an AIS target into the ARPA display, the navigator will be able to see all available information for the particular vessel. Besides the easier access of AIS information through the ARPA, there are five more areas that the AIS integration improves the radar performance:

- Detection of targets which are in radar shadow areas
- Identification of radar targets into vessel's names
- Takes account of the vessels rate of turn (ROT), hence, predicting more accurately the target's path
- In some cases extends the radar's range
- Clarifies the target intentions

AIS can become a useful source of supplementary information and an important tool in enhancing situation awareness of the traffic conditions. The AIS-ARPA interface improves the navigator's ability to make early decisions based on real-time data, and avoid potential collisions.

The AIS combined with ECDIS and ARPA will have a risk reducing effect on the likelihood of collision, given that one can easily see other vessels in the area close to the vessel. The crew can easily see the direction and speed of the vessel in proximity and make calls accordingly. In doubtful cases the other vessel can even be called by their correct name and thus is more likely to respond quickly. The risk reducing effect has been assessed to 20 % for all vessels in the area (ref. /36/), given the assumption that all vessels will have AIS integrated by 2015.

6.3.4 Traffic separation scheme

Traffic separation schemes consist of dedicated lanes for vessels in opposite directions. The traffic corridors may only be defined in the maps, physically separated by buoys or in some cases the corridors are divided by separation corridors in order to improve separation of the vessels. Special attention is required in areas where ports are located, given the fact that vessels in this area may have to cross the corridors.

A traffic separation scheme has been implemented in the area Vardø – North Cape and entered into force by 1st January 2004. Regarding the rest of the Barents Sea and the northern Norwegian Sea (Vardø - Røst) future assessments for the purpose of establishing separation regimes will be undertaken. The separation scheme is illustrated in Figure 6.1. The established scheme consists of 1.5 nm wide lanes in each direction, divided by a 1 nm separation corridor. Physical dividers are not planned for, as the separation lane is assessed to be sufficient to separate the vessels.

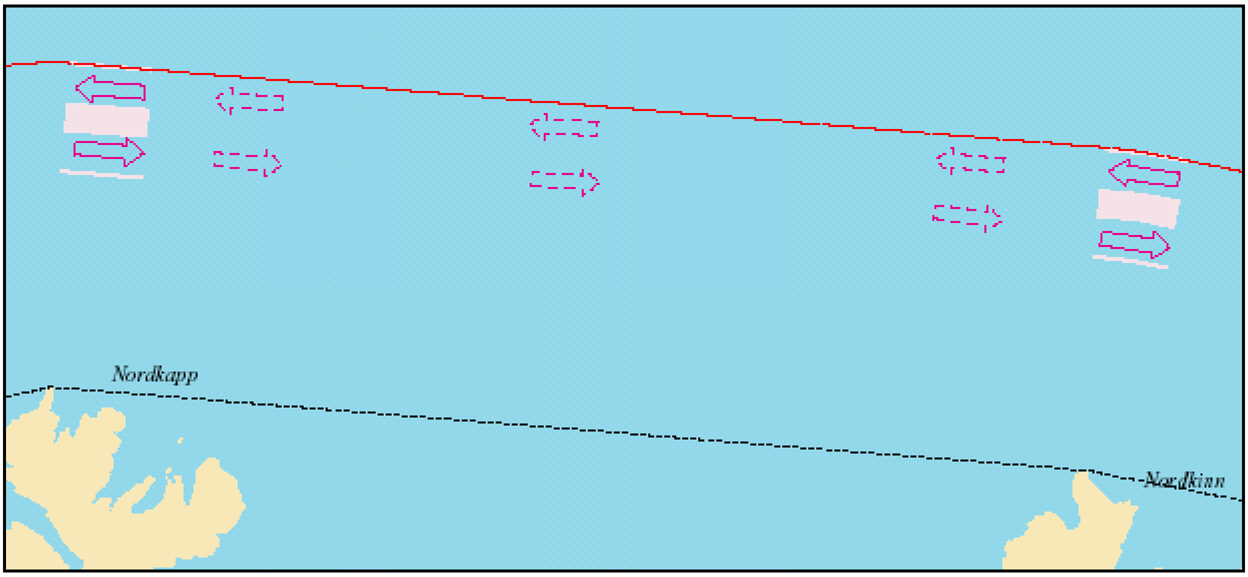


Figure 6.1 Vessel separation scheme providing 1.5 nm wide corridors in each direction, divided by a 1 nm separation corridor. The red line indicates the 12 nm territorial waters limit. Light red areas indicate traffic separation zones.

Vessel separation in itself has a risk reducing effect, but in this assessment this effect has been included in the Vessel Traffic Services (VTS), as discussed in the next sub section.

6.3.5 Vessel traffic service

Vessel Traffic Services (VTS) are shore-side systems, which ranges from the provision of simple information messages to vessels, such as position of other traffic or meteorological hazard warnings, to extensive management of traffic within a port or waterway.

Generally, vessels entering a VTS area report to the authorities, usually by radio, and may be tracked by the VTS control centre. Vessels must keep watch on a specific frequency for navigational or other warnings, while they may be contacted directly by the VTS operator if there is a risk of an incident or, in areas where traffic flow is regulated, to be given advice on when to proceed.

A VTS is proposed located in Vardø, and in this assessment it is assumed to be up and running by 2015. The VTS will have a risk reducing effect on the probability for collisions the effect is enhanced by introducing traffic separation and the implementation of AIS. The VTS will be able to track most vessels within the territorial waters, and advice any vessels deviating from the traffic separation scheme to correct their course. The traffic in opposite direction is thus likely to be separated by 1 nm and the risk reducing effect is estimated to 40 % for all collisions in the area, ref /36/.

The VTS will also be able to locate and direct tugs to assist vessels that have lost power. The effect of the connection of tugs and VTS is discussed in the next sub section.

6.3.6 Placement of tugs at strategic locations

The Coastal Directorate's contingency department has prepared a report concerning the availability of tugs in the Barents Sea (ref /35/). The conclusion of the report is that three tugs or vessel of similar capability (e.g. standby vessels, coastguard vessels) should be placed at strategic locations in the Barents Sea region. The need for three vessels is based on the recent adjusted territorial border from 4 nm to 12 nm. The ministry of Fisheries have assigned three vessels for this purpose and the placement of the vessels can be seen in the figure below.

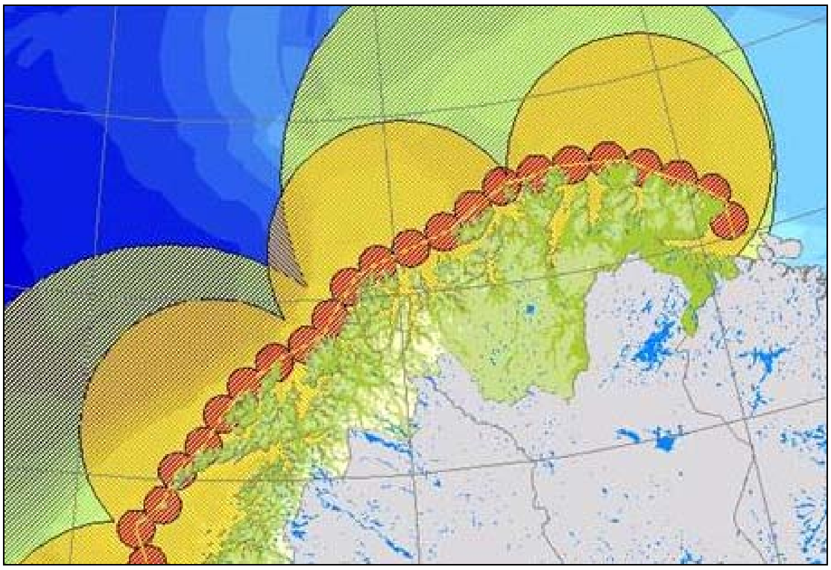


Figure 6.2 Necessary response areas for tugs assigned to support vessels loosing engine power outside 4 nm (red circles), 12 nm (dark yellow circles) and 20 nm (light yellow circles) respectively.

The proposed development of oil and gas fields in the Norwegian economic zone will also result in a number of standby and supply vessels to be located in the region, which potentially may be of assistance if vessels start drifting.

The risk reducing effect of having tug support readily available is considerable for drift grounding. It is assessed that by increasing the territorial limit to 12 nm and establishing VTS, as discussed above, the tugs will have a 70 % probability of reaching a vessel in distress at any given position in the Barents Sea region, ref /36/. The tugs then have to receive towing lines from the vessel in distress. According to current rules and regulations, all tankers above 20 000 dwt shall be equipped with emergency towing arrangements that can be released even if the tanker has a complete engine failure. This equipment is seldom used and may for some reason or another not be operative when needed. The probability of the tug not being able to secure a line to the vessel in distress has been assessed to 10 % of all cases, ref. /42/. The probability of a tug being able to help a vessel in distress (consisting of the probability of reaching the vessel and of securing the line) in the area is set to 63 %.

6.4 Accident frequency

6.4.1 General frequency trend

When analyzing accident statistics it can be concluded that there in general is a declining trend. The trend is depending on many factors, e.g. technological improvement, higher awareness, increased safety culture, experience, better defined rules and increased competence. Based on an assessment of statistics, grounding, collision and fire/explosion accident frequencies are reduced by 10 %. For structural failure there is no statistics indicating a future decrease, and the accident frequency is therefore not changed.

For the purpose of assessing the risk pattern the area of concern has been divided in to sub-areas. Within each sub-area each route has been further assessed with respect to risk potential. The sub-areas and routes assessed are presented in Figure 6.3.

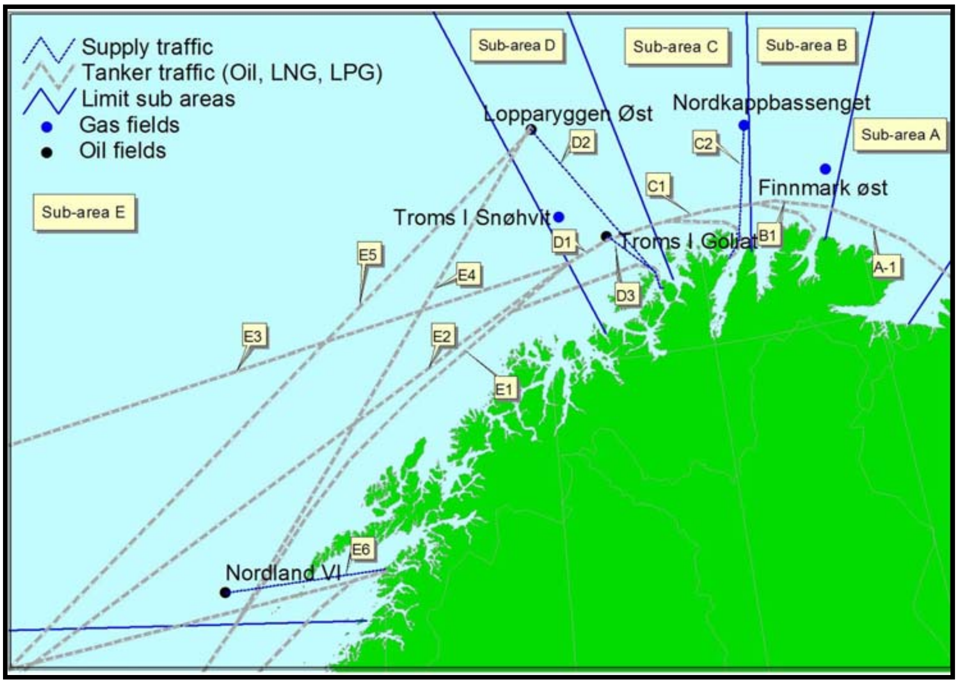


Figure 6.3 Division of the Norwegian Sea and the Barents Sea for the purpose of the risk assessment.

6.4.2 Grounding

There are two different grounding scenarios; powered grounding which means that the vessel hits ground with the engines still running and drift grounding which means that the vessel has lost propulsion and is drifting aground.

Powered grounding

Oil Tankers

Spill of crude oil or bunkers may occur due to powered grounding. Powered grounding is the event that the vessel proceeds down an unsafe track, even though it is able to follow a safe track, due to errors related to planning, navigating, piloting and/or technical failure.

Using the LRFP database (ref /33/), which includes all registered groundings (both powered and drifting) for vessels larger than 10 000 dwt from 1990-2001, the frequency is 1.6E-07 per nautical mile. Statistics show that out of all groundings, powered grounding represents 80 % of the accidents (ref /32/). This means that the frequency for powered grounding is in the order of 1.3E-07 per nautical mile. Including the trend reduction the frequency is 1.2E-07 per nautical mile**.**

Gas carriers and supply vessels

Spill of bunker oil can be a consequence of a gas carrier or supply vessel accident. There is some expected gas carrier traffic from Russia, and there is also a future traffic scenario with gas carriers and supply vessels to and from the planned oil and gas fields Snøhvit, Goliat, Lopparyggen Øst, Nordkappsbassenget and Finnmark Øst. The LRFP database presents a grounding frequency of 1.2E-07 per nautical mile for gas carriers (ref /39/) and 5.6E-08 per nautical mile for supply vessels (ref /40/). Using the same assessment as for oil tankers /41/, the resulting base frequencies are 8.6E-08 per nautical mile for gas carriers and 4.1E-08 per nautical mile for supply vessels.

Frequency calculations

The frequencies are as mentioned based on generic accident data. In order to adapt the frequency to the local conditions and thereby taking environmental and human factors like current, wind, type of passage, risk reducing measures, distance sailed, average crew action and experience into account the following calculation is used:

$$\mathbf{P_{PoweredGrounding} = P_{GroundingBase} \times H \times F}$$

where;

P_{Base} 1.2E-07 per nautical mile (oil tankers)

8.6E-08 per nautical mile (gas carriers)

4.1E-08 per nautical mile (supply vessels)

H = Factor that indicates the difficulty of the area and the average crew actions. Compared to the world-wide statistics it is assessed that for most routes there are no special conditions in this case which means that this factor does not increase nor decrease the probability. However, for the routes passing far away from land (E2 – E5) the probability of powered grounding is negligible.

F = Effect of risk reducing measures. The implementation of ECDIS onboard vessels and VTS is assessed to result in a 40 % reduction.

Table 6.1 Accident frequency for Powered Grounding. Geographical location of the routes is given in Figure 6.4. E-08 = 10^{-8}.

	Cargo	P_{base}	Environment and human factor H	Risk reducing factor F	Total frequency (per nm)
Route A1	Oil	1.2E-07	1	0.6	**7.2E-08**
Route A1	Gas	8.6E-08	1	0.6	**5.1E-08**
Route B1	Oil	1.2E-07	1	0.6	**7.2E-08**
Route B1	Gas	8.6E-08	1	0.6	**5.1E-08**
Route C1	Oil	1.2E-07	1	0.6	**7.2E-08**
Route C1	Gas	8.6E-08	1	0.6	**5.1E-08**
Route C2	Supply	4.1E-08	1	0.6	**2.5E-08**
Route D1	Oil	1.2E-07	1	0.6	**7.2E-08**
Route D1	Gas	8.6E-08	1	0.6	**5.1E-08**
Route D2	Supply	4.1E-08	1	0.6	**2.5E-08**
Route E1	Oil	1.2E-07	1	0.6	**7.2E-08**
Route E1	Gas	8.6E-08	1	0.6	**5.1E-08**
Route E2-E5	Oil & Gas	-	-	-	**Negligible**
Route E6	Supply	4.1E-08	1	0.6	**2.5E-08**

Drift Grounding

Oil tankers

Spill of crude oil or bunker oil may also occur due to drift grounding. Drift grounding is the event that the vessel drifts aground due to engine/propulsion failure. The use of LRFP (as done for powered grounding) to find the drift grounding accident frequency for the areas analyzed in this report is assessed not to be comparable to world-wide statistics due to the type of external environment. Instead, DNV statistics showing the frequency for engine failure is used, 1.7E-06 per nautical mile ref /32/. This number is based on generic data and includes accidents with duration of more than a few minutes. Due to the general declining risk trend, the resulting frequency is 1.5E-06 per nautical mile.

Gas carriers and supply vessels

With an assumption that the gas carriers and supply vessels are equipped with conventional fuel engines, the base frequency will be same as for oil tankers, 1.5E-06 per nautical mile.

Frequency calculations

When a vessel begins to drift, it does not automatically mean it will lead to grounding. If the vessel is sailing in open sea it is rather unlikely. Also in coastal areas there exist many factors which can reduce the risk for drift grounding. Risk reducing measures include tug assistance, possibility of anchoring and the chance of actually repairing the engine damage in time.

Information about the area, for example wind and current conditions also comes into the equation. In the following risk model, these circumstances are accounted for:

$\mathbf{F_{DriftGrounding} = F_{Loss\ of\ propulsion} \times P_{Rep} \times P_{Anch} \times P_{Wind} \times F}$

where;

$F_{Loss\ of\ propulsion}$ = 1.5E-06 per nautical mile

P_{Rep} = Probability of not repairing the engine in time. This is assessed to be 50 %.

P_{Anch} = Probability that anchoring will fail. Anchoring is assessed to be very difficult due to depths and sea bottom characteristics. The probability of failure is therefore set to 80 %.

$P_{Current\&Wind}$ = The probability that the tanker will drift towards shore. The probability of an oil tanker drifting towards shore is assessed differently for the different area routes due to current and wind. In general, the current comes from SW and follows the shore, sometimes turning towards land. Wind data for the Barents Sea (ref /38/) shows in general that SW, S and SE winds are dominating. In the analysis, different wind stations and current maps have been used for the different routes.

F = Effect of other risk reducing measures. The risk for drift grounding can be reduced by tug assistance. It is assessed that tugs can reach 70 % of all drifting vessels and that 90 % of all tug operations are successful, giving a reduction of 63 %.

Table 6.2 Accident frequency for Drift Grounding. Geographical location of the routes is given in Figure 6.4. E-07 = 10^{-7}

	Cargo	$F_{Loss\ of\ propulsion}$	Repair failure P_{Rep}	Anchoring failure P_{Anch}	Current and Wind towards shore $P_{Current\&Wind}$	Risk reducing factor F	Total frequency
Route A1	Oil	1.5E-06	0.5	0.8	0.4	0.37	**8.9E-08**
Route A1	Gas	1.5E-06	0.5	0.8	0.4	0.37	**8.9E-08**
Route B1	Oil	1.5E-06	0.5	0.8	0.5	0.37	**1.1E-07**
Route B1	Gas	1.5E-06	0.5	0.8	0.5	0.37	**1.1E-07**
Route C1	Oil	1.5E-06	0.5	0.8	0.5	0.37	**1.1E-07**
Route C1	Gas	1.5E-06	0.5	0.8	0.5	0.37	**1.1E-07**
Route C2	Supply	1.5E-06	0.5	0.8	0.5	0.37	**1.1E-07**
Route D1	Oil	1.5E-06	0.5	0.8	0.6	0.37	**1.3E-07**
Route D1	Gas	1.5E-06	0.5	0.8	0.6	0.37	**1.3E-07**
Route D2	Supply	1.5E-06	0.5	0.8	0.6	0.37	**1.3E-07**
Route E1	Oil	1.5E-06	0.5	0.8	0.5	0.37	**1.1E-07**
Route E1	Gas	1.5E-06	0.5	0.8	0.5	0.37	**1.1E-07**
Route E2-E5	Oil & Gas	-	-	-	-	-	**Negligible**
Route E6	Supply	1.5E-06	0.5	0.8	0.5	0.37	**1.1E-07**

6.4.3 Collision

Collisions originate from navigational or in some cases technical failures. These failures cause loss of control on at least one of the vessels, at the same time as the other vessel is not able to prevent the collision. As a result of a collision, crude oil or bunker oil may be spilled to the sea.

