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1.1 The Barents Sea

1.1.1 Ecosystem overview

1.1.1.1. Ecosystem components

Physical environment and plankton

The Barents Sea is a shelf area separated from the Norwegian Sea by the continental slope. It has an average depth of 230 m, although deeper channels and basins exist which strongly influence currents (Figure 1.1.1.1.1) (von Quillfeldt and Dommasnes, in prep.). North-flowing currents transport warm Atlantic water into the Barents Sea and north along the western coast of Svalbard (Figure 1.1.1.1.1). The branch flowing into the Barents Sea separates into a southern part and a northern part. Cold Arctic water flows into the Barents Sea from the northeast to the southwest. In the west there is a sharp, relatively stationary transition zone between Atlantic and Arctic water called the Polar Front following the bottom contours along approximately the 2°C isotherm. In the east, the transition zone is less distinct and much wider. The Polar Front constitutes a natural, dynamic bio-geographical border for many ecosystem properties. The Barents Sea area is highly productive. However, many factors contribute to great differences between years in the ability of the primary and secondary production to support the larger organisms. Inflowing and outflowing water facilitates mixing of the water and nutrient supply and, therefore, primary production. Moreover, there is a substantial transport of organisms into the area (e.g. *Calanus finmarchicus* from the Norwegian Sea, and ice fauna from the Arctic Ocean). Advection results in the accumulation of many organisms (e.g. shrimp) in areas like the trenches on the Spitsbergen shelf. The areas around Bjørnøya and northeastward toward Hopen (Spitsbergenbanken) have depths of 20-100 m and mixing of the water reaches the bottom. The steady supply of new nutrients in these shallow areas makes them the most productive in the Barents Sea and, therefore, attractive to young fish feeding on zooplankton.

There are also variations in the spatial structure of the flux. This may partly explain the variation in advections in nutrients, phytoplankton, and zooplankton from the Norwegian Sea to the Barents Sea, since the timing of strong inflow events have to co-occur with peaks in the phyto- and zooplankton biomass in the Norwegian Sea in order to have maximum effect on the Barents Sea ecosystem. The properties of inflowing Atlantic water fluctuate considerably interannually, particularly in heat content, which again influence winter ice conditions. The northern, central, and eastern parts of the Barents Sea as well as most of the areas around Svalbard are covered with ice during winter, and the northern parts have ice also during summer in most years. This sea ice is mostly seasonal (i.e. one-yearly), with drift ice dominating. There is a relationship between sea temperature during winter and ice coverage, while meteorological conditions, especially increased radiation, are controlling factors during summer. During "cold" years ice also covers part of the Atlantic waters for some time.

As the ice melts a stable surface layer develops, uncovering winter concentrations of nutrient salts. The spring algae bloom starts 6–8 weeks earlier at the ice edge than in open sea further south. These favourable production conditions support large concentrations of crustaceans and other species of zooplankton and abundant fish, seabirds, and marine mammals which feed on them. The blooms in Arctic water are, however, often short-lasting compared to those in Atlantic water, which are therefore more productive overall. Warm years with less ice result in higher production, generally shorter generation times for zooplankton and greater import of zooplankton from the south than in cold years. A critical phase for the ecosystem is the transition from a warm to a cold period, with reduced production of phytoplankton and zooplankton to support the populations of larger animals dependent on them.

In cold years, when the ice stretches into Atlantic water, the warm Atlantic water under the ice prompts melting to start 4–6 weeks earlier than if the ice only covers Arctic waters. This may create an early spring phytoplankton bloom, but at the same time the probability of a mismatch between the bloom and zooplankton grazers increases and a greater part of the primary production is likely to sink down to the sea floor.

Some microalgae, zooplankton, and ice amphipods, have life histories dependent on the sea ice. Ice algae are a particularly important food source early in spring before primary production starts, and it is evident that regional and seasonal variations in sea ice development influence the overwintering strategy of grazing organisms. The production of ice algae has been estimated to be about one-fifth of the total primary production, depending on the extent of the ice-free areas.

The water temperatures in the Barents Sea have been relatively high during most of the 1990s, with a continuous warm period from 1989–1995. During 1996–1997, the temperature was just below the long-term average before it turned warm again at the end of the decade, and has remained warm until present. 2004 has been one of the warmest years recorded and with a record salinity (Figure 1.1.1.1.2) (Føyn, in prep.).

The calanus species are the most abundant zooplankton in the Barents Sea and also the most important for pelagic fish like herring, capelin and polar cod. Its biomass fluctuates between years. Investigations on species compositions of plankton, however, are scarce. The warm and salient water are good conditions for several of the plankton species, but as the 0-group abundance of several fish stocks was recorded to be high in 2004 in the Barents Sea, grazing is expected to be a constraint on the abundance of zooplankton in 2005.

Bottom habitat and bottom fauna

Most of the area in the Barents Sea is covered by fine-grained sediment with coarser sediment prevailing on the relatively shallow shelf banks (<100 m) or in the sub littoral zone around islands (Jørgensen and Hop, in prep.). Stones and boulders are only locally abundant. The most southwesterly parts of the Barents Sea are influenced by Atlantic fauna with the diverse warm-water fauna decreasing and cold-water species increasing to the east and north. In general, the fauna biomass, including the benthic, increases near the polar front and in the shallow regions and edges of the banks. A generally reduced biomass towards the west is likely due to reduced mixing of water and consequently a shortage of food. The richest infauna is found on the sandy silts and silty-sand floors. Low biomass occur at areas with impeded upwelling, in areas of low primary production (and reduced vertical flux), and areas of less suitable substrata with heavy sedimentation (e.g. inner parts of glacial fjords).

In the open parts of the Barents Sea, polychaetes (bristle worms) are predominant at great depths and on soft sediment. Bivalves dominate lesser depths and harder bottoms. The main mass of echinoderms is found in western and central parts of the Sea, whereas the mass developments of bivalves are found in the southeastern parts of the Sea. The deeper western part of the Sea is rich in echinoderms and particularly poor in polychaetes. The bivalves are considerably reduced with depth, whereas the echinoderms increase in numbers and the polychaetes remain essentially unchanged.

Red king crab (*Paralithodes camtschatica*) was introduced to the Barents Sea, the Murmansk fiord, in the 1960s (Jørgensen and Hop, in prep.). The stock is growing and expanding eastwards, but more dominantly along the Norwegian coast westwards. Adult red king crabs are opportunistic omnivores. Epibenthic species such as the commercial Iceland scallop *Chlamys islandica* beds might be particularly exposed to risk of local extinction. Decapods are known predators of benthic bivalves, including scallops. Both the red king crab and the scallop have a sub-Arctic distribution. The Iceland scallop has a life span of 30 years, and matures after 3–6 years.

Northern shrimp (*Pandalus borealis*) is an important prey for several fish species, especially cod, but also other fish stocks like blue whiting (ICES 2005A). Consumption by cod significantly influences shrimp population dynamics. The estimated amount of shrimp consumed by cod is on average much higher than shrimp landings. Shrimp is most abundant in central parts of the Barents Sea and close to Svalbard, mostly at depths of 200–350 meter (Aschan, 2000). It is common close to the sea floor, preferably silt or fine-grained sand. Shrimp in the southern parts of the Barents Sea grow and mature faster than shrimp in the central or northern parts.

Fish community

The Barents Sea is a relatively simple ecosystem with few fish species of potentially high abundance. These are Northeast Arctic cod, saithe and haddock, Barents Sea capelin, polar cod, and immature Norwegian spring-spawning herring. The last few years there has in addition been an increase of blue whiting migrating into the Barents Sea. The abundance in 2004 was estimated to be 1.4 million tonnes (IMR, 2004). The composition and distribution of species in the Barents Sea depend considerably on the position of the polar front. Variation in the recruitment of some species, including cod and herring, has been associated with changes in the influx of Atlantic waters into the Barents Sea.

Capelin is a key species because it feeds on the zooplankton production near the ice edge and is usually the most important prey species in the Barents Sea, serving as a major transporter of biomass from the northern Barents Sea to the south (von Quillfeldt and Dommasnes, in prep.). During summer they migrate northwards as the ice retreats, and thus have continuous access to new zooplankton production in the productive zone recently uncovered by the ice. They often end up at 78–80°N by September–October, and then they start a southward migration to spawn on the northern coasts of Norway and Russia. Cod prefer capelin as a prey, and feed on them heavily as the capelin spawning migration brings them into the southern and central Barents Sea. Capelin also is important prey for several species of marine mammals and birds.

Fluctuations of the capelin stock have a strong effect on growth, maturation, and fecundity of cod, as well as on cod recruitment because of cannibalism. The juveniles of the Norwegian spring-spawning herring stock are distributed in the southern parts of the Barents Sea. They stay in this area for about three years before they migrate west and southwards along the Norwegian coast and mix with the adult part of the stock. The presence of young herring in the area has a profound effect on the recruitment of capelin, and it has been shown that when rich year classes of herring enter the Barents Sea, the recruitment to the capelin stock is poor and in the following years the capelin stock collapses. This happened after the rich 1983 and 1992 year classes of herring entered the Barents Sea. Also, when medium-sized year classes of herring are spread into the area there is a clear sign of reduction in recruitment to the capelin stock, as is currently the case. In this way, the herring impact both the capelin stock (directly) and the cod stock (indirectly).

Cod is the most important predator fish species in the Barents Sea, and feeds on a large range of prey, including the larger zooplankton species, most of the available fish species, amphipods and shrimp (ICES 2004). The cod migrates out of the Barents Sea and spawns in the Lofoten area in March. The average age at first maturation has been declining over the last decades (ICES, 2004). Haddock is also a common species, and migrates partly out of the Barents Sea. It is a predator on smaller organisms including bottom fauna. The stock has large natural variations in stock size. Saithe is common in coastal water. The smaller individuals feed on zooplankton, but larger saithe are known to be predators on fish.

In warm years there may be considerable quantities of blue whiting coming in with the Atlantic water in the southern Barents Sea. The blue whiting is a plankton feeder. Polar cod is a cold-water species found particularly in the eastern Barents Sea and in the north. It seems to be an important forage fish for several marine mammals, but to some extent also for cod. There is little fishing on this stock.

Deep-sea redfish and golden redfish used to be important elements in the fish fauna in the Barents Sea, but presently the stocks are severely reduced. Young redfish are plankton eaters, but larger individuals take larger prey, including fish. Fishing on these two species is severely restricted in order to rebuild the stock.

Greenland halibut is a large and voracious fish predator with the continental slope between the Barents Sea and the Norwegian Sea as its most important area, but it is also found in much of the Barents Sea.

Marine mammals and seabirds

Some mammal species have temperate mating and calving areas and/or feeding areas in the Barents Sea (e.g. minke whale (*Balaenoptera acutorostrata* and harp seals (*Pagophilusa groenlandicus)*), others reside in the Barents Sea all year round (e.g. white-beaked dolphin (*Lagenorhynchus albirostris*) and harbour porpoise (*Phocoena phocoena*)) (Bjørge and Kovacs, in prep.). Some species are rare, either because this is natural (like white whale (*Delphinapterus leucas*)) or because of historic exploitation (like bowhead whale (*Balaena mysticetus*)). Other species are abundant (like harp seals and white-beaked dolphin). The diet of the marine mammals ranges from zooplankton to fish like capelin and cod. The total consumption of marine mammals in the Barents Sea is estimated to be some million tonnes of biomass, whereof the consumption of minke whales and harp seals on fish of commercial fish stocks, like capelin, cod, and haddock, may amount to the same order as the total commercial catches of these stocks (Nilssen *et al.*, 2000 and Folkow *et al.*, 2000). There are annual quotas on minke whales and harp seals.

The Barents Sea area, including the Lofoten area, is an important Arctic area for seabirds, and a significant number of them reside in the Barents Sea also during the winter (Anker-Nilssen *et al.,* 2000). More than 30 species of seabirds have been registered in the region. The numbers of seabirds in the Barents Sea have been estimated to 20 million individuals (Barrett *et al.,* 2001). The most abundant species are Brünnich's guillemot (*Uria lomvia),* black-legged kittiwake (*Rissa tridactyla),* Atlantic puffin (*Fratercula arctica),* little auk (*Alle alle*), and northern fulmar (*Fulmarus glacialis)* of which the three first prefer fish as prey. Barett *et al.* (2001) estimated the total consumption of seabirds in the Barents Sea area to be half a million tonnes of 0-group and 1-group fatty fish: capelin, herring and sandeel. Some species, like Brünnich's guillemot and Atlantic puffin, seem to be sensitive to weak year classes of fish stocks (Anker-Nilssen *et al.,* 2000). Brünnich's guillemot experienced a serious decline as a result of the collapse of the Norwegian Spring-spawning herring in the late 1960s and declines also when the capelin stock collapses. Atlantic puffin is affected when year classes of herring are poor, although the relationship is not as clear as with the Røst colonies in the Lofoten area. While harvest of marine birds has a long tradition in the Barents Sea region, it is now reduced and strongly regulated.

There is a close link between marine and terrestrial ecosystems, particularly in terms of energy transport from sea to land (Bjørge and Kovacs, in prep.). Bird colonies often support nutrient-demanding plant communities, upon which geese and reindeer can subsist. Terrestrial vegetation also serves as a habitat for many rare invertebrates. Arctic foxes can subsist on seabirds and their eggs; fox denning areas are often in the vicinity of bird cliffs. Nutrient supply from seabirds can also influence the production in some lakes (observed on Bjørnøya and elsewhere). Furthermore, land serves as haul-out places (for birthing, moulting) for some marine mammals, denning areas for polar bears and as nesting sites for many seabirds.

1.1.1.2 Impact of fishing activity on the ecosystem

The most widespread gear used in the Barents Sea for demersal fish species is otter trawl. In order to conclude on the total impact of trawling, an extensive mapping of fishing effort and bottom habitat would be necessary. However, its qualitative effects have been studied to some degree. The most serious effects of otter trawling have been demonstrated for hard-bottom habitats dominated by large sessile fauna, where erected organisms such as sponges, anthozoans, and corals have been shown to decrease considerably in abundance with the passing of the ground gear. In sandy bottoms of high seas fishing grounds trawling disturbances have not produced large changes in the benthic assemblages, as these habitats may be resistant to trawling due to natural disturbances and large natural variability. Studies on impacts of shrimp trawling on clayey-silt bottoms have not demonstrated clear and consistent effects, but potential changes may be masked by the more pronounced temporal variability in these habitats (Løkkeborg, in press). The impacts of experimental trawling have been studied on a high seas fishing ground in the Barents Sea (Kutti *et al., in press.*) Trawling seems to affect the benthic assemblage mainly through resuspension of surface sediment and through relocation of shallow burrowing infaunal species to the surface of the seafloor.

Lost gears such as gillnets may continue to fish for a long time (ghostfishing). The catching efficiency of lost gillnets has been examined for some species and areas, but at present no estimate of the total effect is available. Other types of fishery-induced mortality include burst net, and mortality caused by contact with active fishing gear such as escape mortality. Some small-scale effects are demonstrated, but the population effect is not known.

The harbour porpoise is common in the Barents Sea region south of the polar front. The species is most abundant in coastal waters. The harbour porpoise is subject to severe bycatches in gill net fisheries (Bjørge and Kovacs, in prep). In 2004 Norway initiated a monitoring program on bycatches of marine mammals in fisheries.

Several bird scaring devices have been tested for long-lining, and a simple one, the bird-scaring line (Løkkeborg 2003), not only reduces significantly bird bycatch, but also increases fish catch, as bait loss is reduced. This way there is an economic incentive for the fishermen, and where bird bycatch is a problem, the bird scaring line is used without any forced regulation.

Estimates on unreported catches for cod in 2002, 2003, and 2004 indicate that this is a considerable problem. Unreported catches for North-East Arctic cod are estimated at 90 000–115 000 tonnes each of these years, i.e. 20% of the total catches (ICES, 2005b). For coastal cod, estimates of catches from some fisheries (e.g. tourist and recreational) are not available, but could be of the order of 30% (ICES, 2005b).

Discarding of cod, haddock, and saithe is thought to be significant in some periods although discarding is illegal in Norway and Russia. Data on discarding is scarce, but attempts to obtain better quantification continue.

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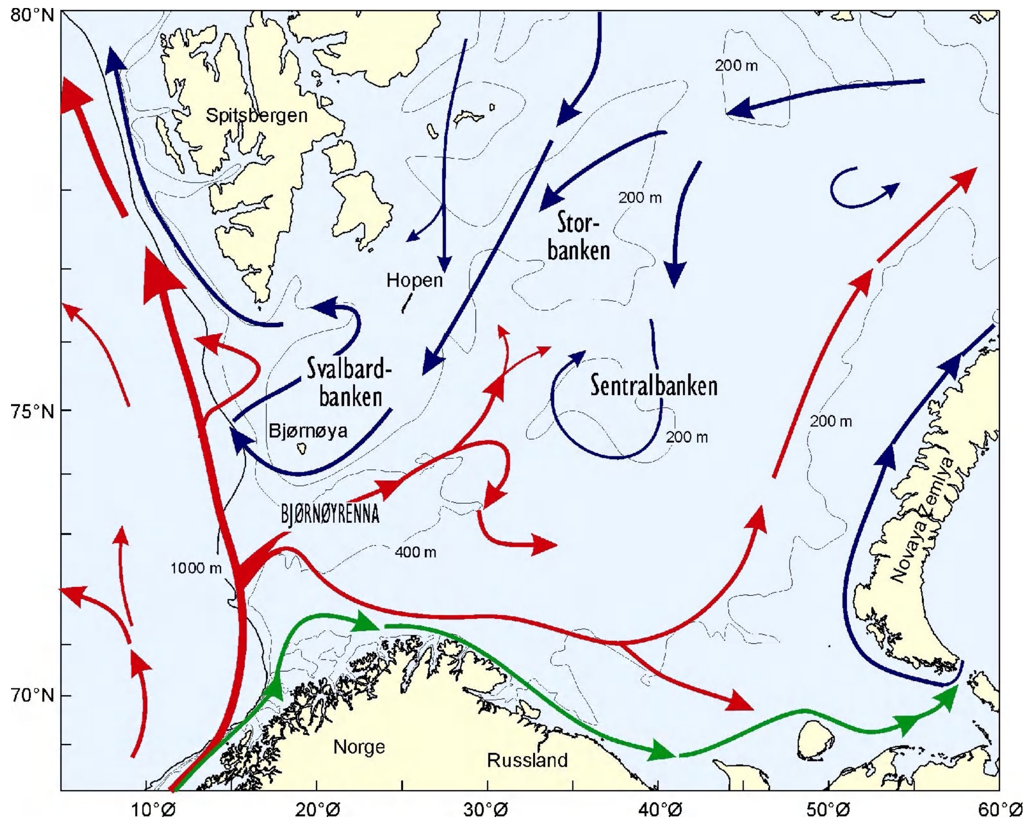


Figure 1.1.1.1.1 Main currents and depths in the Barents Sea. The red arrows show Atlantic water, the blue: arctic water, and the green: coastal water.

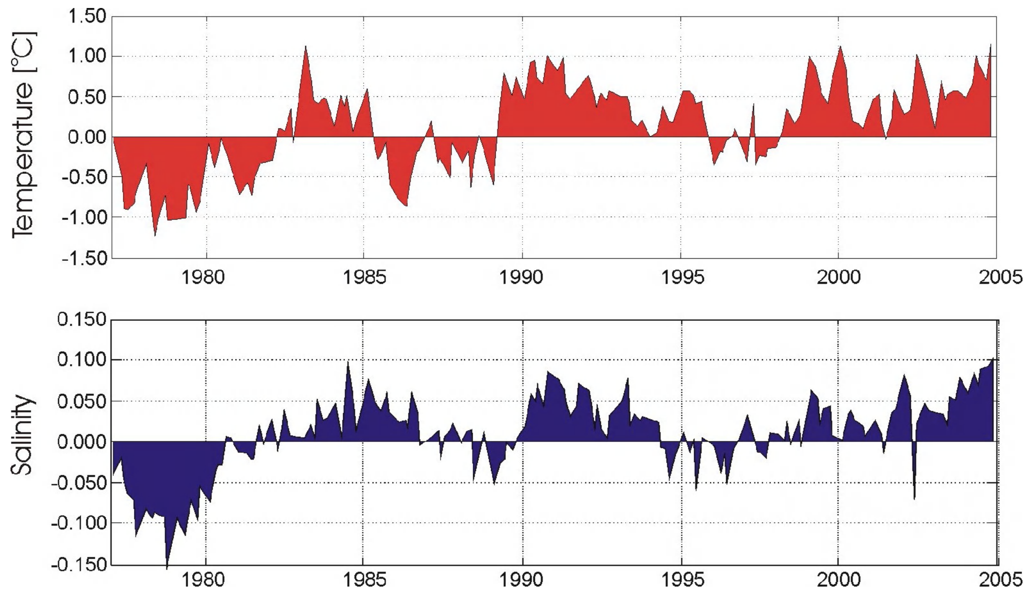


Figure 1.1.1.1.2 Average temperature and salinity of the Fugløya-Bjørnøya section.

1.2 Norwegian Sea

1.2.1 Ecosystem overview

1.2.1.1 Ecosystem components

General geography

The Norwegian Sea is traditionally defined as the ocean bounded by a line drawn from the Norwegian Coast at about 61°N to Shetland, further to the Faroes-East Iceland-Jan Mayen-the southern tip of Spitsbergen-the Vesterålen at the Norwegian coast and the along the coast. In addition a wedge-shaped strip along the western coast of Spitsbergen is included in the area. The offshore boundaries follow in large part the mid-Atlantic subsurface ridges.

The Norwegian Sea covers an area of 1.1 million km^2 and has a volume of more than 2 million km^3, i.e. an average depth of about 2000 m. The Norwegian Sea is divided into two separate basins of 3000-m to 4000-m depth, with maximum depth 4020 m. Along the Norwegian coast there is a relatively narrow continental shelf, between 40 and 200 km wide, which has a varied topography and geology. It has a relatively level sea-bottom with depths between 100 and 400 m. The shelf is crossed by several troughs deeper than 300 m. Moraine deposits dominate the bottom substratum on the shelf, but soft layered clay is commonly found in the deeper parts. Gravely and sandy bottoms are found near the shelf-break and on ridges where the currents are expected to be strong and the sedimentation rates low.

General oceanography

The circulation in the Norwegian Sea is strongly affected by the topography. On the continental shelf at the eastern margin of the area flows the low salinity Norwegian Coastal Current. It enters the area from the North Sea in the south and exits to the Barents Sea in the north east. The inflow of water from the north Atlantic to the Norwegian Sea takes place through the Faroe-Shetland Channel and flows over the Iceland-Faroe Ridge. At the northern slope of the ridge the warm Atlantic water meets the cold Arctic water and the boundary between these waters is called the Iceland Faroe Front. The major part of the warm and high salinity Atlantic Water continues northward as the Norwegian Atlantic Current along the Norwegian shelf, but parts of it branches into the North Sea and also into the more central parts of the Norwegian Sea. At the western boundary of the Barents Sea, the NAC further bifurcates into the North Cape Current flowing eastwards into the Barents Sea and the West Spitsbergen Current flowing northwards into the Polar Ocean through the Fram Strait.

The border zones between the domains of the Norwegian Atlantic Current and the Arctic waters to the west are known as the Arctic and Jan Mayen Fronts, located north and south of Jan Mayen, respectively. Cold Arctic water flows into the southern Norwegian Sea in the East Icelandic current.

With respect to the underlying waters, there is evidence that the Arctic Intermediate Water has been expanding in volume in recent decades (Blindheim, 1990; Blindheim et al., 2000). The Arctic Intermediate water manifests itself as a salinity minimum in the water column and it blankets the entire Norwegian Sea, thus precluding direct contact between the warm surface waters and the dense deep waters ($T < -0.5°C$) whose properties are defined by inflows from the Greenland Sea. The circulation in the deep waters is topographically influenced and clockwise in the two basins. The cold deep water flows out of the Norwegian Sea through the Faroe Bank channel, the deepest connection to the North Atlantic (Blindheim 2004).

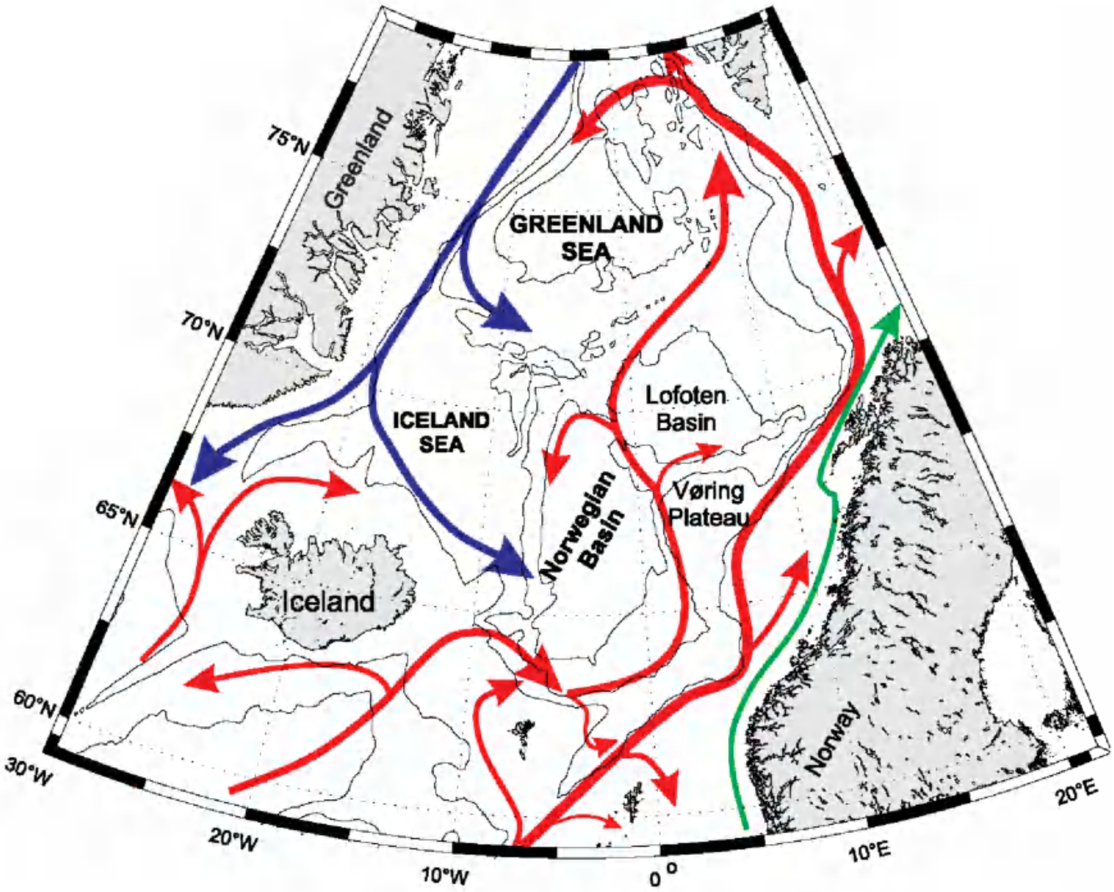


Figure 1.2.1.1.1 Norwegian Sea main circulation pattern.

Climate variability

Between Iceland and Jan Mayen variation in the volume of Arctic waters carried by the East Icelandic Current (EIC) may result in relatively large shifts of the front between the cold Arctic waters and the warm Atlantic water. Fluctuations in fluxes and water-mass properties in the two major current systems are therefore of decisive importance for the structure and distribution of the water masses in the Nordic Seas. A high NAO index with strong westerly winds results in increased transport in the EIC. E.g. in the early 1990s the NAO index was high and the Arctic water occupied a larger portion of the Norwegian Sea. The volume of and properties of the Arctic water carried directly into the Norwegian Sea by the EIC play a larger role than previously believed in the creation of variability in the distribution of water masses and their properties in the Nordic Seas (Blindheim et al. 2000 and Blindheim 2004).

Phytoplankton

The annual rate of primary production in the Atlantic Water has been estimated to be about 80 g C m^{-2} $year^{-1}$ (Rey 2004). Of this production about 60% is new production, i.e. the remainder 40% of the production is assumed to be based on regenerated nutrients. The new production represents the potential for harvest in the ocean. The spring bloom, defined as the time of the maximum chlorophyll concentration, occurs in the mean around 20^{th} of May, but may occur a month earlier or later. The most important group of phytoplankton is the diatoms, with most of the species belonging to the Order Centralis, and the most important representatives are species of the genus *Thalassiosira* and *Chaetoceros*. After the diatom spring bloom the phytoplankton community is often dominated by the flagellate *Phaeocystis pouchetii*. In the Norwegian Coastal Current the primary production varies from 90–120 g C m^{-2} $year^{-1}$.

Zooplankton

The zooplankton community of the Norwegian Sea is dominated by copepods and euphausids. The main copepod is *Calanus finmarchicus* in the Atlantic water while *Calanus hyperboreus* is the dominant species in the Artic watermasses. The main euphausids are *Meganychthiphanes norvegica*, *Thysanoessa inermis*, and *Thysanoessa longicaudata*. Other important zooplankton are the hyperids *Themisto libellula* and *Themisto abyssorum*. The plankton community show varying productivity with concentrations of the most important species *Calanus finmarchicus* varying for instance between about 8 g/m^2 dryweight in 1997 to 28 g/m^2 dryweight in 1995. The highly variable availability of zooplankton is an important factor for fish stock productivity.

Benthic habitats in the Norwegian Sea

Coral reefs formed by the cold-water coral *Lophelia pertusa* are quite common in the eatern shelf area of the Norwegian Sea. Nowhere else in the world similar densities and sizes of such reefs have been found. The largest reef, or reef-complex (comprising several closely situated individual reefs) known as the Røst Reef, is situated south-west off Lofoten. *Lophelia* reefs offers habitats (microhabitats) for a great diversity of other species. Redfish (*Sebastes* spp.) are common on the reefs. The great abundances of this fish have been known by local fishers for a long time. More recent fishery practice employing rock hopper trawl gear close to or directly on these reefs has led to severe damages. Other corals such as gorgonians also form habitats utilised by fish and other organisms. These habitats are often called "gorgonian forests", and are common in some fjords and along the shelf break.

Fish community of the Norwegian Sea

The Norwegian Sea fish community is characterised by a number of large stocks of medium sized highly migratory pelagic species exploiting the pelagic zone of the waste areas with large bottom depths, smaller mesopelagic species exploiting the same areas and several demersal and pelagic stocks exploiting and/or spawning in the marginal eastern continental shelf areas. The large stocks exploiting the area for feeding must be regarded key species in the ecosystem while those visiting the more marginal north eastern shelf area for spawning are expected to be of less significance.

The main pelagic stocks feeding in the area are the blue whiting, *Micromesistius poutassou*, NE Atlantic mackerel, *Scomber scombrus,* and Norwegian spring-spawning herring, *Clupea harengus*. Herring also spawns in the eastern shelf areas. With regard to horizontal distribution in the feeding areas herring is the most northern one, mackerel more southern while blue whiting seems distributed over most of the area. With regard to vertical distribution during the feeding season mackerel is closest to the surface, herring somewhat deeper, while blue whiting as a mesopelagic species with the deepest mean depth distribution. Other important mesopelagic species in the area are redfish *Sebastes sp.*, pearlsides, *Maurolicus muelleri,* and lanternfishes, *Benthosema glaciale*. The open Norwegian Sea all the way into the polar front is an important nursery area for the lumpsucker, *Cyclopterus lumpus,* and the northeastern shelf areas are important spawning grounds. Local stocks of herring exist in many fjords along the Norwegian coastline. The stocks make limited migration out in to the open waters for feeding.

None of the main pelagic species has their entire lifecycle within the Norwegian Sea ecosystem. Blue whiting spawns west of the British Isles and perform a northerly and westerly feeding migration into the Faroese ecosystem and the Norwegian Sea ecosystem. Mackerel spawn west of the British Isles and in the North Sea and perform northerly feeding migrations into the Norwegian Sea. Norwegian spring-spawning herring has its main spawning and feeding areas in the Norwegian Sea while the main nursery and young fish areas is in the neighbouring Barents Sea ecosystem.

As pelagic feeders all the three stocks must be expected to have major influences on the ecosystem. Studies on this subject have only been carried out to a limited degree and what exists are mainly of descriptive character. For instance was the highest catches of salmon ever (1970s) taken during a period when the herring stock was at a record low level. This has been suggested to be a potential effect of reduced competition beneficial for salmon stock productivity (Hansen et al., 2000).