Collision includes both head-on and crossing collisions. A head-on collision occurs when two vessels sail with a course straight towards each other, and one or both vessels give way too late. It is assumed that the collision will be at 90 degrees since one or both vessels will try to avoid the collision and give way (but is unsuccessful). A crossing collision is when two vessels' courses cross and at least one of the vessels fail to give way. A 90 degree collision is assumed to be applicable also in this case.

Oil tankers

The frequency of collision for tankers operating in coastal areas worldwide is 5.0E-07 per nautical mile according to ref /32/ and according to ref /33/ 6.3E-07 per nautical mile. The two sources give a similar frequency but 5.0E-07 is chosen because the traffic density along the Norwegian coastline is estimated not to be higher than the average worldwide. Taking the trend decrease into account, the base frequency for collision is 4.5E-07 per nautical mile.

Gas carriers and supply vessels

Bunker oil spill caused by a collision can result in environmental impact. According to the LRFP database, gas carriers have a collision frequency of 2.9E-07 per nautical mile (ref /39/) and supply vessels a frequency of 2.3E-08 per nautical mile (ref /40/). Using the same assessment as for oil tankers, the resulting base frequencies are at 8.6E-08 per nautical mile for gas carriers and 2.1E-08 per nautical mile for supply vessels.

Frequency calculations

The Barents Sea is a large geographical area with varying risks for collisions. It is therefore necessary to make a few simplifications in order to estimate the probability for collision. Especially with respect to external conditions like traffic density, current and type of passage. The presumed passages have been divided into different sections and the accident frequency for each section is calculated using the following formula:

$$\mathbf{P_{Collision} = P_{CollisionBase} \times H \times F}$$

$P_{CollisionBase}$ = 4.5E-07 per nautical mile

H = Factor that indicates the difficulty of the area, i.e. taking environmental conditions, traffic density etc. into account. It is assessed that most of the main routes has a low traffic density and relatively easy navigational conditions which leads to a reduction of 50 %. However, route C2, D1, D2 and E6 has a more complex traffic picture and hence a reduction between 0 – 30 %. The routes E2-E5 have a lower traffic density and therefore a 90 % reduction.

F = Effect of risk reducing measures. The use of vessel lanes and VTS is assessed to reduce the risk for collision with 40 %. The use of AIS will have a 20 % reduction impact.

The resulting frequencies for collision during passage are presented in Table 6.3.

Table 6.3 Accident frequency for Collision. Geographical location of the routes is given in Figure 6.4. E-08 = 10^{-8}

	Cargo	$P_{CollisionBase}$	Passage difficulty H	Risk reducing factor F	Total Frequency
Route A1	Oil	4.5E-07	0.5	0.48	**1.1E-07**
Route A1	Gas	8.6E-08	0.5	0.48	**2.1E-08**
Route B1	Oil	4.5E-07	0.5	0.48	**1.1E-07**
Route B1	Gas	8.6E-08	0.5	0.48	**2.1E-08**
Route C1	Oil	4.5E-07	0.5	0.48	**1.1E-07**
Route C1	Gas	8.6E-08	0.5	0.48	**2.1E-08**
Route C2	Supply	2.1E-08	0.7	0.80	**1.2E-08**
Route D1	Oil	4.5E-07	1	0.48	**2.2E-07**
Route D1	Gas	8.6E-08	1	0.48	**4.1E-08**
Route D2	Supply	2.1E-08	1	0.80	**1.7E-08**
Route E1	Oil	4.5E-07	0.5	0.48	**1.1E-07**
Route E1	Gas	8.6E-08	0.5	0.48	**2.1E-08**
Route E2 – E5	Oil	4.5E-07	0.1	0.80	**3.6E-09**
Route E2 – E5	Gas	8.6E-08	0.1	0.80	**6.9E-09**
Route E6	Supply	2.1E-08	1	0.80	**1.7E-08**

6.4.4 Structural failure

Spill of crude oil or bunker oil to the sea may occur due to structural failure. Vessels with a structural failure suffer from cracks and other damages that are caused by the dynamic forces the vessels is exposed to. The frequency for structural failure can be affected by the amount and quality of maintenance on the vessel concerned.

The frequency of structural failure for crude oil tankers has been assessed based on relevant data from the LRFP database (ref /41). The database is considered to give a representative picture of tankers in the world fleet with respect to accidents. However, it should be noted that the frequencies for structural failure also include single hull tankers (assumed not to be in traffic in the Barents Sea 2015).

Today, there are no reliable structural failure frequencies for double hull tankers. Therefore are the figures for both double and single hull tankers used, which is considered to be conservative (but the best figure available). It could be argued that there should be an adjustment of the frequencies, but since there are no data indicating an increase or decrease, no adjustment is made.

The LRFP frequencies have been adjusted in order to reflect the fact that the Barents Sea is a coastal area with a harsher environment than the world average. The adjustment is assessed to be a probability increase of 10 %. The resulting frequency for structural failure is: 1.1E-8 per nautical mile

According to ref /32/ the same frequency is 1.6E-8 per nautical mile. Considering that ref /32/ is based on statistics including older vessels, 1.1E-8 per nautical mile is chosen as the frequency for structural failure.

For gas carriers and supply vessels, the same assumptions are made which leads to gas carriers having a structural failure frequency of 1.7E-08 per nautical mile (ref /39/) and supply vessels having a frequency of 3.4E-08 per nautical mile (ref /40/).

6.4.5 Fire/Explosion

A fire/explosion in the cargo area may damage the cargo tanks to such an extent that crude oil is spilled to the sea. The oil tanker frequency for fire/explosion has been assessed based on relevant data from the LRFP database (ref /33/) for double hull tankers. The database is considered to give a representative picture of the tanker world fleet with respect to fire/explosion accidents.

The fire/explosion frequencies include events originating in cargo area and events escalating to the cargo area (other fire/explosions are assessed to have a negligible environmental impact). The events escalating to the cargo area are typically events originating in the main engines, power supply, auxiliary systems, boilers and some hull structures.

The frequency for fire/explosion events, occurring at sea for the Barents Sea oil tankers, is: 2.9E-08 per nautical year (ref /33/).

According to ref /32/ the accident frequency for fire/explosion is estimated to be 1.0E-8 per nautical mile (statistics for vessels larger than 17,000 dwt). The two frequencies are in the same order but it is assessed that 2.9E-8 is the most relevant figure for the type of vessels in the Barents Sea area (due to size, double hull etc.). With the declining trend factor, the resulting frequency is 2.6E-08 per nautical mile.

Similarly, the frequency for gas carriers is 6.2E-8 per nautical mile (ref /39/) and 9.0E-8 per nautical mile for supply vessels (ref /40/).

6.5 Accident consequence

The consequence estimation focuses on oil pollution and thus no other cargo types (e.g. LNG, LPG and dry bulk) have been included. The consequences of other cargos are negligible compared to oil.

6.5.1 Theoretical outflow given collision and grounding

The theoretical outflow for tankers for oil given collision and grounding can be found using a model described in MARPOL 73/78, ref. /43/.

For the purpose of calculating hypothetical oil outflow from oil tankers, the extent of damage was calculated in accordance with damage assumptions provided in MARPOL 73/78. The damage is assumed to have the shape of a three dimensional parallelepiped on the bottom and side of the vessel.

The extent of the damage primarily depends on the vessel's principal dimensions and is assumed to be fixed throughout all the cases. The tables below present the calculated extent of the damage for side and bottom damages respectively. All dimensions given are in metres.

Table 6.4 Extent of damage – Collision events

Vessel's DWT (tons)	Longitudinal Ext. of Damage	Transverse Ext. of Damage	Vertical Ext. of Damage
283 000	14.5	11.4	31.0
160 000	14.1	9.6	23.1
105 000	12.7	8.4	21.0

Table 6.5 Extent of damage – Power Grounding Events

Vessel's DWT (tons)	Longitudinal Ext. of Damage	Transverse Ext. of Damage	Vertical Ext. of Damage
283 000	31.8	9.5	3.8
160 000	27.4	8.0	3.2
105 000	23.4	7.0	2.8

Table 6.6 Extent of damage – Drifting Grounding Events

Vessel's DWT (tons)	Longitudinal Ext. of Damage	Transverse Ext. of Damage	Vertical Ext. of Damage
283 000	5.0	5.0	3.8
160 000	5.0	5.0	3.2
105 000	5.0	5.0	2.8

The hypothetical outflow of oil was calculated with respect to the number of compartments penetrated, based on the extent of the damage. The combinations of cargo tanks penetrated were found by applying the potential damages to different locations along the cargo area and thus finding different combinations. The combinations presented may not represent all possibilities, but includes the ones most likely to happen.

On the 160 000 and 105 000 dwt vessels, centre cargo tanks are very rare. In most cases the vessels have two tanks in the transverse dimension of equal capacity. Only the VLCCs are here assumed to have three tanks in the transverse dimension.

The hypothetical outflow results are presented in table 6.7 and 6.8.

Table 6.7 Collision – Hypothetical Flow of Oil (tons)

Compartment penetrated	283,000 dwt	160,000 dwt	105,000 dwt
1 WCT*	18 000	12 200	8 500
2 WCT	36 000	24 500	17 000
1 WCT + 1 CCT**	41 500	24 500***	17 000***

* Wing Cargo Tank (WCT)
** Centre Cargo Tank (CCT)
*** 2 WCT

Table 6.8 Power/ Drifting Grounding – Hypothetical Flow of Oil (tons)*

Compartment penetrated	283,000 dwt	160,000 dwt	105,000 dwt
1 WCT	6 000	4 100	2 800
1 CCT	7 900	4 100	2 800
2 WCT	12 000	8 200	5 600
2 CCT	15 700	8 200	5 600
1 WCT + 2 CCT	21 700	12 200	8 500
2 WCT + 2 CCT	27 700	16 300	11 300
2 WCT + 1 CCT	19 800	12 200	8 500
1 WCT + 1 CCT	13 800	8 200	5 600

*Although the extent of the damage in the two types of grounding is substantially different, amounts spilled (given the different combinations of penetrated tanks) are the same.

The tables above give theoretical outflow of oil for different number of tanks damaged. In addition to the cargo tanks, ballast tanks may also be damaged. The likelihood for each of the combinations is not identical. As a rule of thumb, the more cargo tanks damaged the lower is the likelihood of a given combination. Large amounts of oil will of course not be spilled in all accidents, one reason being that only ballast tanks may have been damaged. For some accidents the amount of oil spilled will be negligible or zero and in some cases it will be larger. According to MARPOL, the likelihood of different number of cargo tanks (ballast tanks not included) being damaged is presented in Table 6.9, ref. /43/. The numbers are valid for both grounding and collision.

Table 6.9 Likelihood of oil spill size given an accident according to MARPOL.

Spill amount	Likelihood per accident
Zero spill	0.84
1 tank	0.13
2 - 4 tanks	0.03

All the above mentioned calculations are based on the assumption that the vessel will suffer a serious casualty and not a total loss, and the calculations are based on an average damage size. In reality, some damages will be larger and in some cases the average damage size may even lead to a total loss.

6.5.2 Accident consequences – Tankers for oil

The following section describes the consequences given an accident involving tankers for oil. The consequences are given for laden tankers and it is assumed that all tanks penetrated given an accident are full.

All tankers are assumed to have double hull, as all tankers with single hull are supposed to be phased out before 2015 and in some areas even earlier.

The consequences for laden tankers are assessed to be similar for all sizes wrt. number of tanks penetrated and percentage of the penetrated tank content spilled. The amount spilled will though vary with tanker size given that a 283 000 dwt tanker has larger tanks than a 100 000 dwt tanker.

Grounding

The consequence of grounding is dependent on the type of sea bottom and the vessel's type of hull. It is assumed that all the vessels in 2015 have double hull, given the different phase-out schemes implemented. The sea bottom in the area is mainly rocky and thus it is assumed rocky sea bottom in the consequence estimation below. The consequences resulting from grounding are assumed to be identical for drift and power grounding.

The extent of damage given grounding is as given in Table 6.5 and Table 6.6, resulting in a given number of cargo tanks penetrated as shown in Table 6.8 (mean values). Closer examination of the values presented in Table 6.8 shows that the spill consequences are assessed to an average of 30% of the content of each compartment penetrated. According to ref /32/, 20 % of each compartment penetrated is released given grounding. Both values are based on an assessment of different sea bottom types around the world from all sand to all rocks. It seems that the calculations in MARPOL are based mostly on rocky sea bottoms. The coastline in the Barents Sea is rocky and therefore a value of 30 % of the compartment content spilled given a penetration is used in the further calculations (rather than 20%).

The different potential consequences given grounding with a fully loaded oil tanker are presented in the table below, ref /32/.

Table 6.10 Accident consequences, grounding of laden tanker

Spill size	**Frequency** (per accident)
Zero spill	0.64
30 % of 1 tank	0.13
30 % of 2 tanks	0.01
Total loss, all cargo	0.22

The consequences in the table above differ from the ones given in MARPOL and presented in Table 6.9. Table 6.9 says nothing regarding the likelihood of a total loss. It is in this analysis assessed that if more than 2 tanks are penetrated, the accident is highly likely to be a total loss. This gives a probability of less than 3% of total loss which is assessed to be low. The calculations do not consider survivability of the vessel and only look at average accident consequences. Therefore the numbers for accidents resulting in no spill are assessed to be too high.

In Table 6.10, it is assessed that every 5th grounding will lead to a total loss given grounding, which seems somewhat high. According to ref /33/, 10%, of all groundings lead to a total loss. This number is based on newer accident statistics valid for double hull tankers and is therefore assessed to be a more valid number for the area analysed.

Another important factor is the duration of a given spill. The duration will directly influence the possibility to introduce consequence reducing measures and the effect of these measures. The duration for the different consequence categories are given in ref. /44/. The duration estimates given in the references are more or less identical and as given in Table 6.11. The duration for the total loss are based on more soft sea bottoms than in the study area. The effect of rocky bottom may be shorter duration. A closer examination of previous grounding accidents such as Braer (ref. /45/) shows that it is reasonable to assume 7 day duration for total losses.

Based on the discussion above the accident consequences are given in the table below.

Table 6.11 Adjusted accident consequences, grounding of laden tanker

Spill size	**Frequency** (per accident)	**Duration of spill** (ref **/44/**)
Zero spill	0,74	N/A
30 % of 1 tank	0,13	12 hours
30 % of 2 tanks	0,03	12 hours
Total loss, all cargo	0,1	7 days

Collision

A collision involves 2 vessels, one is hit and one is being hit. The estimations of the consequences of a collision are in this analysis limited to one vessel at a time in order not to double count the spills.

The likelihood of oil spill given an accident presented in Table 6.9, are mean values and do not include total losses. According to ref /32/ the total loss frequency per accident is 15%, but according to LRFP ref/2/ statistics the number is around 10%. The estimated consequences for a collision with a fully loaded oil tanker are presented in table 6.12. The final numbers where derived by use of expert judgement, ref. /36/.

Table 6.12 Accident consequences, collision of laden tanker

Spill size	**Frequency** (per accident)	**Duration of spill** (ref **/44/**)
Zero spill	0,71	N/A
All of 1 tank	0,115	2 hours
All of 2 tanks	0,095	12 hours
Total loss, all cargo	0,08	7 days

The assumption that all cargo in a penetrated tank will be lost corresponds well with the theoretical calculations as given in section 6.5.2.

Structural failure

The consequence of a structural failure is dependant on the type of hull. Given that all tankers by the year 2015 will have double hull, it is assessed that a crack in a cargo tank will only affect the adjacent tank and thus no oil will leak into the sea. There is of course a possibility that the oil leaked from the cargo tank pollutes the ballast water in the adjacent tank and be released when discharging the ballast water. This possibility is not included in this study. For very serious structural failure, it is assessed that the vessel will sink and all cargo will be released, ref /32/.

Estimated consequences of a structural failure with a laden tanker are given in the table below.

Table 6.13 Accident consequences, structural failure of a laden tanker

Spill size	**Frequency** (per accident)	**Duration of spill** (ref **/44/**)
Zero spill	0,79	N/A
Total loss, all cargo	0,21	7 days

Fire/ Explosion

Fires and especially explosions are very likely to lead to an oil spill. The oil spilled will, though, in many cases burn. It is in this analysis assumed that 80 % of the oil spilled will burn, ref /32/.

In the case of a fire/explosion 3 potential scenarios have been identified, ref /32/:

1. In 12 % of the cases there will be small or no environmental consequences. It is estimated that the small spill is of maximum 100 tons.
2. In 24 % of the cases, 20 % of 1 cargo tank will be spilled. 80 % of the spilled oil is assumed to burn and thus the oil spill will be 4 % of 1 tank.
3. In the remaining 64 % of the cases, the vessel will be a total loss. There are 2 potential spill scenarios in case of a total loss:
   - In 90 % of the total losses all oil in 6 tanks will be spilled and 80 % of this will burn. The oil spilled will thus be 20 % of 6 tanks.
   - In the remaining total losses, the accident will escalate to become more severe and all oil in the vessel will be spilled over a period of up till 7 days.

Estimated consequences of a fire and/or explosion in a laden tanker are given in the table below.

Table 6.14 Accident consequences, fire and/or explosion in a laden tanker

Spill size	**Frequency** (per accident)	**Duration of spill** (ref **/44/**)
Minor damages, < 100 tons	0,12	1 hour
4 % of 1 tank	0,24	1 hour
20 % of 6 tanks	0,58	12 hours
Total loss, all cargo	0,06	7 days

6.5.3 Accident consequences – Other Vessels

Accidents involving other vessel types than tankers for oil might result in some bunker oil being spilled. The consequences of a given accident for other vessels than tankers for oil, are for simplification here assumed to be identical for all other vessel types. That is, the percentage of the content of the bunkers oil tank spill, are identical. The actual volume of bunkers oil carried by a given vessel will off course vary according to vessel type and size, and thus the actual volume spilled will vary.

The sub sections below only present the consequence numbers directly and do not include any discussion around the numbers. The discussion found in the representative accident types in section 6.5.2 are assessed to also be valid for the other vessel types and thus is not presented again.

The bunkers oil spilled are also valid for tankers for oil in ballast condition. The bunkers oil spilled with laden tankers is in this report assumed to be negligible compared to the amount of crude oil spilled.

Grounding

The estimated consequences for grounding with all other vessels than laden tankers are presented in the table below. The total loss frequency per accident is set to 10% given to same reasons as discussed. The other frequencies have been taken from ref /32/.

Table 6.15 Accident consequences, grounding of other vessels

Spill size	**Frequency** (per accident)	**Duration of spill** (ref **/44/)**
Zero spill	0,81	N/A
30 % of 1 tank	0,09	12 hours
Total loss, all bunkers	0,1	7 days

Collision

The estimated consequences for collision with all other vessels than laden tankers are presented in the table below. The total loss frequency per accident has been set identical as for tankers for oil and the other numbers taken from ref /32/.

Table 6.16 Accident consequences, collision of other vessels

Spill size	**Frequency** (per accident)	**Duration of spill** (ref **/44/)**
Zero spill	0,75	N/A
All of 1 tank	0,17	2 hours
Total loss, all bunkers	0,08	7 days

Structural failure

The estimated consequences for structural failure with all other vessels than laden tankers are presented in the table below. The frequencies per accident have been set identical as for laden tankers and the accident spill sizes are taken from ref /32/.

Table 6.17 Accident consequences, structural failures of other vessels

Spill size	**Frequency** (per accident)	**Duration of spill** (ref **/44/)**
Zero spill	0,79	N/A
Total loss, all bunkers	0,21	7 days

Fire/ Explosion

In case of a fire and/or explosion for other vessels it is estimated that all bunkers will be released and that 80 % of this will burn thus resulting in 20 % of the total bunkers volume being spilled.