The North East Artic cod, *Gadus morhua,* and haddock, *Melanogrammus aeglefinnu,s* have their main adult feeding and nursery areas in the Barents Sea while the main spawning areas are along the eastern shelf areas of the Norwegian Sea and into the SE parts of the Barents Sea ecosystem. There are local cod stocks connected to the coast and only doing limited migrations from the coast for feeding. The Northeast Artic saithe also spawn along the eastern shelf areas of the Norwegian Sea and has important nursery areas on this coastline and into the Barents Sea on the Finnmark coast. The migration of older and mature saithe are to a large degree linked with those of the Norwegian spring-spawning herring out into the high seas areas of the Norwegian Sea. There are also stocks of ling, *Molva molva,* and tusk, *Bromse brosme,* along the eastern shelf region. Greenland halibut, *Reinhardtius hippoglossoides,* is found along the eastern shelf and also in the western areas in the shelf areas of Jan Mayen. Other important species inhabiting the hydrographic transition zone include roughead grenadier, *Macrourus berglax*, several species of eelpouts, *zoarcids,* and the rajiids, *Raja hyperborean, R radiate* and *Bathyraja spinicauda* (Bergstad et al., 1999).

The demersal species are in general connected to the eastern shelf area and the presence of the largest stocks is connected to spawning. The fish then migrates back to the Barents Sea for feeding. The fry also in general drift out of the Norwegian Sea and into the Barents Sea. As compared to the pelagic stocks, the demersal stocks must accordingly be regarded as less significant for the Norwegian Sea ecosystem as a whole.

Seabirds

The Norwegian Sea is currently estimated to hold approximately 20 million seabirds. This number includes a breeding population of 4.5 million pairs and their young as well as non-breeding immatures, deferred breeders and visitors from other waters (Barrett et al. 2002, Anker-Nilssen & Lorentsen 2004). The two dominating species of this important seabird community, the Atlantic puffin *Fratercula arctica* and the northern fulmar *Fulmarus glacialis*, are both pelagic and account for 31% and 28% of seabird numbers, respectively. Whereas few of the 7.7 million seabirds breeding on Iceland are considered part of the Norwegian Sea ecosystem, a coarse estimate of 2.0 million visiting fulmars and equally many wintering little auks *Alle alle* were added to these calculations.

Twenty-two species breed in numbers exceeding 2000 pairs, including half the world population of European storm-petrels *Hydrobates pelagicus* (265 000 pairs). Northern fulmar (1.0 milllion pairs), great cormorant *Phalacrocorax carbo carbo* (20 000 pairs), European shag *P. aristotelis* (20,000 pairs), great skua *Stercorarius skua* (6,000 pairs) and Atlantic puffin (1.8 million pairs) also constitutes more than 25% of the biogeographical population they belong to, and common eider *Somateria mollissima*, common gull *Larus* canus, herring gull *L. argentatus*, great black-backed gull *L. marinus*, black-legged kittiwakes *Rissa tridactyla* and common guillemots *Uria aalge* and black guillemot *Cepphus grylle arcticus* also are relatively abundant species.

The annual consumption of seabirds in the Norwegian Sea amounts to about 1.2 million tonnes (Anker-Nilssen & Lorentsen 2004). An estimated 0.47 million tonnes are invertebrate prey, two thirds of which are eaten by the fulmars. Correspondingly, 45% of the 0.77 million tonnes of fish prey are taken by the puffins. In terms of quantity the single-most important fish prey is 0-group herring produced by the Norwegian spring-spawning stock, but lesser sandeels *Ammodytes marinus* and young (0–2 group) gadoids such as NE Arctic saithe *Pollachius virens* and haddock *Melanogrammus aeglefinus* are also expected to be important.

Only a small selection of colonies are monitored at a regular basis and in most cases the existing knowledge is insufficient to explain the documented population trends in any detail (see Anker-Nilssen & Lorentsen for a summary). One exception is the importance of 0-group herring for the reproduction of puffins at Røst in the Lofoten Islands, the largest seabird colony in mainland Europe, breeding parameters of which have proven to be early and accurate indicators of herring year class strength (e.g. Anker-Nilssen 1992, Sætre et al. 2002, Durant et al. 2003).

Seals in the Norwegian Sea

There are two seal stocks of particular importance in the Norwegian Sea: Harp and hooded seals. Both species are mainly connected to the Norwegian Sea through feeding. They show opportunistic feeding patterns in that different species are consumed in different areas and at different times of the year.

Whales in the Norwegian Sea

Due to topographical and hydrographic characteristics beneficial for production the Norwegian Sea has abundant stocks of whales feeding on plankton, pelagic fishes and Cephalopods. Besides minke whale, fin whale, blue whale, sperm whale, humpback and killer whales are important species in the area. Except from killer whales all species are seasonal migrators visiting the Norwegian Sea for feeding during the summer.

The minke whale *Balaenotera acutorostrata* is the smallest in size and most numerous in stock size of the baleen whales in the Norwegian Sea. It is found throughout the area, in particular along the eastern shelf area and in the Jan Mayen area. The species is an opportunistic feeding with special preference for herring in the Norwegian Sea ecosystem.

The killer whales *Orcinus orca* in the area are closely linked to the yearly migrations of the Norwegian spring-spawning herring. In the present wintering area of the herring, the Vestfjord, Tysford, and Ofotfjord an estimated 500 killer whales have been feeding on herring during the winter months. A total estimate of killer whales for the Norwegian Sea and the Barents Sea it is at some few thousands individuals.

1.2.1.2 Impact of fishing activity on the ecosystem

Destruction of deepwater coral reefs has been documented in the eastern shelf areas. These descriptions have resulted in management measures like area closures for bottom trawling. Effects on bottom fauna could be expected from bottom trawling activities in the eastern shelf areas.

Work is carried out within the frames of ICES in order to sort out the scale of unintentional bycatch of salmon in the pelagic fisheries in the Norwegian Sea (SGBYSAL), but no such major effects have been documented so far.

Mortality of seabirds occurs in longline fisheries. Magnitude and species composition is unknown.

Bycatch of harbour porpoise is routinely observed in net fisheries. In episodes of coastal invasion of artic seals large mortality of seals has been observed in net fisheries. This mortality has not been regarded problematic for seal stocks due to healthy state of these stocks and a general low harvesting level.

Mortality of large marine mammals due to bycatch has not been described and is probably low.

Ghost fisheries have been documented through dredging of lost gear along the eastern shelf area. A programme for retrieval of such gears is in action along the Norwegian coast towards the Norwegian Sea. A high number of ghost fishing nets are retrieved yearly. The need for such activity is probably larger than what is currently carried out given the fish mortality observed in retrieved nets.

A major collapse in the herring stock was observed during the late 1960s. Various analyses have shown that the fisheries were a major factor driving the collapse.

1.3 The human use of the ecosystem

1.3.1 Overall impacts

1.3.2 The fisheries

The major demersal stocks in the Northeast Arctic include cod, haddock, saithe, and shrimp. In addition, redfish, Greenland halibut, and flatfishes (e.g., long rough dab, plaice) are common on the shelf and at the continental slope, with ling and tusk found also at the slope and in deeper waters. In 2004, landings of slightly less than 0.9 million t were taken from the stocks of cod, haddock, saithe, redfish, and Greenland halibut, which is an increase of about 10% compared to 2003. An additional catch of about 100 000 t was taken from other demersal stocks, including crustaceans, not assessed at present.

The major pelagic stocks are capelin, herring, and polar cod. The highly migratory species blue whiting and mackerel extend their feeding migrations into this region. There was no fishery for capelin in the area in 2004 due to the stock being in poor condition, and there was no directed fishery for herring in the area. The highly migratory species blue whiting and mackerel extend their feeding migrations into this region, but there is no directed fishery for the species in the area. Species with relatively small landings include salmon, halibut, hake, pollack, whiting, Norway pout, anglerfish, lumpsucker, argentines, grenadiers, flatfishes, horse mackerel, dogfishes, skates, crustaceans, and molluscs.
The most widespread gear used in the central Barents Sea is bottom trawl, but also long line and gillnets for the demersal fisheries, and purse seine and pelagic trawl for the pelagic fisheries. Other gears more common along the coast include handline and Danish seine. Gears used in a relatively minor degree are float line (used in a small but directed fishery for haddock along the coast of Finnmark in Norway) and various pots and traps for fish and crabs. The variety of the gears varies with time, space and countries, with Norway having the largest variety caused by the coastal fishery. For Russia, the most common gear is trawl, but a longline fishery is present (mainly directed for cod and wolffish). The other countries mainly use trawl.

For most of the exploited stocks an agreed quota is decided (TAC). In addition to an agreed quota, a number of additional regulations are applied. The regulation differs among gears and species and may be different from country to country, and a non-exhaustive list is summarised in Table 1.3.2.1.

The fishery on Norwegian coastal cod is conducted both with trawlers and with smaller coastal vessels using traditional fishing gears like gillnet, longline, handline, and Danish seine. The fishery is dominated by gillnet (50%), while longline/handline account for about 20%, Danish seine 20% and trawl 10% of the total catch. Norwegian vessels take all the reported catch. However, trawlers from other countries probably take a small amount when fishing near the Norwegian coast fishing for Northeast Arctic cod and Northeast Arctic haddock.

The fishery for Northeast Arctic cod is conducted both by an international trawler fleet operating in offshore waters and by vessels using gillnets, longlines, handlines and Danish seine operating both offshore and in the coastal areas. 60–80% of the annual landings are from trawlers.

Northeast Arctic haddock are harvested throughout the year. In years when the commercial stock is low they are mostly caught as bycatch in the cod trawl fishery, and when the commercial stock abundance and biomass are high haddock are harvested in a targeted fishery. On average approximately 25% of the catch is with conventional gears, mostly longline, which are used almost exclusively by Norway. Part of the longline catches are from a directed fishery.

Northeast Arctic saithe are mainly harvested by purse seine and trawl fisheries, which accounted for 60% of the landings in 2000. A traditional gillnet fishery for spawning saithe accounts for about 22%. The remaining catches are taken by Danish seine and handline in addition to minor bycatches in the longline fishery for other species. Some changes in recent regulations have led to fewer amounts being taken by purse seine.

Greenland halibut fisheries are dominated by longline and gillnets and operate in relatively deep waters with minimum bycatch implication. Target trawl fishery has been prohibited and trawl catches are limited to bycatch only.

The only directed fisheries for *Sebastes mentella* (deep-sea redfish) are trawl fisheries. Bycatches are taken in the cod fishery and as juveniles in the shrimp trawl fisheries. Traditionally, the fishery for *S. mentella* was conducted by Russia and other East European countries on grounds located south of Bear Island towards Spitsbergen.

The fishery for *Sebastes marinus* (golden redfish) is mainly conducted by Norway which accounts for 80–90% of the total catch. Germany also has a long tradition of a trawl fishery for this species. The fish are caught mainly by trawl and gillnet, and to a lesser extent by longline and handline. The trawl and gillnet fishery have benefited from the females concentrating on the "spawning" grounds during spring. Some of the catches by Norway, and most of the catches taken by other countries, are taken in mixed fisheries together with saithe and cod. Important fishing grounds are the Møre area (Svinøy), Halten Bank, the banks outside Lofoten and Vesterålen, and Sleppen outside Finnmark. Traditionally, *S. marinus* has been the most popular and highest priced redfish species.

The recent developments in the stocks of cod, haddock, saithe, Greenland halibut, redfish, herring, and capelin are summarized in the following:

Coastal cod is experiencing reduced reproductive capacity and is harvested unsustainably.

For Northeast Arctic cod, the spawning biomass is considered to have full reproductive capacity but, based on the most recent estimates of fishing mortality, is at risk of being harvested unsustainably.

Northeast Arctic haddock has full reproduction capacity and is harvested sustainably.

Northeast Arctic saithe has full reproduction capacity and is harvested sustainably.

The stock status of Greenland halibut in Subareas I and II is not precisely known. SSB has been low since the late 1980s, but shows a slight increase in recent years.

The stock of *Sebastes mentella* is experiencing reduced reproductive capacity and is at present near a historical low.

The available information on *Sebastes marinus* indicate that this stock is in very poor condition with reduced reproductive capacity.

The capelin stock is experiencing a risk of reduced reproduction capacity, but is currently not harvested.

The Norwegian spring-spawning herring is classified as having full reproduction capacity and is harvested sustainably.

Most stocks are overexploited, i.e. the current fishing mortality exceeds the level that would give a high yield in the longer term.

The state of the individual stocks is presented in more detail in the stock Sections 1.5.1 to 1.5.8.

Table 1.3.2.1 Description of fisheries by gears. The gears are abbreviated as: trawl roundfish (TR), trawl shrimp (TS), longline (LL), gillnet (GN), handline (HL), purse seine (PS), Danish seine (DS) and trawl pelagic (TP). The regulations are abbreviated as: Quota (Q), mesh size (MS), sorting grid (SG), minimum catching size (MCS), minimum landing size (MLS), maximum bycatch of undersized fish (MBU), maximum bycatch of non-target species (MBN), maximum as bycatch (MB), closure of areas (C), restrictions in season (RS), restrictions in area (RA), restriction in gear (RG), maximum bycatch per haul (MBH), as bycatch by maximum per boat at landing (MBL), number of effective fishing days (ED), number of vessels (EF), restriction in effort combined with quota and tonnage of the vessel (ER).

Species	Directed fishery by gear	Type of fishery	Landings in 2004 (tonnes)	As bycatch in fleet(s)	Location	Agreements and regulations
Capelin	PS, TP	seasonal	0	TR, TS	Northern coastal areas to south of 74°N	Bilateral agreement, Norway and Russia
Coastal cod	GN, LL, HL, DS	all year	32599	TS, PS, DS, TP	Norwegian coast line	Q, MS, MCS, MBU, MBN, C, RS, RA
Cod	TR, GN, LL, HL	all year	580000	TS, PS, TP, DS	North of 62°N, Barents Sea, Svalbard	Q, MS, SG, MCS, MBU, MBN, C, RS, RA
Wolffish[1]	LL	all year	21081	TR, (GN), (HL)	North of 62°N, Barents Sea, Svalbard	Q, MB
Haddock	TR, GN, LL, HL	all year	116293	TS, PS, TP, DS	North of 62°N, Barents Sea, Svalbard	Q, MS, SG, MCS, MBU, MBN, C, RS, RA
Saithe	PS, TR, GN	seasonal	161916	TS, LL, HL, DS, TP	Coastal areas north of 62°N, southern Barents Sea	Q, MS, SG, MCS, MBU, MBN, C, RS, RA
Greenland halibut[2]	LL, GN	Seasonal	18762	TR	deep shelf and at the continental slope	Q, MS, RS, RG, MBH, MBL
Sebastes mentella	No directed fishery	all year	4914	TR	deep shelf and at the continental slope	C, SG, MB
Sebastes marinus	GN, LL,HL	all year	7293	TR	Norwegian coast	SG, MB MCS, MBU, C
Shrimp	TS	all year	43600		Spitsbergen, Barents Sea, Coastal	ED, EF, SG, C, MCS

[1]The directed fishery for wolffish is mainly Russian EEZ and in ICES area IIB, and the regulations are mainly restricted to this fishery

[2]The only directed fishery for Greenland halibut is by a limited Norwegian fleet, comprising vessels less than 28 m.

1.4 Assessments and advice

Mixed fisheries and fisheries interactions

All fisheries should be considered in the management. The major fisheries in the area are:

1. Factory and freezer trawlers operating in the whole area all year round, targeting mainly cod, haddock, and saithe and taking other species as bycatch. The number of these vessels has been stable in recent years, at a lower level than previously.
2. Fresh fish trawlers operating in Subarea I and Division IIa all year round, targeting mainly cod and haddock, taking other species as bycatch. The number of these vessels has been reduced in recent years.
3. Freezer trawlers operating in Subarea I and Division IIb fishing shrimp. The number of these vessels has been stable.
4. Large purse seiners and pelagic trawlers targeting herring, mackerel, blue whiting, capelin, and polar cod in seasonal fisheries in this region. These vessels fish some of the same species in other areas as well.
5. Small fresh fish trawlers targeting shrimp and capelin in near-coast areas in Subarea I. The size of this fleet has decreased in recent years.
6. A fleet of vessels using conventional gears (gillnet, longline, handline, and Danish seine) mainly in near-shore fisheries, targeting various demersal species all around the year. This fleet, together with fleets 7 and 8, accounts for approximately 30% of the landings of demersal stocks. This share is maintained by quota allocation. When vessels in this fleet are modernised or replaced, there is a trend towards medium-sized (app. 15–20 m) multi-gear vessels with crews of 3–5.
7. Small purse seiners targeting saithe in coastal waters in a seasonal fishery, to a large extent vessels belonging to the group using conventional gears.
8. Longliners operating offshore, targeting non TAC-restricted species, mainly ling, blue ling, and tusk. These vessels are generally larger than those in the coastal fisheries and use technologically advanced auto-line systems.
9. Small vessels using gillnets, longlines, handlines, and Danish seine operating in near shore waters along the Norwegian coast north of 62°N, exploiting coastal cod, and Northeast Arctic cod.

Some of these fisheries are mixed fisheries, with many stocks exploited together in various combinations. In cases where significant interactions occur, management advice must consider both the state of individual stocks and their simultaneous exploitation. Stocks in the poorest condition, particularly those having reduced reproductive capacity, necessarily become the overriding concern for the management of mixed fisheries where stocks are exploited either as a targeted species or as a bycatch.

Single-stock exploitation boundaries and critical stocks

The state and the limits to exploitation of the individual stocks are presented in the stock sections (Sections 1.5.1 to 1.5.8). ICES considers limits to exploitation of single stocks as follows:

Species	State of the stock			ICES considerations in relation to single-stock exploitation boundaries			Upper limit corresponding to single-stock exploitation boundary for agreed management plan or in relation to precautionary limits. Tonnes or effort in 2006
	Spawning biomass in relation to precautionary limits	Fishing mortality in relation to precautionary limits	Fishing mortality in relation to target reference points	in relation to agreed management plan	in relation to precautionary limits	in relation to target reference points	
Northeast Arctic cod	Full reproductive capacity	F in 2004 is higher than intended under the management plan	NA	Implies a TAC of 471 000 t in 2006	Management plan precautionary but not fully enforced		471 000 t
Norwegian Coastal cod	Reduced reproductive capacity	Harvested unsustainably	NA		No catch and recovery plan should be developed and implemented		No catch
Northeast Arctic haddock	Full reproductive capacity	Harvested sustainably	NA	There is an agreed harvest control rule but it has not been evaluated yet.	Less than 112 000 t		< 112 000 t
Northeast Arctic saithe	Full reproductive capacity	Harvested sustainably	NA		Less than 202 000 t		< 202 000 t
Greenland halibut	Unknown	Unknown	NA		Do not exceed recent low catches (13 000 t)		< 13 000 t
Sebastes mentella	Reduced reproductive capacity	Unknown	NA		No directed trawl fishery, area closures and low bycatch limits		0 t
Sebastes marinus	Reduced reproductive Capacity	Unknown	NA		More stringent protective measures		0 t
Shrimp	Unknown	Unknown			**ICES recommends that a TAC should be implemented for 2006 and set no higher than the current catch level of 40 000 t.**		< 40 000 t

Identification of critical stocks

The table above identifies the stocks that have reduced reproductive capacity, i.e. Norwegian coastal cod and the two redfish stocks in Subareas I and II (*Sebastes marinus* and *Sebastes mentella*). These stocks are an overriding concern in the management advice.

ICES advice for fisheries management

The fisheries in the Northeast Arctic should therefore be managed such that the following rules apply simultaneously:

1. **For Norwegian coastal cod, there should be no catch.**
2. **For *Sebastes marinus* and *Sebasted mentella* in Subareas I and II, there should be no directed fishery and stronger regulations are advised to reduce bycatch.**
3. **The fishing of all other species should be restricted within the precautionary limits or according to the management plan as indicated in the table of individual stock limits above.**

Furthermore, unless ways can be found to harvest species caught in a mixed fishery within precautionary limits for all those species individually, then fishing should not be permitted.

Management considerations

ICES notes that this advice presents a strong incentive to fisheries to avoid catching species when their reproductive capacity is reduced. If industry-initiated programmes aim at reducing catches of species with reduced reproductive capacity to levels close to zero in mixed fisheries, then these programmes could be considered in the management of these fisheries. Industry-initiated programmes to pursue incentives should be encouraged, but must include a high rate of independent observer coverage, or other fully transparent methods for ensuring that their catches of species with reduced reproductive capacity are fully and credibly reported.

The demersal fisheries are highly mixed, usually with a clear target species dominating, and with low linkage to the pelagic fisheries (see table below). Although the degree of mixing may be high, the effect of the fisheries will vary among the species. More specifically, the coastal cod stock and the two redfish stocks are presently at very low levels. Therefore, the effect of the mixed fishery will be largest for these stocks. In order to rebuild these stocks, further restrictions in the regulations should be considered (e.g. closures, moratorium, restrictions in gears). A quantification of the degree of mixing and impact among species requires detailed information about the target species and mix per catch/landing and gear. Such data exist for some fleets (e.g. the trawler fleet), but is incomplete for other fleets. The available data has not yet been gathered and compiled for a quantitative analysis.

Flexibility in coupling between the fisheries. Fleets and impact on the other species (H - high, M - medium, L - low and 0 - nothing). The lower diagonal indicates what gears couples the species, and the strength of the coupling is given in the upper diagonal. The gears are abbreviated as: trawl roundfish (TR), trawl shrimp (TS), longline (LL), gillnet (GN), handline (HL), purse seine (PS), Danish seine (DS) and trawl pelagic (TP).

Species	**Cod**	**Coastal cod**	**Haddock**	**Saithe**	**Wolffish**	**S. *mentella***	**S. *marinus***	**Greenland halibut**	**Capelin**	**Shrimp**
Cod		H	H	H	M	M	M	M	L	M-H juvenile cod
Coastal cod	TR, PS, GN, LL, HL, DS		H	H	L	L	M-L	L	0-L	L
Haddock	TR, PS, GN, LL, HL, DS	TR, PS, GN,LL, HL, DS		H	M	M	M	L	0-L	M-H juvenile haddock
Saithe	TR, PS, GN, LL, HL, DS	TR, PS, GN,LL, HL, DS	TR, PS, GN, LL, HL, DS		L	L	M	0	0	0
Wolffish	TR, GN, LL, HL	TR,GN, LL, HL	TR, GN, LL, HL	TR, GN, LL, HL		M	M	M	0	M juvenile wolffish
S. mentella	TR	TR	TR	TR	TR		M	H	H juvenile Sebastes	H juvenile Sebastes
S. *marinus*	TR,GN, LL	TR,GN, LL	TR,GN, LL	TR,GN	TR, LL	TR		L	0	L-M juvenile Sebastes
Greenland halibut	TR, GN, LL,DS	TR,GN, LL	TR, GN, LL,DS	TR, GN, LL,DS	TR, LL	TR	TR		0	M-H juvenile
Capelin	TR, PS, TS, TP	PS, TP	TR, PS, TS, TP	PS	TP	TP	TP	None		L
Shrimp	TS	TS	TS	TS	TS	TS	TS	TS	TS	

Accordingly, at least the following fisheries are suspected of having significant interactions that deserve attention in setting up TACs applying to single stocks:

- Norwegian coastal cod are caught together with Northeast Arctic cod in some fisheries.
- For *Sebastes marinus*, some of the catches by Norway, and most of the catches taken by other countries, are taken in mixed trawl fisheries.
- *Sebastes mentella* is caught as a bycatch in the cod fishery, the pelagic fishery for blue whiting and NSS herring and as juveniles in the shrimp trawl fisheries.
- Shrimp trawl fishery with bycatch of juvenile redfish and Greenland halibut.
- Directed pelagic trawl fisheries targeting herring and blue whiting in the Norwegian Sea where 15% catch of redfish is allowed.

The catch options that would apply if single stocks could be exploited independently of others are presented in the sections on individual stocks (Sections 1.5.1 to 1.5.8).

However, for the mixed demersal fisheries, catch options must be based on the expected catch in specific combinations of effort in the various fisheries, taking into consideration the advice given above. The distributions of effort across fisheries should be responsive to objectives set by managers, but must also result in catches that comply with the scientific advice presented above.

At the 31st meeting of the Joint Russian-Norwegian Fisheries Commission, the Parties agreed on a harvesting strategy for Northeast Arctic cod and haddock. In 2004 ICES evaluated HCR for cod and stated that the rule was incomplete in the last part. It was amended by ICES for performing the evaluation. The amended HCR was considered by ICES as consistent with the Precautionary Approach. At the 33rd Session of The Joint Norwegian-Russian Fishery Commission the HCR was amended for rebuilding situations and ICES was requested to evaluate the new rule and provide an advice in accordance to it. For Northeast Arctic cod, ICES evaluated the rules as amended and concluded that a management plan based on these rules is in agreement with the Precautionary Approach, provided that the spawning biomass is above $\mathbf{B}_{lim}$ and that the assessment uncertainty and implementation error are not greater than those calculated from historical data. The harvest strategy has not been evaluated for haddock.

ICES has been asked to calculate management options for 2006 on the basis of the harvest control rule as amended. The calculated catches and SSBs are given in Sections 1.5.1 and 1.5.3.

Regulations in force and their effects

The fisheries in Subareas I and II are managed by TAC constraints for the main stocks and by allocation of TAC shares amongst states with established fishing interests. These Subareas consist mainly of waters within EEZs, but also contain some waters outside EEZs.

For the main species, the fisheries in the EEZs are regulated by quotas at a variety of scales (vessels, fleets, species, seasons). Management measures also regulate minimum landing size, mesh size, and use of sorting grids. Since January 1997, the use of sorting grids in the trawl fisheries has been mandatory for most of the Barents Sea and Svalbard area. Minimum landing size is also a minimum catching size, implying that vessels have to avoid fishing grounds with small-sized fish. Discarding is prohibited in some EEZs. Time and area closures may be implemented to protect small fish.

Compilation of effort data relevant to the different species is difficult when the fisheries are regulated by vessel quotas. In some cases the effort targeted at the main species, e.g., cod, may be calculated, but it is almost impossible to calculate effort for non-target species.

Quality of assessments and uncertainties

The unreported landings for Northeast Arctic cod have apparently increased sharply in 2002 and have remained at this level since. The main mechanism used for avoiding quota control seems to be trans-shipping of fish from the Barents Sea. The assessment includes estimates of non-reported landings. The catch forecast refers to total catch, which would only be equivalent to a TAC if no unreported landings occur in the future. This has to be taken into account when using the results of the catch forecasts.

References

ICES 2004. Report of the ICES Advisory Committee on Fishery Management, 2004.

1.4.1 Special requests

1.4.1.1 Long-term Management Advice on NEA cod and haddock (Norway)

The Joint Norwegian-Russian Fisheries Commission has requested ICES to:

"The harvest control rule for North-East Arctic Cod was evaluated by ICES in spring 2004. ICES regarded the harvest control rule to be consistent with the Precautionary Approach, provided adequate measures to ensure rebuilding of the stock in cases when SSB falls below B_{pa}.

At the meeting of the Joint Norwegian-Russian Fisheries Commission in October 2004, the harvest control rule was amended by including such pre-agreed measures for a rebuilding situation. ICES is requested to consider if this amendment is satisfactory with regard to the Precautionary Approach.

ICES is further requested to give advice on levels of catch and effort for 2006 consistent with the agreed amended harvest control rule for North-East Arctic Cod.

Finally we request assessment of the North-East Haddock stock, and comments upon aspects of the agreed experimental harvest rule in relation to the recruitment situation for this stock, and catch options according to the experimental harvest control rule and to an exploitation equal to F_{pa} level."

ICES comments

The evaluation of the amended harvest control rule is provided below. The advice on levels of catch and effort for 2006 consistent with the amended harvest control rule for North East Arctic cod and haddock is provided in Sections 1.5.1 and 1.5.3, respectively.

The amended harvest control rule (HCR) is as follows:

"The Parties agreed that the management strategies for cod and haddock should take into account the following:

conditions for high long-term yield from the stocks

achievement of year-to-year stability in TACs

full utilization of all available information on stock development

On this basis, the Parties determined the following decision rules for setting the annual fishing quota (TAC) for Northeast Arctic cod (NEA cod):

estimate the average TAC level for the coming 3 years based on F_{pa}. TAC for the next year will be set to this level as a starting value for the 3-year period.

the year after, the TAC calculation for the next 3 years is repeated based on the updated information about the stock development, however the TAC should not be changed by more than +/- 10% compared with the previous year's TAC.

if the spawning stock falls below B_{pa}, the procedure for establishing TAC should be based on a fishing mortality that is linearly reduced from F_{pa} at B_{pa}, to F= 0 at SSB equal to zero. At SSB-levels below B_{pa} in any of the operational years (current year, a year before and 3 years of prediction) there should be no limitations on the year-to-year variations in TAC.

The Parties agreed on similar decision rules for haddock, based on F_{pa} and B_{pa} for haddock, and with a fluctuation in TAC from year to year of no more than +/-25% (due to larger stock fluctuations)."

For Northeast Arctic cod, ICES evaluated the above decision rules through simulation studies, for details see the Technical Annex below. These studies indicate that a management plan based on these rules is in agreement with the Precautionary Approach, provided that SSB is above $\mathbf{B}_{lim}$ and that the assessment uncertainty and implementation error are not greater than those calculated from historical data. The decision rules seem to be effective in situations when SSB is close to $\mathbf{B}_{lim}$. The decision rules allow for fishing below $\mathbf{B}_{lim}$ and ICES may advise no fishing (F=0) in such situations.

For Northeast haddock, ICES is requested to comment on "*aspects of the agreed harvest control rule in relation to the recruitment dynamics for the haddock stock*". ICES has not yet evaluated the harvest control rule for that stock, but is prepared to provide such evaluation in 2006. This will be done using simulation studies similar to those provided for cod, taking into account the particularities of the dynamics of that stock. In particular, recruitment for this haddock stock has been sporadic, with the exception of recruitment for recent years which has been more stable. ICES observed that stocks exhibiting sporadic recruitment may need different measures to protect large year classes as they recruit to the fishery. Additionally, the retrospective pattern of this stock shows that the Northeast Arctic haddock assessment tends to overestimate stock size (and underestimate fishing mortality) to a significant degree in some years. These factors would need to be investigated through simulations mimicking the recruitment dynamics of this haddock stock, taking into account the assessment and implementation errors and biases.

The calculated catches and SSBs on the basis of the harvest control rule as amended are given in Sections 1.5.1 and 1.5.3.

Technical Annex to the response

For North-East Arctic cod, ICES evaluated the decision rules as amended at the meeting of the Joint Norwegian-Russian Fisheries Commission in October 2004.

In mathematical terms, the rule can be described in the following way:

Let y denote the year for which the quota is to be set. Let the term "3-year rule (F1, x)" denote applying the 3-year average rule described above with $\mathbf{F}_{5\text{-}10}$=F1 and an x % limit on year-to-year changes in TAC. The limit on increase of TAC from year to year could be set different from the limit on decrease from year to year, but such asymmetric rules were not tested. It is assumed that SSB(y) is not affected by F(y), which is in line with the current settings used by AFWG (the proportion of F and M before spawning is set at 0).

If SSB(y) > $\mathbf{B}_{pa}$ then
    if SSB(y-1) > $\mathbf{B}_{pa}$ and SSB(y+1) > $\mathbf{B}_{pa}$ and SSB(y+2) > $\mathbf{B}_{pa}$
        F(y) set by 3-year rule (0.40, 10%)
    else
        F(y) set by 3-year rule (0.40, unconstrained)
    else
        F(y) set by 3-year rule (0.40 SSB(y) / $\mathbf{B}_{pa}$, unconstrained).

SSB(y+1) and SSB(y+2) in this calculation is derived using F=0.40 in years y and y+1.

The evaluation of HCRs for NEA cod has been done using simulation models. Important issues for the evaluation of harvest control rules are the choice of population model, inclusion of uncertainty in population model, the choice of initial values for simulations, the formulation of harvest control rules for use in the evaluation (constant F rules, how to reduce F when SSB<$\mathbf{B}_{pa}$, limit on year-to-year variation in catch, etc.), and performance measures for harvest control rules (yield, stock size, F, probability of SSB<$\mathbf{B}_{lim}$, annual variation in catches, etc.). This year's evaluation of the HCR takes into account the comments made by ICES in 2004 on the need to take assessment and implementation error and bias into consideration in the evaluation of harvest control rules.

Thus, in this evaluation, the assessment and implementation error and bias were modelled explicitly as percentages of stock overestimation and level of over-fishing. In particular, the simulations took into account the retrospective error observed historically (stock bias in the range of -9% to 30% depending upon ages, with CV ranging from 20% to 62%). The implementation error was based on the differences between the catch and quota for the 1987–2003 period (12% bias with a CV of 18%).

To evaluate the effect of the assessment and implementation errors, two situations were tested through long-term simulations using a fishing mortality of 0.4, i.e. without invoking HCR:

1) assuming a low natural mortality on ages 3 and 4 (M=0.2, Run 1);

2) assuming a high natural mortality on ages 3 and 4 (M+0.7 and 0.4, respectively, for Run 2).

Table 1.4.1.1 Results of long-term simulations

Run No.	Realised F	Catch	TSB	SSB	Recruits	% years SSB<$\mathbf{B}_{lim}$	% years SSB<$\mathbf{B}_{pa}$	Average year-to-year % change in TAC
1	0.61	921	3155	761	689	0.0	3.8	17
2	0.56	490	1895	452	689	0.1	48.5	22

In both runs, the realised F (when assessment and implementation errors have been taken into account) is around 0.6, but the total stock and the spawning stock are at a much higher level in Run 1, and consequently the catches taken are also much higher in this simulation. SSB falls below $\mathbf{B}_{lim}$ in 0.0 and 0.1% of the years for Runs 1 and 2, respectively. The proportion of years the SSB is below $\mathbf{B}_{pa}$ is also low for Run 1, while for Run 2 this happens in almost half of the years.

In addition, the performance of the amended rule was tested in a situation where stock rebuilding is needed. This testing of the JNRC-2004-rule was done using medium-term simulations of the NEA cod stock with initial levels below $\mathbf{B}_{pa}$. Two situations were simulated; one where the recruitment cycle was near its maximum during the years immediately following the start of the simulation (labelled "high recruitment" in tables), and one where the cycle was near its minimum (labelled "low recruitment"). In both cases an increased natural mortality on the youngest age groups (M_3=0.7, M_4=0.4) was assumed.

To study the performance of the rule in a stock recovery situation, simulations were started in 1985, when the total stock size was 957 000 tonnes and the SSB was 193 000 t, i.e. below $\mathbf{B}_{lim}$. The year 1985 was chosen because it was a year with a fairly low stock size, as well as a year when the stock was not dominated by a single year class. However, since the performance of the rule might be different in a situation where weak or strong year classes enter the stock in the beginning of the period, the runs made covered both these situations. Technically, because a cyclical recruitment function was applied, this was done by shifting the period of the cycle so that the start of the period either corresponded to a maximum or a minimum of the recruitment cycle.

The natural mortality for the two youngest age groups was set to 0.7 and 0.4, respectively, reflecting high cannibalism. This might seem unrealistic in a situation where the stock is at a low level or the recruitment level is low. However, this can be regarded as a worst-case scenario. The fishing pattern was set equal to the 1985 pattern. Uncertainty in initial stock size and future stock assessments was included in the same way as in the long-term simulations described above. In each case, 2000 simulations were performed.

The results of the simulations are given in the following tables.

Mean SSB (1000 tonnes) in 1986–1990 for different runs

Run no.	Mean SSB 1986	Mean SSB 1987	Mean SSB 1988	Mean SSB 1989	Mean SSB 1990
Low recruitment	173730	181096	453602	411426	485809
High recruitment	173357	176586	441973	446824	640728

Probability of SSB> $\mathbf{B}_{pa}$ in 1986–1990 for different runs

Run no.	P(SSB > B_{pa}) 1986	P(SSB > B_{pa}) 1987	P(SSB > B_{pa}) 1988	P(SSB > B_{pa}) 1989	P(SSB > B_{pa}) 1990
Low recruitment	0.00	0.00	0.44	0.19	0.58
High recruitment	0.00	0.00	0.35	0.40	0.94

Probability of SSB> $\mathbf{B}_{lim}$ in 1986–1990 for different runs

Model	P(SSB > B_{lim}) 1986	P(SSB > B_{lim}) 1987	P(SSB > B_{lim}) 1988	P(SSB > B_{lim}) 1989	P(SSB > B_{lim}) 1990
Low recruitment	0.00	0.01	1.00	1.00	1.00
High recruitment	0.00	0.00	1.00	1.00	1.00

Mean catches (1000 tonnes) in 1986–1990 for different runs

Model	Mean catch 1986	Mean catch 1987	Mean catch 1988	Mean catch 1989	Mean catch 1990
Low recruitment	119938	171849	356674	350897	372113
High recruitment	129442	185734	401360	417611	426942

Mean realized F values in 1986–1990 for different runs

Model	Mean F 1986	Mean F 1987	Mean F 1988	Mean F 1989	Mean F 1990
Low recruitment	0.39	0.38	0.67	0.62	0.60
High recruitment	0.43	0.42	0.69	0.61	0.57

For both situations (low and high recruitment), the probability of SSB being above $\mathbf{B}_{\mathrm{lim}}$ is very low for the first two years. However, from the third year and onwards, both situations translate into a 100% probability of this happening. The probability for the SSB to be above $\mathbf{B}_{\mathrm{pa}}$ is zero during the first two years, but then increases during the next three years. They are higher for the high-recruitment run, but vary somewhat with the varying strength of the incoming year classes.

These results are indicative of the trajectory of the stock in response to the application of the HCR, but the actual trajectory and time of response will depend on how far SSB is below $\mathbf{B}_{\mathrm{lim}}$ and of the initial stock structure. However, in this region the model may not capture the stock dynamic and ICES may therefore advise on a zero TAC in these situations when SSB is below $\mathbf{B}_{\mathrm{lim}}$.

It should be noted that the conclusions drawn here are based on a risk level of 5%. They will hold also for higher risk levels. The risk level to use should be decided by managers. If a risk level lower than 5% is preferred, the harvest control rule should be evaluated against that level.

1.4.1.2 Request from the Norwegian Government regarding Greenland Sea harp and hooded seals and White Sea/Barents Sea harp seals

The Government of Norway has requested ICES as follows:

ICES has previously been requested to assess biological reference points for Greenland Sea harp seals, Greenland Sea hooded seals, and White Sea/Barents Sea harp seals. In response, ICES has discussed and agreed on a conceptual framework for applying the precautionary approach to the management of harp and hooded seals. However, until updated information about the stocks of hooded becomes available, implementation of biological limits should be restricted to the more data-rich harp seal stocks. Against this background, we would like to request ICES to establish biological limits for Greenland Sea harp seals and White Sea/Barents Sea harp seals.

Based on a recent white paper on marine mammal policy, the Norwegian Storting (Parliament) voted in support for a new management policy approach for marine mammals in 2004. The policy includes:

- *Increase catch quotas for the Northeast Atlantic harp seal stocks substantially from the current levels to reduce these stocks to levels that will give the maximum long-term harvest of seals.*
- *Increase the hooded seal stock level as compared with present level in order to get a better long term output.*

It is emphasized that no harvest driven stock changes should be performed in such a way that the resulting levels falls below precautionary or limit reference levels. For this reason we would request an assessment of the status of the stocks of harp and hooded seals in the Greenland Sea and harp seals in the White Sea/Barents Sea.

Furthermore, ICES should assess the impact on these stocks of an annual harvest of:

a) current harvest levels,
b) sustainable catches (defined as the fixed annual catches that stabilizes the future 1+ population),
c) twice the sustainable catches as defined above.

ICES Comments

The request involves three issues:

- establishing biological limits for Greenland Sea harp seals and White Sea/Barents Sea harp seals;
- assessment of the status of the stocks of harp and hooded seals in the Greenland Sea and harp seals in the White Sea/Barents Sea;
- assessment of the impact on these stocks of three different levels of annual harvest.

The request concerns three populations of seals: Greenland Sea harp seals, White Sea/Barents Sea harp seals and Greenland Sea hooded seals (see Figure 1.4.1.2.1).

Figure 1.4.1.2.1 Locations of North Atlantic harp and hooded seal stocks. Green spots mark the whelping and moulting areas for the White Sea (also called the East Ice) stock of harp seals, the Greenland Sea or West Ice stocks of harp and hooded seals (West Ice), and the northwest Atlantic stocks (Front and Gulf areas) of harp and hooded seals. Dark blue marks the entire distributional areas.

Regarding biological limits, a framework based on population numbers in accordance with international practices is presented. A key parameter in such a framework is the pristine population, approximated by the largest population which has been observed in the past (N_{max}). In the present situation all the populations have been increasing for the last decades and are thus at their maximum size and are expected continue to increase with present exploitation levels. N_{max} can therefore not be estimated presently and an alternative approach based on historical observations of stock increase rather than pristine population size is suggested as an interim solution.

Regarding the request for "sustainable" yields it should be noted that the use of "sustainable" in this context is not identical to the interpretation of "sustainable" normally applied in ICES advice. "Sustainable catch" as defined in the request means that the catch is risk neutral with regard to maintaining the population at its current size disregarding whether the current size is on the safe side of biological limits. ICES would normally define sustainable catch as the catch which would be risk averse in regard to maintain the stock at the safe side of biological limits. In order to avoid confusion the term "maintenance catch" is used to reflect the catch which will maintain the population at its present level as requested.

1.4.1.2.1 Biological limits for seal harvest

In response to a request by the Joint Norwegian-Russian Fisheries Commission (ICES 2003 p 489-490) ICES has proposed a framework for biological reference points and a corresponding management framework. The framework relates to population numbers with the pristine (not exploited) stock size as a key reference point.

In accordance with the precautionary approach a distinction is made between data adequate and data poor situations. Data adequate stocks should have data available for estimating abundance where a time series of at least five abundance estimates should be available spanning a period of 10-15 years with surveys separated by 2-5 years, the most recent abundance estimates should be prepared from surveys and supporting data (e.g., birth and mortality estimates) that are no more than 5 years old, and the accuracy of abundance estimates should have a Coefficient of Variation of about 30%. Stocks whose abundance estimates do not meet all these criteria are considered data poor.

Based upon these criteria, the Greenland Sea hooded seal stock is classified as 'data poor'. Although reproductive data for the Greenland Sea harp seal stock needs to be updated, there are sufficient pup production estimates to classify this stock as 'data adequate'. There have been 5 pup production surveys since 1998 in the White Sea. The quality of the pup surveys is sufficient to classify the stock 'data adequate'. However, as for the Greenland Sea, reproductive data for this stock is not current. Recent reproductive data are required for both of these stocks to maintain these classifications.

For a 'data adequate' species a framework was presented in response to a request by the Joint Norwegian-Russian Fisheries Commission (ICES CRR 261 (2003) p 489-490). Two precautionary and one conservation (limit) reference level are proposed. All reference levels relate to the pristine population size, which is the population which would be present on average in the absence of exploitation, or a proxy of the pristine population (e.g. maximum population size historically observed, N_{max}). A conservation or lower limit reference point, N_{lim}, identifies the lowest population size which should be avoided with high probability. Between those points it is suggested that two precautionary reference points are used as decision signposts for increasingly restrictive management to be introduced when the population approaches the conservation limit. In accordance with practices in the Western Atlantic ICES recommends that the limit reference point (N_{lim}) could be either 30% of the historical accurate maximum population estimates or should be set independently using IUCNs vulnerable criteria. This is the point where COSEWIC would consider listing the species as threatened under the Canadian Species-At-Risk Act (SARA; www.sararegistry.gc.ca). However, N_{lim} may not conform to any threshold value under the US Endangered Species Act (www.nmfs.noaa.gov/prot_res/).

The first precautionary reference level could be established at 70% (N_{70}) of $N_{max.}$ When the population is between N_{70} and N_{max}, harvest levels may be decided that may stabilise, reduce or increase the population, so long as the population remains above the N_{70} level. When a population falls below the N_{70} level, conservation objectives are required to allow the population to recover to above the precautionary (N_{70}) reference level. N_{50} is a second precautionary reference point where more strict control rules must be implemented, whereas the N_{lim} reference point is the ultimate limit point at which all harvest must be stopped.

For data poor stocks, it is recommended that only the lower tier (below N_{lim}) be defined. In this case, the four tiers effectively collapse to two (i.e., above and below N_{lim}). Below N_{lim} all harvest must be stopped, and conservative and effective management measures will at all times be required when the stock is below N_{max}.

Presently the time series only covers period with significant hunting pressure. The hunting pressure has been reduced in the last decades resulting in an increase in the populations since the 1970s. As a result the harp seal populations are presently at their highest historical level (for the time series since the 1940s) and the present exploitation is expected to allow a continuation of population increase. It is not presently possible to evaluate possible density dependent effects on mortality, growth or reproduction which will emerge in the event that the stocks would grow to larger sizes than have been observed historically, approaching the carrying capacity of the environment. It is therefore not possible to estimate the carrying capacity or pristine stock or proxies such as N_{max}. It is a further complication that the carrying capacity will be variable dependent on changes in the ecosystem and an estimation of pristine stock would therefore need to take such events into account. Examples of such changes could be changes in climatic conditions, in size of prey stocks, and in diseases. A framework based on reference points relating to pristine stock as outlined above can therefore not be applied with the present knowledge about the dynamics of these populations.

In the absence of a historical time series which enables estimates of N_{max} it is suggested that a risk avoidance management strategy is implemented. The stocks of harp seals in the Greenland Sea, White and Barents Sea have increased continuously from historical minimum levels in the 1960s. The populations have thus demonstrated an ability to grow from the historical minimum populations in the 1960s whereas the dynamics for populations below that size is unknown. As a precautionary management approach it is therefore suggested that management is implemented such that the populations are above the historical minimum populations with high probability. Recent abundance estimates implies that present populations are above historical minimum with high probability. Maintaining the populations at or above the present level will thus be in accordance with precautionary management. This is in accordance with the advice given in 2003. The maximum exploitation, which will maintain the populations on the present estimated sizes are presented below for the individual stocks.

1.4.1.2.2 Assessments of the status of the stocks of harp and hooded seals in the Greenland Sea and harp seals in the White Sea/Barents Sea.

Population assessments were based on a population model that estimates the current total population size. These estimates are then projected into the future to provide a future population size for which statistical uncertainty is provided for each set of catch options. The same population dynamic model was used for both of the Northeast Atlantic harp seal populations but with stock specific population parameters. A full assessment of hooded seals must await availability of updated abundance estimates (based on surveys conducted in March 2005) and will be performed in 2006.

Harp Seals

Greenland Sea Harp Seal

State of stock/exploitation: The adult population is at the highest level estimated in the historical time series. Based on previous (1983-1991) mark-recapture data and recent (2002) aerial survey data, the stock in 2005 is estimated to be 618,000 (95% C.I. 425,000-845,000) 1+ animals with a pup production of 106,000 (95% C.I. 71,000-141,000).

The total catches were 9,895 (including 8,288 pups) in 2004 and 5,808 (4,680 pups) in 2005. Removals were 23-38% of the allocated quotas, which was 15,000 animals one year old or older (1+ animals). The quota has been implemented such that parts of, or the whole quota, could be taken as weaned pups assuming 2 pups equaled one 1+ animal. Russia has not participated in this hunt since 1994.

Catches have remained significantly less than the quota since 1993. Catch figures are given in Table 1.4.1.2.1.

Management objectives:

There are no explicit management objectives for this stock. The Norwegian sealing regulations for 1985-2005 are given in Table 1.4.1.2.2.

Catch estimates: Based on the request from the government of Norway, options are given for three different catch scenarios:

- Current catch level (average of the catches in the period 2001 – 2005);
- Maintenance catches (defined as the fixed annual catches that stabilizes the future 1+ population);
- Two times the maintenance catches.

The catch options are further expanded using different proportions of pups and 1+ animals in the catches.

As a measure of the possible trends in the population when applying fixed annual catches, the ratio between the simulated size of the 1+ population in 2015 and 2005 (D_{1+}) is used.

Option #	Catch level	Proportion of 1+ in catches	Pup catch	1+ catch	D_{1+}		
PRIOR					Lower CI	point	Upper CI
1	Current	25.6% (current level)	3,303	1,138	1.18	1.51	1.83
2	Maintenance	25.6%	36,688	12,624	0.61	1.01	1.41
3	Maintenance	100%	0	31,194	0.66	1.05	1.44
4	2 X maint.	25.6%	73,376	25,248	0.00	0.45	0.97
5	2 X maint.	100%	0	62,388	0.058	0.55	1.03

Continuing with current catch level (Options 1) will likely result in an increase in population size. The maintenance catches (Options 2 and 3) are generally higher than estimated previously, but the confidence interval for the depletion statistics (D_{1+}) is wider. The reason is that the current estimate of natural mortality of the 1+ population is lower than the fixed value (0.12) used in the previous assessment. Catches two times maintenance levels will result in the population declining by approximately 45-55% in the next 10 years and the population will ultimately be reduced to zero if this fixed catch level is maintained. It should be noted that "maintenance" is used here to describe a situation where the stock size in 10 years is predicted to be similar to the present.

Elaboration and special comment: From 14 March to 6 April 2002 aeroplane (photographic) and helicopter (visual) surveys were carried out in the Greenland Sea pack-ice to assess the pup production of harp seals using traditional strip transect methodology. The total estimate of pup production was 98 500 with a coefficient of variation for the survey of

17%. This is a minimum estimate as it was not corrected for areas not photographed and for pups born after the survey in one of the three areas surveyed.

Pup production estimates (from previous tag-recapture experiments (1983-1991) and from recent (2002) aerial surveys):

Year	Pup production estimates	c.v. (%)
1983	58539	10.4
1984	103250	14.7
1985	111084	19.9
1987	49970	7.6
1988	58697	18.4
1989	110614	7.7
1990	55625	7.7
1991	67271	8.2
2002	98500	17.9

As well as these pup estimates the model includes age at maturity and estimates of natural mortality and natality. Based on these inputs the model estimated the following 2005 abundance for Greenland Sea harp seals: 618,000 (95% C.I. 413,000-823,000) 1+ animals with a pup production of 106,000 (95% C.I. 71,000-141,000).

The current estimate is higher, but more uncertain, than the estimate obtained previously (348 800, 95% C.I. 318 000–379 000. These differences are primarily due to the change in the estimate of M_{1+} (Natural mortality) and the inclusion of additional sources of uncertainty in the parameters.

Source of information

Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals, St.John's, Newfoundland, Canada, 30 August - 3 September 2005 (CM 2006/ACFM:6)

Catch data: Table 1.4.1.2.1 summarises the catches of harp seals in the Greenland Sea after World War II.

Table 1.4.1.2.1 Catches of harp seals in the Greenland Sea ("West Ice"), 1946–2005[a], incl. catches for scientific purposes.

	Norwegian catches			Russian catches			Total catches		
Year	Pups	1 year And Older	Total	pups	1 year And Older	total	Pups	1 year And Older	Total
1946–50	26606	9464	36070	-	-	-	26606	9464	36070
1951–55	30465	9125	39590	-	-	_b	30465	9125	39590
1956–60	18887	6171	25058	1148	1217	2365[b]	20035	7388	27423
1961–65	15477	3143	18620	2752	1898	4650	18229	5041	23270
1966–70	16817	1641	18458	1	47	48	16818	1688	18506
1971	11149	0	11149	-	-	-	11149	0	11149
1972	15100	82	15182	-	-	-	15100	82	15182
1973	11858	0	11858	-	-	-	11858	0	11858
1974	14628	74	14702	-	-	-	14628	74	14702
1975	3742	1080	4822	239	0	239	3981	1080	5061
1976	7019	5249	12268	253	34	287	7272	5283	12555
1977	13305	1541	14846	2000	252	2252	15305	1793	17098
1978	14424	57	14481	2000	0	2000	16424	57	16481
1979	11947	889	12836	2424	0	2424	14371	889	15260
1980	2336	7647	9983	3000	539	3539	5336	8186	13522
1981	8932	2850	11782	3693	0	3693	12625	2850	15475
1982	6602	3090	9692	1961	243	2204	8563	3333	11896
1983	742	2576	3318	4263	0	4263	5005	2576	7581
1984	199	1779	1978	-	-	-	199	1779	1978
1985	532	25	557	3	6	9	535	31	566
1986	15	6	21	4490	250	4740	4505	256	4761
1987	7961	3483	11444	-	3300	3300	7961	6783	14744
1988	4493	5170	9663[c]	7000	500	7500	11493	5670	17163
1989	37	4392	4429	-	-	-	37	4392	4429
1990	26	5482	5508	0	784	784	26	6266	6292
1991	0	4867	4867	500	1328	1828	500	6195	6695
1992	0	7750	7750	590	1293	1883	590	9043	9633
1993	0	3520	3520	-	-	-	0	3520	3520
1994	0	8121	8121	0	72	72	0	8193	8193
1995	317	7889	8206	-	-	-	317	7889	8206
1996	5649	778	6427	-	-	-	5649	778	6427
1997	1962	199	2161	-	-	-	1962	199	2161
1998	1707	177	1884	-	-	-	1707	177	1884
1999	608	195	803	-	-	-	608	195	803
2000	6328	6015	12343	-	-	-	6328	6015	12343
2001	2267	725	2992	-	-	-	2267	725	2992
2002	1118	114	1232	-	-	-	1118	114	1232
2003	161	2116	2277	-	-	-	161	2116	2277
2004	8288	1607	9895	-	-	-	8288	1607	9895
2005	4680	1128	5808[d]	-	-	-	4680	1128	5808[d]

[a] For the period 1946–1970 only 5-year averages are given.

[b] For 1955, 1956 and 1957 Soviet catches of harp and hooded seals reported at 3,900, 11,600 and 12,900, respectively (Sov. Rep. 1975). These catches are not included.

[c] Including 1431 pups and one adult caught by a ship which was lost.

[d] Preliminary numbers.

Table 1.4.1.2.2 Summaries of Norwegian sealing regulations for harp seals in the Greenland Sea ("West Ice"), 1985–2005.

	Opening Date	Closing Date	Quotas[1] Total	Pups	Fem.	Males	Allocations Norway	Soviet/Russia
1985	10 April	5 May	(25,000)[2]	(25,000)[2]	0[3]	0[3]	7,000	4,500
1986	22 March	5 May	11,500	11,500	0[3]	0[3]	7,000	4,500
1987	18 March	5 May	25,000	25,000	0[3]	0[3]	20,500	4,500
1988	10 April	5 May	28,000	0[3,4]	0[3,4]	0[3,4]	21,000	7,000
1989	18 March	5 May	16,000	-	0[3]	0[3]	12,000	9,000
1990	10 April	20 May	7,200	0	0[3]	0[3]	5,400	1,800
1991	10 April	31 May	7,200	0	0[3]	0[3]	5,400	1,800
1992-93	10 April	31 May	10,900	0	0[3]	0[3]	8,400	2,500
1994	10 April	31 May	13,100	0	0[3]	0[3]	10,600	2,500
1995	10 April	31 May	13,100	0	0[3]	0[3]	10,600[5]	2,500
1996	10 April	31 May[6]	13,100[7]				10,600	2,500[9]
1997-98	10 April	31 May	13,100[8]				10,600	2,500[9]
1999-00	10 April	31 May	17,500[10]				15,000	2,500[9]
2001-05	10 April	31 May	15,000[10]				15,000	

1 Other regulations include: Prescriptions for date for departure Norwegian port; only one trip per season; licensing; killing methods; and inspection.
2 Basis for allocation of USSR quota.
3 1 year+ seals protected until 9 April; pup quota may be filled by 1 year+ after 10 April.
4 Any age or sex group.
5 Included 750 weaned pups under permit for scientific purposes.
6 Pups allowed to be taken from 26 March to 5 May.
7 Half the quota could be taken as weaned pups, where two pups equalled one 1+ animal.
8 The whole quota could be taken as weaned pups, where two pups equalled one 1+ animal.
9 Russian allocation reverted to Norway.
10 Quota given in 1+ animals, parts of or the whole quota could be taken as weaned pups, where 2 pups equalled one 1+.

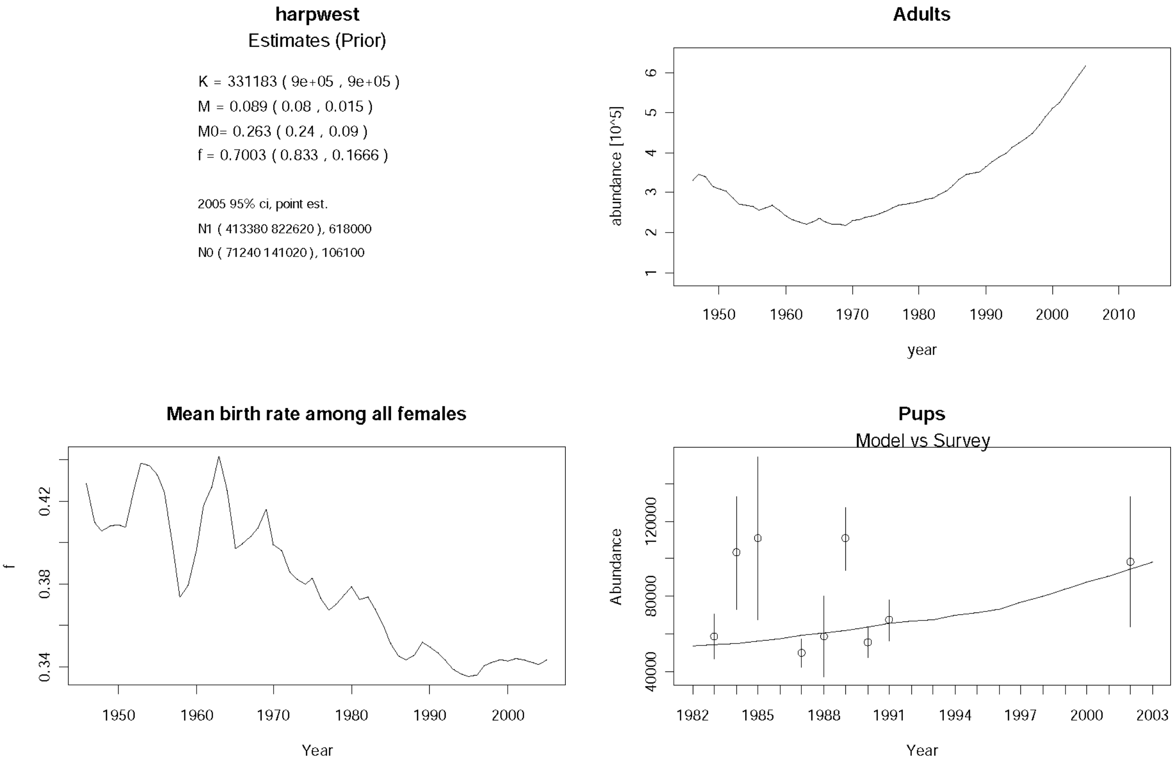


Figure 1.4.1.2.2 Fitted model and model diagnostics for harp seals in the Greenland Sea. Estimated N_{1+} population trajectory (panel labelled Adult). The lower-right panel shows 95% intervals (vertical bars) for available pup production estimates, and modelled pup production (solid line).

White Sea/Barents Sea Harp Seal

State of stock

The adult population is estimated to be at the highest level in the historical time series. Based on Russian surveys in 1998, 2000, 2002 and 2003, the stock in 2005 is estimated to be 2 065 000 (95% C.I. 1 497 000 - 2 633 000) 1+ animals with a pup production of 361 000 (95% C.I. 299 000 - 423 000).

No commercial catches were taken from this stock in 2004. The total removal from this stock in 2004 was, therefore, only 33 1+ animals taken for scientific purposes in the northern Barents Sea. The combined catches for 2005 were 22,474 (including 15,420 pups).

Catch figures are given in Table 1.4.1.2.3.

Management objectives

There are no explicit management objectives for this stock. Sealing regulations for 1979-2005 are given in Table 1.4.1.2.4.

Catch estimation

Based on the request from the Norwegian government, options are given for three different catch scenarios:

- Current catch level (average of the catches in the period 2001 – 2005)
- Maintenance catches (defined as the fixed annual catches that stabilizes the future 1+ population)
- Two times the maintenance catches.

The maintenance catches are defined as the (fixed) annual catches that stabilise the future 1+ population. The catch options are further expanded using different proportions of pups and 1+ animals in the catches.

As a measure of the possible trends in the population when applying fixed annual catches, the ratio between the simulated size of the 1+ population in 2015 and 2005 (D_{1+}) is used.

Option #	Catch level	Proportion of 1+ in catches	Pup catch	1+ catch	D_{1+}		
PRIOR					Lower CI	Point	Upper CI
1	Current	11.5% (current level)	25,945	3,371	***0.91***	***1.35***	***1.78***
2	Maintenance	11.5%	153,878	19,995	***0.57***	***0.98***	***1.39***
3	Maintenance	100%	0	78,198	***0.62***	***1.04***	***1.50***
4	2 X maint.	11.5%	307,756	39,990	***0.12***	***0.53***	***0.93***
5	2 X maint.	100%	0	156,396	***0.24***	***0.67***	***1.10***

Continuing with the current catch level (Options 1) will likely result in an increase in population size. The maintenance catches (Options 2 and 3) are generally higher than estimated previously, but the confidence interval for the depletion statistics (D_{1+}) is wider. The reason is that the current estimate of natural mortality of the 1+ population is lower than the fixed value (0.09) used in the previous assessment. Catches two times maintenance levels will result in the population declining by approximately 50-67% in the next 10 years and the population will ultimately be reduced to zero if this fixed catch level is maintained. It should be noted that "maintenance" is used here to describe a situation where the stock size in 10 years is predicted to be similar to the present.

Elaboration and special comment: Reproductive rates in this stock are lower than those observed in other harp seal stocks. Growth rates have declined and the age of maturity for both males and females has increased since the early 1960s. All these observations may indicate density dependent factors affecting population dynamics of this stock, but this requires further investigations.

There are reports that pup mortality rates may vary substantially in the White Sea region, and that in recent years these rates have been very high. For this reason, the 2005 abundance of White Sea harp seals was estimated under the assumption that the ratio between the natural mortality of pups and adults was 5 instead of 3.

Aeroplane surveys of White Sea harp seal pups were conducted in March 2004 and 2005 using traditional strip transect methodology and multiple sensors. Results obtained in the 2004 surveys were negatively biased due to late and incomplete coverage, whereas the results from the more successful 2005 survey are still being analysed.
Using the model described above, the current status of the White Sea stock of harp seals was assessed.

Pup production estimates (from Russian aerial surveys):

Year	Pup production estimate	c.v. (%)
1998	286 260	7.3
2000	322 474	8.9
2000	339 710	9.5
2002	330 000	10.3
2003	327 000	12.5

For 2000 there are two independent estimates for pup production.

As well as these pup estimates the model includes age at maturity and estimates of natural mortality and natality. Based on these inputs the model estimated the following 2005 abundance of harp seals in the White Sea: 2 065 000 (95% C.I. 1 497 000-2 633 000) 1+ animals with a pup production of 361 000 (95% C.I. 299 000-423 000).

Source of information

Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals, St.John's, Newfoundland, Canada, 30 August - 3 September 2005 (CM 2006/ACFM:6).

Catch data: Table 1.4.1.2.3 summarises the catches of harp seals of the White Sea population after World War II.

Table 1.4.1.2.3 Catches of harp seals in the White Sea/Barents Sea ("East Ice"), 1946–2005[a,b].

	Norwegian catches			Russian catches			Total catches		
Year	Pups	1 year And Older	total	pups	1 year and older	total	Pups	1 year And Older	Total
1946–50			25057	90031	55285	145316			170373
1951–55			19590	59190	65463	124653			144243
1956–60	2278	14093	16371	58824	34605	93429	61102	48698	109800
1961–65	2456	8311	10767	46293	22875	69168	48749	31186	79935
1966–70			12783	21186	410	21596			34379
1971	7028	1596	8624	26666	1002	27668	33694	2598	36292
1972	4229	8209	12438	30635	500	31135	34864	8709	43573
1973	5657	6661	12318	29950	813	30763	35607	7474	43081
1974	2323	5054	7377	29006	500	29506	31329	5554	36883
1975	2255	8692	10947	29000	500	29500	31255	9192	40447
1976	6742	6375	13117	29050	498	29548	35792	6873	42665
1977	3429	2783	6212[c]	34007	1488	35495	37436	4271	41707
1978	1693	3109	4802	30548	994	31542	32341	4103	36344
1979	1326	12205	13531	34000	1000	35000	35326	13205	48531
1980	13894	1308	15202	34500	2000	36500	48394	3308	51702
1981	2304	15161	17465[d]	39700	3866	43566	42004	19027	61031
1982	6090	11366	17456	48504	10000	58504	54594	21366	75960
1983	431	17658	18089	54000	10000	64000	54431	27658	82089
1984	2091	6785	8876	58153	6942	65095	60244	13727	73971
1985	348	18659	19007	52000	9043	61043	52348	27702	80050
1986	12859	6158	19017	53000	8132	61132	65859	14290	80149
1987	12	18988	19000	42400	3397	45797	42412	22385	64797
1988	18	16580	16598	51990	2501[e]	54401	51918	19081	70999
1989	0	9413	9413	30989	2475	33464	30989	11888	42877
1990	0	9522	9522	30500	1957	32457	30500	11479	41979
1991	0	9500	9500	30500	1980	32480	30500	11480	41980
1992	0	5571	5571	28351	2739	31090	28351	8310	36661
1993	0	8758[f]	8758	31000	500	31500	31000	9258	40258
1994	0	9500	9500	30500	2000	32500	30500	11500	42000
1995	260	6582	6842	29144	500	29644	29404	7082	36486
1996	2910	6611	9521	31000	528	31528	33910	7139	41049
1997	15	5004	5019	31319	61	31380	31334	5065	36399
1998	18	814	832	13350	20	13370	13368	834	14202
1999	173	977	1150	34850	0	34850	35023	977	36000
2000	2253	4104	6357	38302	111	38413	40555	4215	44770
2001	330	4870	5200	39111	5	39116	39441	4875	44316
2002	411	1937	2348	34187	0	34187	34598	1937	36535
2003	2343	2955	5298	37936	0	37936	40279	2955	43234
2004	0	33	33	0	0	0	0	33	33
2005	1162	7035	8197	14258	19	14277	15420	7054	22474[g]

[a] For the period 1946–1970 only 5-year averages are given.