The estimated consequences for structural failure with all other vessels than laden tankers are presented in the table below /32/.

Table 6.18 Accident consequences, fire/explosion of other vessels

Spill size	**Frequency** (per accident)	**Duration of spill** (ref **/44/**)
Zero spill	0,36	N/A
Total loss, 20 % of bunkers	0,64	7 days

6.6 Risk picture 2015 resulting from the new oil trade

The risk picture as presented in this section includes oil spill risk from both cargo oil (crude oil) and bunker oil. The tables are divided between the two different oil types and by the accident consequence estimations.

6.6.1 Total risk in all routes

Table 6.19 summarizes the results from each cargo oil spill accident scenario i.e. powered grounding, drift grounding, collision, structural failure and fire/explosion accidents. The frequencies are valid for each route where a tanker sails in laden condition and there is no distinction between special defined areas which potentially could have a higher frequency (hot spots) and the areas in between.

Table 6.19 Total risk for oil spill in 2015. Geographical location of the routes is given in Figure 6.4. 0 in accident consequence indicate accident without any oil spill. E-02 = 10^{-2}

Route	**Accident consequence** (tons per accident)							
	0	**< 100**	**100 – 2 000**	**2 000 – 20 000**	**20 000 – 100 000**	**> 100 000**	**Total Freq. (per route)**	**Total Freq. (per nm in location)**
A1	9,1E-03	1,4E-04	2,8E-04	2,5E-03	1,0E-03	4,8E-04	**1.4E-02**	**1.7E-04**
B1	8,0E-03	1,1E-04	2,3E-04	2,2E-03	8,8E-04	4,1E-04	**1.2E-02**	**1.8E-04**
C1	8,0E-03	1,1E-04	2,3E-04	2,2E-03	8,8E-04	4,1E-04	**1.2E-02**	**1.8E-04**
D1	1,1E-02	1,1E-04	2,2E-04	2,9E-03	1,2E-03	5,2E-04	**1.6E-02**	**2.6E-04**
E1	1,5E-02	2,1E-04	4,3E-04	4,1E-03	1,7E-03	7,8E-04	**2.2E-02**	**6.4E-05**
E2	2,5E-03	2,3E-04	4,6E-04	1,4E-03	5,6E-04	2,0E-04	**5.3E-03**	**1.5E-05**
E3	2,1E-03	1,9E-04	3,9E-04	1,2E-03	4,8E-04	1,7E-04	**4.5E-03**	**1.3E-05**
E4	8,9E-04	8,1E-05	1,6E-04	5,9E-04	1,7E-04	-	**1.9E-03**	**5.5E-06**
E5	1,0E-03	9,4E-05	1,9E-04	6,8E-04	2,0E-04	-	**2.2E-03**	**5.5E-06**
Total Frequency (per conseq.)	**5,8E-02**	**1,3E-03**	**2,6E-03**	**1,8E-02**	**7,1E-03**	**3,0E-03**	**8.9E-02**	**9.0E-04**

The table also shows the total frequency divided by the length of the route, resulting in a frequency per geographical location (expressed per nautical mile). As mentioned, there is no distinction between hot spots and the areas in between.

The table shows that an oil spill scenario in the range between 2,000 -20,000 tons is the scenario most likely to occur (excluding the scenario in which no spill occurs). The return period for this scenario is approximately 55 years. The return period of all scenarios together (i.e. any kind of accident in any route) is approximately 11 years (8.9E-02).

A similar table can also be presented for bunker spill accident scenarios. Table 6.20 includes all new gas carrier and supply vessel traffic, as well as tankers sailing in ballast condition.

Table 6.20 Total risk for bunker spill in 2015. Geographical location of the routes is given in Figure 6.4. 0 in accident consequence indicate accident without any bunker spill. E-01 = 10^{-1}

Route	**Accident consequence** (tons per accident)					
	0	**< 400**	**400 - 1000**	**1000 - 5000**	**Total frequency (per route)**	**Total frequency (per nm in location)**
A1	1.3E-02	1.4E-03	2.6E-04	3.0E-03	**1.8E-02**	**2.0E-04**
B1	1.3E-02	1.4E-03	3.5E-04	2.8E-03	**1.7E-02**	**2.2E-04**
C1	1.4E-02	1.6E-03	4.7E-04	2.9E-03	**1.9E-02**	**2.4E-04**
C2	1.5E-03	4.9E-04	1.2E-04	1.8E-04	**2.3E-03**	**1.4E-05**
D1	1.9E-02	1.9E-03	8.0E-04	4.2E-03	**2.6E-02**	**3.5E-04**
D2	8.1E-03	2.3E-03	6.9E-04	9.8E-04	**1.2E-02**	**4.5E-05**
D3	1.2E-03	3.5E-04	1.0E-04	1.6E-04	**1.8E-03**	**1.8E-05**
E1	3.1E-02	4.3E-03	1.4E-03	6.1E-03	**4.3E-02**	**9.4E-05**
E2	4.7E-03	4.3E-03	9.2E-05	5.6E-04	**9.7E-03**	**1.8E-05**
E3	3.0E-03	2.7E-03	4.9E-05	3.7E-04	**6.1E-03**	**1.2E-05**
E4	5.4E-04	4.3E-04	0.0E+00	8.3E-05	**1.1E-03**	**3.0E-06**
E5	6.2E-04	5.0E-04	0.0E+00	9.6E-05	**1.2E-03**	**3.0E-06**
E6	6.0E-03	1.7E-03	5.1E-04	7.3E-04	**9.0E-03**	**4.5E-05**
Total frequency (per consequence)	**1.2E-01**	**2.3E-02**	**4.9E-03**	**2.2E-02**	**1.7E-01**	**1.3E-03**

The result shows that if a bunker spill occurs, it will either be very small or quite large. The return period of a large bunker spill (> 1,000 ton) is approximately 45 years. The return period of all scenarios together (i.e. any kind of accident in any route) is approximately 6 years (1.7E-01).

Looking at the different routes, one can conclude that route E1 has the highest accident frequency. The reason for this is mainly because of the length of the route but also because it is fairly close to shore. If one are to find the route with the highest frequency per nautical mile route D1 stands out as a hot spot. It has approximately 50% higher frequency than the route with the second highest frequency, both when it comes to cargo oil spills and bunker spills. Along D1, the places where one can expect crossing traffic going to Lopparyggen, Snøhvit and Goliat are the places with the highest risk.

Generally it can be said that bunker oil spills are more frequent than cargo oil spills, but (not surprisingly) the worst consequences are associated with cargo oil spills.

6.6.2 Total risk per accident type

In order to find and suggest proper risk control options it is also interesting to look at the oil spill frequencies and amounts sorted by accident type. These are summarised in table 6.21 and table 6.22 presented below.

Table 6.21 Total risk for oil spill in 2015, divided by accident type. 0 in accident consequence indicate accident without any oil spill. E-02 = 10^{-2}

Accident type	Accident consequence (tons per accident)						
	0	< 100	100 – 2 000	2 000 – 20 000	20 000 – 100 000	> 100 000	Total Freq.
Powered grounding	1,2E-02	-	-	2,5E-03	9,1E-04	6,7E-04	**1,6E-02**
Drift grounding	1,8E-02	-	-	3,9E-03	1,4E-03	6,5E-04	**2,4E-02**
Collision	2,4E-02	-	-	5,9E-03	2,9E-03	1,1E-03	**3,4E-02**
Structural Failure	3,6E-03	-	-	-	6,1E-04	3,4E-04	**4,5E-03**
Fire/ Explosion	0,0E+00	1,3E-03	2,6E-03	5,4E-03	1,2E-03	2,3E-04	**1,1E-02**
Total Frequency (per conseq.)	**5,8E-02**	**1,3E-03**	**2,6E-03**	**1,8E-02**	**7,1E-03**	**3,0E-03**	**8.9E-02**

Table 6.22 Total risk for bunker spill in 2015, divided by accident type. 0 in accident consequence indicate accident without any bunker spill. E-01 = 10^{-1}

Route	Accident consequence (tons per accident)				
	0	< 400	401 - 1000	1001 - 5000	Total frequency
Powered grounding	2.2E-02	-	9.9E-04	4.1E-03	**2.7E-02**
Drift grounding	4.5E-02	-	2.8E-03	7.7E-03	**5.5E-02**
Collision	2.6E-02	-	1.1E-03	7.7E-03	**3.5E-02**
Structural Failure	9.8E-03	-	-	2.6E-03	**1.2E-02**
Fire/Explosion	1.3E-02	2.3E-02	-	-	**3.7E-02**
Total frequency (per consequence)	1.2E-01	2.3E-02	4.9E-03	2.2E-02	**1.7E-01**

Comparing the four accident categories, the study shows that the combined grounding accidents dominate cargo spill accidents with a frequency of 4.0E-02, followed by collision accidents with

3.4E-02. The frequency for bunker spills is also dominated by grounding accidents, which almost have the same frequency as all the other spill accident categories combined (fire/explosion, structural failure, collision). The result is expected since the traffic density in the region is fairly low.

Grounding has the highest frequency for very large oil spills, closely followed by collisions. It should also be noted that if a vessel suffers from a structural failure it will either have no spill at all or a major oil spill.

7 ENVIRONMENTAL RISK EVALUATION

7.1 Environmental impact of shipping activities

This section provides information about the main categories of environmental impacts associated with maritime activity, considering emissions to air, discharges to sea and waste streams. Maritime activities affect the environment in varying extent depending on operational profile of the fleet, age of the vessels and type of cargo handled. Focus on environmental impact is often linked to accidental events. However, operational events may also cause unwanted impact to the environment. Hence when considering the potential impact to the environment both regular operations and accidental events should be included.

Based on general knowledge of the impact of maritime operations on the environment, a list of major environmental aspects can be given as in Table 7.1.

Table 7.1 Main environmental aspects related to maritime operations and accidents.

Environmental aspect	Issues of concern	Reasoning
1. Onboard production of oily wastes, sewage and garbage	Possible shortage of reception facilities Illegal discharges to sea Onboard incineration	Long operational periods at sea imply waste storage problems. Potential impact is related to onboard generated pollutants. Increased maritime activity will increase the overall waste, sewage and garbage produced. The cruise industry produces large amounts of waste and sewage. A major part of the modern cruise fleet has sewage treatment arrangements onboard and discharge to sea is expected to be of treated sewage according to national and international regulations. Waste generated on board can be discharged to sea according to national and international regulations (i.e. MARPOL annexes). Waste generated on board can be incinerated, however the share of incinerated waste and waste delivered onshore is not identified.
2. Discharge of ballast water of foreign origin	Risk of changed biodiversity by introduction of alien marine organisms to the Arctic.	At present small amounts of foreign ballast water is discharged in the Norwegian Sea and the Barents Sea. However substantially larger volumes are expected discharged in the future due to increased tanker activity. Cruise vessels may discharge ballast water

		although in relatively smaller amounts compared to other vessel types. However the discharge may occur in near shore area of high environmental vulnerability. Origin and risk potential of invasive species in the ballast water is not fully documented for the area of concern. The new convention on ballast water management was agreed upon in February 2004. The managerial regime of the convention differs on ballast water volume and existing and future vessels. Overall all vessels operating after 2016 must comply with the defined ballast water performance standard implying that treatment technologies must be applied.
3. Release of chemicals by leaching from anti-fouling paints	Risk of reduction in biodiversity	A new convention on the control of harmful anti-fouling systems on ships was adopted in October 2001. At present there are few vessels operating in the area and thereby low TBT input. The ban on the use of TBT as an anti-fouling agent in 2003 is expected effective in 2008 and hence TBT is not regarded as a high risk impact. Other chemical compounds may be applied in anti-fouling paints and should be handled according to the intentions of the convention on anti fouling paints.
4. Cruise traffic / tourist landing	Disturbance of vulnerable resources on land	Ongoing cruise activity is at present low and expected to have a low impact with respect to disturbance. The activity is expected to increase in the future.
5. General ship operations	Safe Control & Monitoring	Future maritime activity is expected to increase mainly due to expected increase in petroleum activity and increased transit traffic from Russia.
Accidents	**Issues of concern**	**Reasoning**
6. Tanker traffic	Transport of oil products has high potential impact in case of accidents.	The environmental impact of an accident occurring in the area is high. Both the national and international maritime activity in the Barents Sea is expected to increase considerably the next few years, resulting in an increased risk of incidents involving

		discharge of oil products.
7. Heavy bunker oil as cargo and fuel	Heavy bunker oil has very high potential impact if discharged to the environment.	Heavy bunker oil is used on several types of vessels, implying that incidents can occur in all parts of the area where shipping activity takes place. The impact of an accident occurring is regarded as very high. The expected increase in shipping activity strengthens the reasoning given above.
8. Tugging / Towing of vessels	Increased accidental risk	At present the tugging / towing activity of vessels is low. The activity though is expected to increase in the future due to increased maritime operations.
9. Loading and unloading activities in general	Increased risk of discharges of oil, oily water, bilge water and other hazardous substances.	Loading and un loading activities are complex operations involving human element, technical solutions on board and loading and unloading facilities. Hence it poses and general risk for discharges in near shore areas. The maritime operations in the area are increasing causing increased loading and unloading activities. Ship to ship loading of petroleum products can further be expected to increase although figures documented volume and level of activity is not given.
10. Cruises / Passenger vessels	Increased accidental risk in near ice or near shore operation.	Ongoing cruise activity is at present low and poses at present a low risk for accidents in ice infected / near shore areas. However, the cruise activities operate in near shore areas with high environmental vulnerability. A small oil discharge in such an area as the ice edge or outside bird cliffs may result in high environmental impact although the total amount of oil discharged is small. The activity is expected to increase in the future and hence an increased risk is expected.

7.2 Operational discharges

Operational discharges from shipping are generated by operations on board (oil, chemicals, sewage, ballast water and garbage) or during cargo operations (oil, chemicals, vapour and dust) resulting in discharges to sea (anti fouling paints, oil products, ballast water, sewage etc.), emissions to air (CO_2, NOx, SO_2, VOC, and particulars) and delivery of waste and garbage to land. Noise and physical disturbance are other impact factors generated by navigation, particularly in ice-infected areas.

7.2.1 Onboard production of oily wastes, sewage and garbage

The amount of waste, sewage and garbage produced on board can be relatively high and is very high on cruise and passenger vessels compared to other vessel traffic. It should however, be noted that many vessels used for these purposes normally hold very high standards and are often "optimised" with respect to environmental aspects. At present the cruise operations are limited in the northern Norwegian Sea and the Barents Sea, but are expected to increase in particular in the area around Svalbard.

Port reception facilities are established along the Norwegian coast and provide according to the port authorities satisfying waste handling with respect to amount and type of waste delivered. Unless wastes generated on board are transported to the reception facilities these products are incinerated on board and hereby contributing to the emissions to air. It is also experienced that due to lack of facilities, sewage, garbage and oily wastes are dumped to sea. Oily wastes, sewage and garbage are to be discharged to sea according to local and international legislation. IMO standards on incinerators are also established. Securing the full implementation of MARPOL Annexes entered into force is an ongoing task and will reduce the discharges to sea and hence reduce the marine environmental impact.

7.2.2 Discharge of ballast water

Transfer of living organisms (aquatic plants, animals and pathogens) via ballast water has increased with growing maritime activity and larger and faster ships. Carlton /62/ has given a comprehensive review of the ballast water history which has further been updated by Endresen et. al /63/. Undesirable spreading of exotic organisms has been described as the biggest threat to biodiversity and as the next big pollution challenge for the shipping industry causing irreversible processes affecting human health and industrial activities as well as the ecological balance of the seas. In several cases the introduction of non-indigenous species has caused great economic consequences, and there is an increasing realisation of the ecological costs of biological invasions in the irretrievable loss of native biodiversity.

Presently the quantity of ballast water to the Barents Sea from other biogeographical regions is low. However, an increase in the traffic, and in particular the growth in petroleum transport from this area, is expected to substantially increase the amount of ballast water discharged in the area. Today Narvik is the largest recipient of ballast water in the area with approximately 5 million m^3 discharged annually (/64/ study undertaken as part of the Barents Sea ULB). In 2006 when the export of LNG/LPG starts up from Snøhvit (Hammerfest) a similar volume will be discharged in this port (/65/ study undertaken for Statoil) mainly originating from North America and southern European ports. Petroleum production in the Norwegian sector of the Barents Sea (ranked as a medium activity level) will further lead to additional 14 million m^3 ballast water discharged in 2015.

IMO by the Marine Environment Protection Committee (MEPC) adopted in February 2004 a new international convention on ballast water and sediment management to prevent the transfer of harmful aquatic organisms /25/. The target date for finalising the work within the Marine Environment Committee is 2004. The managerial regime of the convention differs on ballast water volume and on existing and new vessels. If the contents of the convention are not changed all vessels operating after 2016 are to comply with the ballast water performance standard implying that treatment technologies should be applied.

7.2.3 Release of TBT and other biocides from anti fouling paints

The release of anti-fouling paints has proven to have adverse impact on the marine environment. A new IMO convention will prohibit the use of harmful organotins (TBT) in anti-fouling paints applied on ships and will establish a mechanism to prevent the potential future use of other harmful substances in anti-fouling systems. The International Convention on the control of harmful anti-fouling systems on ships was adopted on 5th October 2001 at the end of a five-day Diplomatic Conference held at IMO Headquarters in London. The resolution called for a global prohibition on the application of organotin compounds which act as biocides in anti-fouling systems on ships by 1st January 2003, and a complete prohibition by 1st January 2008.

7.2.4 Emissions to air

Air emissions from ships (CO_2, NOx, SO_2, VOC, and particulars) have various environmental impacts. Emission of CO_2 and CH_4 alters the greenhouse effect of the atmosphere. Sulphur and nitrogen compounds will oxidise in the atmosphere to form sulphate and nitrate, and thus contribute to acidification and eutrophication. Emissions of nitrogen oxides, carbon monoxide and VOC (Volatile Organic Compounds) will lead to enhanced ground level ozone formation and methane oxidation and thus influence the greenhouse effect. It is generally acknowledged that areas of low expose are highly vulnerable to increased expose of anthropogenic impact. It should be noted that this is not only the case for impacts from emissions to air but of other environmental aspects as well.

7.3 Accidental events – oil pollution

The tanker traffic in the Norwegian Sea and the Barents Sea will increase due to growing petroleum production and export from Norway and northern Russia. Tanker traffic itself is not expected to have a higher rate of accidents than other traffic; however, the potentially high environmental impact of a tanker accident leading to oil pollution addresses the need for precaution related to this activity. Some reviews of oil spill effects in the marine environment are given in /61/, /73/, /70/, /66/, /71/, /72/.

The severity of a spill will depend on several factors, such as oil type, spill quantity and the circumstances at the time of the spill. The time of year and the weather conditions will determine the presence of vulnerable marine resources, as well as the drift and spreading of oil and the subsequent environmental effects. Effects that may be caused by an oil spill are many and complex, and can be directed to different organisational levels in the ecosystems (cells, tissue, organs, individuals, populations, communities, habitats). In addition to ecological effects the severity of an oil spill could also be considered in relation to possible socioeconomic impacts, such as commercial harvesting and subsistence hunting.

7.3.1 Ice edge

Oil that disperses and dissolves in the water masses may cause lethal and sub lethal effects to plankton and fish eggs and larvae. The effects to phyto- and zooplankton in oceanic waters are generally insignificant because of wide distribution of the plankton populations and communities, high growth rates and short generation times. During spring and summer in the area in question, however, a short term, intensive production takes place within a zone 20-50 km from the ice edge (ref section 3 of this report). This highly concentrated production makes it vulnerable to oil pollution. Ship accidents leading to oil spills may cause major damage not only to plankton communities, but also to the associated species and community.

7.3.2 Seabirds

The direct effect of oil pollution to seabirds is clogging of the fine structures of the feathers. Oiled plumage reduces the insulation capacity significantly and the bird may suffer from thermal stress. Birds may also ingest oil; probably mainly from preening oiled plumage.

The most vulnerable bird species are those that are gregarious, spend most of their time on the water, and dive rather than fly up when disturbed. The most vulnerable species are belonging to the ecological groups of:

- pelagic diving seabirds (as alcids)
- coastal diving seabirds (as loons, divers, shags, cormorants and several ducks)

The sensitivity of sea birds populations is depended on several factors including size and density of breeding population, season, life cycle and reproduction strategy in addition to threat from other sources. Several seabird species are not able to fly during moulting and are hence highly vulnerable to oil at sea.

Experience from earlier oil spills show that the mortality of seabirds is not only dependent on the volume of oil spilled (Table 7.2). More important are number and type of sea bird species present, distribution of the populations, quality of oil and season.

Table 7.2 Observed and estimated seabird mortality due to accidental oil spill

Accident	Year	Oil spilled (ton)	Observed mortality	Estimated mortality
Braer	1993	95 000	1 542	6 700 *)
Exxon Valdez	1989	50 000	36 000	375 000 - 500 000
Stylis	1980	Unknown	50 000	-
Amoco Cadiz	1978	257 000	4 572	20 000
Arrow	1970	10 000	567	7 000
Torrey Canyon	1967	18 000	7 815	30 000

*) expected that observed mortality represents 23% of total mortality.

The area of consideration along the Norwegian coast holds some of Norway's largest nesting cliffs with several pelagic and coastal diving seabird species highly vulnerable to oil pollution. Some of these populations have been declining the last years which increase the sensitivity of the population to additional stress. Several of the species present are of national / international preservation value, and / or are on the red list, under special responsibility, key species or indicator species.

The presence of rich fish resources (spawning, larvae etc.) in this area and the high diversity of the benthic communities leads to high densities of sea birds also during the autumn and winter.

7.3.3 Sea mammals

Oil on the sea surface may affect marine mammals. The vulnerability is highest in species that depend on fur for heat isolation, and lower in species that use blubber for isolation. Further, the vulnerability is very dependent on the characteristics of the oil; the vulnerability is high for fresh oil which cause inhalation of hydrocarbon vapours, and in general low for exposure to weathered oil. External oil exposure (skin etc.) does generally not cause serious effects. It is also believed that most marine mammals can detect and avoid oil slicks.

The most comprehensive and updated review of effects of oil on sea mammals has been provided by Geraci and St. Aubin (/66/). Other reviews on oil pollution and sea mammals are presented in /61/ and /67/. The *Exxon Valdez* incident in 1989 provides some of the most comprehensive documentation on effects of oil on marine mammals.

Several incidents have caused oil exposure to sea mammals. Some of these are listed in table 7.3. Most incidents involve ship vessels spilling fuel, bunker oil or crude oil in coastal areas. It is very difficult to categorise the effects according to oil type and the characteristics of the oil when actually exposing sea mammals; this is usually poorly documented.

The southern Barents Sea and the northern Norwegian coastline are important for several marine mammals where the seals dominate in number and the whales in biomass. Several local populations of sea mammals, in particular seal species, are distributed along the whole Norwegian coastline of consideration. The biological production along the ice edge leads to high concentrations of several marine mammals. The most sensitive periods are during reproduction (concentrated distribution, young seals depend on fur for heath isolation) and during spring – summer along the ice edge.

The most vulnerable species of mammals are seals that aggregated in larger groups for resting and moulting. For these species a larger part of a population can be impacted by oil than is the case for species with a more wide spread distribution. The most common species of seal along the Norwegian coast are grey seal and harbour seal both with resting and moulting areas in the outer part of the coast.

Table 7.3 Reported incidents of impact of oil spills on seals (adapted from /79/).

Date	Location and source	Oil type/ quantity (ton)	Impact	Ref.
Mar 1967	English Channel; *Torrey Canyon*	Crude oil: 18 000	Grey seals observed surfacing through slick, 3 oiled seals found dead or dying.	/77/ /88/
Jan 1969	Gulf of St.Lawrence; storage tank	Bunker C: 15	10-15000 harp seals coated. Unspecified number of dead seals recovered.	/74/ /75/
Feb 1969	Santa Barbara, California; *Union Oil Well*	Crude oil: > 100 000	Oiled harbour seals, elephant seals and California sea lions observed on Channel Island and along mainland coasts. Mortalities not conclusively linked to oil.	/90/ /91/ /92/
Feb 1970	Chedabucto Bay, Sable Island, N.S.; *Arrow*	Bunker C: 15 000	50-60 harbour seals and 100 grey seals oiled on Sable Island. 500 oiled seals in Chedabucto Bay. 24 found dead, some with oil in mouth or stomach	/97/ /76/
Aug 1974	Straits of Magellan; *Metula*	Crude oil: 53 000	Sea lions and fur seals in the area apparently unaffected	/78/
Mar 1978	France, *Amoco Cadiz*	Crude oil: 257 000	2 of 4 dead grey seals coated with oil. No causal relationship	/89/
Mar 1978	Great Yarmouth, UK, *Eleni V*	Heavy fuel: 3 800	20 oiled seals observed	/93/
Oct 1978	South Wales, *Christos Bitas*	Crude oil: 3 000	Mortality of 16 of 23 seals	/94/
Des 1978	Shetland Islands, Scotland, *Esso Bernicia*	Bunker C: 370.000 gallon	Some seals oiled. No deaths reported.	/95/ /106/
Mar 1989	Prince William Sound, Alaska, *Exxon Valdez*	Crude oil: 50 000	Estimated mortality as a direct result of the oil spill was about 300 harbour seals in oiled parts of Prince William Sound. 3000-4000 sea otters (about 35%) were estimated killed. About 1000 sea otter carcasses were recovered.	/67/
Feb 1996	Wales, *Sea Empress*	Crude oil: 72000 tonnes	Some grey seals were observed heavily affected, however, to date there appears to have been no evidence of pollution-related seal mortality.	/68/

7.3.4 Effect on fish populations and fishery

<u>Direct effect on fish species</u>

Eggs and larvae stages of fish species are vulnerable to oil pollution. Acute effects on eggs and larvae are expected to occur when the oil fraction in water exceeds 0.05 ppm. Especially fish species that spawn in shallow inshore areas as lagoons are vulnerable to dispersion of oil from an oil slick at the surface. If an oil spill occurs during the main spawning season of cod and capelin, which shows high concentrations of spawns an impact on the year can be expected.

Adult fish tends to sense oil in the water and avoid oil-polluted areas. However, fish living in shallow waters may be affected by dispersed oil in the water and sediment. One year class of plaice and sole disappeared from heavily contaminated areas after the Amoco Cadiz spill at the French coast. However there was no evidence of effects on the fisheries of these two species subsequent to the spill.

Indirect effect, ecosystem disturbance

Effects on plants, algae and animal species that are used for shelter, nursery ground and food by fish may lead to unwanted effects on the fish population. Such indirect effects are extremely difficult to measure due to high biological variability, and even more difficult to assess in advance.

Direct effect on fishery

Tainting is an important direct effect on fisheries. Tainted fish loose their market value in addition the market value can be lost due to the fair of tainting. It is difficult for fishermen to sell fish from areas where an oil spill newly has taken place even though it is no sign of tainting in the fish. An oil spill within an important fishing area during season will result in limitations and even bans on fishing activities. This will give a direct economical impact to the industry as well as indirect impact due to rumours on reduced quality of the fish. Thus a commercial effect of an oil spill can be significant even though there are no detectable effects on the fish.

Aquaculture industry

As for the fishing industry oil in water may also affect the aquaculture industry, either directly because of oil in water that may stress the fish (or shellfish) and result in increased mortality, or indirectly because cages are moved to other locations. Indirect effects may also arise because of market effects (rumours in tainting and reduced quality) or because of the need for destruction of affected fish.

7.3.5 Summary

Significant negative effects of acute oil pollution from tanker accidents in the area from Røst to Nordkapp, are considered to be likely for offshore seabirds, and to a lesser degree for marine mammals, fish species and the aquaculture industry. Potential economic effects of oil spills in this area to fisheries and aquaculture though should not be excluded, although the potential ecological effects on the fish species are considered to be uncertain. Although the offshore area is an important production area it is not considered any significant potential for harmful effects to plankton communities or the marine biomass production or diversity. Accumulation of petroleum hydrocarbons in the marine food web is not plausible because of low water solubility of oil and detoxification systems in marine organisms, and consequently low potential for bioaccumulation/ biomagnification (uptake from water and food and transfer through the food web).

7.4 Environmental areas at risk

The risk assessment on international maritime traffic identifies the areas along the coast of Troms to be the areas having the highest risk, i.e. the areas of D1 and E1 as presented in figure 6-3. The risk is mainly caused by high traffic density and crossing lanes.

An assessment of valuable areas (summing up in section 3) has identified a total of 18 areas in the northern Norwegian Sea and the Barents Sea holding resources and features of key importance to the ecosystem and unique characteristics. Of these are 4 areas described to have the highest value. These are the

- Polar Front
- The Ice edge
- Tromsøflaket
- Lofoten – Røst – Vesterålen

The vulnerability of the environmental resources encompasses several elements as presented in the sub-sections above. Oil pollution is regarded as the incident of highest concern with respect to environmental resources. The following resources are regarded as being most vulnerable to oil spill:

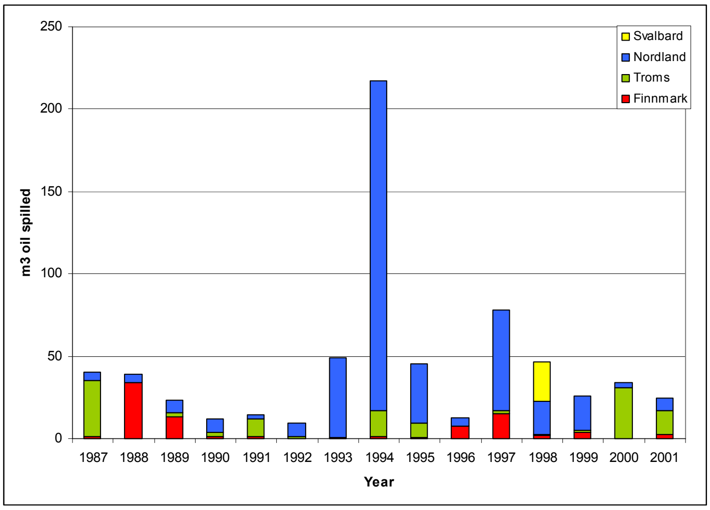
- Seabirds
    - pelagic diving seabirds
    - coastal diving seabirds
    - wintering, moulting and foraging areas of species group above
    - bird cliffs with species foraging at sea
- Marine mammals
    - Breeding
    - Whelping areas
    - Moulting areas
- Spawning areas of fish
- Sheltered coastal areas

The shipping lanes posing the highest risk from international maritime operations are located along the coast of Troms (lane D1 and E1). These lanes are located close to the valuable areas of Tromsøflaket and Lofoten – Røst – Vesterålen. These areas also hold resources having high vulnerability and ecological importance as described above.

8 MITIGATING AND PROTECTIVE MEASURES

8.1 Environmental effects

Increasing petroleum exploration and export will cause a substantial change of the maritime traffic in the area. The most important environmental effect of the maritime industry is accidental spills of oil. Volume of fuel spilled increase with size of vessel, and largest spills are from oil tankers (cargo). Several earlier analyses have demonstrated correlation between accident frequency and distance sailed (SAFECO, 1997; 1998). Traffic in this area has been dominated by fishing vessels and relative small general cargo ships. This is reflected in the oil spill statistics for Norwegian waters (Figure 8.1) with small spills and high frequency (>10/year).



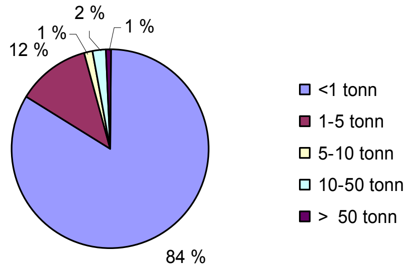


Figure 8.1 Historical oil spills from ships in Norwegian waters (http://www.miljostatus.no/)

Based on estimates such as presented in section 6 the Norwegian authorities have started to plan and implement mitigating measures in the region. Preventive risk reducing measures that are highly likely to be implemented by 2015 is described in section 6 and included in the risk analysis. These will only be briefly discussed here. Other mitigating measures are oil spill response systems and regulations reducing air emissions, waste management etc.

8.2 Implemented protective measures

The following describes protective measures already implemented or expected implemented by 2015.

8.2.1 Increase limit of territorial waters

The Norwegian government increased the boundary of Norwegian territorial waters from 4 nm to 12 nm by 1st January 2004.. The increased limit of the territorial waters will not in itself have a risk reducing effect, but is vital for the effect of some of the measures implemented or to be implemented.

8.2.2 Vessel traffic service (VTS)

Vessel Traffic Services (VTS) are shore-side systems, which range from the provision of simple information messages to vessels, such as position of other traffic or meteorological hazard warnings, to extensive management of traffic within a port or waterway. A VTS is proposed established in Vardø and will have a risk reducing effect on the probability for collisions. The VTS arrangement is regulated under SOLAS, section V Safety of Navigation and is further detailed in under IMO resolutions and national regulations. The VTS can provide information of the vessel, assist in navigation and organise the traffic pattern. The contents and functionality of the VTS will be aligned with the specific needs in the area and the response to the traffic situation in the area.

The effect in the specific area is enhanced by introducing:

- Traffic separation schemes. This is dedicated “corridors” for vessels in opposite directions. The traffic corridors may only be defined in the maps, physically separated by buoys or in some cases the corridors are separated by separation lanes in order to better separate the vessels.
- Automatic Identification System (AIS) is designed to send and receive information in relation to a vessel’s identity (e.g. name, call sign, and dimensions), course (e.g. route, speed) and cargo. The VTS will be able to track most vessels within the territorial waters, and advice any vessels deviating from the traffic separation scheme to correct their course.
- Tugs at strategic locations. At present one tug is ordered placed along the coastline of consideration. A total of three tugs or vessel of similar capability (e.g. standby vessels, coastguard vessels) though are expected placed at strategic locations in the Barents Sea region by 2015. The VTS will be able to locate and direct tugs to assist vessels that have lost power. The need for three vessels is dependent on the fact that the territorial limit is decided increased from 4 nm to 12 nm. The risk reducing effect of having tug support readily available is considerable for drift grounding. It is expected that the upgrade of the tugs stationed in the area is regularly assessed an improved according to the changes of the fleet.

It should be noted that a mandatory ship reporting regime in international waters must be agreed on by the IMO while in national waters such a reporting regime can be defined by the national state.

8.2.3 Electronic Chart Display and Information System (ECDIS)

ECDIS is a navigation aid that can be used instead of nautical paper charts and publications to plan and display the vessel’s route, plot and monitor positions throughout the intended voyage. ECDIS is assessed to have a direct risk reducing effect on power grounding.

8.2.4 Implementation of routeing regime

Routing systems can similar to reporting systems be established for the purpose of safeguarding health, safety at sea and the environment. Systems approved by the IMO can be assigned for specific vessel categories or vessels transporting specific goods. The aim of such a routing regime should be seen in the context of the specific risk of concern. The Norwegian authorities has defined a routing regime in the area Vardø – North Cape, entered into force by 1st January 2004 (reference is made to ”Forskrift om påbudte seilingsleder i territorialfarvannet for skipstrafikk som representerer en miljørisiko – Kyststrekningen Vardø – Nordkapp”). The scheme includes the establishment of 1.5 nm wide corridors in each direction, divided by a 1 nm separation lane. Physical dividers are not regarded as necessary. The traffic separation scheme will be placed inside the extended territorial waters. Several vessels are at present travelling further from the cost than 12 nm. When establishing a traffic separation scheme one should consider the potential impact of situations where the scheme may lead the vessels closer to the coast than what is at present the situation. Physical dividers are not planned for, as the separation lanes is assessed to be sufficient to separate the vessels.

8.2.5 Contingency management and planning regime

Existing oil spill contingency regime in Norway is described in detail at the homepage of Norwegian Clean Seas Association for Operating Companies - NOFO (http://planverk.nofo.no/). Norwegian contingency encompasses governmental as well as inter municipal and private actors. It is expected that the contingency regime will be upgraded by 2015.

The contingency management regime includes both preventive contingency as well as incident management.

Preventive contingency includes policing of existing national and international regulations and management and monitoring of assigned regulated traffic lanes. Other preventive measures can be regulation of type of tonnage as requirements to double hull for high risk cargo (oil, chemicals) vessels and particularly assigned lanes for high risk traffic (differentiated by season, cargo type, ship type). Important input to preventive measures will be given through an environmental impact assessment and a risk analysis on maritime activities indicating type of activity giving high risk (tonnage, cargo, age etc), risk incidents (fire, collision, grounding etc.) and high risk areas. Optimised management and training regime ensuring optimal use of all resources should be implemented.

Incident management implies having adequate and sufficient resources to undertake comprehensive contingency actions under varying conditions (weather, type of ship, type of product discharged/expected discharged). This includes technical equipment (planes, ships, booms, skimmers, unloading equipment, tugs etc), communication lines (satellite and other common communication lines) and necessary personnel. First line contingency will be limited and additional resources should be made available from other areas (land based). It is reasonable that the response time from these additional resources should be as in the North Sea area, i.e. 24 hours. The Coastal Directorate have established 15 depots along the Norwegian coastline. Of these are 6 depots located in Longyearbyen, Vadsø, Hammerfest, Tromsø, Lødingen and Bodø.

An environmental risk analysis and oil spill contingency assessment on oil spill preparedness has been conducted by the Norwegian pollution control authority (/28/). The report has assessed several scenarios for the Barents Sea region identifying contingency needs related to type of equipment, dispersants, oil recovery system, off-loading systems, cleaning capabilities, response time, remote sensing and surveillance and human resources are addressed.

At present upgrading of the governmental oil spill preparedness is ongoing to meet the addressed requirements to response time, where focus is put on the northern areas including the Barents Sea area.

Further on the Norwegian authorities are working jointly with Russian authorities for the purpose of improving the maritime operations and oil spill contingency management in the region.

The possibility for intervention of a vessel outside territorial waters can be undertaken in accordance to the International Convention relating to Intervention on the high seas in cases of oil pollution casualties of 29th November 1969.

During a contingency and rescue operation routines are established to provide support from emergency response service (ERS) whenever it is found appropriate.

8.2.6 Places of refuge and beaching

In the process after the Prestige incident the issue of places of refuge and beaching areas have been discussed. Norway is according to the EU directive 2002/59/EF of 27th June 2002 on traffic monitoring, surveillance and information systems required to develop a contingency plan for assisting ship with reduced capacity of engine or engine failure.

The Norwegian Coastal Directorate has recently evaluated the designation of places of refuge and a number of 69 places of refuge and 62 areas for beaching have been defined. The areas are evenly distributed along the coast and several sites are located along the coastline of Troms and Finnmark. Site for beaching is an area where a ship can be set onshore to prevent sinking of the ship. Several places of refuge areas can be applied for the same purpose.

Places of refuge and beaching have also been established within the proposed PSSA to ensure that when such actions are relevant to be taken they are performed at places where the impacts to the environmental and other interests are limited.

The areas are assigned taking into account the general vulnerability of the area, protection to dominating weather conditions, ease of navigation and occurrence of other interests (e.g. aquaculture farming). The use of places of refuge and beaching sites will improve the contingency actions, reduce actions time and ensure reduced impact to vulnerable resources.