[b] Incidental catches of harp seals in fishing gear on Norwegian and Murman coasts are not included (see Table 8.2.3.2).

[c] Approx. 1300 harp seals (unspecified age) caught by one ship lost are not included.

[d] An additional 250–300 animals were shot but lost as they drifted into Soviet territorial waters.

[e] Russian catches of 1+ animals after 1987 selected by scientific sampling protocols.

[f] Included 717 seals caught to the south of Spitsbergen, east of 14^{o} E, by one ship which mainly operated in the Greenland Sea.

[g] Preliminary.

Table 1.4.1.2.4 Summary of sealing regulations for the White Sea/Barents Sea ("East Ice"), 1979–2005.[1]

Season	Opening dates Soviet/ Russian	Opening dates Norwegian sealers	Closing date	Quotas – Allocations Total	Quotas – Allocations Soviet/ Russia	Quotas – Allocations Norway
Harp seals[2]						
1979–80	1 March	23 March	30 April[3]	50,000[4]	34,000	16,000
1981	-	-	-	60,000	42,500	17,500
1982	-	-	-	75,000	57,500	17,500
1983	-	-	-	82,000	64,000	18,000
1984	-	-	-	80,000	62,000	18,000
1985-86	-	-	-	80,000	61,000	19,000
1987	-	-	20 April[3]	80,000	61,000	19,000
1988	-	-	-	70,000	53,400	16,600
1989–94	-	-	-	40,000	30,500	9,500
1995	-	-	-	40,000	31,250	8,750[5]
1996	-	-	-	40,000	30,500	9,500
1997-98	-	-	-	40,000	35,000	5,000
1999	-	-	-	21,400[6]	16,400	5,000
2000	27 Febr	-	-	27,700[6]	22,700	5,000
2001-02	-	-	-	53,000[6]	48,000	5,000
2003	-	-	-	53,000[6]	43,000	10,000
2004-05	-	-	-	45,100[6]	35,100	10,000

[1] Quotas and other regulations prior to 1979 are reviewed by Benjaminsen, 1979.
[2] Hooded, bearded and ringed seals protected from catches by ships.
[3] The closing date may be postponed until 10 May if necessitated by weather or ice conditions.
[4] Breeding females protected (all years).
[5] Included 750 weaned pups under permit for scientific purposes.
[6] Quotas given in 1+ animals, parts of or the whole quata could be taken as pups, where 2,5 pups equalled one 1+ animal.

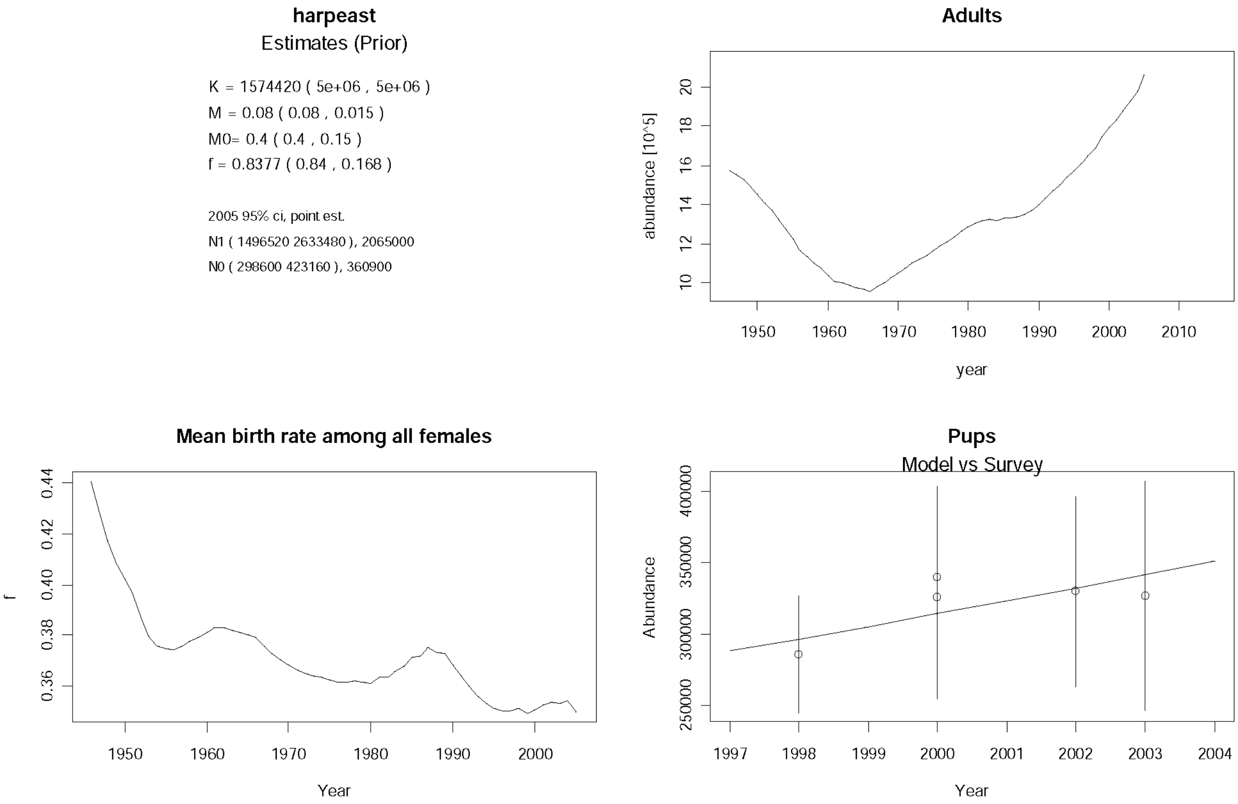


Figure 1.4.1.2.3 Fitted model and model diagnostics for harp seals in the Barents Sea / White Sea. Estimated N_{1+} population trajectory (panel labelled Adult). The lower-right panel shows 95% intervals (vertical bars) for available pup production estimates, and modelled pup production (solid line)

Hooded Seals

Greenland Sea Hooded Seal

State of stock/exploitation

There is not sufficient data to assess the current stock status in an historical perspective. Preliminary results from a pup survey conducted in 2005 suggest that pup production in 2005 may be lower than observed in the previous survey (1997). Based on a Norwegian aerial survey in 1997, the stock in 2003 was estimated to be 120 000 (95% C.I. 65 000-175 000) 1+ animals with a pup production of 29 000 (95% C.I. 17 000-41 000).

Total catches (all taken by Norway as Russian sealers did not operate in the Greenland Sea in the period) were 4,881 (including 4,217 pups) in 2004 and 3,752 (3,633 pups) in 2005. This was 87% and 67% of the identified maintenance yields, respectively. The quota was implemented such that parts of, or the whole quota, could be taken as weaned pups assuming 1.5 pups equalled one 1+ animal.

Between 1990 and 2000 less than 30% of the quota was taken each year. Catch figures are given in Table 1.4.1.2.5.

Management objectives

There are no explicit management objectives for this stock. Sealing regulations for 1979-2005 are given in Table 1.4.1.2.6.

Relevant factors to be considered in management

The 1997 estimate of pup production is the only estimate available for the Greenland Sea hooded seal stock. The single estimate of pup production is over 8 years old and there are no estimates of reproductive rates for this stock.

A new aerial and vessel survey of hooded seal pup production in the Greenland Sea pack-ice was conducted in March 2005. The results will be used to estimate the 2005 hooded seal pup production, but will not be available until 2006. Preliminary results suggest, however, that pup production in 2005 may be lower than observed in the previous survey (1997).

Catch estimation

ICES was requested to give options (with indication of medium term consequences) for three different catch scenarios:

- Current catch level (average of the catches in the period 2001 – 2005)
- Maintenance catches (defined as the fixed annual catches that stabilizes the future 1+ population)
- Two times the maintenance catches.

Due to lack of data it is not possible to provide these options for this stock.

Given the poor data available on this stock and indications that pup production may be reduced management of this stock should be extremely cautious.

Source of information

Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals, St.John's, Newfoundland, Canada, 30 August - 3 September 2005 (CM 2006/ACFM:6).

Catch data: Table 1.4.1.2.5 summarizes the catches of hooded seals in the Greenland Sea after World War II.

Table 1.4.1.2.5 Catches of **hooded seals** in the Greenland Sea ("West Ice"), 1946–2005[a], incl. catches for scientific purposes.

Year	Norwegian catches			Russian catches			Total catches		
	Pups	1 year and older	Total	Pups	1 year And Older	total	Pups	1 year and older	Total
1946–50	31152	10257	41409	-	-	-	31152	10257	41409
1951–55	37207	17222	54429	-	-	-[b]	37207	17222	54429
1956–60	26738	9601	36339	825	1063	1888[b]	27563	10664	38227
1961–65	27793	14074	41867	2143	2794	4937	29936	16868	46804
1966–70	21495	9769	31264	160	62	222	21655	9831	31486
1971	19572	10678	30250	-	-	-	19572	10678	30250
1972	16052	4164	20216	-	-	-	16052	4164	20216
1973	22455	3994	26449	-	-	-	22455	3994	26449
1974	16595	9800	26395	-	-	-	16595	9800	26395
1975	18273	7683	25956	632	607	1239	18905	8290	27195
1976	4632	2271	6903	199	194	393	4831	2465	7296
1977	11626	3744	15370	2572	891	3463	14198	4635	18833
1978	13899	2144	16043	2457	536	2993	16356	2680	19036
1979	16147	4115	20262	2064	1219	3283	18211	5334	23545
1980	8375	1393	9768	1066	399	1465	9441	1792	11233
1981	10569	1169	11738	167	169	336	10736	1338	12074
1982	11069	2382	13451	1524	862	2386	12593	3244	15837
1983	0	86	86	419	107	526	419	193	612
1984	99	483	582	-	-	-	99	483	582
1985	254	84	338	1632	149	1781	1886	233	2119
1986	2738	161	2899	1072	799	1871	3810	960	4770
1987	6221	1573	7794	2890	953	3843	9111	2526	11637
1988	4873	1276	6149[c]	2162	876	3038	7035	2152	9187
1989	34	147	181	-	-	-	34	147	181
1990	26	397	423	0	813	813	26	1210	1236
1991	0	352	352	458	1732	2190	458	2084	2542
1992	0	755	755	500	7538	8038	500	8293	8793
1993	0	384	384	-	-	-	0	384	384
1994	0	492	492	23	4229	4252	23	4721	4744
1995	368	565	933	-	-	-	368	565	933
1996	575	236	811	-	-	-	575	236	811
1997	2765	169	2934	-	-	-	2765	169	2934
1998	5597	754	6351	-	-	-	5597	754	6351
1999	3525	921	4446	-	-	-	3525	921	4446
2000	1346	590	1936	-	-	-	1346	590	1936
2001	3129	691	3820	-	-	-	3129	691	3820
2002	6456	735	7191	-	-	-	6456	735	7191
2003	5206	89	5295	-	-	-	5206	89	5295
2004	4217	664	4881	-	-	-	4217	664	4881
2005	3633	119	3752[d]	-	-	-	3633	119	3752[d]

[a] For the period 1946–1970 only 5-year averages are given.

[b] For 1955, 1956 and 1957 Soviet catches of harp and hooded seals reported at 3,900, 11,600 and 12,900, respectively (Sov. Rep. 1975). These catches are not included.

[c] Including 1048 pups and 435 adults caught by one ship which was lost.

[d] Preliminary.

Table 1.4.1.2.6 Norwegian sealing regulations for hooded seals in the Greenland Sea ("West Ice") in 1985–2005.

	Opening	Closing	Quotas [1]				Allocations	
	Date	Date	Total	Pups	Fem.	Males	Norway	Soviet/Russia
1985	22 March	5 May	(20 000) [2]	(20 000) [2]	0 [3]	Unlim.	8 000 [4]	3 300
1986	18 March	5 May	9 300	9 300	0 [3]	Unlim.	6 000	3 300
1987	18 March	5 May	20 000	20 000	0 [3]	Unlim.	16 700	3 300
1988	18 March	5 May	(20 000) [2]	(20 000) [2]	0 [3]	Unlim.	16 700	5 000
1989	18 March	5 May	30 000		0 [3]	Incl.	23 100	6 900
1990	26 March	30 June	27 500	0	0	Incl.	19 500	8 000
1991	26 March	30 June	9 000	0	0	Incl.	1 000	8 000
1992-94	26 March	30 June	9 000	0	0	Incl.	1 700	7 300
1995	26 March	10 July	9 000	0	0	Incl.	1 700 [5]	7 300
1996	22 March	10 July	9 000 [6]				1 700	7 300
1997	26 March	10 July	9 000 [7]				6 200	2 800 [9]
1998	22 March	10 July	5 000 [8]				2 200	2 800 [9]
1999-00	22 March	10 July	11 200 [10]				8 400	2 800 [9]
2001-03	22 March	10 July	10 300 [10]				10 300	
2004-05	22 March	10 July	5 600 [10]				5 600	

1 Other regulations include: Prescriptions for date for departure Norwegian port; only one trip per season; licensing; killing methods; and inspection.
2 Basis for allocation of USSR quota.
3 Breeding females protected ; two pups deducted from quota for each female taken for safety reasons.
4 Adult males only.
5 Included 750 weaned pups under permit for scientific purposes.
6 Pups allowed to be taken from 26 March to 5 May.
7 Half the quota could be taken as weaned pups, where two pups equaled one 1+ animal.
8 The whole quota could be taken as weaned pups, where two pups equaled one 1+ animal.
9 Russian allocation reverted to Norway.
10 Quota given in 1+ animals, parts of or the whole quota could be taken as weaned pups, where 1,5 pups equaled one 1+ animal.

1.5 THE BARENTS SEA AND THE NORWEGIAN SEA

1.5.1 Northeast Arctic cod

State of the stock

Spawning biomass in relation to precautionary limits	Fishing mortality in relation to precautionary limits/management plan	Fishing mortality in relation to highest yield	Fishing mortality in relation to agreed target	Comment
Full reproductive capacity	F in 2004 is higher than intended under the management plan	Overexploited	Not applicable	Lack of enforcement of the management plan has resulted in exploitation above the level intended in the management plan

Based on the most recent estimates of SSB, ICES classifies the stock as having full reproduction capacity. Based on the most recent estimates of fishing mortality, the stock is exploited with a fishing mortality higher than that intended under the management plan. The SSB has been above $\mathbf{B}_{pa}$ since 2002, after a period (1998–2001) when it was below $\mathbf{B}_{pa}$. Fishing mortality in the period 1997–2000 was among the highest observed and well above $\mathbf{F}_{pa}$, even above $\mathbf{F}_{lim}$. Surveys indicate that the 2001 year class is poor, while the 2002 and 2004 year classes are around average and the 2003 year class is somewhat below average.

Management objectives

At the 33rd meeting of the Joint Russian-Norwegian Fisheries Commission (JRNC) in November 2004, the following decision was made:

"The Parties agreed that the management strategies for cod and haddock should take into account the following:

conditions for high long-term yield from the stocks
achievement of year-to-year stability in TACs
full utilization of all available information on stock development

On this basis, the Parties determined the following decision rules for setting the annual fishing quota (TAC) for Northeast Arctic cod (NEA cod):

estimate the average TAC level for the coming 3 years based on F_{pa}. TAC for the next year will be set to this level as a starting value for the 3-year period.

the year after, the TAC calculation for the next 3 years is repeated based on the updated information about the stock development, however the TAC should not be changed by more than +/- 10% compared with the previous year's TAC.

if the spawning stock falls below B_{pa}, the procedure for establishing TAC should be based on a fishing mortality that is linearly reduced from F_{pa} at B_{pa}, to F= 0 at SSB equal to zero. At SSB-levels below B_{pa} in any of the operational years (current year, a year before and 3 years of prediction) there should be no limitations on the year-to-year variations in TAC.

The Parties agreed on similar decision rules for haddock, based on F_{pa} and B_{pa} for haddock, and with a fluctuation in TAC from year to year of no more than +/-25% (due to larger stock fluctuations).[1]"

ICES has evaluated these decision rules for cod and a management plan based upon them is in accordance with the precautionary approach (see Section 1.4.3.1) when the SSB is above $\mathbf{B}_{lim}$.

[1] This quotation is taken from point 5.1, in the Protocol of the 33rd session of The Joint Norwegian-Russian Fishery Commission and translated from Norwegian to English. For an accurate interpretation, please consult the text in the official languages of the Commission (Norwegian and Russian).

Reference points

	ICES considers that:	ICES proposed that:
Precautionary Approach reference points	$\mathbf{B}_{lim}$ is 220 000 t	$\mathbf{B}_{pa}$ be set at 460 000 t
	$\mathbf{F}_{lim}$ is 0.74	$\mathbf{F}_{pa}$ be set at 0.40

Yield and spawning biomass per Recruit
F-reference points

	Fish Mort Ages 5-10	Yield/R	SSB/R
Average Current	0.57	1.24	1.67
$\mathbf{F}_{max}$	0.25	1.35	4.43
$\mathbf{F}_{0.1}$	0.12	1.23	8.17

In these calculations, weight-at-age and maturity-at-age are averaged for the years 2003–2005 and the exploitation pattern for the years 2002–2004. Most of the points in the stock/recruitment plot are from years with later maturation and higher selection on young fish and $\mathbf{F}_{med}$ is therefore misleading and not included above.

Technical basis:

$\mathbf{B}_{lim}$: change point regression	$\mathbf{B}_{pa}$: the lowest SSB estimate having >90% prob. of being above $\mathbf{B}_{lim}$
$\mathbf{F}_{lim}$: F corresponding to an equilibrium stock = $\mathbf{B}_{lim}$	$\mathbf{F}_{pa}$: the highest F estimate having >90% prob. of being below $\mathbf{F}_{lim}$

Single stock exploitation boundaries

Exploitation boundaries in relation to existing management plans

The management plan implies a TAC of 471 000 t in 2006. This catch projection includes catches that, in earlier years, were non-reported. If enforcement continues to be ineffective the TAC should be reduced accordingly.

Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential and considering ecosystem effects

The current fishing mortality, estimated at 0.57, is well above fishing mortalities that would lead to high long-term yields ($\mathbf{F}_{0.1}$=0.12 and $\mathbf{F}_{max}$=0.25). This indicates that long-term yield will increase at fishing mortalities well below the historic values. Fishing at such a lower mortality would lead to higher SSB and therefore lower the risk of observing the stock outside precautionary limits.

Exploitation boundaries in relation to precautionary limits

The agreed management plan has been evaluated to be consistent with the precautionary approach when the SSB is above $\mathbf{B}_{lim}$. However, the management plan is not fully enforced, resulting in non-reported landings and exploitation above what was intended in the management plan.

Short-term implications

Outlook for 2006:

Basis: F(2005) = $\mathbf{F}_{2002\text{-}2004}$ = 0.57; SSB(2006) = 661; catch (2005) = 596.

Rationale	TAC (2006)[1]	Basis	F (2006)	SSB (2007)	%SSB change [1)]	% TAC change [2)]
Zero catch	0	F=0	0	1076	63	-
Status quo	566	$\mathbf{F}_{sq}$	0.57	624	- 6	17
High long-term yield	290	$\mathbf{F}_{max}$	0.25	840	27	-40
Agreed management plan	471	TAC(man. plan)	0.45	697	6	-3
Precautionary limits	426	$\mathbf{F}_{pa}$	0.40	732	11	-12

Weights in '000 t. Shaded scenarios are not considered consistent with the Precautionary Approach.
1) SSB 2007 relative to SSB 2006.
2) TAC 2006 relative to TAC 2005.
It is assumed that the TAC will be implemented and that the landings in 2006 therefore correspond to the TAC.
Because ICES considers the management plan to be consistent with the Precautionary Approach when SSB is above $\mathbf{B}_{pa}$ the scenario with F=0.45 is not shaded.

Management considerations

Concerns about under-reporting of catches in recent years continue. Estimates for 2002–2004 indicate about 20% in addition to official catches due to unreported landings. Unreported landings will reduce the effect of management measures and will undermine the intended objectives of the harvest control rule. It is important that management agencies ensure that all catches are counted against the TAC.

Management plan evaluations

The decision rules proposed by the Commission in 2004 (JRNC-2004-rule) were evaluated using simulations that took account of variations in biological properties such as recruitment, weight, and maturity, as well as uncertainty in assessments. The results of that evaluation are presented in Section 1.4.3.1. A management plan based on these rules would be in agreement with the precautionary approach, provided that the SSB is above $\mathbf{B}_{lim}$, and that the assessment uncertainty, assessment error and implementation error are not greater than those calculated from historic data and used in the evaluation.

Factors affecting the fisheries and the stock

Regulations and their effects

TAC regulations are in place and there is some non-compliance resulting in significant unreported catches. Estimates of non-reported landings were 90 000–115 000 t for 2002–2004. The main mechanism used for avoiding quota control seems to be trans-shipping of fish from the Barents Sea.

Discarding of cod, haddock, and saithe is thought to be significant in some periods although discarding is illegal in Norway and Russia. Data on discarding are scarce, but attempts to obtain better quantification continue.

In addition to quotas, the fisheries are regulated by mesh size limitations, a minimum catching size, a maximum bycatch of undersized fish, maximum bycatch of non-target species, closure of areas with high densities of juveniles, and other seasonal and area restrictions. Since January 1997, sorting grids have been mandatory for the trawl fisheries in most of the Barents Sea and Svalbard area.

The fisheries are controlled by inspections of the trawler fleet at sea, by a requirement of reporting to catch control points when entering and leaving the EEZs, VMS satellite tracking for some fleets, and by inspections of all fishing vessels when landing the fish. Keeping a detailed fishing logbook onboard is mandatory for most vessels, and large parts of the fleet report to the authorities on a daily basis.

The effects of these regulations have not been evaluated.

Changes in fishing technology and fishing patterns

Since January 1997, sorting grids have been mandatory for the trawl fisheries in most of the Barents Sea and Svalbard area.

The environment

The Northeast Arctic cod is characterized by significant year-to-year variations in the growth rate. In different years the mean weight of fish at the same age may differ by a factor of 2 or 3. Among the factors influencing cod growth are water temperature, food supply, and cod population abundance.

Northeast Arctic cod is an important predator on other species in the ecosystem, notably capelin. The management of Arctic cod will therefore have implications on the dynamics of these stocks.

Changes in growth, maturity, and cannibalism are linked to the abundance of capelin. Capelin abundance has decreased since 2000 and is expected to be low in 2006. The variations observed over the last 20 years indicate some delay between capelin variation and variation in growth, maturity, and cannibalism for cod. In general, the mean weight of cod is expected to decrease slightly from 2005 to 2007. This has been considered in the assessment.

When capelin is abundant, the total consumption of cod by harp seals is estimated to be about 100 000 tonnes. When capelin abundance is low in the Barents Sea (as it was in 1993–1996 and it is now), the consumption of cod by harp seals has been estimated to increase to 300 000 tonnes in 1993–1996. So far, this has not been considered in the assessment.

Scientific basis

Data and methods

Analytical assessment is based on catch-at-age data, using one commercial CPUE series and three survey series. The total effect of the discarding is still unclear and requires more work before it can be included in the assessments. Estimates of cannibalism are included in the natural mortality. The yield forecast includes an account of expected changes in growth.

Uncertainties in assessment and forecast

Various sources of information have been used to quantify the amount of cod landed (around 20% unreported landings), e.g., observations/inspections by the Norwegian coast guard (both trans-shipping vessels and fishing vessels), satellite tracking (VMS) of trans-shipping vessels and fishing vessels, detailed information on landings in Norway and supplementary and supporting information on landings in Russia, EU and Canada. Also, direct and indirect information from trans-shipping companies and information on quotas and catches by several fishing companies have been available. This has been considered in the assessment.

Discarding is happening in age groups 3 and 4, and the evidence available suggests that the assessment of SSB and fishing mortality is not affected by the uncertainty around them.

Environmental conditions

The population dynamic parameters vary with the environment as described above. Recent changes in the environment have been taken into account by using the recent three-year average for maturation and cannibalism, and by prediction of weight-at-age.

Comparison with previous assessment and advice

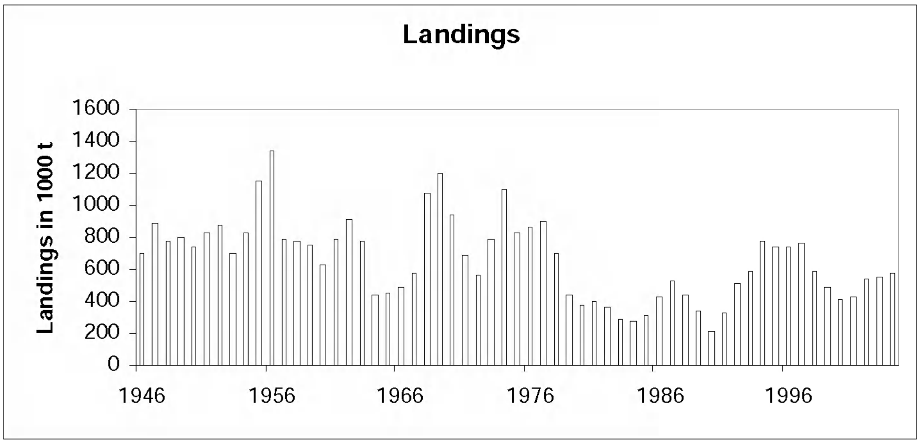
The current assessment estimates the total biomass in 2004 to be 9% lower and the SSB 16% lower than in the previous assessment, while the fishing mortality for 2003 is now estimated to be 9% higher.

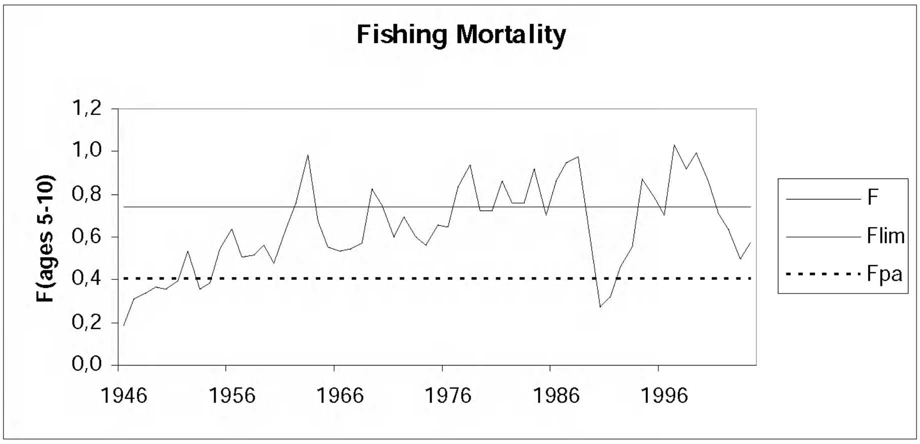
Source of information

Report of the Arctic Fisheries Working Group, 19–28 April 2005 (ICES CM 2005/ACFM:20).

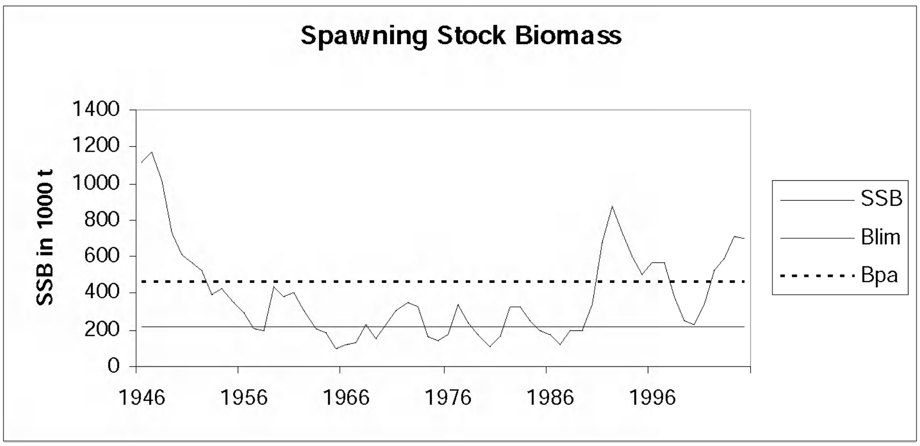
Year	ICES Advice	Single-stock exploitation boundaries	Predicted catch corresp. to advice	Predicted catch corresp. to single-stock exploitation boundaries	Agreed TAC	Official landings	ACFM landings	Unreported landings
1987	Gradual reduction in F		595		560	552	523	
1988	F = 0.51; TAC (Advice November 87) (Revised advice May 88)		530 (320-360)		590 451	459	435	
1989	Large reduction in F		335		300	348	332	
1990	F at $\mathbf{F}_{low}$; TAC		172		160	210	212	25
1991	F at $\mathbf{F}_{low}$; TAC		215		215	294	319	50
1992	Within safe biological limits		250[2]		356	421	513	130
1993	Healthy stock		256[2]		500	575	582	50
1994	No long-term gains in increased F		649[2]		700	795	771	25
1995	No long-term gains in increased F		681[2]		700	763	740	
1996	No long-term gains in increased F		746[2]		700	759	732	
1997	Well below $\mathbf{F}_{med}$		< 993		850	792	762	
1998	F less than $\mathbf{F}_{med}$		514		654	615	593	
1999	Reduce F to below $\mathbf{F}_{pa}$		360		480	506	485	
2000	Increase B above $\mathbf{B}_{pa}$ in 2001		110		390		415	
2001	High prob. of SSB>$\mathbf{B}_{pa}$ in 2003		263		395		426	
2002	Reduce F to well below 0.25		181		395		535	90
2003	Reduce F to below $\mathbf{F}_{pa}$		305		395		551	115
2004	Reduce F to below $\mathbf{F}_{pa}$		398		486		579	90
2005	Take into account coastal cod and redfish bycatches	Apply catch rule	485		485			
2006	Take into account coastal cod and redfish bycatches	Apply amended catch rule	471					

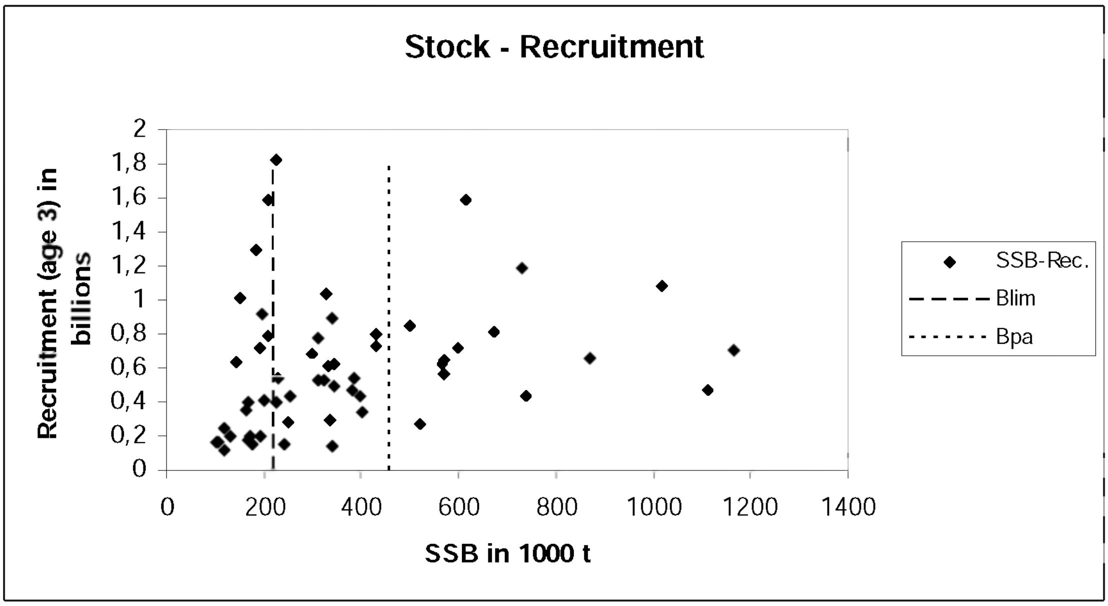
Weights in '000 t.

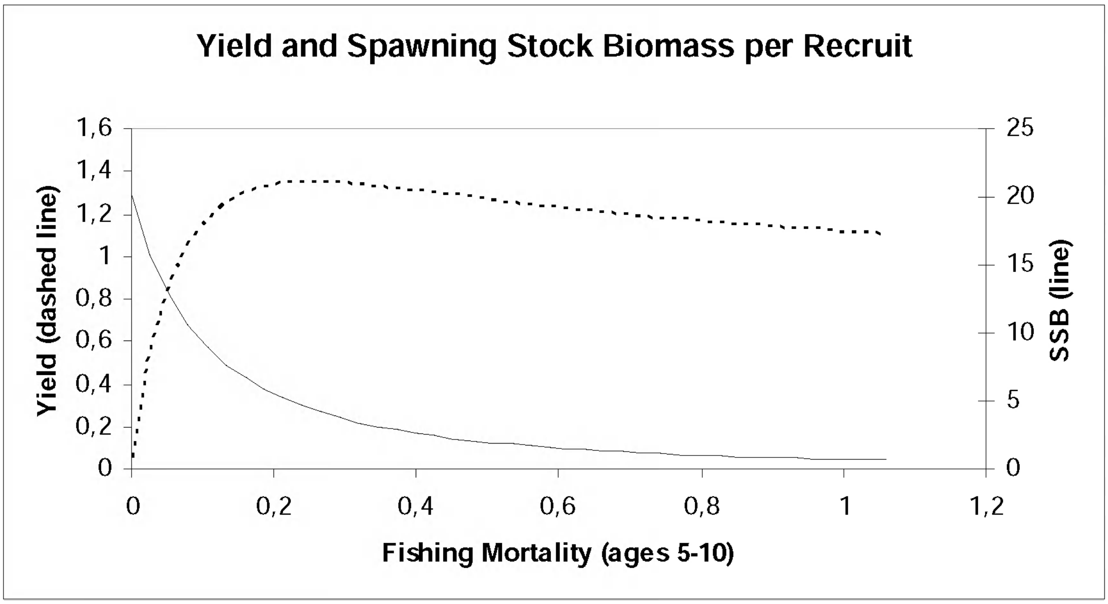

Landings
Landings in 1000 t
1600
1400
1200
1000
800
600
400
200
0
1946
1956
1966
1976
1986
1996


Fishing Mortality
F(ages 5-10)
1,2
1,0
0,8
0,6
0,4
0,2
0,0
1946
1956
1966
1976
1986
1996
F
Flim
Fpa


Recruitment (age 3)
Recruitment in billions
2
1,5
1
0,5
0
1946
1956
1966
1976
1986
1996


Spawning Stock Biomass
SSB in 1000 t
1400
1200
1000
800
600
400
200
0
1946
1956
1966
1976
1986
1996
SSB
Blim
Bpa


Stock - Recruitment
Recruitment (age 3) in billions
SSB in 1000 t
0
0,2
0,4
0,6
0,8
1
1,2
1,4
1,6
1,8
2
0
200
400
600
800
1000
1200
1400
SSB-Rec.
Blim
Bpa


Yield and Spawning Stock Biomass per Recruit
Yield (dashed line)
SSB (line)
Fishing Mortality (ages 5-10)
0
0,2
0,4
0,6
0,8
1
1,2
1,4
1,6
0
5
10
15
20
25
0
0,2
0,4
0,6
0,8
1
1,2

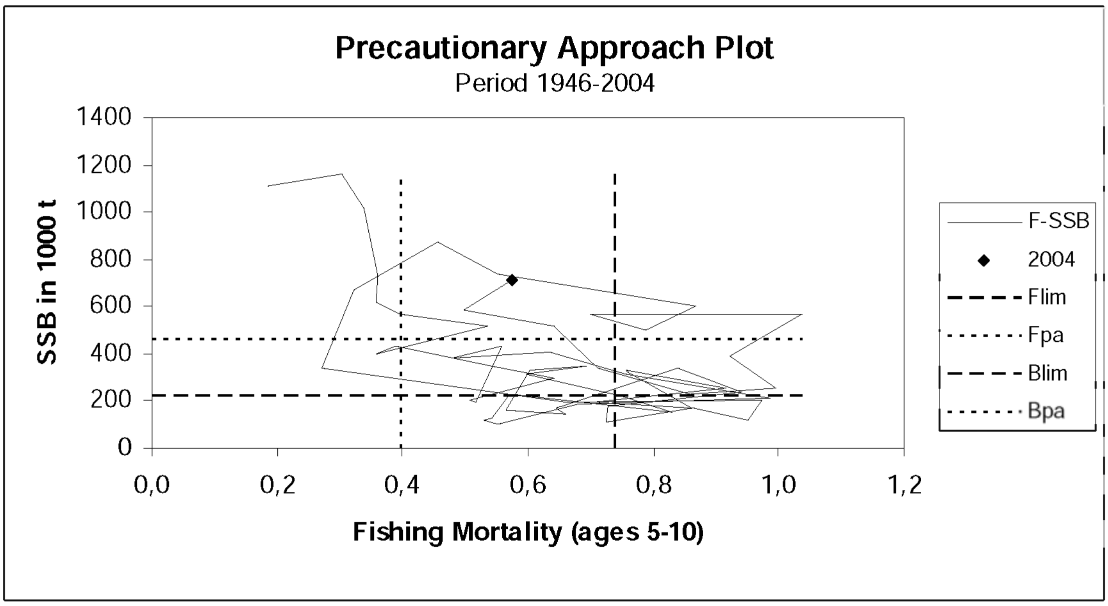

Precautionary Approach Plot
Period 1946-2004
SSB in 1000 t
Fishing Mortality (ages 5-10)
0
200
400
600
800
1000
1200
1400
0,0
0,2
0,4
0,6
0,8
1,0
1,2
F-SSB
2004
Flim
Fpa
Blim
Bpa

Table 1.5.1.1 Northeast Arctic COD. Total catch (t) by fishing areas and unreported catch (Data provided by Working Group members.)

Year	Sub-area I	Division IIa	Division IIb	Unreported catches	Total catch
1961	409 694	153 019	220 508		783 221
1962	548 621	139 848	220 797		909 266
1963	547 469	117 100	111 768		776 337
1964	206 883	104 698	126 114		437 695
1965	241 489	100 011	103 430		444 983
1966	292 253	134 805	56 653		483 711
1967	322 798	128 747	121 060		572 605
1968	642 452	162 472	269 254		1 074 084
1969	679 373	255 599	262 254		1 197 226
1970	603 855	243 835	85 556		933 246
1971	312 505	319 623	56 920		689 048
1972	197 015	335 257	32 982		565 254
1973	492 716	211 762	88 207		792 685
1974	723 489	124 214	254 730		1 102 433
1975	561 701	120 276	147 400		829 377
1976	526 685	237 245	103 533		867 463
1977	538 231	257 073	109 997		905 301
1978	418 265	263 157	17 293		698 715
1979	195 166	235 449	9 923		440 538
1980	168 671	199 313	12 450		380 434
1981	137 033	245 167	16 837		399 037
1982	96 576	236 125	31 029		363 730
1983	64 803	200 279	24 910		289 992
1984	54 317	197 573	25 761		277 651
1985	112 605	173 559	21 756		307 920
1986	157 631	202 688	69 794		430 113
1987	146 106	245 387	131 578		523 071
1988	166 649	209 930	58 360		434 939
1989	164 512	149 360	18 609		332 481
1990	62 272	99 465	25 263	25 000	212 000
1991	70 970	156 966	41 222	50 000	319 158
1992	124 219	172 532	86 483	130 000	513 234
1993	195 771	269 383	66 457	50 000	581 611
1994	353 425	306 417	86 244	25 000	771 086
1995	251 448	317 585	170 966		739 999
1996	278 364	297 237	156 627		732 228
1997	273 376	326 689	162 338		762 403
1998	250 815	257 398	84 411		592 624
1999	159 021	216 898	108 991		484 910
2000	137 197	204 167	73 506		414 870
2001	142 628	185 890	97 953		426 471
2002	184 789	189 013	71 242	90 000	535 045
2003	163 109	222 052	51 829	115 000	551 990
2004 [1]	177 888	219 261	92 296	90 000	579 445

[1] Provisional figures.

Table 1.5.1.2 Northeast Arctic COD. Nominal catch (t) by countries (Subarea I and Divisions IIa and IIb combined). (Data provided by Working Group members)

Year	Faroe Islands	France	German Dem.Rep.	Fed.Rep. Germany	Norway	Poland	United Kingdom	Russia[2]		Others	Total all countries
1961	3 934	13 755	3 921	8 129	268 377	-	158 113	325 780		1 212	783 221
1962	3 109	20 482	1 532	6 503	225 615	-	175 020	476 760		245	909 266
1963	-	18 318	129	4 223	205 056	108	129 779	417 964		-	775 577
1964	-	8 634	297	3 202	149 878	-	94 549	180 550		585	437 695
1965	-	526	91	3 670	197 085	-	89 962	152 780		816	444 930
1966	-	2 967	228	4 284	203 792	-	103 012	169 300		121	483 704
1967	-	664	45	3 632	218 910	-	87 008	262 340		6	572 605
1968	-	-	225	1 073	255 611	-	140 387	676 758		-	1 074 084
1969	29 374	-	5 907	5 543	305 241	7 856	231 066	612 215		133	1 197 226
1970	26 265	44 245	12 413	9 451	377 606	5 153	181 481	276 632		-	933 246
1971	5 877	34 772	4 998	9 726	407 044	1 512	80 102	144 802		215	689 048
1972	1 393	8 915	1 300	3 405	394 181	892	58 382	96 653		166	565 287
1973	1 916	17 028	4 684	16 751	285 184	843	78 808	387 196		276	792 686
1974	5 717	46 028	4 860	78 507	287 276	9 898	90 894	540 801		38 453	1 102 434
1975	11 309	28 734	9 981	30 037	277 099	7 435	101 843	343 580		19 368	829 377
1976	11 511	20 941	8 946	24 369	344 502	6 986	89 061	343 057		18 090	867 463
1977	9 167	15 414	3 463	12 763	388 982	1 084	86 781	369 876		17 771	905 301
1978	9 092	9 394	3 029	5 434	363 088	566	35 449	267 138		5 525	698 715
1979	6 320	3 046	547	2 513	294 821	15	17 991	105 846		9 439	440 538
1980	9 981	1 705	233	1 921	232 242	3	10 366	115 194		8 789	380 434
						Spain					
1981	12 825	3 106	298	2 228	277 818	14 500	5 262	83 000		-	399 037
1982	11 998	761	302	1 717	287 525	14 515	6 601	40 311		-	363 730
1983	11 106	126	473	1 243	234 000	14 229	5 840	22 975		-	289 992
1984	10 674	11	686	1 010	230 743	8 608	3 663	22 256		-	277 651
1985	13 418	23	1 019	4 395	211 065	7 846	3 335	62 489		4 330	307 920
1986	18 667	591	1 543	10 092	232 096	5 497	7 581	150 541		3 505	430 113
1987	15 036	1	986	7 035	268 004	16 223	10 957	202 314		2 515	523 071
1988	15 329	2 551	605	2 803	223 412	10 905	8 107	169 365		1 862	434 939
1989	15 625	3 231	326	3 291	158 684	7 802	7 056	134 593		1 273	332 481
1990	9 584	592	169	1 437	88 737	7 950	3 412	74 609		510	187 000
1991	8 981	975	**Greenland**	2 613	126 226	3 677	3 981	119 427 [3]		3 278	269 158
1992	11 663	2	3 337	3 911	168 460	6 217	6 120	182 315	**Iceland**	1 209	383 234
1993	17 435	3 572	5 389	5 887	221 051	8 800	11 336	244 860	9 374	3 907	531 611
1994	22 826	1 962	6 882	8 283	318 395	14 929	15 579	291 925	36 737	28 568	746 086
1995	22 262	4 912	7 462	7 428	319 987	15 505	16 329	296 158	34 214	15 742	739 999
1996	17 758	5 352	6 529	8 326	319 158	15 871	16 061	305 317	23 005	14 851	732 228
1997	20 076	5 353	6 426	6 680	357 825	17 130	18 066	313 344	4 200	13 303	762 403
1998	14 290	1 197	6 388	3 841	284 647	14 212	14 294	244 115	1 423	8 217	592 624
1999	13 700	2 137	4 093	3 019	223 390	8 994	11 315	210 379	1 985	5 898	484 910
2000	13 350	2 621	5 787	3 513	192 860	8 695	9 165	166 202	7 562	5 115	414 870
2001	12 500	2 681	5 727	4 524	188 431	9 196	8 698	183 572	5 917	5 225	426 471
2002	15 693	2 934	6 419	4 517	202 559	8 414	8 977	184 072	5 975	5 484	445 045
2003	19 427	2 921	7 026	4 732	191 977	7 924	8 711	182 160	5 963	6 149	436 990
2004 [1]	19 226	3 621	8 196	6 187	212 117	11 285	14 004	201 525	7 201	6 082	489 445

[1] Provisional figures.

[2] USSR prior to 1991.

[3] Includes Baltic countries.

Table 1.5.1.3 Northeast Arctic cod.

Year	Recruitment Age 3 thousands	SSB tonnes	Landings tonnes	Mean F Ages 5-10
1946	728139	1112776	706000	.1857
1947	425311	1165059	882017	.3047
1948	442592	1019114	774295	.3398
1949	468348	729879	800122	.3619
1950	704908	615339	731982	.3566
1951	1083753	568705	827180	.3966
1952	1193111	520599	876795	.5348
1953	1590377	396417	695546	.3572
1954	641584	429694	826021	.3879
1955	272778	346919	1147841	.5437
1956	439602	299823	1343068	.6401
1957	804781	207840	792557	.5089
1958	496824	195377	769313	.5169
1959	683690	432489	744607	.5596
1960	789653	383479	622042	.4789
1961	916842	404228	783221	.6348
1962	728338	311678	909266	.7576
1963	472064	208207	776337	.9866
1964	338678	186570	437695	.6789
1965	776941	102315	444930	.5533
1966	1582560	120722	483711	.5302
1967	1295416	129784	572605	.5439
1968	164955	227215	1074084	.5704
1969	112039	151870	1197226	.8292
1970	197105	224482	933246	.7493
1971	404774	311662	689048	.5956
1972	1015319	346511	565254	.6928
1973	1818949	332913	792685	.6020
1974	523916	164491	1102433	.5633
1975	621616	142028	829377	.6595
1976	613942	171238	867463	.6457
1977	348054	341385	905301	.8379
1978	638490	241536	698715	.9406
1979	198490	174699	440538	.7264
1980	137735	108253	380434	.7241
1981	150868	166926	399038	.8632
1982	151830	326132	363730	.7583
1983	166828	327180	289992	.7560
1984	397819	251086	277651	.9161
1985	523638	193474	307920	.7038
1986	1036924	170270	430113	.8649
1987	286228	118329	523071	.9510
1988	204599	202171	434939	.9745
1989	172779	194362	332481	.6605
1990	242750	340196	212000	.2712
1991	411793	674435	319158	.3212
1992	721139	869997	513234	.4554
1993	896056	738043	581611	.5533
1994	810607	601464	771086	.8683
1995	659633	499779	739999	.7892
1996	439076	570123	732228	.6993
1997	719501	564839	762403	1.0358
1998	843002	387048	592624	.9230
1999	568929	255778	484910	.9963
2000	623467	229345	414868	.8594
2001	545725	335284	426471	.7108
2002	429971	520014	535045	.6412
2003	546256	585309	551990	.4966
2004	296504	713578	579445	.5739
2005	576000	701319		
Average	601993	384076	660999	.6430

1.5.2 Norwegian coastal cod (Subareas I and II)

State of the stock

Spawning biomass in relation to precautionary limits	Fishing mortality in relation to precautionary limits	Fishing mortality in relation to highest yield	Fishing mortality in relation to agreed target	Comment
Reduced reproductive capacity	Harvested unsustainably	Overexploited	Not applicable	Despite the absence of precautionary limits, there is clear evidence that the stock is harvested unsustainably and SSB is below any candidate for $\mathbf{B}_{lim}$

The unreported landings of coastal cod increase the uncertainty of the absolute level of the total stock, SSB, recruitment, and fishing mortality considerably. The assessment is, however, considered to reflect the trend in the stock. The level of SSB and recruitment is uncertain, but is considered to show a clear stock-recruitment pattern. In the absence of defined precautionary reference points, the state of the stock cannot be evaluated with regard to these. However, the SSB is, at present, at the lowest observed level. Recruitment in recent years has decreased rapidly to very low levels. Recruitment is clearly impaired at SSB below 100 000 t and, at present, SSB is well below this level. SSB in 2006 will therefore be well below any $\mathbf{B}_{lim}$ candidate and ICES considers that the stock is at a level where reproductive capacity has been reduced. Fishing mortality reference points are not defined, but the present fishing mortality is far too high in view of the state of the stock. The stock is harvested unsustainably.

Management objectives

There are no management objectives specified.

Reference points

Not established.

Yield and spawning biomass per Recruit
F-reference points:

	Fish Mort Ages 4-7	Yield/R	SSB/R
Average Current	0.51	1.33	1.58
$\mathbf{F}_{max}$	0.48	1.33	1.74
$\mathbf{F}_{0.1}$	0.23	1.22	4.67
$\mathbf{F}_{med}$	0.21	1.18	5.21

Single-stock exploitation boundaries

Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential and considering ecosystem effects

The current estimated fishing mortality is high, considerably higher than a fishing mortality that would lead to high long-term yields ($\mathbf{F}_{0.1}$ = 0.23). Once the stock is recovered, fishing at such lower mortalities would lead to higher SSB and, therefore, lower risks of fishing outside precautionary limits.

Exploitation boundaries in relation to precautionary limits

No catch should be taken from this stock in 2006 and a recovery plan should be developed and implemented as a prerequisite to reopening the fishery. The recovery plan should include monitoring the trajectory of the stock, clearly stating specified reopening criteria, and monitoring the fishery when it is reopened.

Management considerations

The SSB is at a historical low level and the year classes recruiting to the SSB over the next few years are estimated to be poor. Continued fishing is expected to lead to a further decrease in the SSB.

Norwegian coastal cod is managed as part of the Norwegian Northeast Arctic cod fishery. An expected yield of 40 000 t from the coastal cod has been added annually since the mid-1970s to the quota for Northeast Arctic cod, except for 2004 (20 000 t) and 2005 (21 000 t). In order to avoid any catch of the Norwegian coastal cod stock, the advised restrictions should apply to all fisheries catching cod where it mixes with Northeast Arctic cod.

Factors affecting the fisheries and the stock

Regulations and their effects

In 2005, measures were taken to reduce fishing on this stock, but there is no formal recovery plan.

In addition to quotas, the fishery is regulated by the same minimum catch size, minimum mesh size on the fishing gears as for the Northeast Arctic cod, maximum by-catch of undersized fish, closure of areas having high densities of juveniles, and by seasonal and area restrictions.

The quota for Norwegian coastal cod was reduced from 40 000 t in 2003 to 20 000 t in 2004 and 21 000 t in 2005. To achieve a reduction in landings of coastal cod, new technical regulations were adopted in 2004 and extended in Norway. In the new regulations, several fjords are closed for direct cod fishing with vessels larger than 15 meters. These regulations are supposed to reduce the exploitation on cod in the fjords and to displace fishing to cod outside the fjords where the proportion of Northeast Arctic cod is higher and that of coastal cod lower. Furthermore, fishing vessels smaller than 15 meter fishing with gillnet is the fleet taking the highest amount of coastal cod. According to the new regulations, this fleet has no new restrictions and will probably still fish a considerable amount of coastal cod. The aim of the regulation system is to restrict the landings to a maximum of 21 000 t (for 2005), but at catches of this size the stock is still expected to decline at current productivity.

The 2004 landings were in the range of 33 000 t, i.e. above the 2004 TAC of 20 000t. It appears that the new regulations came into effect in the spring, after a significant portion of the catch had already been taken.

Scientific basis

Data and methods

The analytical assessment is based on catch-at-age data and on an acoustic survey. The assessment is considered indicative of stock trends and may not reflect absolute stock sizes. This assessment tends to overestimate fishing mortality and underestimate the stock size in the most recent years. This does not invalidate the overall conclusion.

Uncertainties in assessment and forecast

The landings of coastal cod are severely underestimated. Both tourist and recreational fishing activity are landing a considerable amount of coastal cod. These landings are not reported and not included in the official statistics. Although it certainly has been unreported for a long period, there are no available data for years other than 2003 (where it was estimated to be in the range of 30% of the commercial catch). It is also unknown whether the amount of unreported catch fluctuates with the stock size or with other factors. ICES therefore considered that unreported landings should not be included in the assessment until data is available for a longer time period.

The catches and survey indices are estimated by distinguishing between coastal cod and Northeast Arctic cod through inspection of the otoliths. The precision and accuracy of the method has been investigated by comparison of different otolith readers and results from genetic investigation. Preliminary results indicate an accuracy of more than 95%.

Comparison with previous assessment and advice

The current assessment estimates SSB in 2004 to be about 87% higher than in the previous assessment, while the F in 2003 is estimated to be 30% lower.

Source of information

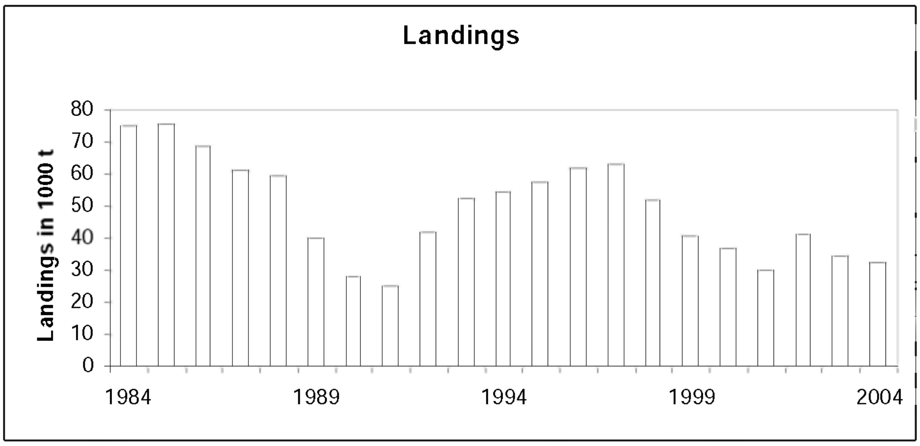
Report of the Arctic Fisheries Working Group, 19–28 April 2005 (ICES CM 2005/ACFM:20)

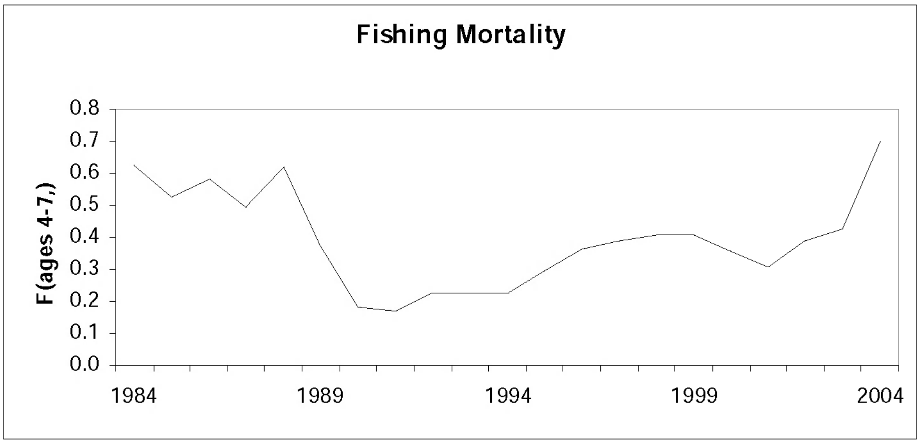
Year	ICES Advice	Predicted catch corresp.to advice	Agreed TAC[1]	Official landings[3]	ACFM landings[2]
1987	Not assessed		40		61
1988	Not assessed		40		59
1989	No advice		40		40
1990	No advice		40		28
1991	Included in TAC for Subareas I and II		40		25
1992	Shot forecast included in TAC for I and II		40		42
1993	Shot forecast included in TAC for I and II		40		53
1994	No advice		40		55
1995	No advice		40		57
1996	No advice		40		62
1997	No advice		40		63
1998	No advice		40		52
1999	No advice		40		41
2000	No advice		40		37
2001	Reduce F considerably	22	40		30
2002	catches should be reduced by the same proportion as for Northeast Arctic cod	13	40		41
2003	Reduce F considerably	8	40		35
2004	A recovery plan	0	20		33
2005	A recovery plan	0	21		
2006	A recovery plan	0			

Weights in '000 t.

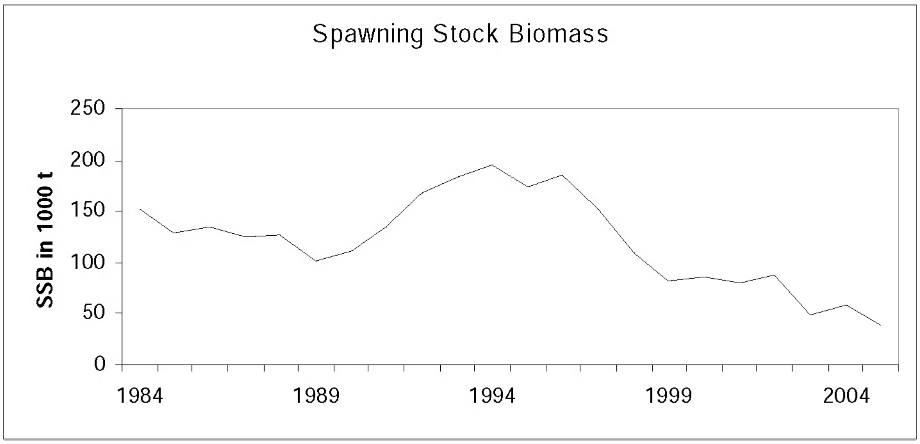
[1]40 000 tonnes has until 2003 been added annually to the agreed TAC of Northeast Arctic cod; 20 000 t were added in 2004 and 21 000 t in 2005.

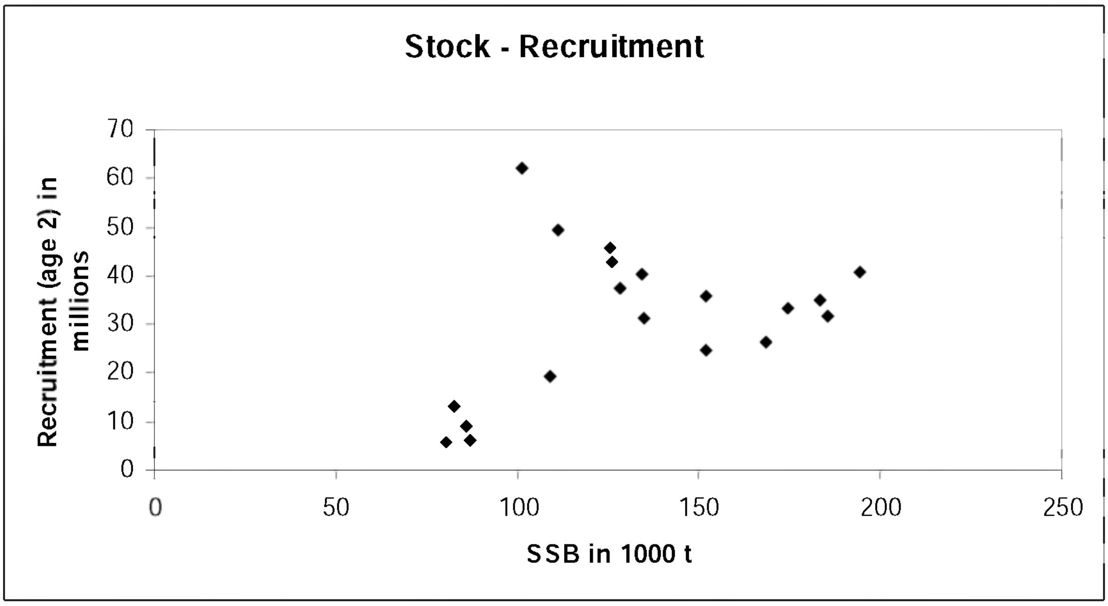
[2] Estimated according to otolith type. [3] No official landings.

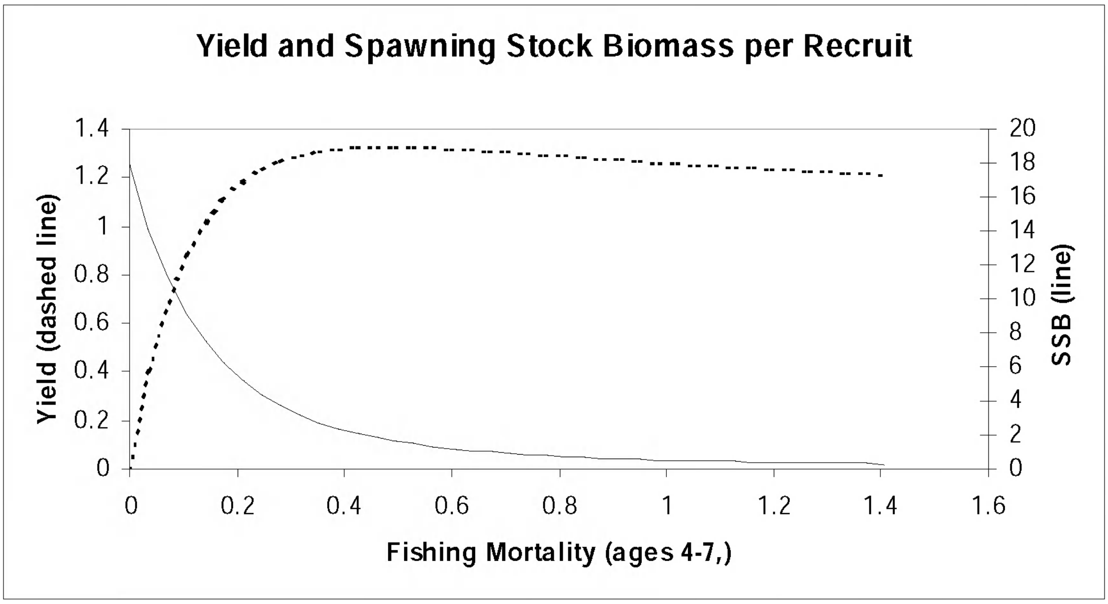

Landings
Landings in 1000 t
0
10
20
30
40
50
60
70
80
1984
1989
1994
1999
2004


Fishing Mortality
F(ages 4-7,)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
1984
1989
1994
1999
2004


Recruitment (age 2)
Recruitment in millions
0
20
40
60
80
100
1984
1989
1994
1999
2004


Spawning Stock Biomass
SSB in 1000 t
0
50
100
150
200
250
1984
1989
1994
1999
2004


Stock - Recruitment
Recruitment (age 2) in millions
70
60
50
40
30
20
10
0
0
50
100
150
200
250
SSB in 1000 t


Yield and Spawning Stock Biomass per Recruit
Yield (dashed line)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
SSB (line)
20
18
16
14
12
10
8
6
4
2
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
Fishing Mortality (ages 4-7,)

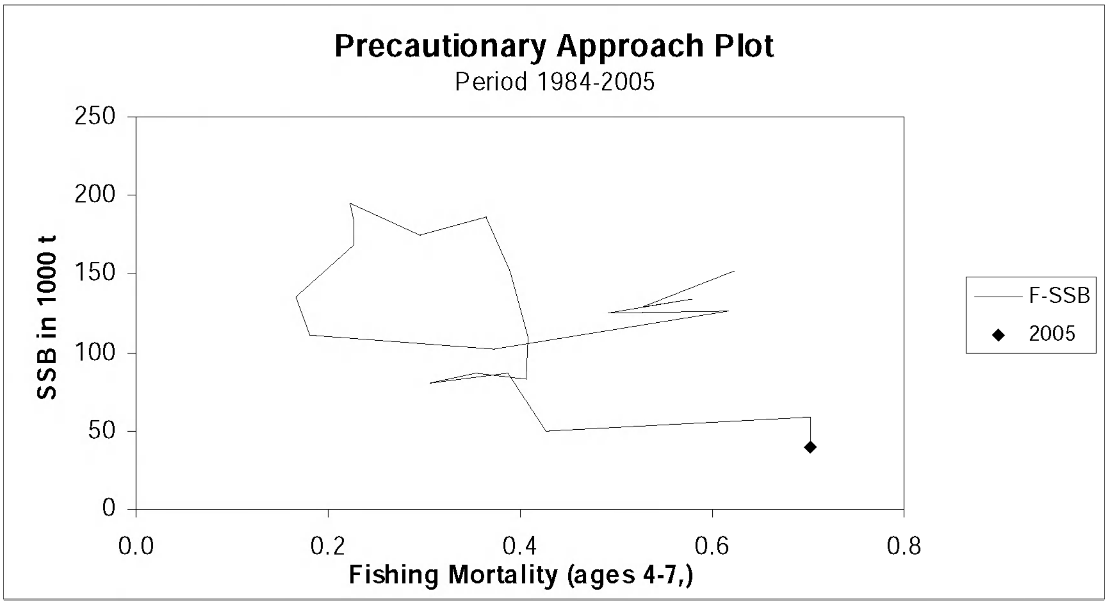

Precautionary Approach Plot
Period 1984-2005
SSB in 1000 t
250
200
150
100
50
0
0.0
0.2
0.4
0.6
0.8
Fishing Mortality (ages 4-7,)
F-SSB
2005

Table 1.5.2.1 Landings of Norwegian coastal cod in Subareas I and II.