For further details related to positioning of ports of refuge and beaching areas the Coastal Directorate should be consulted (http://www.kystverket.no).

8.2.7 Loading & unloading of cargo

Loading and unloading of cargo increases the risk of discharges of oil and chemicals. These are to some extent complex operations involving the human element, technical solutions and loading and unloading facilities in port. Improved facilities in port for such operations will reduce the potential of incidents of discharges of cargo.

A Norwegian regulation encompassing loading and unloading of bulk vessels will enter into force 1st March 2004. The regulation is compliant to the EU directive 2001/96 and encompasses procedures for safe handling of cargo to avoid exceeding the strength and structure capacity of the vessel.

8.2.8 Emissions to air

Emissions to air are as discharges to sea mainly regulated through MARPOL and EU policies/directives. Implementation of the relevant annexes of MARPOL and EU directives/policies on emissions to air is expected to generally improve the environment of the Barents Sea area. The MARPOL Annex 6 regulating NOx emission is expected ratified and implemented in 2004. The EU directive on sulphur contents in bunker (COM 1999/32) is adopted and is at present under revision. The EU has further adopted a new strategy to reduce atmospheric emissions from seagoing ships. The strategy comprises a Commission Communication to the Parliament and Council and an accompanying proposal for a Directive on the sulphur content of marine fuel (/24/).

If the proposed revision is accepted it is expected to enter into force by 2005. A separate Norwegian regulation on VOC collection is established (/16/) and should be considered applied for offshore activities in the Barents Sea as well.

8.2.9 Management of oily wastes, sewage and garbage

Discharges to sea are regulated through MARPOL and respective annexes, voluntary guidelines and EU policies/directives. In general ship generated waste can either be delivered to shore, incinerated onboard or discharged to sea (legally or illegally).

In cases were wastes are incinerated onboard the IMO standards on incinerators should be followed. Full implementation of relevant MARPOL Annexes entered into force in the region is expected to secure the environmental concerns that arise on waste, sewage and garbage discharges to sea.

As part of a study undertaken in 2002 among 68 Norwegian ports on status and quality of waste reception facilities the following information was provided /3/:

Type of waste	Comments
Oily waste	Oily wastes can be received by 36 – 55% of all ports, depending on type of oily waste generated. More than 53% of the ports report that they “fully satisfy” or “satisfy” the reception facility requirements.
Noxious Liquid Substances	Noxious liquid substances can be received by about 35% of all ports, encompass category A, B, C and D. More than 47% of the ports report that they “fully satisfy” or “satisfy” the reception facility requirements.
Sewage	Sewage can be received by 47% of all ports, encompass both black and grey water. More than 50% of the ports report that they “fully satisfy” or “satisfy” the reception facility requirements.
Garbage	Garbage can be received by up to 80% of all ports, depending upon type of garbage. More than 83% of the ports report that they “fully satisfy” or “satisfy” the reception facility requirements.
Ozone depleting substances	Ozone depleting substances can be received by 32% of all ports. More than 47% of the ports report that they “fully satisfy” or “satisfy” the reception facility requirements.

Documentation of waste reception facilities in northern Russia is not provided. The lack of such facilities implies either the use of reception facilities in other ports outside the region, incineration onboard or discharge to sea or a combination of such.

A Norwegian regulation entered into force in October 2003 requiring ports to receive ship generated waste. The regulation represents a follow up of a EU Directive on waste reception facilities entered into force in 2003 encompassing all ship entering the EU or the EEC region.

8.3 Proposed implemented protective measures

The following describes protective measures already implemented that can be or should be considered improved. Further additional protective measures are proposed.

8.3.1 Implementation of traffic separation scheme

For the purpose of protecting sensitive environmental resources a traffic separation scheme can be established according to the IMO assembly resolution A.14/Res.572 on “General Provisions on Ships’ Routeing” and a routeing and reporting systems near or in the area, under the International Convention for the Safety of Life at Sea (SOLAS, /10/). This can be undertaken by routeing the traffic at safe distance from sensitive areas or by organising the traffic within or near such areas in an environmentally sound manner taking into account safety aspects of the ship. Prior to establishing a traffic separation scheme a detailed description of the environmental resources at stake, description of existing and expected future maritime activities and an risk assessment of maritime activities should be produced to support the decision process.

The existing traffic separation scheme in the area Vardø - Nordkapp consists of three differentiating lanes:

1. a 1.5 nm wide inner lane for traffic going in the north-east direction
2. a 1 nm separation lane
3. a 1.5 nm wide outer lane for traffic going in the south-west direction

The Norwegian authorities are at present evaluating an additional traffic separation scheme in the sea area Vardø – Røst, see previous section.

The whole coastline of Troms and Finnmark holds environmental resources of high value. Hence for the purpose of protecting this coastline a traffic separation regime is recommended placed along the coast of Troms county as well. To reduce the impact with fishing activities the traffic separation regime is recommended placed outside the main fishing areas, i.e. at 20 nm from the coast line. A separation regime should be seen in the context of the potential establishment of a PSSA. As can be seen in section 9 a traffic separation regime has been suggested within the proposed PSSA.

Reporting of maritime traffic within the traffic separation scheme will be covered by the AIS and further reporting regime is not at present considered necessary in the area.

Maritime traffic regulated by the traffic separation scheme

The traffic separation scheme regulates the following maritime operations:

- Vessels transporting cargo regulated under MARPOL 73/78 Annex 1, 2 and 3.
- Vessels with a total bunker oil capacity of more than 300m^3.

Vessels except from the traffic separation scheme includes:

- Fishing vessels
- Military vessels

The Costal Directorate can give exemptions to the regulation and can under special conditions repeal the regulation.

8.3.2 Reporting regime

The suggested traffic separation scheme and the use of AIS are expected to provide a relatively good reporting regime within the proposed PSSA, see section 9. Under special circumstances the EU directive 2002/59 on reporting should be followed by any vessel operating under AIS. However, the need for such a reporting regime should be assessed in detail before a final conclusion is given.

8.3.3 AIS distribution and coverage

At present 35 AIS stations are proposed established along the Norwegian coast. The suggested traffic separation scheme of the proposed PSSA extends further from the coast than the expected range of the AIS (25 – 30 nm). To support the need for AIS within the whole suggested traffic separation scheme of the proposed PSSA, one (1) AIS station should be considered placed offshore, either on a buoy or on an offshore petroleum installation).

8.3.4 Ballast water management

Introduction of harmful marine species is of great concern and regarded as one of the 4 major impacts to the marine environment. Presently the amount of foreign ballast water introduced to the region is low. However, an increase in the traffic is expected to increase the amount of foreign ballast water introduced in the region.

IMO has established a guideline for the control and management of ballast water where the objective is to minimize the transfer of harmful aquatic organisms (/17/). The work on establishing an international convention for the management and control of ballast water under the IMO is in the final phase and is expected finalized during a diplomatic conference in 2004 /25/. The ratification process within IMO indicates time frame of 5 – 10 years prior to ratification of the convention. Several countries have established national regulations for ballast water control and Norway is in the process of establishing a similar regime expected to enter into force by 2004 although a final decision is yet to be made. The risk of ballast water imported and planned imported to the area should be assessed and give input to the specific ballast water management regime for the region.

9 CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions on assessment of PSSA status in the northern part of the Norwegian Sea and the Norwegian part of the Barents Sea.

The oceanographic conditions in the Barents Sea and the connecting north east Norwegian Sea and the ice edge ecosystem are regarded as essential features to the marine ecosystems of the Barents Sea. The conclusions from the risk assessments undertaken show that the special characteristics of certain areas with its environmental resources and ecological mechanisms meet the criteria for designation of PSSA status according to IMO Res.A.927(22).

A prospective assignment of PSSA and adopted protective measures should hence take into account the following:

1) Areas having high value

- Polar Front
- The Ice edge
- Tromsøflaket
- Lofoten – Røst – Vesterålen

2) Areas having resources of high vulnerability

- Seabirds
    - pelagic diving seabirds
    - coastal diving seabirds
    - bird cliffs with species foraging at sea
    - wintering, moulting and foraging areas of species above
    - bird cliffs with species foraging at sea
- Marine mammals
    - Breeding areas
    - Whelping areas
    - Moulting areas
- Spawning areas of fish
- Sheltered coastal areas

3) The geographical areas having the highest maritime risk picture:

- the area along the coast of Troms county

4) The maritime activity posing high risk

- discharge of oil from bunker and tankers

5) Maritime operations or incidents posing the highest risk

- drift grounding
- power grounding
- collisions

6) Existing and planned implemented protective measures

9.2 Recommendations for PSSA status in the Norwegian part of the Barents Sea and the northern part of the Norwegian Sea

Evaluating the issues given above indicate that there is a potential for proposing a PSSA in the region.

The whole area assessed for the purpose of PSSA status holds environmental resources posing high environmental value and are highly vulnerable to anthropogenic impact including maritime operations. Considering the present and future maritime operations in the area and the risk picture posed by these activities operations however, only a smaller area is presently proposed as PSSA. It should be noted though that areas outside the proposed PSSA are highly vulnerable to impact even single incidents and any changes in the maritime operations in the area should result in revaluation of the protection status of the area of the northern Norwegian Sea and the Barents Sea as a whole.

9.2.1 Proposed PSSA area

The proposed PSSA is presented in figure 9.1 and is located in the north east part of the Norwegian Sea bordering to the Barents Sea. Table 9.1 presents a summary of the fulfilment of the Barents Sea area to the criteria of PSSA status related to ecological, socio-economics and scientific criteria. Table 9.2 lists criteria met for the proposed designated PSSA. The PSSA proposed is encompassed by the areas of Tromsøflaket and the area Lofoten – Røstbanken - Vesterålen. The other 2 areas identified as being of high value (the Polar Front and the Ice Edge) are not expected to be impacted by international maritime operations to the same extent and hence they are not part of the proposed PSSA.

The proposed PSSA has a larger extension than the 2 identified vulnerable areas together. A buffer zone has been assigned between the two areas for the purpose to ease the administration of the PSSA.

The extension of the proposed area designated as a PSSA is given by the area bounded by a line connecting the following geographical positions and the main land of Norway:

1) Lat: 66° 30' Long: 13° 0' (eastward extension is the main land of Norway)

2) Lat: 67° 21' Long: 8° 56'

3) Lat: 71° 32' Long: 17° 41'

4) Lat: 71° 34' Long: 20° 41'

5) Lat: 71° 0' Long: 24° 0' (eastward extension is the main land of Norway)

A traffic separation scheme is proposed outside the two vulnerable areas of Tromsøflaket and Lofoton – Røst – Vesterålen. The two areas are identified within the buffer zone where the proposed routing is established.

Traffic separation scheme position 1

The routing position 1 is positioned west of the vulnerable area of Lofoten – Røstbanken – Vesterålen but within the buffer zone of the proposed PSSA.

The area is defined by the following positions:

Northern position:	Lat: 067° 25' 09.9134"	Long: 008° 52' 35.2160"
Southern position:	Lat: 067° 22' 12.0457"	Long: 008° 49' 15.5641"

Shortest distance from land is 60 nm

Traffic separation scheme position 2

The routing position 2 is positioned west of the vulnerable area of Tromsøflaket but within the buffer zone of the proposed PSSA.

The area is defined by the following positions:

Eastern position:	Lat: 071° 36' 27.8804"	Long: 017° 46' 37.0912"
Bend:	Lat: 071° 36' 20.8834"	Long: 017° 36' 40.4430"
Southern position:	Lat: 071° 33' 53.3737"	Long: 017° 30' 03.8083"

Shortest distance from land is 80 nm.

An additional traffic separation scheme is proposed 20 nm north of Nordkapp to ensure that the traffic directed to and from the traffic separation regime within the PSSA is undertaken in a safe manner.

Traffic separation scheme position 3

An additional traffic separation scheme is proposed 20 nm north of Nordkapp to ensure that the traffic directed to and from the traffic separation regime within the PSSA is undertaken in a safe manner.

The area is defined by the following positions:

Eastern position:	Lat: 071° 32' 42.1939"	Long: 025° 42' 56.7185"
Western position:	Lat: 071° 32' 53.8656"	Long: 025° 32' 48.8003"

Shortest distance from land is 20 nm.

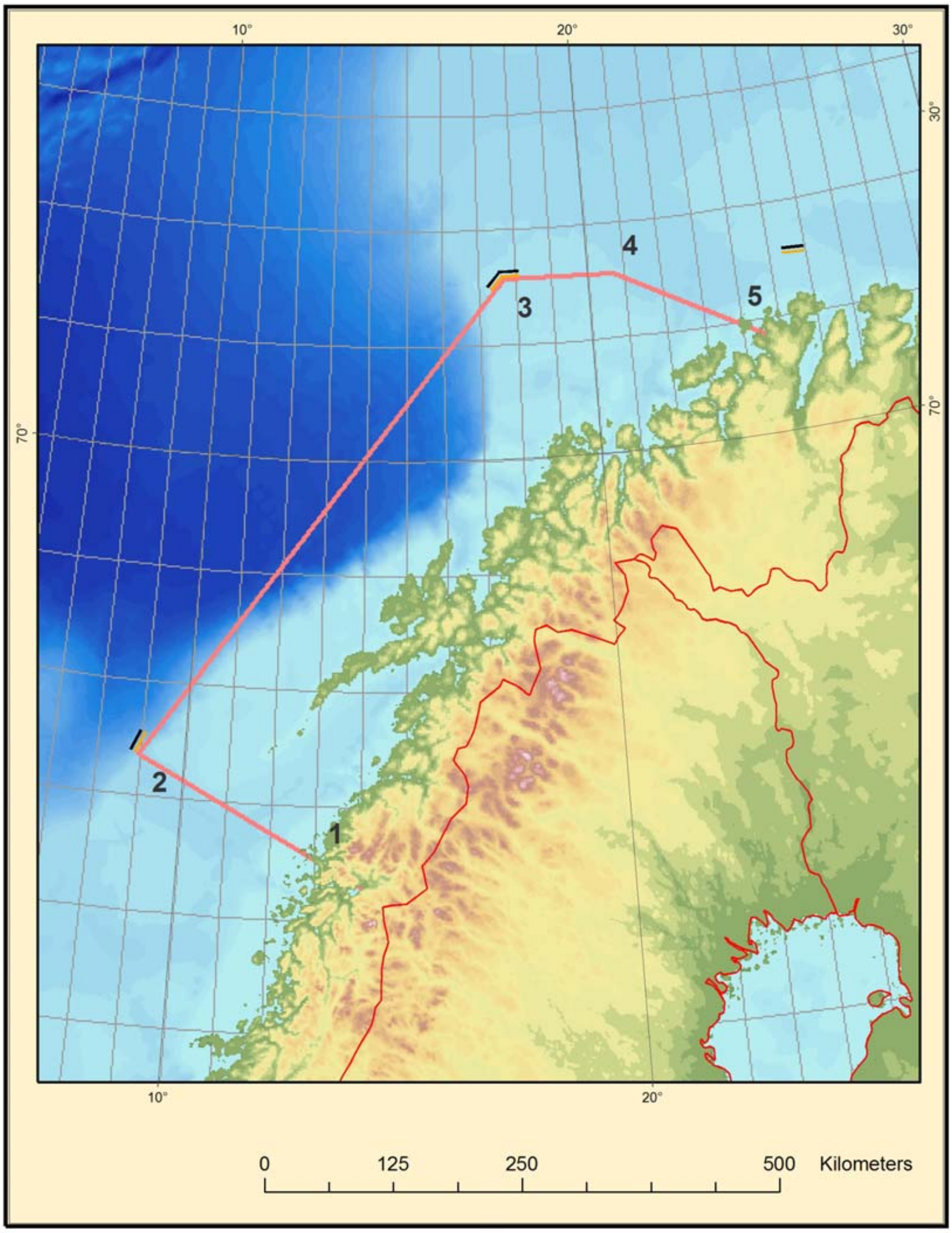


Figure 9.1. North east Norwegian Sea PSSA. Area proposed designated as PSSA in northern Norwegian Sea and the Barents Sea, indicated by a red line. Sectors indicated in black and yellow are suggested traffic separation schemes.

Table 9.1 Summary of the fulfilment of the Barents Sea area to the criteria of PSSA status according to IMO resolution A.927(22), ref /4/.

Criteria in Res. A. 720(17)	Compliance to criteria
Oceanographical conditions (wrt §5 of Res a.927(22))	The ocean currents increase the risk of damage to the sea from discharges caused by accident or regular operations. Because of the current system in the Barents Sea the discharge will follow the current system along the coast or to the very sensitive area in the north. The ice-edge ecosystem is typical for the Barents Sea, and regarded as very sensitive for impact specifically oil spills. The occurrence of ice is further known to affect the contingency actions. The establishment of continuous and discontinuous gyres between different water masses and over the bank areas within the Barents Sea are features essential to the plankton growth and hence important fish, marine mammals and seabirds living upon planktonic organisms. The northern Barents Sea holds sea ice all through the year. In some years the ice extends far south in the Barents Sea during winter. The connection to the Atlantic water masses in the Norwegian Sea which transports plankton rich water into the Barents Sea is regarded as essential to the plankton ecosystems of this sea
Ecological conditions (wrt §4 of Res a.927(22))	The ecosystems of the Barents Sea are among the most productive in the world due to the shallow areas and influx of warm water from the south and nutrient rich water from the north caused by melting of ice revealing nutrient waters. Fish, seabirds and marine mammals are represented in high numbers within the Barents Sea. The north east part of the Norwegian Sea also poses important spawning areas of ecologically important species. Parts of the Barents Sea is characterised by having the largest areas of near-pristine wilderness in Europe. Most of the marine and substantial parts of the terrestrial ecosystems are intact, with undisturbed habitats and vegetation, and viable, un-harvested populations of fish, birds and mammals. The area are protected or proposed protected at international level due to the existence of vulnerable populations of seabirds and marine mammals. Areas are also protected or proposed protected to preserve relatively pristine ecosystems. Within the Barents Sea there are populations of seabirds, fish and marine mammals feeding upon plankton or plankton feeders, regarded as of international conservation value. Many of these species are given to be vulnerable according to stock sizes. The plankton communities located along the ice edge in the Barents Sea and within gyres over shallow bank areas are crucial for the ecosystem in the area. The ecological features of the Barents Sea and north east Norwegian sea is essential for the ecological features along the coastline representing strong ecological interactions between the sea and the coast. In the Arctic area there is an influx of energy from the sea to the land which maintains and develops the ecosystem on land and islands.
Socio-economic conditions (wrt §4 of Res a.927(22))	The Barents Sea has some of the world's largest fish stocks. More than 50% of all fishermen in Norway live in the northern part of Norway. The employment along the coast has always been and is still related to fishery

	industry. Further growth of aquaculture is also an important basis for the development along the coast in the northern part of Norway. The numerous fishing villages in the area signify the importance of this development, both as cultural-historical documentation and as a natural business activity. Tourism is also very important and increasing and is strongly related to the sea and coastal areas. The environmental resources represented by the sea and the coastal area and the interrelations thereof are major preconditions for the value of the area , economically as well as cultural. Thus, economic growth and exploitation of these resources are critical and may pose a threat to the vulnerable marine environment.
Scientific conditions (wrt §4 of Res a.927(22))	The Barents Sea area is highly valuable as scientific and environmental reference areas and important in climatic processes and indicators of globally important changes (atmosphere-sea-ice-ocean).
Vessel traffic(wrt §5 of Res a.927(22))	Vessel traffic was earlier dominated by fishing vessels with local distribution of bunker oil with small coastal tankers as the most important environmental risk. The traffic is located in near shore areas. However fisheries also occur in the central part of the Barents Sea along the continental edge. Increased Russian export of crude oil and heavy fuel oil has caused a significant growth in tanker traffic the last three years. More than 200 vessels transited the area in 2003. This traffic is expected to increase to more than 600 tankers in 2015 with average size going up from less than 50 000 dwt in 2002 to more than 150 000 dwt. The Russian traffic is located close to the Norwegian coastline and passes through areas with high density of fishing vessels. Export of oil and gas from the Norwegian sector of the Barents Sea and Norwegian Sea will cause a further growth in tanker traffic from 2006. Production scenarios developed by the Ministry for Oil and Energy indicate that between 400 and 700 crude and gas tankers will be involved in this export in 2015. In addition cruise traffic and general cargo is expected to grow by 5- 10 % in the next 10 – 20 years.
Other considerations (wrt §5 of Res a.927(22))	
- Reception facilities	Waste reception facilities are established in major ports of Norway and are reported to provide sufficient facilities for waste reception.
- Influence by other sources	In comparison with most other areas of the world, the Barents Sea remains a “clean” environment. It should be noted though that the Barents Sea is also affected by long distance transport of pollutants causing concern of the environment.
- Implemented management regime	Norway has a thorough and long term policy on marine environmental protection internationally (through ratification of MARPOL annexes, OSPAR, AMAP, the Bonn agreement, the Copenhagen agreement, bilaterally agreements with Russia) as well as nationally. The concern about the Barents Sea area is specifically addressed in the Report to the Storting No. 12 Protecting the Riches of the Seas /8/. The management regime includes extensive development and maintenance of a pollution prevention and contingency regime, routing regime within the territorial waters (12 nm) and establishment of waste reception facilities and implementation of regulation for delivery of waste in port /11/.