Year	Landings in '000 t.
1984	74
1985	75
1986	69
1987	61
1988	59
1989	40
1990	28
1991	25
1992	42
1993	53
1994	55
1995	57
1996	62
1997	63
1998	52
1999	41
2000	37
2001	30
2002	41
2003	35
2004*	33
Average 1984–2004	49

*) Provisional data.

Table 1.5.2.2 Norwegian Coastal cod.

Year	Recruitment Age 2 thousands	SSB tonnes	Landings tonnes	Mean F Ages 4-7,
1984	87985	152196	74824	0.6220
1985	74904	128288	75451	0.5274
1986	35906	134124	68905	0.5802
1987	37302	125442	60972	0.4907
1988	40441	126081	59294	0.6172
1989	45637	101516	40285	0.3722
1990	43021	111346	28127	0.1807
1991	62064	134690	24822	0.1672
1992	49493	168502	41690	0.2275
1993	31262	183614	52557	0.2278
1994	26443	194527	54562	0.2219
1995	34935	174646	57207	0.2960
1996	40871	185765	61776	0.3650
1997	33489	152068	63319	0.3889
1998	31875	109221	51572	0.4093
1999	24618	82634	40732	0.4060
2000	19503	86106	36715	0.3546
2001	13153	80266	29699	0.3065
2002	9191	87057	40994	0.3880
2003	5740	49111	34635	0.4275
2004	6066	58357	32599	0.7029
2005	7566	39427		
Average	34612	121136	49083	0.4083

1.5.3 Northeast Arctic haddock (Subareas I and II)

State of the stock

Spawning biomass in relation to precautionary limits	Fishing mortality in relation to precautionary limits	Fishing mortality in relation to highest yield	Fishing mortality in relation to agreed target	Comment
Full reproductive capacity	Harvested sustainably	Overexploited	No agreed target	

Based on the most recent estimates of SSB, ICES classifies the stock as having full reproductive capacity. Based on the most recent estimates of fishing mortality, ICES classifies the stock to be harvested sustainably in 2004. Fishing mortality in 2004 is estimated to be slightly below $\mathbf{F}_{pa}$, but is expected to increase somewhat in 2005. The SSB in 2004 is estimated to be above $\mathbf{B}_{pa}$, and is expected to increase further in the short term at current fishing levels. The year classes after 1997 are estimated to be above or at the long-term average.

Management objectives

At the 33rd meeting of the Joint Russian-Norwegian Fisheries Commission (JRNC) in November 2004, the following decision was made:

"The Parties agreed that the management strategies for cod and haddock should take into account the following:

conditions for high long-term yield from the stocks
achievement of year-to-year stability in TACs
full utilization of all available information on stock development

On this basis, the Parties determined the following decision rules for setting the annual fishing quota (TAC) for Northeast Arctic cod (NEA cod):

estimate the average TAC level for the coming 3 years based on F_{pa}. TAC for the next year will be set to this level as a starting value for the 3-year period.

the year after, the TAC calculation for the next 3 years is repeated based on the updated information about the stock development, however the TAC should not be changed by more than +/- 10% compared with the previous year's TAC.

if the spawning stock falls below B_{pa}, the procedure for establishing TAC should be based on a fishing mortality that is linearly reduced from F_{pa} at B_{pa}, to $F= 0$ at SSB equal to zero. At SSB-levels below B_{pa} in any of the operational years (current year, a year before and 3 years of prediction) there should be no limitations on the year-to-year variations in TAC.

The Parties agreed on similar decision rules for haddock, based on F_{pa} and B_{pa} for haddock, and with a fluctuation in TAC from year to year of no more than +/-25% (due to larger stock fluctuations).[1]"

ICES has not evaluated whether this management plan for haddock is in accordance with the Precautionary Approach. A process for this evaluation has been identified (see Section 1.4.3.1).

Reference points

	ICES considers that:	ICES proposed that:
Precautionary Approach reference points	$\mathbf{B}_{lim}$ is 50 000 t	$\mathbf{B}_{pa}$ be set at 80 000 t
	$\mathbf{F}_{lim}$ is 0.49	$\mathbf{F}_{pa}$ is set at 0.35

[1] This quotation is taken from point 5.1, in the Protocol of the 33rd session of The Joint Norwegian-Russian Fishery Commission and translated from Norwegian to English. For an accurate interpretation, please consult the text in the official languages of the Commission (Norwegian and Russian).

Target reference points	NA	NA

Yield and spawning biomass per Recruit
F-reference points

	Fish Mort Ages 4-7	Yield/R	SSB/R
Average last 3 years	0.35	0.66	0.98
F_{max}	0.65	0.68	0.40
$F_{0.1}$	0.19	0.59	1.95
F_{med}	0.38	0.67	0.88

Candidates for reference points which are consistent with taking high long-term yields and achieving a low risk of depleting the productive potential of the stock may be identified in the range of $\mathbf{F_{0.1}}$-$\mathbf{F_{pa}}$.

Technical basis

$\mathbf{B_{lim}}$: only poor recruitment has been observed from 4 years of SSB < 50 000 t and all moderate or large year classes have been produced at higher SSB.	$\mathbf{B_{pa}} = \mathbf{B_{lim}} * 1.67$.
$\mathbf{F_{lim}}$ = median value of $\mathbf{F_{loss}}$.	$\mathbf{F_{pa}} = \mathbf{F_{med}}$. The stock has sustained higher fishing mortality for most of the period after 1950; however, low SSB has often resulted.

Single-stock exploitation boundaries

Exploitation boundaries in relation to existing management plans

The Joint Russian-Norwegian Fisheries Commission has agreed on a harvest control rule for NEA haddock. The catch rule will not be evaluated before 2006. The ICES advice is thus based on the precautionary limits.

Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential and considering ecosystem effects

The current estimated fishing mortality is 0.37. To have fishing mortalities above $\mathbf{F_{0.1}}$ (0.19) would be no gain to the long-term yield. Fishing at such lower mortalities would lead to higher SSB and, therefore, lower risks of fishing outside precautionary limits.

Exploitation boundaries in relation to precautionary limits

In order to harvest the stock within precautionary limits, fishing mortality should be kept no higher than $\mathbf{F_{pa}}$ (0.35) in any year. This corresponds to landings of less than 112 000 t in 2006.

Short-term implications

Outlook for 2006

Basis: Catch (2005) = 117. F(2005)=0.37; SSB(2006) = 155.

Rationale	TAC (2006)[1]	Basis	F (2006)	SSB (2007)	%SSB change [2)]	% TAC change [3)]
Zero catch	0	F=0	0	256	+65	-
Status quo	112	$\mathbf{F_{sq}}=\mathbf{F_{pa}} * 0.99$	0.35	172	+11	-4
High long-term yield	65	F(long-term yield)	0.19	205	+32	-44
Agreed management plan	120	F(management plan)	0.37	168	+8	+2
Precautionary limits	112	$\mathbf{F_{pa}}$	0.35	172	+11	-4

Weights in '000 t. Shaded scenarios are not considered consistent with the Precautionary Approach.
[1)] It is assumed that the TAC will be implemented and that the landings in 2005 therefore correspond to the TAC.
[2)] SSB 2007 relative to SSB 2006.
[3)] TAC 2006 relative to TAC 2005.

Management considerations

The dynamics of this stock have in the past been driven by sporadic strong year classes that lead to wide fluctuations in the SSB. In recent years, recruitment has been more stable.

Haddock is taken both as a directed fishery and as bycatch in the NEA cod fishery.

Management plan evaluations

The management plan has not been evaluated yet, but will be evaluated in 2006 (see Section 1.4.3.1).

Factors affecting the fisheries and the stock

Regulations and their effects

The fishery is regulated by quotas. The fishery is also regulated by a minimum catching size, a minimum mesh size in trawls and Danish seine, a maximum bycatch of undersized fish, maximum bycatch of non-target species, closure of areas with high density of juveniles, and other area and seasonal restrictions. Since January 1997, sorting grids have been mandatory for the trawl fisheries in most of the Barents Sea and Svalbard area.

The fisheries are controlled by inspections of the trawler fleet at sea, by a requirement of reporting to catch control points when entering and leaving the EEZs, and by inspections of all fishing vessels when landing the fish. Keeping a detailed fishing logbook onboard is mandatory for most vessels, and large parts of the fleet report to the authorities on a daily basis. There is some evidence that the present catch control and reporting systems are not sufficient to prevent under-reporting of catches and discards.

The environment

Variation in the recruitment of haddock has been associated with the changes in the influx of Atlantic waters to the large areas of the Barents Sea shelf. Water temperature at the first and second years of the haddock life cycle is a fairly reliable indicator of year-class strength. If mean annual water temperature in the bottom layer during the first two years of haddock life does not exceed 3.75°C (Kola-section), the probability of the appearance of strong year classes is very low, even considering the favorable effects of other factors. Besides, a steep rise or fall of the water temperature shows a marked effect on the abundance of year classes. Nevertheless, water temperature is not always a decisive factor in the formation of year-class abundance.

Haddock can vary their diet and act as both predator and plankton-eater or benthos-eater. During spawning migration of capelin, haddock prey on capelin and their eggs on the spawning grounds. When the capelin abundance is low or when their areas do not overlap, haddock can compensate for the lack of capelin with other fish species, i.e. young herring or euphausiids and benthos, which are predominant in the haddock diet throughout a year. Density-dependent growth has been observed for this stock.

The appearance of strong haddock year classes usually leads to a substantial increase in natural mortality of juveniles as a result of cod predation. This has been taken into account in the assessment.

Similar to cod, annual consumption of haddock by marine mammals, mostly seals and whales, depends on the stock size of capelin which is their main prey. In years when the capelin stock is large, the importance of haddock in the diet of marine mammals is minimal, while under a reduced capelin stock a considerable increase is observed in the consumption by marine mammals. So far this has not been considered in the assessment.

Scientific basis

Data and methods

The analytical assessment is based on catch-at-age data and 3 surveys. It includes mortality from predation by NEA cod.

Uncertainties in assessment and forecast

None of the surveys have a complete coverage of the stock. The proportion of a year class being outside the coverage varies between year classes. There are indications of unreported landings, but the extent of this is not known. Discarding is known to be a (varying) problem in the longline fisheries. It is related to the abundance of haddock close to, but below the minimum landing size. Year effects in a survey are quite common. The results of the forecast are sensitive to the estimates of variable maturity weight-at-age, and natural mortality rates.

Comparison with previous assessment and advice

In comparison to the previous assessment, this assessment shows a slight reduction (less than 15%) in fishing mortality for the period 1998–2003. This is accompanied by a slight increase (in the range of 13%) in SSB for 2002–2004.

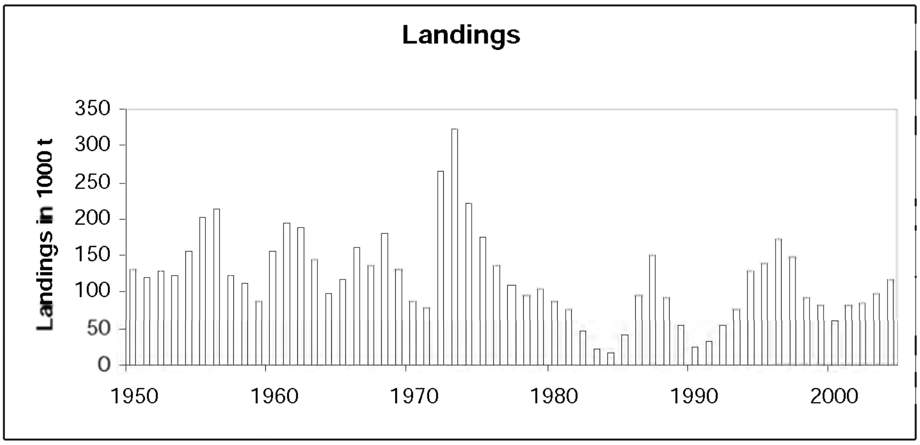
Source of information

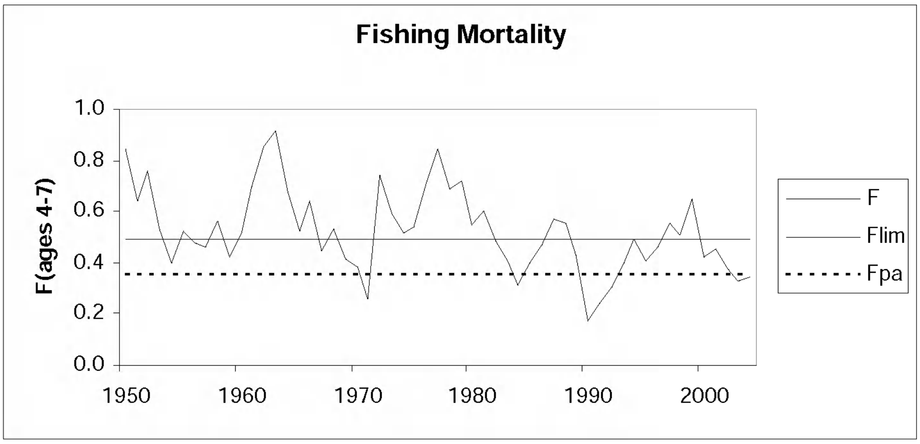
Report of the Arctic Fisheries Working Group, 19–28 April 2005 (ICES CM 2005/ACFM:20)

Year	ICES Advice	Predicted catch corresp. to advice	Agreed TAC[1]	Official landings	ACFM landings[1]
1987	No increase in F; TAC	160	250	155	151
1988	No increase in F	<240	240	95	92
1989	Large reduction in F	69	83	60	55
1990	No directed fishery	-	25	27	26
1991	No directed fishery	-	28	34	34
1992	Within safe biological limits	35[2]	63	58	54
1993	No long-term gains in increasing F	56[2]	72	83	78
1994	No long-term gains in F>$\mathbf{F}_{med}$	97[3]	120	125	121
1995	No long-term gains in F>$\mathbf{F}_{med}$	122[3]	130	139	138
1996	No long-term gains in F>$\mathbf{F}_{med}$	169[3]	170	177	173
1997	Well below $\mathbf{F}_{med}$	<242	210	152	149
1998	Below $\mathbf{F}_{med}$	<120	130	100	94
1999	Reduce F below $\mathbf{F}_{pa}$	<74	78	82	82
2000	Reduce F below $\mathbf{F}_{pa}$	<37	62	61	61
2001	Reduce F below $\mathbf{F}_{pa}$	<66	85	82	82
2002	Reduce F below $\mathbf{F}_{pa}$	<64	85	84	84
2003	Reduce F below $\mathbf{F}_{pa}$	< 101	101	97	97
2004	Reduce F below $\mathbf{F}_{pa}$	< 120	130	116	116
2005	Reduce F below $\mathbf{F}_{pa}$	<106	117		
2006	Reduce F below $\mathbf{F}_{pa}$	<112			

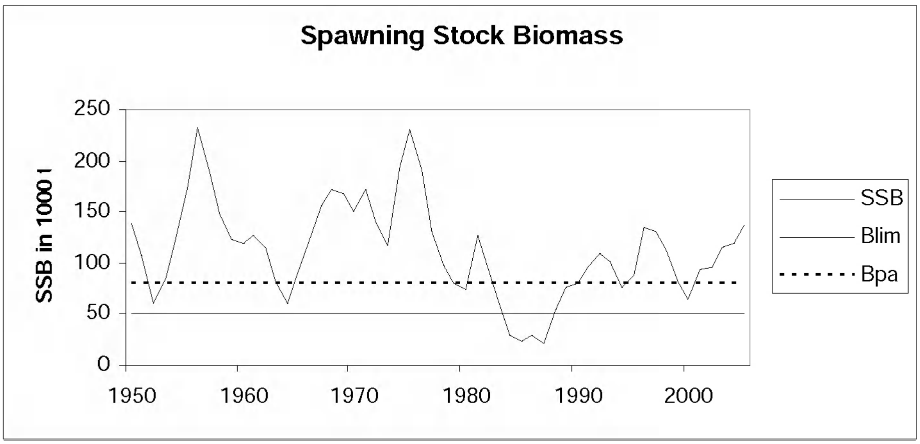
Weights in '000 t.

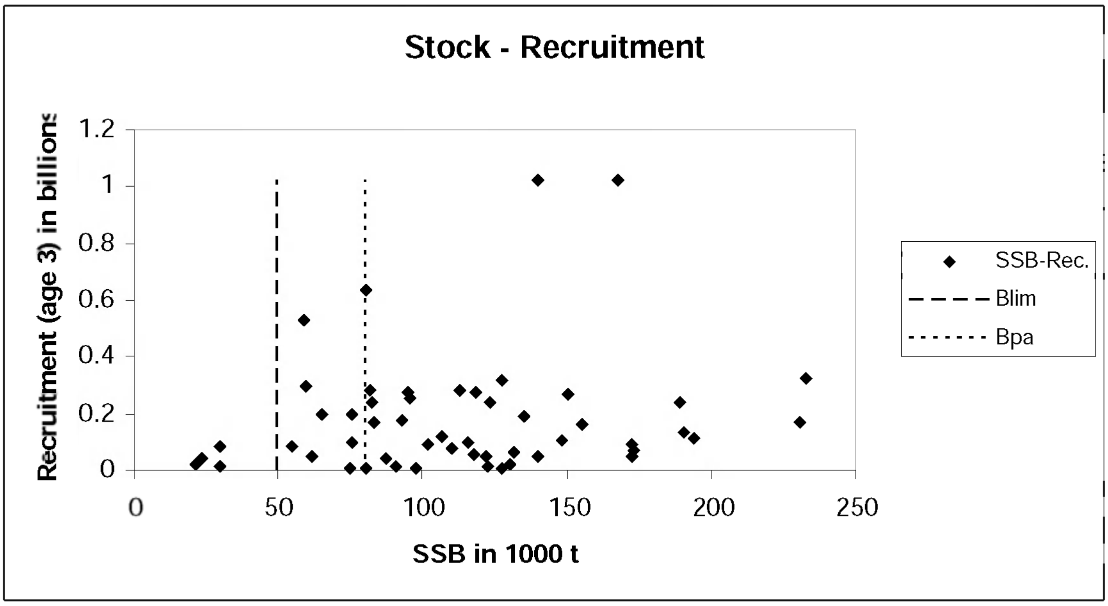
[1]Haddock in Norwegian coastal areas south of 67°N not included. [2]Predicted catch at *status quo* F. [3]Predicted landings at $\mathbf{F}_{med}$.


Landings
Landings in 1000 t
350
300
250
200
150
100
50
0
1950
1960
1970
1980
1990
2000

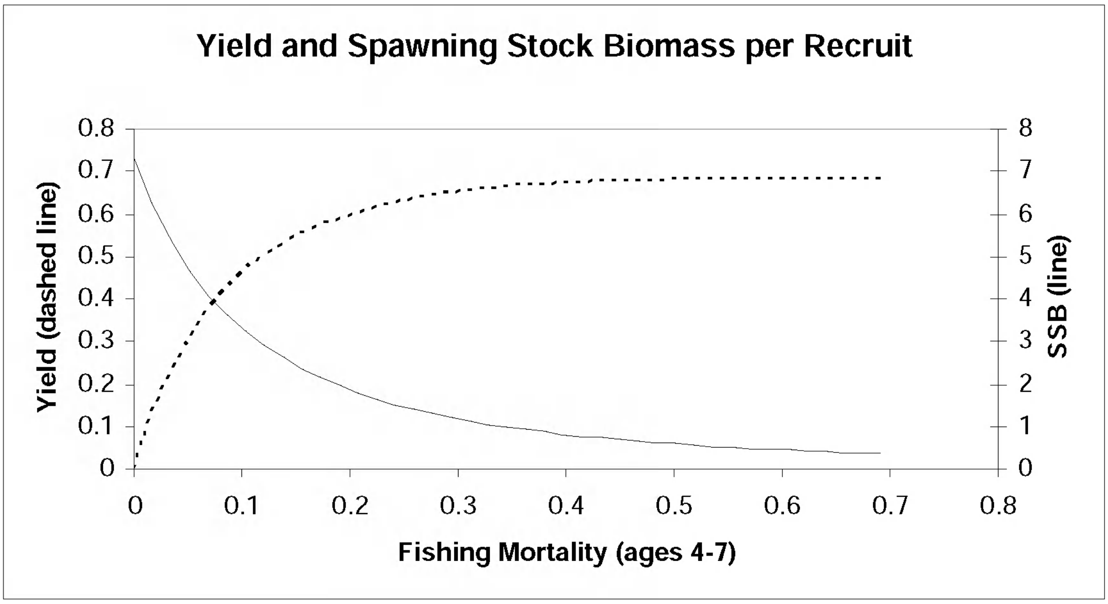

Fishing Mortality
F(ages 4-7)
1.0
0.8
0.6
0.4
0.2
0.0
1950
1960
1970
1980
1990
2000
F
Flim
Fpa


Recruitment (age 3)
Recruitment in billions
1.2
1
0.8
0.6
0.4
0.2
0
1950
1960
1970
1980
1990
2000

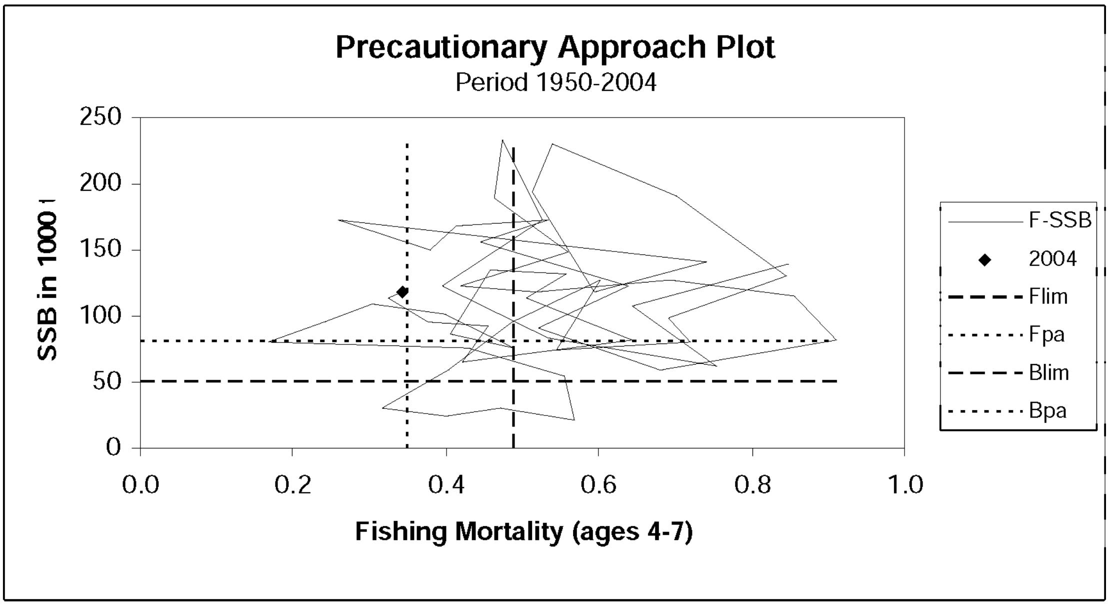

Spawning Stock Biomass
SSB in 1000 t
250
200
150
100
50
0
1950
1960
1970
1980
1990
2000
SSB
Blim
Bpa



Stock - Recruitment
Recruitment (age 3) in billions
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
SSB in 1000 t
SSB-Rec.
Blim
Bpa



Yield and Spawning Stock Biomass per Recruit
Yield (dashed line)
SSB (line)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
8
7
6
5
4
3
2
1
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Fishing Mortality (ages 4-7)



Precautionary Approach Plot
Period 1950-2004
SSB in 1000 t
250
200
150
100
50
0
0.0
0.2
0.4
0.6
0.8
1.0
Fishing Mortality (ages 4-7)
F-SSB
2004
Flim
Fpa
Blim
Bpa

Table 1.5.3.1 Northeast Arctic HADDOCK. Total nominal catch (t) by fishing areas.

Year	Subarea I	Division IIa	Division IIb	Total
1960	125 026	27 781	1 844	154 651
1961	165 156	25 641	2 427	193 224
1962	160 561	25 125	1 723	187 408
1963	124 332	20 956	936	146 224
1964	79 262	18 784	1 112	99 158
1965	98 921	18 719	943	118 578
1966	125 009	35 143	1 626	161 778
1967	107 996	27 962	440	136 397
1968	140 970	40 031	725	181 726
1969	89 948	40 306	566	130 820
1970	60 631	27 120	507	88 257
1971	56 989	21 453	463	78 905
1972	221 880	42 111	2 162	266 153
1973	285 644	23 506	13 077	322 226
1974	159 051	47 037	15 069	221 157
1975	121 692	44 337	9 729	175 758
1976	94 054	37 562	5 648	137 264
1977	72 159	28 452	9 547	110 158
1978	63 965	30 478	979	95 422
1979	63 841	39 167	615	103 623
1980	54 205	33 616	68	87 889
1981	36 834	39 864	455	77 153
1982	17 948	29 005	2	46 955
1983	7 550	13 872	185	21 607
1984	4 000	13 247	71	17 318
1985	30 385	10 774	111	41 270
1986	69 865	26 006	714	96 585
1987	109 425	38 181	3 048	150 654
1988	43 990	47 087	668	91 745
1989	31 116	23 390	353	54 859
1990	15 093	10 344	303	25 741
1991	18 772	14 417	416	33 605
1992	30 746	22 177	964	53 887
1993	47 574	27 010	3 037	77 621
1994	75 059	46 329	7 315	128 703
1995	70 390	54 169	14 118	138 677
1996	112 781	57 189	3 294	173 264
1997	78 335	67 917	2 504	148 756
1998	45 471	47 774	701	93 946
1999	36 096	42 036	4 214	82 346
2000	25 312	31 857	4 126	61 292
2001	35 071	39 449	7 323	81 842
2002	40 559	30 630	12 537	83 726
2003	53 726	35 386	8 491	97 603
2004[1]	64 790	39 423	12 147	116 293

[1]Provisional figures. Norwegian catches on Russian quotas are included.

Table 1.5.3.2 Northeast Arctic HADDOCK. Nominal catch (t) by countries, Subarea I and Divisions IIa and IIb combined.

Year	Faroe Islands	France	German Dem.Re.	Fed. Re. Germ.	Norway	Poland	United Kingdom	Russia[2]	Others	Total
1960	172	-	-	5 597	46 263	-	45 469	57 025	125	154 651
1961	285	220	-	6 304	60 862	-	39 650	85 345	558	193 224
1962	83	409	-	2 895	54 567	-	37 486	91 910	58	187 408
1963	17	363	-	2 554	59 955	-	19 809	63 526	-	146 224
1964	-	208	-	1 482	38 695	-	14 653	43 870	250	99 158
1965	-	226	-	1 568	60 447	-	14 345	41 750	242	118 578
1966	-	1 072	11	2 098	82 090	-	27 723	48 710	74	161 778
1967	-	1 208	3	1 705	51 954	-	24 158	57 346	23	136 397
1968	-	-	-	1 867	64 076	-	40 129	75 654	-	181 726
1969	2	-	309	1 490	67 549	-	37 234	24 211	25	130 820
1970	541	-	656	2 119	37 716	-	20 423	26 802	-	88 257
1971	81	-	16	896	45 715	43	16 373	15 778	3	78 905
1972	137	-	829	1 433	46 700	1 433	17 166	196 224	2 231	266 153
1973	1 212	3 214	22	9 534	86 767	34	32 408	186 534	2 501	322 226
1974	925	3 601	454	23 409	66 164	3 045	37 663	78 548	7 348	221 157
1975	299	5 191	437	15 930	55 966	1 080	28 677	65 015	3 163	175 758
1976	536	4 459	348	16 660	49 492	986	16 940	42 485	5 358	137 264
1977	213	1 510	144	4 798	40 118	-	10 878	52 210	287	110 158
1978	466	1 411	369	1 521	39 955	1	5 766	45 895	38	95 422
1979	343	1 198	10	1 948	66 849	2	6 454	26 365	454	103 623
1980	497	226	15	1 365	61 886	-	2 948	20 706	246	87 889
1981	381	414	22	2 398	58 856	**Spain**	1 682	13 400	-	77 153
1982	496	53	-	1 258	41 421	-	827	2 900	-	46 955
1983	428	-	1	729	19 371	139	259	680	-	21 607
1984	297	15	4	400	15 186	37	276	1 103	-	17 318
1985	424	21	20	395	17 490	77	153	22 690	-	41 270
1986	893	33	75	1 079	48 314	22	431	45 738	-	96 585
1987	464	26	83	3 106	69 333	99	563	76 980	-	150 654
1988	1 113	116	78	1 324	57 273	72	435	31 293	41	91 745
1989	1 218	125	26	171	31 825	1	590	20 903	-	54 859
1990	875	-	5	128	17 634	-	494	6 605	-	25 741
1991	1 117	60	**Greenld**	219	19 285	-	514	12 388	22	33 605
1992	1 093	151	1 719	387	30 203	38	596	19 699	1	53 887
1993	546	1 215	880	1 165	36 590	76	1 802	34 700	646	77 620
1994	2 761	678	770	2 412	64 688	22	4 673	51 822	877	128 703
1995	2 833	598	1 351	2 675	72 864	14	3 108	54 516	718	138 677
1996	3 743	537	1 524	942	89 500	669	2 275	73 857	217	173 264
1997	3 327	495	1 877	972	97 789	424	2 340	41 228	304	148 756
1998	1 566	241	854	385	68 747	257	1 241	20 559	96	93 946
1999	1 003	64	252	437	48 632	652	694	30 520	92	82 346
2000	631	169	432	931	34 172	582	814	22 738	823	61 292
2001	1 210	324	553	554	41 269	1 497	1 068	34 307	2 471	81 842
2002	1 564	297	858	627	39 910	1 505	1 125	37 157	2 152	83 726
2003	1 959	382	1 363	918	48 390	1 330	1 018	41 140	1 103	97 603
2004 [1]	2 484	103	1 680	823	53 983	54	1 250	54 347	1 569	116 293

[1]Provisional figures. Norwegian catches on Russian quotas are included.
[2]USSR prior to 1991.

Table 1.5.3.3 Northeast Arctic haddock.