Table 9.2. IMO Resolution A.927(22), ref /4/, criteria met by the area proposed as PSSA in the northern Norwegian Sea and the Barents Sea.

Criteria in Res. A. 720(17)	Area specific compliance to criteria
Ecological conditions (wrt §4 of Res a.927(22))	
Uniqueness	Fulfilled by other areas of the Barents Sea
Critical habitat	Fulfilled by the area proposed designated as PSSA.
Dependency	Fulfilled by other areas of the Barents Sea
Representativeness	Fulfilled by the area proposed designated as PSSA.
Diversity	Fulfilled by the area proposed designated as PSSA.
Productivity	Fulfilled by the area proposed designated as PSSA.
Spawning / breeding ground	Fulfilled by the area proposed designated as PSSA.
Naturalness	Fulfilled by the area proposed designated as PSSA.
Integrity	Fulfilled by other areas of the Barents Sea
Vulnerability	Fulfilled by the area proposed designated as PSSA.
Biogeographical importance	Fulfilled by other areas of the Barents Sea
Socio-economic conditions (wrt §4 of Res a.927(22))	
Economic	Fulfilled by the area proposed designated as PSSA.
Recreation	Fulfilled by the area proposed designated as PSSA.
Human dependency	Fulfilled by the area proposed designated as PSSA.
Scientific conditions (wrt §4 of Res a.927(22))	Fulfilled by the area proposed designated as PSSA.
Vessel traffic(wrt §5 of Res a.927(22))	
Operational factors	Fulfilled by the area proposed designated as PSSA.
Vessel types	Fulfilled by the area proposed designated as PSSA.
Traffic characteristics	Fulfilled by the area proposed designated as PSSA.
Harmful substances carried	Fulfilled by the area proposed designated as PSSA.

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APPENDIX

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IMO GUIDELINES - RESOLUTION A.927(22)

NTERNATIONAL MARITIME ORGANIZATION
IMO

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ASSEMBLY
22nd session
Agenda item 11

A 22/Res.927
15 January 2002
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Resolution A.927(22)
Adopted on 29 November 2001
(Agenda item 11)

GUIDELINES FOR THE DESIGNATION OF SPECIAL AREAS UNDER MARPOL 73/78 AND GUIDELINES FOR THE IDENTIFICATION AND DESIGNATION OF PARTICULARLY SENSITIVE SEA AREAS

THE ASSEMBLY,

RECALLING Article 15(j) of the Convention on the International Maritime Organization concerning the functions of the Assembly in relation to regulations and guidelines concerning maritime safety, the prevention and control of marine pollution from ships and other matters concerning the effect of shipping on the marine environment,

RECALLING ALSO resolution A.720(17) by which the Assembly adopted the Guidelines for the Designation of Special Areas and the Identification of Particularly Sensitive Sea Areas and requested the Marine Environment Protection Committee and the Maritime Safety Committee to keep the Guidelines under review,

RECALLING FURTHER resolution A.885(21) by which the Assembly adopted Procedures for the Identification of Particularly Sensitive Sea Areas and the Adoption of Associated Protective Measures and Amendments to the Guidelines contained in resolution A.720(17), and also requested the Marine Environment Protection Committee and the Maritime Safety Committee to keep these Guidelines under review,

RECOGNIZING the need to update and simplify the Guidelines in order to clarify the procedures for the designation of Special Areas under MARPOL 73/78 and for the identification and subsequent designation of Particularly Sensitive Sea Areas and the adoption of associated protective measures,

HAVING CONSIDERED the recommendations made by the Marine Environment Protection Committee at its forty-sixth session:

1. ADOPTS:

(a) new Guidelines for the Designation of Special Areas under MARPOL 73/78 as set out in Annex 1, which supersede chapter 2 of the Annex to resolution A.720(17); and

(b) new Guidelines for the Identification and Designation of Particularly Sensitive Sea Areas as set out in Annex 2, which supersede chapter 3 of the Annex to resolutions A.720(17) and A.885(21);

2. INVITES Governments to apply the new Guidelines when proposing the designation of a Special Area under MARPOL 73/78 or a Particularly Sensitive Sea Area;

3. REQUESTS both the Marine Environment Protection Committee and the Maritime Safety Committee to keep the new Guidelines under review; and

4. REVOKES resolutions A.720(17) and A.885(21).

A 22/Res.927

ANNEX 1

GUIDELINES FOR THE DESIGNATION OF SPECIAL AREAS UNDER MARPOL 73/78

1 INTRODUCTION

1.1 The purpose of these Guidelines is to provide guidance to Contracting Parties to the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78) in the formulation and submission of applications for the designation of Special Areas under Annexes I, II, and V to the Convention. These Guidelines also ensure that all interests - those of the coastal State, flag State, and the environmental and shipping communities - are thoroughly considered on the basis of relevant scientific, technical, economic, and environmental information and provide for the assessment of such applications by IMO. Contracting Parties should also review and comply with the applicable provisions of Annexes I, II, and V to the Convention in addition to these Guidelines.

2 ENVIRONMENTAL PROTECTION FOR SPECIAL AREAS UNDER MARPOL 73/78

General

2.1 MARPOL 73/78, in Annexes I, II and V, defines certain sea areas as Special Areas in relation to the type of pollution covered by each Annex. A Special Area is defined as "a sea area where for recognised technical reasons in relation to its oceanographical and ecological conditions and to the particular character of its traffic, the adoption of special mandatory methods for the prevention of sea pollution by oil, noxious liquid substances, or garbage, as applicable, is required." Under the Convention, these Special Areas are provided with a higher level of protection than other areas of the sea.

2.2 A Special Area may encompass the maritime zones of several States, or even an entire enclosed or semi-enclosed area. Special Area designation should be made on the basis of the criteria and characteristics listed in paragraphs 2.3 to 2.6 to avoid the proliferation of such areas.

Criteria for the designation of a Special Area

2.3 The criteria which must be satisfied for an area to be given Special Area status are grouped into the following categories:

- oceanographic conditions;
- ecological conditions; and
- vessel traffic characteristics.

Generally, information on each category should be provided in a proposal for designation. Additional information that does not fall within these categories may also be considered.

Oceanographic conditions

2.4 The area possesses oceanographic conditions which may cause the concentration or retention of harmful substances in the waters or sediments of the area, including:

1 particular circulation patterns (e.g. convergence zones and gyres) or temperature and salinity stratification;

2 long residence time caused by low flushing rates;

3 extreme ice state; and

4 adverse wind conditions.

Ecological conditions

2.5 Conditions indicating that protection of the area from harmful substances is needed to preserve:

1 depleted, threatened or endangered marine species;

2 areas of high natural productivity (such as fronts, upwelling areas, gyres);

3 spawning, breeding and nursery areas for important marine species and areas representing migratory routes for sea-birds and marine mammals;

4 rare or fragile ecosystems such as coral reefs, mangroves, seagrass beds and wetlands; and

5 critical habitats for marine resources including fish stocks and/or areas of critical importance for the support of large marine ecosystems.

Vessel traffic characteristics

2.6 The sea area is used by ships to an extent that the discharge of harmful substances by ships when operating in accordance with the requirements of MARPOL 73/78 for areas other than Special Areas would be unacceptable in the light of the existing oceanographic and ecological conditions in the area.

Implementation

2.7 The requirements of a Special Area designation can only become effective when adequate reception facilities are provided for ships in accordance with the provisions of MARPOL 73/78.

Other considerations

2.8 The threat to amenities posed by the discharge of harmful substances from ships operating in accordance with the MARPOL 73/78 requirements for areas other than Special Areas may strengthen the argument for designating an area a Special Area.

2.9 The extent to which the condition of a sea area is influenced by other sources of pollution such as pollution from land-based sources, dumping of wastes and dredged materials, as well as atmospheric deposition should be taken into account. Proposals would be strengthened if measures are being, or will be, taken to prevent, reduce and control pollution of the marine environment by these sources of pollution.

2.10 Consideration should be given to the extent to which a management regime is used in managing the area. Proposals for designation of a Special Area would be strengthened if measures are being taken to manage the area's resources.

3 PROCEDURES FOR THE DESIGNATION OF A SPECIAL AREA

3.1 A proposal to designate a given sea area as a Special Area should be submitted to the Marine Environment Protection Committee (MEPC) for its consideration in accordance with the rules adopted by the IMO for submission of papers.

3.2 A proposal to designate a sea area as a Special Area should contain:

1 a draft amendment to MARPOL 73/78 as the formal basis for the designation; and

2 a background document setting forth all the relevant information to explain the need for the designation.

3.3 The background document should contain the following information:

1 a definition of the area proposed for designation, including its precise geographical co-ordinates. A reference chart is essential.

2 an indication of the type of Special Area proposed. Proposals may be made simultaneously with respect to Annexes I, II and V of MARPOL 73/78, but proposals for each Annex should be presented and evaluated separately.

3 a general description of the area, including information regarding:

- oceanography
- ecological characteristics
- social and economic value
- scientific and cultural significance
- environmental pressures from ship-generated pollution
- other environmental pressures

- measures already taken to protect the area.

This general description may be supported by annexes containing more detailed material, or by references to readily available documentation.

4 an analysis of how the sea area in question fulfils the criteria for the designation of Special Areas set out in paragraphs 2.3 to 2.6.

5 information on the availability of adequate reception facilities in the proposed Special Area.

3.4 The formal amendment procedure applicable to proposals for the designation of Special Areas is set out in article 16 of MARPOL 73/78.

Detailed discharge requirements

3.5 For detailed requirements relating to discharges under Annexes I, II and V to MARPOL 73/78, please refer to the latest version of the Convention in force.

ANNEX 2

GUIDELINES FOR THE IDENTIFICATION AND DESIGNATION OF PARTICULARLY SENSITIVE SEA AREAS

1 INTRODUCTION

1.1 The Marine Environment Protection Committee (MEPC) of the International Maritime Organization (IMO) began its study of the question of Particularly Sensitive Sea Areas (PSSAs) in response to a resolution of the International Conference on Tanker Safety and Pollution Prevention of 1978. The discussions of this concept from 1986 to 1991 culminated in the adoption of Guidelines for the Designation of Special Areas and the Identification of Particularly Sensitive Sea Areas by Assembly resolution A.720(17) in 1991. The procedures contained in this document were further elaborated upon by Assembly resolution A.885(21), adopted in 1999. In a continuing effort to provide a clearer understanding of the concepts set forth in the Guidelines, the MEPC decided to separate the issues of the designation of Special Areas and the identification of Particularly Sensitive Sea Areas into two documents. This document sets forth the Guidelines for the Identification and Designation of PSSAs.

1.2 A PSSA is an area that needs special protection through action by IMO because of its significance for recognized ecological, socio-economic, or scientific reasons and because it may be vulnerable to damage by international shipping activities. In order for the area to be identified as a PSSA, it must meet one of the criteria listed below in section 4. As of 2001, two particularly sensitive sea areas have been designated by IMO: the Great Barrier Reef (MEPC.44(30)) and the Archipelago of Sabana-Camaguey (MEPC.74(40)). Details of designated areas are provided in the Appendix.

1.3 Many international and regional instruments encourage the protection of areas important for the conservation of biological diversity as well as other areas with high ecological, cultural, historical/archaeological, socio-economic or scientific significance. They further call on their Parties to protect such areas from activities, including shipping operations, that may undermine their values.

1.4 The purpose of these Guidelines is to:

(a) provide guidance to IMO Member Governments in the formulation and submission of applications for designation of PSSAs;

(b) ensure that in that process all interests - those of the coastal State, flag State, and the environmental and shipping communities - are thoroughly considered on the basis of relevant scientific, technical, economic, and environmental information regarding the area at risk of damage from international shipping activities and the protective measures to minimize that risk; and

(c) provide for the assessment of such applications by the IMO.

1.5 Identification of any PSSA and the adoption of associated protective measures requires consideration of three integral components: the particular environmental conditions of the area to be identified, the vulnerability of such area to damage by international maritime activities, and the availability of associated protective measures within the competence of IMO to address risks from these shipping activities.

2 INTERNATIONAL SHIPPING ACTIVITIES AND THE MARINE ENVIRONMENT

2.1 Shipping activity can constitute an environmental hazard to the marine environment in general and consequently even more so to environmentally and/or ecologically sensitive areas. Environmental hazards associated with shipping include:

(a) operational discharges;

(b) accidental or intentional pollution; and

(c) physical damage to marine habitats or organisms.

2.2 In the course of routine operations and accidents, ships may release a wide variety of substances either directly into the marine environment or indirectly through the atmosphere. Such pollutants include oil and oily mixture, noxious liquid substances, sewage, garbage, noxious solid substances, anti-fouling paints, foreign organisms and even noise. Many of these substances can adversely affect the marine environment and the living resources of the sea. Pollutants may also damage the environment as a consequence of shipping accidents. In addition, ships may cause harm to marine organisms and their habitats through physical impact. Habitats may be smothered through grounding and ships have been known to strike large marine mammals such as whales.

3 PROCESS FOR THE DESIGNATION OF PARTICULARLY SENSITIVE SEA AREAS

3.1 The IMO is the only international body responsible for designating areas as Particularly Sensitive Sea Areas and adopting associated protective measures. An application to IMO for designation of a PSSA and the adoption of associated protective measures, or an amendment thereto, may be submitted only by a proposing Member Government. Where two or more Governments have a common interest in a particular area, they should formulate a co-ordinated proposal. The proposal should contain integrated measures and procedures for co-operation between the jurisdictions of the proposing Member Governments.

3.2 Member Governments wishing to have the IMO designate a PSSA should submit an application to the MEPC based on the criteria outlined in section 4 and proposed associated protective measures as outlined in section 6. Applications should be submitted in accordance with the procedures set forth in section 7 and the rules adopted by the IMO for submission of papers.

4 ECOLOGICAL, SOCIO-ECONOMIC, OR SCIENTIFIC CRITERIA FOR THE IDENTIFICATION OF A PARTICULARLY SENSITIVE SEA AREA

4.1 The following criteria apply to the identification of PSSAs only with respect to the adoption of measures to protect such areas against damage from international shipping activities.

4.2 These criteria do not, therefore, apply to the identification of such areas for the purpose of establishing whether they should be protected from dumping activities, since that is implicitly covered by the London Convention 1972 (the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972) and the 1996 Protocol to that Convention.

4.3 The criteria relate to PSSAs within and beyond the limits of the territorial sea. They can be used by IMO to designate PSSAs beyond the territorial sea with a view to the adoption of international protective measures regarding pollution and other damage caused by ships. They may also be used by national administrations to identify Particularly Sensitive Sea Areas within their territorial seas.

4.4 In order to be identified as a PSSA, the area should meet at least one of the criteria listed below and should be at risk from international shipping activities, taking into consideration the factors listed in section 5.

Ecological criteria

4.4.1 Uniqueness or rarity - An ecosystem can be unique or rare. An area or ecosystem is unique if it is "the only one of its kind". Habitats of rare, threatened, or endangered species that occur only in one area are an example. An area or ecosystem is rare if it only occurs in a few locations or has been seriously depleted across its range. An ecosystem may extend beyond country borders, assuming regional or international significance. Nurseries or certain feeding areas may also be rare or unique.

4.4.2 Critical habitat - A sea area may be a critical habitat for fish stocks or rare or endangered marine species, or an area of critical importance for the support of large marine ecosystems.

4.4.3 Dependency - Ecological processes of such areas are highly dependent on biotically structured systems (e.g. coral reefs, kelp forests, mangrove forests, seagrass beds). Such biotically structured ecosystems often have high diversity, which is dependent on the structuring organisms. Dependency also embraces areas representing the migratory routes of marine fish, reptiles, birds and mammals.

4.4.4 Representativeness - These areas have highly representative ecological processes, or community or habitat types or other natural characteristics. Representativeness is the degree to which an area represents a habitat type, ecological process, biological community, physiographic feature or other natural characteristic.

4.4.5 Diversity - These areas have a high variety of species or genetic diversity or include highly varied ecosystems, habitats, and communities. However, this criterion may not apply to some simplified ecosystems, such as pioneer or climax communities, or areas subject to disruptive forces, such as shores exposed to high-energy wave action.

4.4.6 Productivity - The area has a high natural biological productivity. Production is the net result of biological and physical processes which result in an increase in biomass in areas of high natural productivity such as oceanic fronts, upwelling areas and some gyres.

4.4.7 Spawning or breeding grounds - The area may be a critical spawning or breeding ground or nursery area for marine species which may spend the rest of their life-cycle elsewhere, or may be a migratory route for sea birds or marine mammals.

4.4.8 Naturalness - The area has a high degree of naturalness, as a result of the lack of humaninduced disturbance or degradation.

4.4.9 Integrity - The area is a biologically functional unit, an effective, self-sustaining ecological entity. The more ecologically self-contained the area is the more likely it is that its values can be effectively protected.

4.4.10 Vulnerability - The area is highly susceptible to degradation by natural events or the activities of people. Biotic communities associated with coastal habitats may have a low tolerance to changes in environmental conditions, or they may exist close to the limits of their tolerance (defined by water temperature, salinity, turbidity or depth). They may suffer such natural stresses as storms or prolonged emersion that determine the extent of their development. Additional stress (such as domestic or industrial pollution, excessive reduction in salinity, and increases in turbidity from watershed mismanagement) may determine whether there is total, partial, or no recovery from natural stress, or the area is totally destroyed. Certain oceanographic and meteorological factors could cause an area to be vulnerable or increase its vulnerability, for example by causing the concentration or retention of harmful substances in the waters or in the sediment of the area, or by otherwise exposing the area to harmful substances. These conditions include circulation patterns such as convergence zones, oceanic fronts and gyres, long residence times caused by low flushing rates, the occurrence of seasonal or permanent density stratification which can result in oxygen depletion in the bottom layer, as well as adverse ice states and wind conditions. An area already subject to environmental stresses owing to human activities or natural phenomena (e.g. natural oil seepage) may be in need of special protection from further stress, including stress arising from international shipping activities.

4.4.11 Bio-geographic importance - An area that either: contains rare biogeographic qualities or is representative of a biogeographic “type” or types, or contains unique or unusual geological features.

Social, cultural and economic criteria

4.4.12 Economic benefit - The area is of particular importance to utilization of living marine resources.

4.4.13 Recreation - The area has special significance for recreation and tourism.

4.4.14 Human dependency - The area is of particular importance for the support of traditional subsistence and/or cultural needs of the local human population.

Scientific and educational criteria

4.4.15 Research - The area has high scientific interest.

4.4.16 Baseline and monitoring studies - The area provides suitable baseline conditions with regard to biota or environmental characteristics.

4.4.17 Education - The area offers the opportunity to demonstrate particular natural phenomena.

4.5 In many cases a PSSA may be identified within a Special Area and vice versa. It should be noted that the criteria with respect to the identification of PSSAs and the criteria for the designation of Special Areas are not mutually exclusive.

5 OTHER CONSIDERATIONS FOR THE IDENTIFICATION OF A PARTICULARLY SENSITIVE SEA AREA

5.1 In addition to meeting at least one of the criteria listed in 4.4, the area should be at risk from international shipping activities. This involves consideration of the following factors:

Vessel traffic characteristics

5.1.1 Operational factors - Types of maritime activities (e.g. small fishing boats, small pleasure craft, oil and gas rigs) in the proposed area that may increase risk to the safety of navigation.

5.1.2 Vessel types - Types of vessels passing through or adjacent to the area (e.g. high-speed vessels, large tankers, or bulk carriers with small under-keel clearance).

5.1.3 Traffic characteristics - Volume or concentration of traffic, vessel interaction, distance offshore or other dangers to navigation, are such as to involve greater risk of collision or grounding.

5.1.4 Harmful substances carried - Type and quantity of substances on board, whether cargo, fuel or stores, that would be harmful if released into the sea.

Natural factors

5.1.5 Hydrographical - Water depth, bottom and coastline topography, lack of proximate safe anchorages and other factors which call for increased navigational caution.

5.1.6 Meteorological - Prevailing weather, wind strength and direction, atmospheric visibility and other factors which increase the risk of collision and grounding and also the risk of damage to the sea area from discharges.

5.1.7 Oceanographic - Tidal streams, ocean currents, ice, and other factors which increase the risk of collision and grounding and also the risk of damage to the sea area from discharges.

In proposing an area as a PSSA and in considering what associated protective measures should be taken, other information that might be helpful includes the following:

any evidence that international shipping activities are causing damage and whether damage is of a recurring or cumulative nature;
any history of groundings, collisions, or spills in the area and any consequences of such incidents;
any foreseeable circumstances or scenarios under which significant damage could occur;
stresses from other environmental sources; and
any measures already in effect and their actual or anticipated beneficial impact.

6 ASSOCIATED PROTECTIVE MEASURES

6.1 In the context of these Guidelines, associated protective measures for PSSAs are limited to actions within the purview of IMO and include the following options:

6.1.1 designation of an area as a Special Area under Annexes I, II or V, or a SOx emission control area under Annex VI of MARPOL 73/78, or application of special discharge restrictions to vessels operating in a PSSA. Procedures and criteria for the designation of Special Areas are contained in the Guidelines for the Designation of Special Areas. Criteria and procedures for the designation of SOx emission control areas maybe found in Annex VI to MARPOL 73/78;

6.1.2 adoption of ships' routeing and reporting systems near or in the area, under the International Convention for the Safety of Life at Sea (SOLAS) and in accordance with the General Provisions on Ships' Routeing and the Guidelines and Criteria for Ship Reporting Systems. For example, a PSSA may be designated as an area to be avoided or it may be protected by other ships' routeing or reporting systems;

6.1.3 development and adoption of other measures aimed at protecting specific sea areas against environmental damage from ships, such as compulsory pilotage schemes or vessel traffic management systems.

6.2 Consideration should also be given to the potential for the area to be listed on the World Heritage List, declared a Biosphere Reserve, or included on a list of areas of international, regional, or national importance, or if the area is already the subject of such international, regional, or national conservation action or agreements.

6.3 In some circumstances, a proposed PSSA may include within its boundaries a buffer zone, in other words, an area contiguous to the site-specific feature (core area) for which specific protection from shipping is sought. However, the need for such a buffer zone should be justified in terms of how it would contribute to the adequate protection of the core area.

7 PROCEDURE FOR THE DESIGNATION OF PARTICULARLY SENSITIVE SEA AREAS AND THE ADOPTION OF ASSOCIATED PROTECTIVE MEASURES

7.1 If an application for PSSA designation is submitted which does not contain a proposal for an associated protective measure or measures, the proposing Member Government should submit the types of measures it is considering. A proposal for at least one associated protective measure shall be submitted within two years of the approval in principle of the PSSA.

7.2 Alternatively, if no associated protective measure is being proposed because IMO measures already exist to protect the area, then the application should show how the area is already being protected by such measures.

7.3 The application should first clearly set forth a summary of the objectives of the proposed PSSA designation, the location of the area, the need for protection and the proposal for associated protective measures. The summary should include the reasons why the proposed associated protective measures are the preferred method for providing protection for the area to be identified as a PSSA.

7.4 Each application should then consist of two parts.

7.4.1 Part I - *Description, significance of the area and vulnerability*

.1 *Description* - a detailed description of the location of the proposed area, along with a chart on which the location of area is clearly marked, should be submitted with the application.

.2 *Significance of the area* - the application should state the significance of the area on the basis of recognized ecological, socio-economic, or scientific reasons and should explicitly refer to the criteria listed above in section 4.

.3 *Vulnerability of the area to damage by international shipping activities* – the application should provide an explanation of the nature and extent of risk that international shipping activities pose to the environment of the proposed area, noting the factors listed in Section 5. The application should explain the effects of the damage on the environmental characteristics of the proposed area and indicate any potential economic harm that may result from such damage.

7.4.2 Part II - *Appropriate associated protective measures and IMO's competence to adopt such measures*

.1 The application should propose the associated protective measures which are available through IMO and show how they provide the needed protection from the threats of damage posed by international maritime activities occurring in and around the area.

(a) The application should identify the proposed measures which may include:

(i) any measure that is already available in an existing instrument; or

(ii) any measure that does not yet exist but that should be available as a generally applicable measure and that falls within the competence of IMO; or

(iii) any measure proposed for adoption in the territorial sea or pursuant to Article 211(6) of the United Nations Convention on the Law of the Sea.

(b) These measures may include ships' routeing measures; discharge restrictions; operational criteria; and prohibited activities, and should be specifically tailored to meet the need of the area at risk.

.2 The application should clearly specify the category or categories of ships to which the proposed associated protective measures would apply, consistent with the provisions of the United Nations Convention on the Law of the Sea, including those related to vessels entitled to sovereign immunity

.3 The application should include the steps that the proposing Member Government has taken or will take to pursue the adoption of a generally applicable measure or the recognition of the proposed measure by IMO.

.4 The application should indicate the possible impact of any proposed measures on the safety and efficiency of navigation, taking into account the area of the ocean in which the proposed measures are to be implemented. The application should set forth such information as:

(a) consistency with the General Provisions on Ships' Routeing, as amended;

(b) implications for vessel safety; and

(c) impact on vessel operations.

7.5 An application for PSSA designation should address all relevant considerations and criteria in these Guidelines, and should include relevant supporting information for each such item.

7.6 The application should contain a summary of steps taken, if any, by the proposing Member Government to date to protect the proposed area.

7.7 The proposing Member Government should also include in the application the details of action to be taken pursuant to domestic law for the failure of a ship to comply with the requirements of the associated protective measures. Any action taken should be consistent with international law as reflected in the United Nations Convention on the Law of the Sea.

8 CRITERIA FOR ASSESSMENT OF APPLICATIONS FOR DESIGNATION OF PARTICULARLY SENSITIVE SEA AREAS AND THE ADOPTION OF ASSOCIATED PROTECTIVE MEASURES

8.1 IMO should consider each application, or amendment thereto, submitted to it by a proposing Member Government on a case-by-case basis to determine whether identification of the area as a PSSA and the adoption of associated protective measures are warranted.

8.2 In assessing each proposal, IMO should take into account the criteria which are to be included in each application as set forth above in section 4 of these Guidelines. In particular, IMO should consider:

.1 the full range of protective measures available and determine whether the proposed associated protective measures are appropriate to address effectively the assessed risk of damage to the proposed area by identified international shipping activities;

.2 whether such measures might result in increased potential for significant adverse effects by international shipping activities on the environment outside the proposed PSSA; and

.3 whether the size of the area is commensurate with that necessary to address the identified need.

8.3 The procedure for considering a PSSA application by IMO is as follows:

.1 the Marine Environment Protection Committee (MEPC) should bear primary responsibility within IMO for considering PSSA applications and all applications should first be submitted to the MEPC;

.2 MEPC should initially review the application to determine whether it addresses the provisions of the Guidelines. If it does, the MEPC may approve in principle the PSSA, and should refer the application, with its associated protective measures, to the appropriate Sub-Committee or Committee (which could be the MEPC itself) that is responsible for addressing the particular associated protective measures proposed for the area. The Sub-Committee may seek the advice of the MEPC on issues pertinent to the application. The MEPC should make no final determination to designate the PSSA until after the associated protective measures are considered by the pertinent Sub-Committee or Committee;

.3 for measures that require approval by the Maritime Safety Committee (MSC), the Sub-Committee should forward its recommendation for approval of the associated protective measures to the MSC or, if the Sub-Committee rejects the measures, it should inform the MSC and MEPC and provide a statement of reasons for its decision. The MSC should consider any such recommendations and, if the measures are to be adopted, it should notify the MEPC of its decision;

.4 if an application is submitted without proposed associated protective measures, except as noted in 7.2, the MEPC may approve in principle the identification of the area as a PSSA, pending submission of at least one proposed associated protective measure within two years of such approval and subsequent adoption of at least one associated protective measure;

.5 if the application is rejected, the MEPC shall notify the proposing Member Government and provide a statement of reasons for its decision; and

.6 after approval by the appropriate Sub-Committee or Committee of the associated protective measures, the MEPC may designate the area as a PSSA.

8.4 IMO should provide a forum for the review and re-evaluation of any associated protective measure adopted, as necessary, taking into account pertinent comments, reports, and observations of the measures. Member Governments which have ships operating in the area of the designated PSSA are encouraged to bring any concerns with the associated protective measures to IMO so that any necessary adjustments may be made. Member Governments that originally submitted the application for identification with the associated protective measures, should also bring any concerns and proposals for additional measures or modifications to any associated protective measure or the PSSA itself to IMO.

8.5 After the designation of a PSSA and its associated protective measures, IMO should ensure that the effective date of implementation is as soon as possible based on the rules of IMO and consistent with international law.

8.6 IMO should, in assessing applications for designation of PSSAs and their associated protective measures, take into account the technical and financial resources available to developing Member Governments and those with economies in transition.

9 IMPLEMENTATION OF DESIGNATED PSSAs AND THE ASSOCIATED PROTECTIVE MEASURES

9.1 When a PSSA is finally designated, all associated protective measures should be identified on charts in accordance with the symbols and methods of the International Hydrographic Organization (IHO). Proposing Member Governments may also chart designated

PSSAs in accordance with appropriate national symbols; however, if an international symbol is adopted by the IHO, proposing Member Governments should mark PSSAs in accordance with such symbol and other IHO recommended methods.

9.2 Proposing Member Governments should ensure that any associated protective measure is implemented in accordance with international law as reflected in the United Nations Convention on the Law of the Sea.

9.3 Member Governments should take all appropriate steps to ensure that ships flying their flag comply with the associated protective measures adopted to protect the designated PSSA. Those Member Governments which have received information of an alleged violation of an associated protective measure by a ship flying their flag should provide the Government which has reported the offence with the details of any appropriate action taken.

APPENDIX

SUMMARIES OF EXISTING PSSAs

1. Great Barrier Reef, Australia
The Great Barrier Reef region was designated as a Particularly Sensitive Sea Area in November 1990 (MEPC 44(30)).
The Great Barrier Reef is the largest system of corals and associated life forms anywhere in the world. The area extends approximately 2,300 km along the eastern coast of Queensland, Australia from just north of Fraser Island in the south (24 30'S) to the latitude of Cape York in the north (10 41'S), and covers an area of 348,000 sq. km on the continental shelf of Australia. It is acknowledged as an area of great natural beauty and is listed on the World Heritage List.

Characteristics which contribute to giving this area special significance:

Ecological criteria

Uniqueness: largest single collection of coral reefs in the world, which biologically supports the most diverse ecosystem known to man.
Dependency: outstanding example of a biotic structured ecosystem of high diversity dependent on the structuring organisms.

Representativeness: largest and most complex example of a coral reef ecosystem in the world.

Diversity: the most diverse ecosystem known to man.

Productivity: numerous areas of high biological productivity.

Naturalness: apart from some very small areas, is still in pristine condition and has not been unduly affected by human activity.

Integrity: contains all ecosystem components required for the continued existence of the species within that system. It may be regarded as a biologically functional unit.

Vulnerability: coral reefs are susceptible to various forms of contaminants in seawater. In addition, physical destruction of reef structures through vessel impacts, anchors, etc. can take many years to be repaired. Various sectors of the region have relatively low flushing rates due to the blocking effect of the reefs. Contaminants in such sectors can persist for lengthy periods of time.

Social, cultural and economic criteria

Economic benefit: commercial fishing and tourism, recreational pursuits including fishing, diving and camping, traditional fishing, scientific research and shipping all occur in the region. It is also a significant shipping route with around 2000 ships passing through each year.

Recreation: commercial tourism is provided by commercial passenger boats which carry around 1.2 million visitors days per annum. The trips range from day trips to extended cruises.

Human dependency: the degree of dependence of the Australian community on the Reef is high. The economic value of the Reef is approximately $1,000 million per annum.

Historic shipwrecks: the register of the National Estate indicates that the Great Barrier Reef region contains some thirty known shipwrecks of historic importance.

Scientific and educational criteria

Research: an area of high scientific interest. Research within the region is focussed at the four island research stations.

Baseline and monitoring studies: areas significant in terms of their potential for scientific research are protected by zoning plans which allow research to be conducted while protecting the areas from other disturbing influences.

Education: the broad range of natural phenomena which may be observed in the region make it an area of the highest educational value.

Historical value: the northern sector is particularly important in the history and culture of the indigenous Aboriginal groups of the coastal areas of north-east Australia. The hazards of navigation resulted in the construction of a large number of lighthouses, some of which have particular historical importance.

Protective Measures

Compulsory Pilotage: On 1 October 1991, the Australian government declared compulsory pilotage areas for the Inner Route between Cairns (latitude 16° 40' S) and Cape York (latitude 10° 41' S) and for Hydrographers Passage. All vessels of 70 metres or more in length and all loaded oil tankers, chemical carriers and gas carriers of any length, must use the services of a pilot licensed by the Australian Maritime Safety Authority (AMSA).

IMO-recommended Pilotage: The International Maritime Organization (IMO) has recommended under resolution A.710(17) that vessels of 70 metres in length and over and all loaded oil tankers, chemical tankers or liquefied gas carriers, irrespective of size, use the pilotage services licensed under Australian Commonwealth, State or Territory law when navigating the Torres Strait and the Great North East channel.

Mandatory reporting: in 1997 Australia introduced a mandatory ship reporting system for all ships 50 metres or more in length, all tankers and INF Code ships, and vessels towing where the ship and tow exceed 150 metres.

2. Archipelago of Sabana-Camaguey, Cuba

The Sabana-Camaguey Archipelago was designated as a PSSA in September 1997 (MEPC.74(40)). It is located in the north-central portion of the Republic of Cuba, extending for 465 kilometres between the Hicacos Peninsula and the Bay of Nuevitas. It is the most extensive island sub-group of the Cuban Archipelago, comprising more than 2,515 islands and small keys.

Within this zone, consideration must be given to the coral reef that borders the archipelago to the North, which gives it good protection and a high conservation value, particularly in view of its good state of preservation and the ecological functions it fulfils.

Along its outer edge there is a coral reef 400 kilometres long, considered as one of the most notable of the Wider Caribbean Region on account of its size and the diversity of its species.

Characteristics which contribute to giving this area special significance:

Ecological criteria

The Archipelago is a highly singular and unique territory particularly on account of its natural scenery and associated biodiversity. Its singularity derives from the predominance of cumulative carbonaceous island complexes which have features not found in the rest of the Cuban subarchipelagos.

This group of islands presents highly significant features, particularly in terms of its biotic resources, on account of which it has been categorised as an independent and clearly defined bio-geographical, ecological and scenic unit.

Its importance in this connection is not only national but also regional, since within this area almost all the habitats, ecosystems and biocenosis found in the different Caribbean islands are represented. The particular ecological sensitivity of this territory lies in its high degree of interdependency, both internal and external. Internally, there is a high degree of interaction and interdependence between the coastal and marine ecosystems, especially in the sequence of coastal lagoons/dune/ systems/beaches/algae/coral reefs; and similarly in the combination of mangrove swamps/coastal lagoons/algae/coral reefs, which occurs most often and most extensively in the island group.

Social, cultural and economic criteria
The Archipelago is one of the country's three most productive fishery zones. If productivity is to be maintained, a priority requirement is the conservation of natural habitats and ecosystems. The area is also of great significance for its fish farming, producing large quantities of fish and shellfish to supply both domestic and international markets and the tourist industry.

Additionally, the tourist potential of the hundreds of kilometres of beaches of the highest quality, both aesthetically and environmentally, constitute a feature of significant importance. An extensive development programme for tourism is being implemented on a short-term, medium-term and longterm basis, promoting not only the "sea, sun and sand" type of tourism but also "ecological" tourism, which explores the wide range of existing natural resources.

Scientific and educational criteria

A Coastal Ecosystems Research Centre based in Cayo Coco, collects and processes data on the area and develops new lines of research and monitoring, providing basic information for the wide range of environmental studies needed to support the longer term development of the territory. The Centre is also involved in developing studies related to the monitoring of the effects of global climate changes, epidemics and mortality in marine organisms, bird and turtle migration; and genetic interchange between marine organism. It is also responsible for environmental monitoring, particularly, in regard to the impact of tourism.

The Centre's activities make an important contribution to education and to a better understanding of the environment. The many ecosystems, biotic communities and characteristic natural processes that exist in the area provide ideal subjects for study, not only by experts and specialists, but also by local people, and by Cuban visitors and tourists who come for purposes of recreation.

Protective Measures

The Traffic Separation Schemes in the territorial waters of the North coast, including those at the latitude of the Costa de Matanzas and in the Canal Viejo de Bahamas, within the territorial waters of the Archipelago Sabana-Camaguey, were approved at the forty-eighth session of the MSC.

MSC at its seventy-second session adopted an area to be avoided in the access routes to the ports of Matanzas and Cardenas

Reference chart: ICH 11425 (Edition of 01/08/1998)
Note: This chart is based on North American Datum (27).

Description of the area to be avoided

The area described below should be avoided by all ships over 150 gross tonnage, for reasons of conservation of unique biodiversity, nature and beautiful scenery. It lies within the coastline of the province of Matanzas and a line connecting the following geographical points:

(1) 23°05'.60 N, 081°28'.50 W Punta Maya Lighthouse
(2) 23°10'.60 N, 081°28'.50 W
(3) 23°19'.50 N, 081°11'.50 W
(4) 23°14'.60 N, 081°07'.20 W Cayo Piedras del Norte
(5) 23°11'.50 N, 081°07'.20 W Punta Las Morlas

Regulations relating to discharges in inland and territorial waters under the jurisdiction of the Sabana-Camaguey Archipelago.

Prohibitions:

Any discharge into the sea, of oil, oily mixtures, noxious liquid substances, garbage or harmful substances from vessels of any type or size.