Year	Recruitment Age 3 thousands	SSB tonnes	Landings tonnes	Mean F Ages 4-7
1950	66026	139644	132125	0.8469
1951	553019	106855	120077	0.6431
1952	60283	61418	127660	0.7546
1953	1023249	83400	123920	0.5336
1954	120542	122079	156788	0.3959
1955	50765	173462	202286	0.5270
1956	167878	232807	213924	0.4730
1957	51537	188884	123583	0.4623
1958	67410	147888	112672	0.5602
1959	322648	123389	88211	0.4185
1960	240840	118280	154651	0.5183
1961	108736	127639	193224	0.6925
1962	240221	115524	187408	0.8548
1963	273037	82499	146224	0.9107
1964	316145	59583	99158	0.6817
1965	100872	90813	118578	0.5208
1966	237489	122890	161778	0.6377
1967	293825	155341	136397	0.4462
1968	17580	172533	181726	0.5344
1969	17380	167712	130820	0.4139
1970	164303	150357	88257	0.3794
1971	94306	172417	78905	0.2589
1972	1020039	140186	266153	0.7410
1973	270060	117788	322226	0.5931
1974	52804	194092	221157	0.5134
1975	48610	230562	175758	0.5393
1976	55885	190764	137264	0.7016
1977	113854	130063	110158	0.8467
1978	170975	97878	95422	0.6904
1979	135034	80154	103623	0.7187
1980	18632	74592	87889	0.5437
1981	6019	127428	77153	0.6021
1982	8158	95280	46955	0.4880
1983	4679	59144	21607	0.4034
1984	8374	30067	17318	0.3159
1985	254767	23499	41270	0.4009
1986	529020	30038	96585	0.4705
1987	86930	21323	150654	0.5678
1988	43109	54611	91745	0.5562
1989	16888	75722	54859	0.4299
1990	24416	80319	25741	0.1685
1991	81493	94880	33605	0.2404
1992	194645	109774	53887	0.3028
1993	635064	101489	77621	0.3989
1994	278552	75203	128703	0.4891
1995	80447	87120	138677	0.4067
1996	91079	135158	173264	0.4590
1997	102304	131368	148756	0.5569
1998	43305	113141	93946	0.5057
1999	191753	81846	82346	0.6450
2000	64293	65183	61292	0.4220
2001	285358	92967	81842	0.4558
2002	284568	96164	83726	0.3758
2003	196319	114357	97603	0.3256
2004	175100	118633	116293	0.3427
2005	295000	136761		
Average	186708	112910	119881	0.5215

1.5.4 Northeast Arctic saithe (Subareas I and II)

State of the stock

Spawning biomass in relation to precautionary limits	Fishing mortality in relation to precautionary limits	Fishing mortality in relation to highest yield	Fishing mortality in relation to agreed target	Comment
Full reproductive capacity	Harvested sustainably	Appropriate (see comment)	No agreed target	In relation to the highest yield, the current fishing mortality is just above $\mathbf{F}_{0.1}$, i.e. the lowest fishing mortality that would lead to high long-term yields.

Based on the most recent estimates of SSB, ICES classifies the stock as having full reproductive capacity. Based on the most recent estimates of fishing mortality, ICES classifies the stock to be harvested sustainably. Fishing mortality is stable and has since 1996 been below $\mathbf{F}_{pa}$. The SSB has since 1994 been well above $\mathbf{B}_{pa}$. After a long period of low stock size, the stock recovered during the 1990s with the recruitment of several above-average year classes. The 1999 year class is estimated to be strong, while the 2000 year class seems to be less than half of the average. No information is available on recent year classes.

Management objectives

There are no explicit management objectives for this stock, but work is in progress on the development of a management strategy.

Reference points

Reference points were recalculated using the ICES standard approach, taking into account the change in the range of age groups used for the calculation of fishing mortality ($\mathbf{F}_{bar}$). The new reference points are provided below:

	ICES considers that:	**ICES proposed that:**
Precautionary Approach reference points (revised in 2005)	$\mathbf{B}_{lim}$ is 136 000 t	$\mathbf{B}_{pa}$ is set at 220 000 t
	$\mathbf{F}_{lim}$ is 0.58	$\mathbf{F}_{pa}$ be set at 0.35

Yield and spawning biomass per Recruit
F-reference points:

	Fish Mort Ages 4-7	Yield/R	SSB/R
Average Current	0.21	0.82	3.07
$\mathbf{F}_{max}$	0.33	0.85	1.89
$\mathbf{F}_{0.1}$	0.15	0.77	4.09
$\mathbf{F}_{med}$	0.39	0.85	1.56

Candidates for reference points that are consistent with taking high long-term yields and achieving a low risk of depleting the productive potential of the stock may be identified in the range of $\mathbf{F}_{0.1}$-$\mathbf{F}_{pa}$.

Technical basis

$\mathbf{B}_{lim}$ = change point regression	$\mathbf{B}_{pa} = \mathbf{B}_{lim} * \exp(1.645*\sigma)$, where σ=0.3
$\mathbf{F}_{lim}$ = F corresponding to an equilibrium stock = $\mathbf{B}_{lim}$	$\mathbf{F}_{pa} = \mathbf{F}_{lim} * \exp(-1.645*\sigma)$, where σ=0.3. This value is considered to have a 95% probability of avoiding the $\mathbf{F}_{lim}$
	$\mathbf{F}_{y}$: not defined

Single-stock exploitation boundaries

Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential and considering ecosystem effects

The current estimated fishing mortality (0.21) is just above the lowest fishing mortality that would lead to high long-term yields ($\mathbf{F_{0.1}}$=0.15).

Exploitation boundaries in relation to precautionary limits

In order to harvest the stock within precautionary limits, fishing mortality should be kept below $\mathbf{F_{pa}}$. This corresponds to landings of less than 202 000 t in 2006.

Short-term implications

Outlook for 2006

Basis: F(2005) =0.32; catch (2005) = 215, SSB(2006)=487.

Rationale	TAC (2006)	Basis[1]	F (2006)	SSB (2007)	%SSB change [2)]	% TAC change [3)]
Zero catch	0	F=0	0	594	22	
Status quo	128	$\mathbf{F_{sq}}$	0.21	473	-3	-40
Precautionary limits	24	$\mathbf{F_{pa}}$ * 0.1	0.03	572	17	-89
	58	$\mathbf{F_{pa}}$ * 0.25	0.09	539	11	-73
	110	$\mathbf{F_{pa}}$ * 0.5	0.18	490	1	-49
	158	$\mathbf{F_{pa}}$ * 0.75	0.26	445	-9	-27
	185	$\mathbf{F_{pa}}$ * 0.90	0.32	420	-14	-14
	202	$\mathbf{F_{pa}}$	0.35	404	-17	-6
	218	TAC($\mathbf{F_{pa}}$)* 1.1	0.39	389	-20	1
	242	TAC($\mathbf{F_{pa}}$)* 1.25	0.44	367	-25	13

Weights in '000 t. Shaded scenarios are not considered consistent with the Precautionary Approach.
[1)] It is assumed that the TAC will be implemented and that the landings in 2005 therefore correspond to the TAC.
[2)] SSB 2007 relative to SSB 2006.
[3)] TAC 2006 relative to TAC 2005.

Management considerations

Since the early 1960s, the fishery has been dominated by purse seiners and trawlers, with a traditional gillnet fishery for spawning saithe as the third major component. The purse seine fishery is conducted in coastal areas and fjords. Historically, purse seiners and trawlers have taken, approximately, equal shares of the catches. Regulation changes led to less relative amounts taken by purse seiners in the last three years.

There is known to be a discarding problem on some trawlers not interested in the saithe fishery or having no or only a small saithe quota, and which are fishing for cod in areas where also saithe is abundant in the catches. There are also records of discarding from the purse seine fishery.

Management plan evaluations

There is no international management plan, but work is in progress to develop a management strategy in Norway.

Factors affecting the fisheries and the stock

Regulations and their effects

TAC regulations are in place on this stock. Norway and Russia have set national measures applicable to their EEZ. In the Norwegian fishery, quotas may be transferred between fleets if it becomes clear that the quota allocated to one of the fleets will not be taken.

In addition to quotas, the fisheries are managed by minimum mesh size, minimum landing size, bycatch regulations, area closures, and other area and seasonal restrictions. In addition, sorting grids are used in the trawl fishery.

Changes in fishing technology and fishing patterns

On March 1st 1999, the minimum landing size was increased to 45 cm for trawl and conventional gears, and to 42 cm (north of Lofoten) and 40 cm (between 62°N and Lofoten) for purse seine, with an exception for the first 3000 t purse seine catch between 62°N and 65°30′N, where the minimum landing size remains at 35 cm.

The environment

The recruitment of saithe may suffer in years with reduced inflow of Atlantic waters.

Other considerations

There is a substantial migration of immature saithe to the North Sea from the Norwegian coast between 62°N and 66°N. In some years, there are also examples of mass migration from northern Norway to Iceland and, to a lesser extent, to the Faroe Islands.

Scientific basis

Data and methods

The analytical assessment is based on catch-at-age data, an acoustic survey, and CPUE data from one commercial fleet (Norwegian trawl).

Uncertainties in assessment and forecast

At the moment it is not possible to evaluate the total level of discarding and to use the information in the assessment.

There is a tendency to overestimate the fishing mortality and underestimate stock size in the assessment year. The lack of recruitment indices is a major problem in the forecast. Prediction of catches beyond the TAC year will, to a large extent, be dependent on assumptions of average recruitment. Furthermore, estimating the stock size in 2005 is uncertain due to the widely conflicting indices of abundance available to the assessment.

Comparison with previous assessment and advice

The current assessment estimated SSB for 2004 to be about 16% higher than in the previous assessment, while the F in 2003 is now estimated to be 0.19 compared to 0.23 in the last assessment.

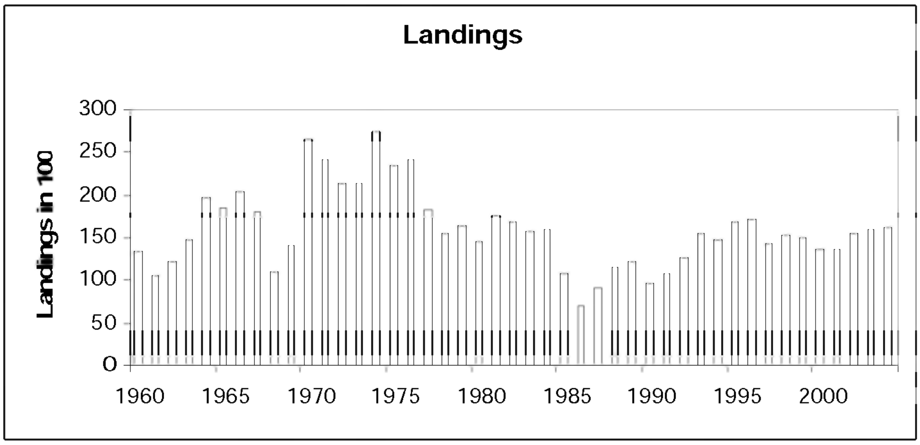
Source of information

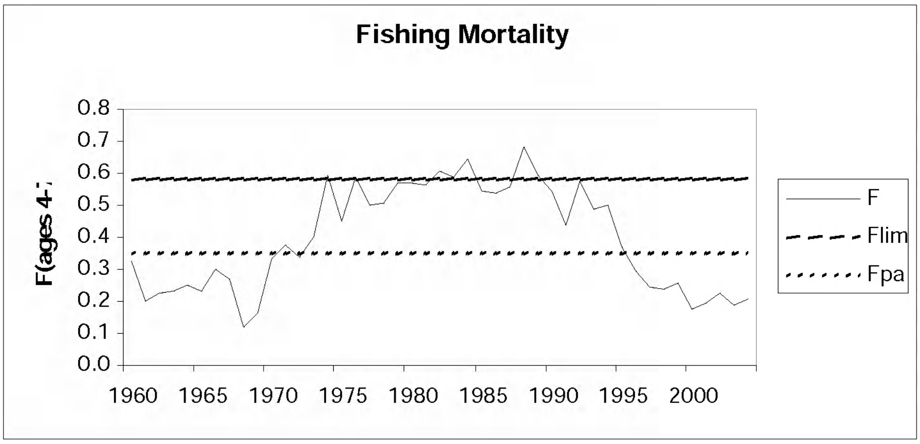
Report of the Arctic Fisheries Working Group, 19–28 April 2005 (ICES CM 2005/ACFM:20)

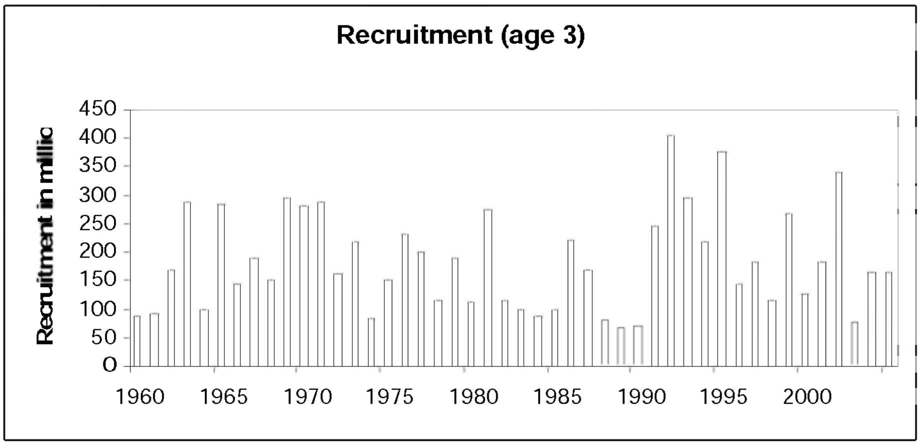
Year	ICES Advice	Single-stock exploitation boundaries	Predicted catch corresp. To advice	Predicted catch corresp. to single-stock exploitation boundaries	Agreed TAC[2]	Official landings	ACFM landings
1987	No increase in F; TAC; protect juveniles		90		-	92	92
1988	No increase in F		< 83		-	114	114
1989	*Status quo* F; TAC		120		120	122	122
1990	F ≤ $\mathbf{F}_{med}$; TAC		93		103	96	96
1991	F at $\mathbf{F}_{low}$; TAC		90		100	107	107
1992	Within safe biological limits		115		115	128	128
1993	Within safe biological limits		132[1]		132	154	154
1994	No increase in F		158[1]		145	147	147
1995	No increase in F		221[1]		165	168	168
1996	No increase in F		158[1]		163	171	171
1997	Reduction of F to $\mathbf{F}_{med}$ or below		107		125	144	144
1998	Reduction of F to $\mathbf{F}_{med}$ or below		117		145[3]	153	153
1999	Reduce F below $\mathbf{F}_{pa}$		87		144[4]	150	150
2000	Reduce F below $\mathbf{F}_{pa}$		89		125[5]	136	136
2001	Reduce F below $\mathbf{F}_{pa}$		<115		135	136	136
2002	Maintain F below $\mathbf{F}_{pa}$		< 152		162[6]	155	155
2003	Maintain F below $\mathbf{F}_{pa}$		< 168		164	160	160
2004	Maintain F below $\mathbf{F}_{pa}$		< 186		169	162	162
2005	Take account of *Sebastes marinus* by-catch	Maintain F below $\mathbf{F}_{pa}$		< 215	215		
2006	Take account of *Sebastes marinus* by-catch.	Maintain F below $\mathbf{F}_{pa}$		< 202			

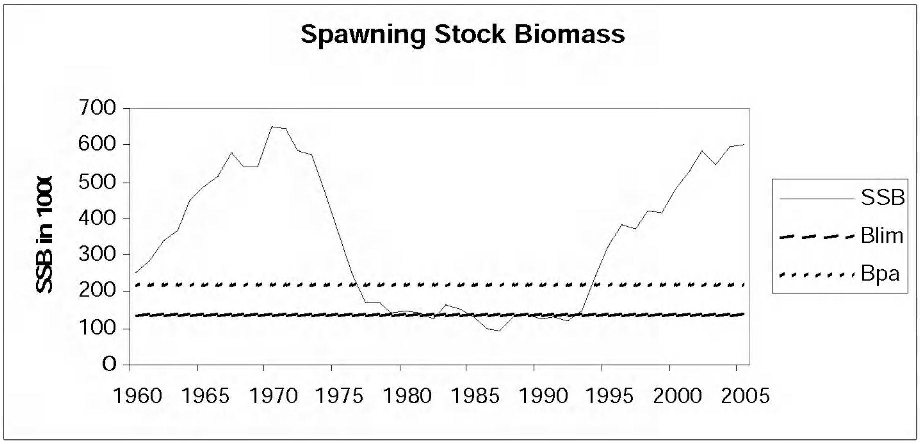
Weights in '000 t.

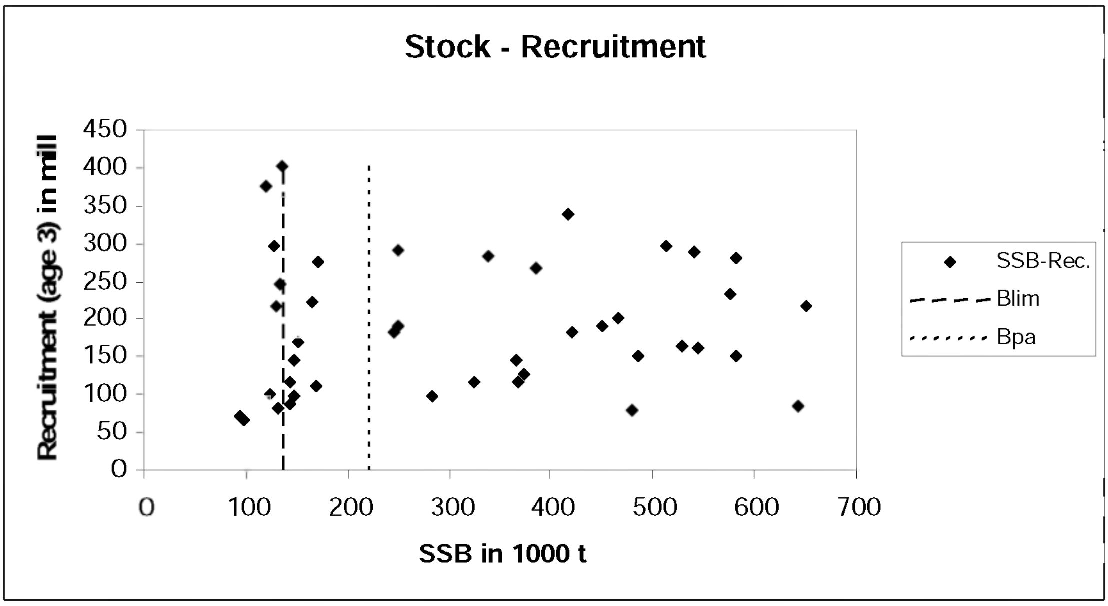
[1] Predicted catch at *status quo* F. [2] Set by Norwegian authorities. [3] TAC first set at 125 000 t, increased in May 1998 after an inter-sessional assessment. [4] TAC set after an inter-sessional assessment in December 1998. [5] TAC set after an inter-sessional assessment in December 1999. [6] TAC first set at 152 000 t, increased in June 2003 after the spring 2002 AFWG assessment.

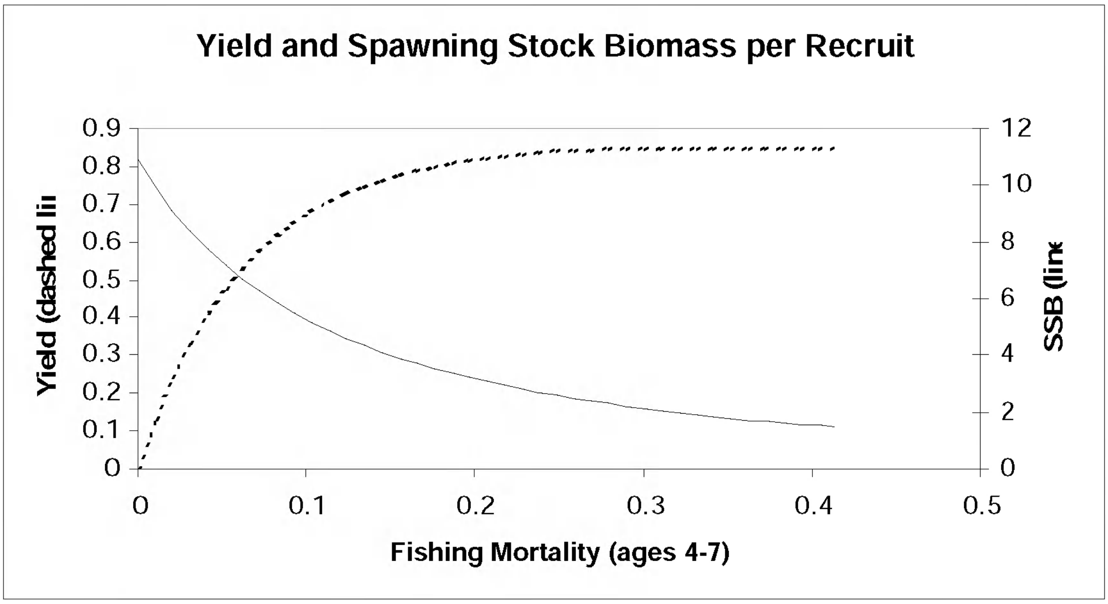

Landings
Landings in 100
300
250
200
150
100
50
0
1960
1965
1970
1975
1980
1985
1990
1995
2000


Fishing Mortality
F(ages 4-7
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1960
1965
1970
1975
1980
1985
1990
1995
2000
F
Flim
Fpa


Recruitment (age 3)
Recruitment in millic
450
400
350
300
250
200
150
100
50
0
1960
1965
1970
1975
1980
1985
1990
1995
2000


Spawning Stock Biomass
SSB in 100(
700
600
500
400
300
200
100
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
SSB
Blim
Bpa


Stock - Recruitment
Recruitment (age 3) in mill
450
400
350
300
250
200
150
100
50
0
0
100
200
300
400
500
600
700
SSB in 1000 t
SSB-Rec.
Blim
Bpa


Yield and Spawning Stock Biomass per Recruit
Yield (dashed lii
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
12
10
8
6
4
2
0
SSB (line
0
0.1
0.2
0.3
0.4
0.5
Fishing Mortality (ages 4-7)

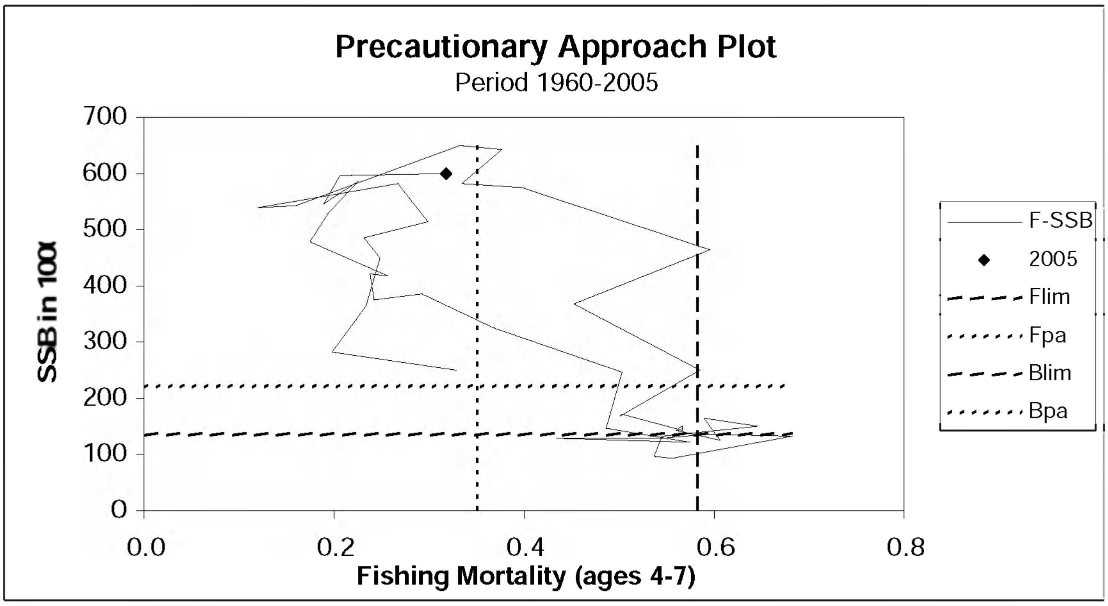

Precautionary Approach Plot
Period 1960-2005
SSB in 100(
700
600
500
400
300
200
100
0
0.0
0.2
0.4
0.6
0.8
Fishing Mortality (ages 4-7)
F-SSB
2005
Flim
Fpa
Blim
Bpa

Table 1.5.4.1 Northeast Arctic saithe. Nominal catch (t) by countries as officially reported to ICES. (Subarea I and Divisions IIa and IIb combined.)

Year	Faroe Islands	France	Germany Dem.Rep	Fed.Rep. Germany	Norway	Poland	Portugal	Russia[3]	Spain	UK (England & Wales)	UK (Scotland)	Others[5]	Total all countries
1960	23	1,700	-	25,948	96,050	-	-	-	-	9,780	-	14	133,515
1961	61	3,625	-	19,757	77,875	-	-	-	-	4,595	20	18	105,951
1962	2	544	-	12,651	101,895	-	-	912	-	4,699	-	4	120,707
1963	-	1,110	-	8,108	135,297	-	-	-	-	4,112	-	-	148,627
1964	-	1,525	-	4,420	184,700	-	-	84	-	6,511	-	186	197,426
1965	-	1,618	-	11,387	165,531	-	-	137	-	6,741	5	181	185,600
1966	-	2,987	813	11,269	175,037	-	-	563	-	13,078	-	41	203,788
1967	-	9,472	304	11,822	150,860	-	-	441	-	8,379	-	48	181,326
1968	-	-	70	4,753	96,641	-	-	-	-	8,781	2	-	110,247
1969	20	193	6,744	4,355	115,140	-	-	-	-	13,585	-	23	140,060
1970	1,097	-	29,362	23,466	151,759	-	-	43,550	-	15,469	221	-	264,924
1971	215	14,536	16,840	12,204	128,499	6,017	-	39,397	13,097	10,361	106	-	241,272
1972	109	14,519	7,474	24,595	143,775	1,111	-	1,278	13,125	8,223	125	-	214,334
1973	7	11,320	12,015	30,338	148,789	23	-	2,411	2,115	6,593	248	-	213,859
1974	46	7,119	29,466	33,155	152,699	2,521	-	38,931	7,075	3,001	103	5	274,121
1975	28	3,156	28,517	41,260	122,598	3,860	6,430	13,389	11,397	2,623	140	55	233,453
1976	20	5,609	10,266	49,056	131,675	3,164	7,233	9,013	21,661	4,651	73	47	242,468
1977	270	5,658	7,164	19,985	139,705	1	783	989	1,327	6,853	82	-	182,817
1978	809	4,345	6,484	18,190	121,069	35	203	381	121	2,790	37	-	154,464
1979	1,117	2,601	2,435	14,823	141,346	-	-	3	685	1,170	-	-	164,180
1980	532	1,016	-	12,511	128,878	-	-	43	780	794	-	-	144,554
1981	236	194	-	8,431	166,139	-	-	121	-	395	-	-	175,516
1982	339	82	-	7,224	159,643	-	-	14	-	731	1	-	168,034
1983	539	418	-	4,933	149,556	-	-	206	33	1,251	-	-	156,936
1984	503	431	6	4,532	152,818	-	-	161	-	335	-	-	158,786
1985	490	657	11	1,873	103,899	-	-	51	-	202	-	-	107,183
1986	426	308	-	3,470	66,152	-	-	27	-	54	21	-	70,458
1987	712	576	-	4,909	85,710	-	-	426	-	54	3	1	92,391
1988	441	411	-	4,574	108,244	-	-	130	-	436	6	-	114,242
1989	388	460[2]	-	606	119,625	-	-	23	506	-	702	-	122,310
1990	1,207	340[2]	-	1,143	92,397	-	-	52	-	681	28	-	95,848
1991	963	77[2]	**Greenland**	2,003	103,283	-	-	504[4]	-	449	42	5	107,326
1992	165	1,890[2]	734	3,451	119,765	-	-	964	6	516	25	-	127,516
1993	31	566[2]	78	3,687	139,288	-	1	9,509	4	408	7	5	153,584
1994	67	151[2]	15	1,863	141,589	-	1	1,640	655	548	9	6	146,544
1995	172[2]	358[2]	53	935	165 001	-	5	1 148	-	589	99	18	168 378
1996	248[2]	346[2]	165[2]	2 615	166 045	-	24	1 159	6[2]	691[2]	16	33[2]	171 348
1997	193[2]	560	363[2]	2 915	136 927	-	12	1 774	41[2]	676	123	45	143 629
1998	366[2]	932	437[2]	2 936	144 103	-	47[2]	3 836	275[2]	334	21	40[2]	153 327
1999	181[2]	638[2]	655[2]	2 473	141 941	-	17[2]	3 929	24[2]	336	3	178[2]	150 375
2000	224[2]	1438[2]	651[2]	2 573[6]	125 950	-	46	4 452	117[2]	445	9	40[2]	135 945
2001	519	1279	701	2 690	125 495	-	75	4 951	119	352	162	59	136 402
2002[1]	520[2]	1048[1]	1138[2]	2 642[6]	143 941	-	118	5 402	37[2]	345	75	81[1]	155 347
2003	561	848	929	2 763	150 205		143	3 893	13[2]	265		98[1]	159 718
2004	708[2]	188[2]	891[2]	2 161[6]	147 718	-	105	9 192	87	543		323[2]	161 916

[1] Provisional figures.
[2] As reported to Norwegian authorities.
[3] USSR prior to 1991.
[4] Includes Estonia.
[5] Includes Denmark,Netherlands, Iceland, Ireland and Sweden
[6] As reported by Working Group members

Table 1.5.4.2 North-East Arctic saithe (Subareas I and II).

Year	Recruitment Age 3 thousands	SSB tonnes	Landings tonnes	Mean F Ages 4-7
1960	88173	250637	133515	0.3276
1961	92920	283486	105951	0.1971
1962	170143	338725	120707	0.2228
1963	289935	365249	148627	0.2334
1964	97186	449676	197426	0.2487
1965	283653	484948	185600	0.2310
1966	144689	513916	203788	0.2983
1967	190738	581740	181326	0.2679
1968	150801	541059	110247	0.1193
1969	296371	543703	140060	0.1606
1970	280751	649873	264924	0.3330
1971	287484	642603	241272	0.3776
1972	161777	583001	214334	0.3346
1973	217484	575498	213859	0.3986
1974	83523	465234	274121	0.5962
1975	149691	367034	233453	0.4519
1976	231999	250078	242486	0.5855
1977	201093	168166	182817	0.5019
1978	117719	171142	154464	0.5040
1979	190761	142891	164180	0.5672
1980	111631	148284	144554	0.5667
1981	275148	142759	175516	0.5602
1982	115581	124369	168034	0.6061
1983	98950	165968	156936	0.5905
1984	86425	151671	158786	0.6461
1985	99330	131900	107183	0.5448
1986	221355	97542	70458	0.5378
1987	169361	93916	92391	0.5568
1988	81295	132908	114242	0.6816
1989	66757	136378	122310	0.5930
1990	71566	126942	95848	0.5449
1991	247349	129510	107326	0.4346
1992	403143	120004	127516	0.5745
1993	295819	146489	153584	0.4869
1994	216577	245956	146544	0.5027
1995	375410	325058	168378	0.3687
1996	145597	385050	171348	0.2922
1997	183907	373998	143629	0.2424
1998	115598	420312	153327	0.2376
1999	268441	416098	150373	0.2578
2000	127656	479935	135945	0.1751
2001	181370	528800	136402	0.1934
2002	339662	586233	155246	0.2247
2003	78720	547766	159757	0.1891
2004	163907[1]	595195	161916	0.2067
2005	163907[1]	599348		
Average	183290	341762	159793	0.39

[1] Geometric mean of 1960-2003

1.5.5 Redfish (*Sebastes mentella*) in Subareas I and II

Table 1.5.5.1 REDFISH in Subareas I and II. Nominal catch (t) by countries in Subarea I, Divisions IIa and IIb combined as officially reported to ICES.