Any discharge of oil or oily mixtures from cargo tanks, including cargo pumps, from petrol tankers and from engine-room bilge areas, mixed with cargo waste.

Dumping at sea of the following types of garbage from ships of any type of size: 1) Plastics, synthetic fishing lines and nets, plastic garbage bags; 2) loose stowage materials, packing materials and coverings; 3) paper, rags, glass, metal, bottles, ceramics or similar materials.

Ships should avoid discharging ballast water or discharging and reloading while transiting waters under the jurisdiction of the Sabana-Camaguey Archipelago (regulation A.774(18): Guidelines for preventing the introduction of unwanted aquatic organisms and pathogens from ships' ballast water and sediment discharges).

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APPENDIX

B

SUMMARY IMO GUIDELINES FOR THE IDENTIFICATION AND DESIGNATION OF PARTICULARLY SENSITIVE SEA AREAS

B
SUMMARY IMO GUIDELINES FOR THE IDENTIFICATION AND DESIGNATION OF PARTICULARLY SENSITIVE SEA AREAS

The following is a summary of the Imo Guidelines for identification and designation of PSSA status. The section is hence presented for those that are not familiar with the contents of the guideline and only needs and overall presentation of the contents.

Introduction

The Maritime Environment Protection Committee (MEPC) of the International Maritime Organization (IMO) began a study of the question of particularly sensitive sea area (PSSA) in response to a resolution of the International Conference on Tanker Safety and Pollution Prevention of 1978. The discussions of this concept from 1986 to 1991 culminated in the adoption of Guidelines for the Designation of Special Areas and the Identification of PSSA by Assembly resolution A.720(17) in 1991 and were further elaborated upon by Assembly resolution A.885(21) in 1999. MEPC decided to separate the issues of the designation of Special Area and PSSA into two documents.

The Assembly resolution A.927(22) adopted on 29th November 2001 (Guidelines for the Designation of Special Areas under MARPOL 73/78 and guidelines for the Identification of Particularly Sensitive Sea Area) is divided into two parts, ref. appendix A (/4/):

- Annex 1: a new guideline for the Designation of Special Areas under MARPOL 73/78
- Annex 2: a new guideline for the Identification of Particularly Sensitive Sea Area

The following text gives a brief description of the guideline for the Identification of Particularly Sensitive Sea Area (PSSA).

A PSSA is an area that needs protection through action by IMO because of its significance for recognized ecological, socio-economic, or scientific reasons and because it may be vulnerable to damage by international shipping activities, ref. §. 2.1 in the Guidelines.

The purpose of these Guidelines is to:

a) provide guidance to IMO Member Governments in the formulation and submission of applications for designation of PSSAs;
b) ensure that in that process all interests are thoroughly considered on the basis of relevant scientific, technical, economic, and environmental information regarding the area of risk of damage from international shipping activities and the protective measures to minimize that risk, and
c) provide for the assessment of such applications by the IMO.

Identification of any PSSA and the adoption of associated protective measures require consideration of three components:

1) the particular environmental conditions of the area to be identified,
2) the vulnerability of such area to damage by international maritime activities, and
3) the availability of associated protective measures within the competence of IMO to address risks from the shipping activities.

Member Governments wishing to have the IMO designate a PSSA should submit an application to the MEPC based on the criteria outlined in chapter 0 and proposed associated protective measures as outlined in chapter 0. Applications should be submitted in accordance with the procedures described in chapter 0. Where two or more Governments have common interest in a particular area, they should formulate a co-ordinated proposal, and the proposal should contain integrated measures and procedures for co-operation between the jurisdictions of the proposing Member Governments, ref. § 3 in the Guidelines.

Criteria for identification of a PSSA
The following criteria apply only to the identification of PSSAs with respect to the adoption of measures to protect such area against damage from international shipping activities.

The criteria relate to PSSAs within and beyond the limits of the territorial sea. They can be used by IMO to designate PSSAs beyond the territorial sea with a view to the adoption of international protective measures regarding pollution and other damage caused by ships. They may also be used by national administrations to identify PSSA within their territorial seas.

In order to be identified as a PSSA, the area should meet at least one of the criteria listed below, ref. § 4 in the Guidelines.

Ecological criteria:

- Uniqueness
- Critical habitat
- Dependency
- Representativeness
- Diversity
- Productivity
- Spawning or breeding grounds
- Naturalness
- Integrity
- Vulnerability
- Bio-geographic importance

Social, cultural and economic criteria:

- Economic benefit
- Recreation
- Human dependency

Scientific and educational criteria:

- Research
- Baseline and monitoring studies
- Education

Other considerations for the identification
In addition to meet at least one of the criteria listed in chapter 0, the area should be at risk from international shipping activities. This involves consideration of the following factors listed below, ref. § 5 in the Guidelines.

Vessel traffic characteristics:
- Operational factors
- Vessel types
- Traffic characteristics
- Harmful substances carried

Natural factors:
- Hydrographical
- Meteorological
- Oceanographic

In proposing an area as a PSSA and in considering what associated protective measures should be taken, other information that might be helpful includes:
- any evidence that international shipping activities are causing damage and whether damage is of a recurring or cumulative nature;
- any history of groundings, collisions, or spills in the area and any consequences of such incidents;
- any foreseeable circumstances or scenarios under which significant damage could occur;
- stresses from other environmental sources; and
- any measures already in effect and their actual or anticipated beneficial impact.

Measures
Associated protective measures for PSSAs are limited to actions within the purview of IMO and include the following options:
- designation of an area as a Special Area under Annexes I, II or V, or a SOx emission control area under Annex VI of MARPOL 73/78, or application of special discharge restrictions to vessels operating in a PSSA.
- adoption of ships' routeing and reporting systems near or in the area, under the International Convention for the Safety of Life at Sea (SOLAS, ref /10/)) and in accordance with the General Provisions on Ships' Routeing and the Guidelines and Criteria for Ship Reporting Systems.
- development and adoption of other measures aimed at protecting specific sea areas against environmental damage from ships.

Consideration should also be given to the potential for the area to be listed on the World Heritage List, declared a Biosphere Reserve, or included on a list of areas of international, regional, or national importance, or if the area is already the subject of such international, regional, or national conservation action or agreements, wrt § 6 in the Guidelines.

Procedure and adoption
If an application for PSSA designation is submitted which does not contain a proposal for an associated protective measure or measures, the proposing Member Government should submit the types of measures it is considering. A proposal for at least one associated protective measure shall be submitted within two years of the approval in principle of the PSSA.
The application should forth a summary of the objectives of the proposed PSSA designation, the location of the area, the need for protection and the proposal for associated protective measures. The summary should include the reasons why the proposed associated protective measures are

the preferred method for providing protection for the area to be identified as a PSSA. Each application should then consist of two parts:

Part I - *Description, significance of the area and vulnerability*
- Description of the location of the proposed area.
- Significance of the area on the basis of recognized ecological, socio-economic, or scientific reasons and should explicitly refer to the criteria listed in chapter 0.
- Vulnerability of the area to damage by international shipping activities, wrt to the factors listed in chapter 0.

Part II - *Appropriate associated protective measures and IMO's competence to adopt such measures*
The application should:
- propose the associated protective measures which are available through IMO and show how they provide the needed protection from the threats of damage posed by international maritime activities occurring in and around the area.
- clearly specify the category or categories of ships to which the proposed associated protective measures would apply, consistent with the provisions of the United Nations Convention on the Law of the Sea, including those related to vessels entitled to sovereign immunity
- include the steps that the proposing Member Government has taken or will take to pursue the adoption of a generally applicable measure or the recognition of the proposed measure by IMO.
- indicate the possible impact of any proposed measures on the safety and efficiency of navigation, taking into account the area of the ocean in which the proposed measures are to be implemented.

An application for PSSA designation should address all relevant considerations and criteria as mention in chapter 0 and 0 , and should include relevant supporting information for each such item. The application should also contain a summary of steps taken, if any, by the proposing Member Government to date to protect the proposed area.

The proposing Member Government should also include in the application the details of action to be taken pursuant to domestic law for the failure of a ship to comply with the requirements of the associated protective measures. Any action taken should be consistent with international law as reflected in the United Nations Convention on the Law of the Sea.

Implementation
When a PSSA is finally designated, all associated protective measures should be identified on charts in accordance with the symbols and methods of the International Hydrographic Organization (IHO). Proposing Member Governments may also chart designated PSSAs in accordance with appropriate national symbols. If an international symbol is adopted by the IHO, proposing Member Governments should mark PSSAs in accordance with such symbol and other IHO recommended methods.

PROPOSING MEMBER GOVERNMENTS SHOULD ENSURE THAT ANY ASSOCIATED PROTECTIVE MEASURE IS IMPLEMENTED IN ACCORDANCE WITH INTERNATIONAL LAW AS REFLECTED IN THE UNITED NATIONS CONVENTION ON THE LAW OF THE SEA.

MEMBER GOVERNMENTS SHOULD TAKE ALL APPROPRIATE STEPS TO ENSURE THAT SHIPS FLYING THEIR FLAG COMPLY WITH THE ASSOCIATED PROTECTIVE MEASURES ADOPTED TO PROTECT THE DESIGNATED PSSA.

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APPENDIX C
EXISTING LEGAL AND OTHER INSTRUMENTS RELATING TO SHIPPING ACTIVITIES

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EXISTING LEGAL AND OTHER INSTRUMENTS RELATING TO SHIPPING ACTIVITIES

The following table presents major international instruments encompassing shipping activities in the Arctic, with respect to both pollution and safety issues.

Other international overall instruments may also control and affect shipping activities. Of these are conventions as Convention on Biological Diversity, Bonn Convention, World Heritage Convention, Ramsar Convention etc.

International instruments controlling the shipping activities.

International Agreements	Adopted	Entry into force	Comments
Biological Diversity	1992	1993	2) Canada (X), Denmark (X), Finland (X), Iceland (X), Norway (X), Russia (X), Sweden (X)
Civil Liability Convention (CLC)	29-Nov-69	19-Jun-75	2) Canada (X) , Denmark (X) , Finland (X) , Iceland (X), Norway (X) , Russia (X), Sweden (X)
CLC Protocol 92	27-Nov-92	30-May-96	1) Canada (X) , Denmark (X) , Finland (X) , Iceland (X), Norway (X) , Sweden (X)
Polar Guidelines			2) Group of Arctic countries developing these IMO Guidelines
COLREG Convention 72	20-Oct-72	15-Jul-77	2) Canada (X) , Denmark (X) , Finland (X) , Iceland (X), Norway (X) , Russia (X), Sweden (X), USA (X)
ESPOO Convention	1991	not yet	2) Canada (X), Finland (X), Norway (X) , Sweden (X)
FUND Convention	18-Dec-71	16-Oct-78	2) Canada (X) , Denmark (X) , Finland (X) , Iceland (X), Norway (X) , Russia (X), Sweden (X)
Fund Protocol 1976	19-Nov-76	22-Nov-94	1) Canada (X) , Denmark (X) , Finland (X) , Iceland (X), Norway (X) , Russia (X), Sweden (X)
Fund Protocol 1992	27-Nov-92	30-May-96	1) Canada (X) , Denmark (X) , Finland (X) , Iceland (X), Norway (X) , Sweden (X)
GPA (Global non-binding framework developed in	1995	not applicable	2) GPA adopted by all Arctic Countries

response to Agenda 21)			
HNS Convention 96	03-May-96	not yet	1)
Limitation of liability for Maritime Claims	19-Nov-76	01-Dec-86	2) Denmark (X), Finland (X) , Norway (X) , Sweden (X)
LOAD LINES Protocol 88	11-Nov-88	3-feb-00	1) , Denmark (X), Norway (X) , Sweden (X), USA (X)
London Convention 72 (LC72)	13-Nov-72	30-Aug-75	2) Canada (X) , Denmark (X) , Finland (X) , Iceland (X), Norway (X) , Russia (X), Sweden (X), USA (X)
London Protocol 96	07-Nov-96	not yet	1) Canada (X) , Denmark (X) , Norway (X)
MARPOL 73/78 (Annex I/II)	17-feb-78	02-Oct-83	2) Compulsory; Canada (X), Iceland (X), Norway (X), Denmark (X) , Finland (X), Russia (X), Sweden (X), USA (X)

MARPOL 73/78 (Annex III)	17-feb-78	01-Jul-92	2) Optional; Denmark (X) , Finland (X) , Iceland (X), Norway (X) , Russia (X), Sweden (X), USA (X)
MARPOL 73/78 (Annex IV)	17-feb-78	not yet	2)Optional-being revised , Denmark (X) , Finland (X) , Russia (X), Sweden (X), Norway (X)
MARPOL 73/78 (Annex V)	17-feb-78	31-Dec-88	2) Optional , Denmark (X) , Finland (X) , Iceland (X), Norway (X) , Russia (X), Sweden (X), USA (X)
MARPOL Protocol 97 (Annex VI)	26-sep-97	not yet	1) Norway (X) , Sweden (X)
Nuclear Safety Convention *	17-Jun-94	24-Oct-96	5) Canada (X), Denmark (A), Finland (A) , Iceland (S), Norway (X) , Russia (A), Sweden (X), USA (X)
OPRC Convention 90	30-Nov-90	13-May-95	2) Canada (X) , Denmark (X) , Finland (X) , Iceland (X), Norway (X) , Sweden (X), USA (X)
OSPAR 3) Ref /2/	22-sep-92	25-mar-98	4) Denmark (X) , Finland (X) , Iceland (X), Norway (X) , Sweden (X)
Protection and Use of Transboundary Water Courses	1992		2) Denmark (X) , Finland (X), Norway (X) , Russia (X), Sweden (X),
RAMSAR	1971	1975	2) Canada (X) , Denmark (X) , Finland (X) , Iceland (X), Norway (X) , Russia (X), Sweden (X), USA (X)
SOLAS Protocol 88, ref /10/	11-Nov-88	03-feb-00	1) , Denmark (X) , Finland (X) ,Norway (X) , Sweden (X), USA (X)
STCW Convention 78	7-Jul-78	28-apr-84	1) Canada (X) , Denmark (X) , Finland (X) , Iceland (X), Norway (X) , Russia (X), Sweden (X), USA (X)
STCW-F Convention 95	7-Jul-95	1-feb-97	1) , Denmark (X) , Finland (X) , Russia (X),
UNCLOS (/9/)	10-Dec-82	16-Nov-94	5) Canada (S) , Denmark (S) , Finland (X) , Iceland (X), Norway (X) , Russia (X), Sweden (X)
UNCLOS - Agreement related to implementation of Part XI, /9/.	10-Dec-82	28-Jul-96	5) Finland (X) , Iceland (X), Norway (X), Russia (X), Sweden (X)
UN-ECE LRTAP	13-Nov-79	16-mar-83	2) Canada (X), Denmark (X), Finland (X), Iceland (X), Norway (X), Russia (X), Sweden (X), USA (X)
(a)Protocol on Long-term Financing	28-sep-84	1988	5) Canada (X), Denmark (X), Finland (X), Norway (X), Russia (X), Sweden

			(X), USA (X)
(b)Protocol on the Reduction of Sulphur Emissions	08-Jul-85	1987	5) Canada (X), Denmark (X), Finland (X), Norway (X), Russia (X), Sweden (X)
(c)Protocol concerning the Control of Emissions of NOx	31-Oct-88	1988	5) Canada (X), Denmark (X), Finland (X), Norway (X), Russia (X), Sweden (X), USA (X)
(d)Protocol on the Control of Emissions of VOCs	18-Nov-91	29-sep-97	5) Canada (S), Denmark (X), Finland (X), Norway (X), Sweden (X), USA (S)
(e)Protocol on the Further Reduction of Sulphur Emissions	14-Jun-94	05-Aug-98	5) Canada (X), Denmark (X), Finland (X), Norway (X), Russia (S), Sweden (X)
(f) Protocol on Heavy Metals	24-Jun-98	not yet	5) Canada (X), Denmark (S), Finland (S), Iceland (S), Norway (X), Sweden (X), USA (S)
(g) Protocol on Persistent Organic Pollutants	24-Jun-98	not yet	5) Canada (X), Denmark (S), Finland (S) , Iceland (S), Norway (X), Sweden (X), USA (S)
(h) Protocol to Abate Acidification, Eutrophication and Ground-level Ozone	01-Dec-99	not yet	5) Canada (S), Denmark (S), Finland (S) ,Iceland (N), Norway (S), Sweden (S), USA (S)
International Convention for the Control and Management of Ships' Ballast Water and sediments.	Not yet	Not yet	The convention is under development and is expected adopted in 2004..
Guidelines for the Control and Management of Ships* Ballast water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens	1997	1997	Voluntary guideline.

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APPENDIX

D
GENERAL DESCRIPTION OF WASTE AND GARBAGE FROM MARITIME ACTIVITIES

D
GENERAL DESCRIPTION OF WASTE AND GARBAGE FROM MARITIME ACTIVITIES

Sludge

From bunker tanks, fuel oil is transferred to a service tank and through an oil separator before being transferred into a day tank. The residue from the separator, or sludge, is a semi-compact mass, which is either automatically flushed off the separator at periods and pumped into a holding tank or scraped off manually and stored in barrels. To be in accordance with MARPOL Annex I, the dumping of sludge into the sea is not allowed.

Oily bilge water

Machinery space bilge water accumulates in the bilge of engine room compartments in all types of ships. The composition of this waste is mainly oil and water from minor leaks in various engine room components, and water from the lubricating oil separator.

When engine room bilge are emptied, a bilge pump transfers the oily bilge water to a separator. The oily component is pumped into the holding tank, while the separated water can be pumped overboard through the ppm monitor. Normally, the holding tank will be the same for sludge from the fuel oil separator, and oily residue from bilge water. Hence, as the sludge extracted from the bilge water may contain metals and washing agents the sludge from the fuel oil separation contains pure oil.

Waste lubricating oil

The lubricating oil causes two types of waste:

- sludge from separation of used lubricating oil
- used lubrication oils

Lubricating oil is continuously being drawn from the engine sump through a lubricating oil separator to extract water and particles from the oil. Normally, the same holding tank as for other sludge residue is used for the particles/sludge from the lubricating oil. Hence, the sludge extracted from the lubricating oil may contain metals while the sludge from the fuel oil separation contains pure oil.

Solid oily waste

Solid oily waste is rags, gaskets, tubes etc. that are covered with different types of oil like lubrication oil, hydraulic oil or fuel oil. In addition deposits in bunkers oil tanks consists of a mixture of oil and sand/soil /rust.

Sewage

Many vessels have a common system for sewage (black-water) and grey-water.

- Sewage (black-water) originates from toilets and urinals. Other liquid that is mixed with the mentioned should also be considered as sewage.
- Grey-water originates from kitchen, laundry, bath, showers etc.

Some ships have conventional systems while other ships have vacuum systems where the difference is mainly related to the amount of water used. Some ships also have sewage treatment plants. These can be of various types as biological treatment or chemical treatment. Some vessels are fitted with a holding tank arrangement.

In general the sewage may be discharged outside 12 nm from land if the ship has no system for treatment of the sewage. If the sewage is collected in a tank the sewage may not be discharged directly but should be discharged in a moderate rate while the ship is keeping a constant speed of at least 4 knots.

Garbage

Garbage is e.g. plastic, paper, metal, wood. Except for plastics, garbage can legally be dumped at sea provided that the distance from nearest shoreline is above certain limits summarised in the Guidelines to MARPOL Annex V. Within special areas, dumping of other waste categories is also restricted. For new, ocean going vessels, especially for ships that create large amounts of garbage (such as cruise ships), incinerators are becoming a standard piece of equipment. It is also possible to install incinerators on older ships, but such an installation is costly, and there is no requirement for such installations in MARPOL.

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