Year	Canada	Denmark	Faroe Islands	France	Germany[4]	Greenland	Iceland	Ireland	Netherlands	Norway	Poland	Portugal	Russia[5]	Spain	UK (E&W)	UK (Scot.)	Total
1984	-	-	-	2,970	7,457	-	-	-	-	18,650	-	1,806	69,689	25	716	-	101,313
1985	-	-	-	3,326	6,566	-	-	-	-	20,456	-	2,056	59,943	38	167	-	92,552
1986	-	-	29	2,719	4,884	-	-	-	-	23,255	-	1,591	20,694	-	129	14	53,315
1987	-	+	450[3]	1,611	5,829	-	-	-	-	18,051	-	1,175	7,215	25	230	9	34,595
1988	-	-	973	3,349	2,355	-	-	-	-	24,662	-	500	9,139	26	468	2	41,494
1989	-	-	338	1,849	4,245	-	-	-	-	25,295	-	340	14,344	5[2]	271	1	46,688
1990	-	37[3]	386	1,821	6,741	-	-	-	-	34,090	-	830	18,918	-	333	-	63,156
1991	-	23	639	791	981	-	-	-	-	49,463	-	166	15,354	1	336	13	67,768
1992	-	9	58	1,301	530	614	-	-	-	23,451	-	977	4,335	16	479	3	31,773
1993	8[3]	4	152	921	685	15	-	-	-	18,319	-	1,040	7,573	65	734	1	29,517
1994	-	28	26	771	1026	6	4	3	-	21,466	-	985	6,220	34	259	13	30,841
1995	-	-	30	748	692	7	1	5	1	16,162	-	936	6,985	67	252	13	25,899
1996	-	-	42[3]	746	618	37	-	2	-	21,675	-	523	1,641	408	305	121	26,118
1997	-	-	7	1,011	538	39[2]	-	11	-	18,839	1	535	4,556	308	235	29	26,109
1998	-	-	98	567	231	47[3]	-	28	-	26,273	13	131	5,278	228	211	94	33,199
1999	-	-	108	61[3]	430	97	14	10	-	24,634	6	68	4,422	36	247	62	30,195
2000	-	-	67[3]	25	222	51	65	1	-	19,052	2	131	4,631	87		203[6]	24,537
2001	-	-	69[3]	397	436	39	38	5	-	23,133[1]	5	186	4,738	91	Estonia	239[6]	29,376
2002	-	-	70[3]	89	141	49[1]	44	4	-	10,601[1]	8[3]	276	4,736	193[2]	15	234[6]	16,460
2003	-	-	16[3]	25	153	44[3]	9	5[3]	89	8,140[1]	7	50	1,431	47	Sweden	258[6]	10,275
2004[1]	-	-	64[3]	17[3]	78	24[3]	40	3	33	7,658	42	240	3,601	260	1	146[6]	12,206

[1] Provisional figures.
[2] Working Group figure.
[3] As reported to Norwegian authorities.
[4] Includes former GDR prior to 1991.
[5] USSR prior to 1991.
[6] UK(E&W)+UK(Scot.)

1.5.5.a *Sebastes mentella* in Subareas I and II

State of the stock

Spawning biomass in relation to precautionary limits	Fishing mortality in relation to precautionary limits	Fishing mortality in relation to highest yield	Comment
Reduced reproductive capacity	Unknown	Unknown	Recruitment failure since 1991

In the absence of defined reference points, the state of the stock cannot be evaluated with regard to these. The only year classes that can contribute to the spawning stock are those prior to 1991 as the following 14 year classes are extremely poor. Surveys indicate that the stock, at present, is near a historical low. The 1991–2004 year classes are indicated to be well below those of the 1980s (see Figure 1.5.5.a.1).

Management objectives

There are no management objectives.

Reference points

No precautionary reference points have been established for this stock.

Single-stock exploitation boundaries

Exploitation boundaries in relation to precautionary limits

The measures introduced in 2003 should be continued, i.e. there should be no directed trawl fishery on this stock and the area closures and low bycatch limits should be retained, until a significant increase in the spawning stock biomass (and a subsequent increase in the number of juveniles) has been detected in the surveys.

Management considerations

Recruitment failure has been observed in surveys for more than a decade. In this regard, it is of vital importance that the juvenile age groups be given the strongest protection from being caught as bycatch in any fishery, i.e. the shrimp fisheries in the Barents Sea and Svalbard area. This will ensure that the recruiting year classes can contribute as much as possible to stock rebuilding.

The only year classes that can contribute to the spawning stock are those prior to 1991 as the following year classes are extremely poor. Consequently, these year classes need to be protected as they offer the only opportunity of increasing the spawning stock for a number of years to come.

Based on estimates of current SSB and the size of year classes in the 1990s, this stock will not be able to support a directed fishery for at least several more years. Rather, it will be necessary to prevent the stock from declining further and to maintain measures to protect this stock from bycatch in other fisheries.

Factors affecting the fisheries and the stock

Regulations and their effects

Since January 1st 2003, all directed trawl fisheries for *S. mentella* have been forbidden in the Norwegian EEZ north of 62°N and in the Svalbard area. Additional protection for adult *S. mentella* comprises area closures. Outside permanently closed areas it is, however, legal to have up to 20% redfish (both species together) in round weight as bycatch per haul and onboard at any time when fishing for other species. Since January 1st, 2005, the bycatch percentage has been reduced to 15% (both species together). ICES considers this value to be appropriate only if it reflects the lowest rate of unavoidable redfish bycatch.

ICES consider that the area closures and low bycatch limits should be retained. An important management objective should be to ensure that the recruiting year classes get the highest possible protection (e.g., in the shrimp fishery) so that they can contribute as much as possible to stock rebuilding.

Changes in fishing technology and fishing patterns

Bycatches are taken in gadoid and shrimp-trawl fisheries. After the introduction of sorting grids in 1993, discarding in the shrimp fishery was reduced. Small redfish less than 18–20 cm are, however, not sorted out by the grid, and criteria for the maximum number of redfish per kilogram shrimp are enforced (10 juvenile redfish per 10 kg shrimp). However, shrimp fishing fields are seldom closed due to this redfish bycatch criterion. Since the current criterion seldom results in extra protection of redfish it may also be considered to decrease the number of redfish allowed as bycatch per 10 kg shrimp as long as the redfish year classes are weak. An important contribution to the rebuilding of the *S. mentella* stock may therefore be to decrease the number of redfish allowed as bycatch per 10 kg shrimp.

For 2004, landings of *S. mentella* taken in the pelagic Russian fishery for herring and blue whiting in the Norwegian Sea were reported to ICES. Of a total Russian catch of 2879 tonnes in 2004, 1510 tonnes (52%) were reported taken as bycatch in these pelagic fisheries. The working group believes that similar bycatches of *S. mentella* may have been taken by other national fleets, but then either discarded or put together with the other species into meal production. Better statistics on this bycatch, and regulations to prevent this continuing, are needed.

Other factors

Traditionally, the directed fishery was conducted by Russia and other East-European countries on grounds from south of Bear Island towards Spitsbergen. From the mid-1970s to the mid-1980s, large catches were taken annually. From the mid-1980s, Norwegian trawlers started fishing along the continental slope (around 500-m depth) further south, on grounds never harvested before, and inhabited primarily by mature fish. After a sharp decrease in the landings from the traditional area until 1987, this fishery on new grounds resulted in a temporary increase in the landings until 1991, after which the landings declined. Since 1991, the fishery has been dominated by Norway and Russia.

Scientific basis

Data and methods

No analytical assessment was possible. Information is based on Norwegian and Russian research vessel surveys carried out since 1980. These surveys provide information on both recruitment and spawning stock biomass.

Uncertainties in assessment and forecast

The signals of the various surveys are in agreement.

Comparison with previous assessment and advice

No change.

Source of information

Report of the Arctic Fisheries Working Group, 19–28 April 2005 (ICES CM 2005/ACFM:20).

Year	ICES Advice	Predicted catch corresp. to advice	Agreed TAC	Official landings[1]	ACFM landings of *S. mentella*
1987	Precautionary TAC	70[1]	85	35	11
1988	F ≤ $\mathbf{F}_{0.1}$; TAC	11	-	41	16
1989	*Status quo* F; TAC	12	-	47	24
1990	*Status quo* F; TAC	18	-	63	35
1991	F at $\mathbf{F}_{med}$; TAC	12	-	68	49
1992	If required, precautionary TAC	22	-	32	16
1993	If required, precautionary TAC	18	18	30	13
1994	If required, precautionary TAC	-	-	31	13
1995	Lowest possible F	-	-	26	10
1996	Catch at lowest possible level	-	-	26	8
1997	Catch at lowest possible level	-	-	26	9
1998	No directed fishery, reduce bycatch	-	-	33	14
1999	No directed fishery, reduce bycatch	-	-	30	11
2000	No directed fishery, bycatch at lowest possible level	-	-	25	10
2001	No directed fishery, bycatch at lowest possible level	-	-	29	18
2002	No directed fishery, bycatch at lowest possible level	-	-	16	7
2003	No directed fishery, bycatch at lowest possible level	-	-	10	2
2004	No directed trawl fishery and low bycatch limits	-	-	12	5
2005	No directed trawl fishery and low bycatch limits	-	-		
2006	No directed trawl fishery and low bycatch limits	-	-		

[1] Includes both *S. mentella* and *S. marinus*. Weights in '000 t.

Sebastes mentella in Subareas I & II

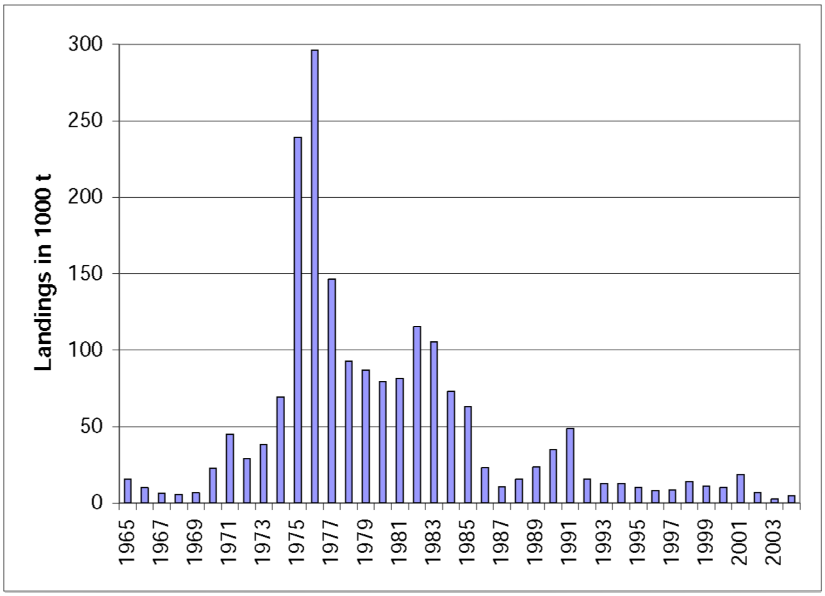


Table 1.5.5.a.1 *Sebastes mentella*. Nominal catch (t) by countries in Subarea I, Divisions IIa and IIb combined.

Year	Canada	Denmark	Faroe Islands	France	Germany[3]	Greenland	Ireland
1986	-	-	-	-	1,252	-	-
1987	-	-	200	63	1,321	-	-
1988			No species specific data available by country.				
1989	-	-	335	1,111	3,833	-	-
1990	-	-	108	142	6,354	36	-
1991	-	-	487	85	-	23	-
1992	-	-	23	12	-	-	-
1993	8	4	13	50	35	1	-
1994	-	28	4	74	18	1	3
1995	-	-	3	16	176	2	4
1996	-	-	4	75	119	3	2
1997	-	-	4	37	81	16	6
1998	-	-	20	73	100	14	9
1999	Iceland	-	73	26	202	50	3
2000	48	Estonia	50	12	62	29	1
2001	3	-	52	16	198	17	4
2002	41	15	53	58	99	18	4
2003	5	-	8	18	32	8	5
2004[1]	10	-	52	13	10	4	3

Year	Norway	Poland	Portugal	Russia[4]	Spain	UK (Eng. & Wales)	UK (Scotland)	Total
1986	1,274	-	1,273	17,815	-	84	-	23,112[2]
1987	1,488	-	1,175	6,196	25	49	1	10,455
1988			No species specific data available by country.					15,586
1989	4,633	-	340	13,080	5	174	1	23,512
1990	10,173	-	830	17,355	-	72	-	35,070
1991	33,592	-	166	14,302	1	68	3	48,727
1992	10,751	-	972	3,577	14	238	3	15,590
1993	5,182	-	963	6,260	5	293	-	12,814
1994	6,511	-	895	5,021	30	124	12	12,721
1995	2,646	-	927	6,346	67	93	4	10,284
1996	6,053	-	467	925	328	76	23	8,075
1997	4,657	1	474	2,972	272	71	7	8,598
1998	9,733	13	125	3,646	177	93	41	14,045
1999	7,884	6	65	2,731	29	112	28	11,209
2000	6,020	2	115	3,519	87		130[5]	10,075
2001	13,975[1]	5	179	3,775	90		120[5]	18,434
2002	2,129[1]	8	242	3,904	190	Sweden	188[5]	6,949
2003	1,222[1]	7	44	952	47	-	124[5]	2,471
2004[1]	1,331	42	235	2,879	257	1	76[5]	4,914

[1] Provisional figures.
[2] Including 1,414 tonnes in Division IIb not split on countries.
[3] Includes former GDR prior to 1991.
[4] USSR prior to 1991.
[5]UK(E&W)+UK(Scot.)

Table 1.5.5.a.2 *Sebastes mentella*. Nominal catch (t) by countries in Subarea I.

Year	Faroe Islands	Germany[4]	Greenland	Norway	Russia[5]	UK(Eng. &Wales)	Iceland	Total
1986[3]	-	-	-	1,274	911	-	-	2,185
1987[3]	-	2	-	1,166	234	3	-	1,405
1988			No species specific data presently available					
1989	13	-	-	60	484	9[2]	-	566
1990	2	-	-	-	100	-	-	102
1991	-	-	-	8	420	-	-	428
1992	-		-	561	408	-	-	969
1993	2[2]	-	-	16	588	-	-	606
1994	2[2]	2	-	36	308	-	-	348
1995	2[2]	-	-	20	203	-	-	225
1996	-	-	-	5	101	-	-	106
1997	-	-	3[2]	12	174	1[2]	-	190
1998	20[2]	-	-	26	378	-	-	424
1999	69[2]	-	-	69	489	-	-	627
2000	-	-	-	47	406	-	48[2]	501
2001	-	-	-	8[1]	296	-	3[2]	307
2002	-	-	-	4[1]	587	-	-	591
2003	-	-	-	6[1]	292	-	-	298
2004[1]	-	-	-	3	355	-	-	358

[1] Provisional figures.
[2] Split on species according to reports to Norwegian authorities.
[3] Based on preliminary estimates of species breakdown by area.
[4] Includes former GDR prior to 1991.
[5] USSR prior to 1991.

Table 1.5.5.a.3 *Sebastes mentella*. Nominal catch (t) by countries in Division IIa.

Year	Faroe Islands	France	Germany[4]	Greenland	Ireland	Norway
1986[3]	-	-	1,252	-	-	-
1987[3]	200	63	970	-	-	149
1988	No species specific data presently available					
1989	312[2]	1,065[2]	3,200	-	-	4,573
1990	98[2]	137[2]	1,673	-	-	8,842
1991	487[2]	72[2]	-	-	-	32,810
1992	23[2]	7[2]	-	-	-	9,816
1993	11[2]	15[2]	35	1[2]	-	5,029
1994	2[2]	33[2]	16[2]	1[2]	2[2]	6,119
1995	1[2]	16[2]	176[2]	2[2]	2[2]	2,251
1996	-	75[2]	119[2]	3[2]	-	5,895
1997	-	37[2]	77	12[2]	2[2]	4,422
1998	-	73[2]	58[2]	14[2]	6[2]	9,186
1999	-	16[2]	160[2]	50[2]	3[2]	7,358
2000	50[2]	11[2]	35[2]	29[2]	-	5,892
2001	33[2]	12[2]	161[2]	17[2]	4[2]	13,673[1]
2002	14[2]	54[2]	59[2]	18[2]	4[2]	1,917[1]
2003	5[2]	17[2]	17[2]	8[2]	5[2]	1,023[1]
2004[1]	17[2]	8[2]	4[2]	4[2]	3[2]	1,026

Year	Sweden	Portugal	Russia[5]	Spain	UK (Eng.& Wales)	UK (Scotland)	Total
1986[3]		1,273	16,904	-	84	-	19,513
1987[3]		1,156	4,469	-	34	1	7,042
1988	No species specific data presently available						
1989		251	9,749	-	158[2]	1[2]	19,309
1990		824	6,492	-	9	-	18,075
1991		159[2]	7,596	-	23[2]	-	41,147
1992		824[2]	1,096	-	27[2]	-	11,793
1993		648[2]	5,328	-	2[2]	-	11,069
1994		687[2]	4,692	8[2]	4[2]	-	11,564
1995		715[2]	5,916	65[2]	41[2]	2[2]	9,187
1996		429[2]	677	5[2]	42[2]	19[2]	7,264
1997		410[2]	2,341	9[2]	48[2]	7[2]	7,365
1998		118[2]	2,626	55[2]	65[2]	41[2]	12,242
1999		56[2]	1,340	14[2]	94[2]	26[2]	9,117
2000		98[2]	2,167	18[2]	Iceland	103[2,6]	8,403
2001		105[2]	2,716	18[2]	-	95[2,6]	16,834
2002		124[2]	2,615	8[2]	41[2]	157[2,6]	5,011
2003		17[2]	448	8[2]	5[2]	102[2,6]	1,655
2004[1]	1[2]	86[2]	2,081	7[2]	10[2]	18[2,6]	3,266

[1] Provisional figures.
[2] Split on species according to reports to Norwegian authorities.
[3] Based on preliminary estimates of species breakdown by area.
[4] Includes former GDR prior to 1991.
[5] USSR prior to 1991.
[6] UK(E&W)+UK(Scot.)

Table 1.5.5.a.4 *Sebastes mentella*. Nominal catch (t) by countries in Division IIb.

Year	Canada	Denmark	Faroe Islands	France	Germany[5]	Greenland	Ireland
1986[4]			Data not available on countries				
1987[4]	-	-	-	-	349	-	-
1988			No species specific data presently available				
1989	-	-	10	28	633	-	-
1990	-	-	8[2]	5[2]	4,681	36[2]	-
1991	-	-	-	13[2]	-	23	-
1992	-	-	-	5[2]	-	-	-
1993	8[2]	4[2]	-	35[2]	-	-	-
1994	-	28[2]	-	41[2]	-	-	1[2]
1995	-	-	-	-	-	-	2[2]
1996	-	-	4[2]	-	-	-	2[2]
1997	-	-	4[2]	-	3	1[2]	4[2]
1998	-	-	-	-	42[2]	-	3[2]
1999	-	-	4[2]	10[2]	42[2]	-	-
2000	-	-	-	1[2]	27[2]	-	1[2]
2001	-	-	19[2]	4[2]	37[2]	-	-
2002	-	-	39[2]	4[2]	40[2]	-	-
2003	-	-	3[2]	1[2]	15[2]	-	-
2004[1]	-	-	35[2]	5[2]	6[2]	-	-

Year	Norway	Poland	Portugal	Russia[6]	Spain	UK(Eng. & Wales)	UK (Scotland)	Total
1986[4]			Data not available on countries					1,414
1987[4]	173	-	19	1,493	25	12	-	2,071
1988			No species specific data presently available					
1989	-	-	89	2,847	5	7[2]	-	3,619
1990	1,331	-	6	10,763	-	63[2]	-	16,893
1991	774	-	7	6,286	1	45[2]	3[2]	7,152
1992	374	-	148[2]	2,073	14	211[2]	3[2]	2,828
1993	137	-	315[2]	344	57[3]	291[2]	-	1,191
1994	356	-	208[2]	21	22[3]	120[2]	12[2]	809
1995	375	-	212[2]	227	2[3]	52[2]	2[2]	872
1996	153	-	38[2]	147	323[2]	34[2]	4[2]	705
1997	223	1[2]	64[2]	457	263[2]	22[2]	-	1,042
1998	521	13[2]	7[2]	642	122[2]	28[2]	1[2]	1,379
1999	457	6[2]	9[2]	902	15[2]	18[2]	2[2]	1,465
2000	82	2[2]	17[2]	946	69[2]		27[2,7]	1,172
2001	294[1]	5[2]	74[2]	763	72[2]	Estonia	25[2,7]	1,293
2002	208[1]	8[2]	118[2]	702	182[2]	15[8]	31[2,7]	1,347
2003	192[1]	7	27[2]	212	39[2]	-	22[2,7]	518
2004[1]	302	42[2]	149[2]	443	250[2]	-	58[2,7]	1,290

[1] Provisional figures.
[2] Split on species according to reports to Norwegian authorities.
[3] Split on species according to the 1992 catches.
[4] Based on preliminary estimates of species breakdown by area.
[5] Includes former GDR prior to 1991.
[6] USSR prior to 1991.
[7]UK(E&W)+UK(Scot.)
[8]Split on species by Working Group.

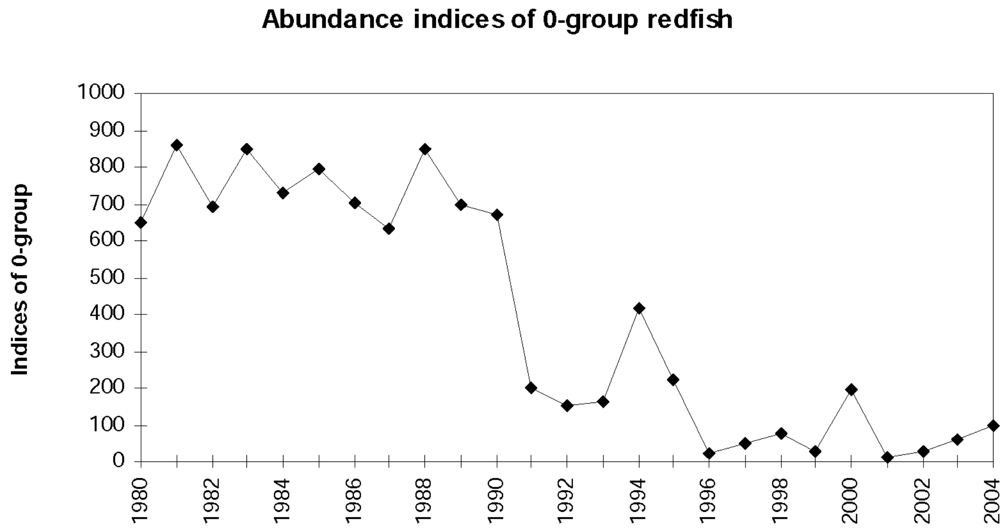


Figure 1.5.5.a.1 Abundance indices of 0-group redfish (believed to be mostly *S. mentella*) in the international 0-group survey in the Barents Sea and Svalbard areas in August–September 1980–2004.

1.5.6 Redfish (*Sebastes marinus*) in Subareas I and II

State of the stock

Spawning biomass in relation to precautionary limits	Fishing mortality in relation to precautionary limits	Fishing mortality in relation to highest yield	Comment
Reduced reproductive capacity	Unknown	Unknown	Recruitment failure since the early 1990s

In the absence of defined reference points, the state of the stock cannot be evaluated with regard to these. Surveys and commercial CPUE show a substantial reduction in abundance and indicate that the stock at present is historically low (Figure 1.5.6.1). The year classes in the last decade have been very low and declining. Presently, this stock is thus in a very poor condition with reduced reproductive capacity. This situation is expected to remain for a considerable period.

Management objectives

There are no management objectives.

Reference points

There are no reference points.

Single-stock exploitation boundaries

Exploitation boundaries in relation to precautionary limits

ICES considers that the area closures and low bycatch limits should be retained, and reiterates that stronger regulations than those recently enforced are needed given the continued decline in SSB and recruitment. The current measures are insufficient to prevent the stock from declining further.

Management considerations

More stringent protective measures should be implemented, such as no directed fishing and extension of the limited moratorium, as well as a further improvement of the trawl bycatch regulations.

It is also of vital importance that the juvenile age groups be given the strongest protection from being caught as bycatch in any fishery, e.g. the shrimp fisheries in the coastal areas as well as in the Barents Sea and Svalbard area. This will ensure that the recruiting year classes can contribute as much as possible to slowing the decline of the stock.

S. marinus is currently being caught, as well, as bycatch in the pelagic trawl fishery for herring and blue whiting in the Norwegian Sea. Much of this is probably discarded or put together with the target species in the fishmeal production. Better statistics on this bycatch, and regulations to prevent this continuing, are needed.

Factors affecting the fisheries and the stock

Regulations and their effects

In 2005, all directed trawl fisheries for redfish (both *S. marinus* and *S. mentella*) outside the permanently closed areas have been forbidden in the Norwegian EEZ north of 62°N and in the Svalbard area. It is, however, legal to have up to 15% redfish (both species together) in round weight as bycatch per haul and onboard at any time when trawling for other species.

A minimum legal landing size of 32 cm has been set for all Norwegian fisheries and international fisheries in the Norwegian EEZ, with the allowance to have up to 10% undersized (i.e., less than 32 cm) specimens of *S. marinus* (in numbers) per haul. In addition, a limited moratorium during April 20–June 19 has been enforced in all fisheries except trawl. When fishing for other species (also during the moratorium), it is allowed to have up to 20% bycatch of redfish (in round weight) summarized during a week fishery from Monday to Sunday. From January 2006, it will be forbidden to use gillnets with mesh size less than 120 mm when fishing for redfish.

The limited moratorium enforced in 2004 seems to have reduced the catches by about 500 t. This is unfortunately an insignificant contribution for preventing further reduction in this stock. Increasing the mesh size for gillnets will have, by itself, minor effects on reducing the current catch level for rebuilding the stock.

Other factors

The fishery is mainly conducted by Norway, accounting for 80–90% of the historical total catch. The fish are caught mainly by trawl and gillnet, and to a lesser extent by longline, Danish seine, and handline, in that order. Some of the catches are taken in mixed fisheries together with saithe and cod. Important fishing grounds are the Møre area (Svinøy), Halten Bank, outside Lofoten and Vesterålen, and at Sleppen outside Finnmark.

Scientific basis

Data and methods

Information is based on Norwegian and Russian research vessel surveys carried out since 1986 as well as from CPUE (kg per trawl hour) from Norwegian trawlers since 1992.

An exploratory assessment was conducted using a simulation model covering the 1986—2004 period. Input data to the model were two fishing fleets (gillnet and other gears) with catch in tonnes, by length and age on a quarterly basis, and the annual Barents Sea joint bottom trawl survey with catch in numbers by length and age. Work on that model is continuing.

Comparison with previous assessment and advice

All present available information confirms last year's evaluation of the stock status.

Source of information

Report of the Arctic Fisheries Working Group, 19–28 April 2005 (ICES CM 2005/ACFM:20).

Year	ICES Advice	Predicted catch corresp. To advice	Agreed TAC	Official landings[1]	ACFM landings of *S. marinus*
1987	Precautionary TAC	-	-	35	24
1988	Reduction in F; TAC	15	-	41	26
1989	*Status quo* F; TAC	24	-	47	23
1990	*Status quo* F; TAC	23	-	63	28
1991	Precautionary TAC	24	-	68	19
1992	If required, precautionary TAC	25	-	32	16
1993	Precautionary TAC	12	12	30	17
1994	If required, precautionary TAC	-	-	31	18
1995	If required, precautionary TAC	-	-	26	16
1996	If required, precautionary TAC	-	-	26	18
1997	If required, precautionary TAC	-	-	26	18
1998	Management plan required as pre-requisite to continued fishing	-	-	33	19
1999	Management plan required as pre-requisite to continued fishing	-	-	30	19
2000	Management plan required as pre-requisite to continued fishing	-	-	25	14
2001	Management plan required as pre-requisite to continued fishing	-	-	29	11
2002	Management plan required as pre-requisite to continued fishing	-	-	16	10
2003	Management plan required as pre-requisite to continued fishing	-	-	10	8
2004	No directed trawl fishery and low bycatch limits	-	-	12	7
2005	More stringent protective measures	-	-		
2006	More stringent protective measures	-	-		

[1]Includes both *S. mentella* and *S. marinus*. Weights in '000 t.

Sebastes marinus in Subareas I & II

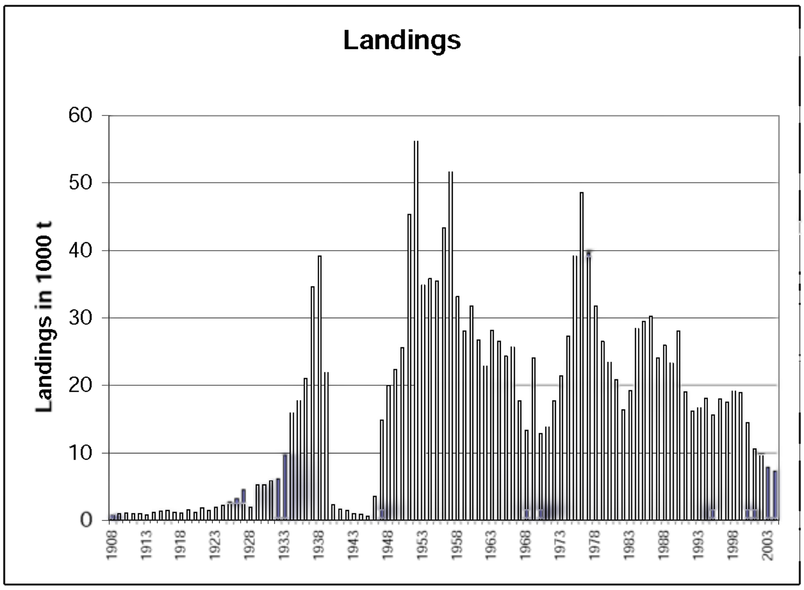


Table 1.5.6.1 *Sebastes marinus*. Nominal catch (t) by countries in Subarea I and Divisions IIa and IIb combined.

Year	Faroe Islands	France	Germany[2]	Greenland	Iceland	Ireland	Netherlands
1986	29	2,719	3,369	-	-	-	-
1987	250	1,553	4,508	-	-	-	-
1988	No species specific data presently available on countries						
1989	3	796	412	-	-	-	-
1990	278	1,679	387	1	-	-	-
1991	152	706	981	-	-	-	-
1992	35	1,289	530	623	-	-	-
1993	139	871	650	14	-	-	-
1994	22	697	1,008	5	4	-	-
1995	27	732	517	5	1	1	1
1996	38	671	499	34	-	-	-
1997	3	974	457	23	-	5	-
1998	78	494	131	33	-	19	-
1999	35	35	228	47	14	7	-
2000	17	13	160	22	16	-	-
2001	17	30	238	17	-	1	-
2002	17	31	42	31	3	-	-
2003	8	8	121	36	4	-	89
2004[1]	12	4	68	20	30		33

Year	Norway	Portugal	Russia[3]	Spain	UK (Eng. & Wales)	UK (Scotl)	Total
1986	21,680	-	2,350	-	42	14	30,203
1987	16,728	-	850	-	181	7	24,077
1988	No species specific data presently available on countries						25,908
1989	20,662	-	1,264	-	97	-	23,234
1990	23,917	-	1,549	-	261	-	28,072
1991	15,872	-	1.052	-	268	10	19,041
1992	12,700	5	758	2	241	2	16,185
1993	13,137	77	1,313	8	441	1	16,651
1994	14,955	90	1,199	4	135	1	18,120
1995	13,516	9	639	-	159	9	15,616
1996	15,622	55	716	81	229	98	18,043
1997	14,182	61	1,584	36	164	22	17,511
1998	16,540	6	1,632	51	118	53	19,155
1999	16,750	3	1,691	7	135	34	18,986
2000	13,032	16	1,112	-		73[4]	14,461
2001	9,158[1]	7	963	1		119[4]	10,551
2002	8,472[1]	34	832	3		46[4]	9,511
2003	6,918[1]	6	479	-		134[4]	7,803
2004[1]	6,327[1]	5	722	3		69[4]	7,292

[1] Provisional figures.
[2] Includes former GDR prior to 1991.
[3] USSR prior to 1991.
[4] UK(E&W)+UK(Scot.)

Table 1.5.6.2 *Sebastes marinus*. Nominal catch (t) by countries in Subarea I.

Year	Faroe Islands	Germany[4]	Greenland	Iceland	Norway	Russia[5]	UK(Eng &Wales)	UK (Scotl)	Total
1986[3]	-	50	-	-	2,972	155	32	3	3,212
1987[3]	-	8	-	-	2,013	50	11	-	2,082
1988				No species specific data presently available					
1989	-	-	-	-	1,763	110	4[2]	-	1,877
1990	5	-	-	-	1,263	14	-	-	1,282
1991	-	-	-	-	1,993	92	-	-	2,085
1992	-	-	-	-	2,162	174	-	-	2,336
1993	24[2]	-	-	-	1,178	330	-	-	1,532
1994	12[2]	72	-	4	1,607	109		-	1,804
1995	19[2]	1[2]	-	1[2]	1,947	201	1[2]	-	2,170
1996	7[2]	-	-	-	2,245	131	3[2]	-	2,386
1997	3[2]	-	5[2]	-	2,431	160	2[2]	-	2,601
1998	78[2]	5[2]	-	-	2,109	308	30[2]	-	2,530
1999	35[2]	18[2]	9[2]	14[2]	2,114	360	11[2]	-	2,561
2000	-	1[2]	-	16[2]	1,983	146		12[6]	2,159
2001	-	11[2]	-	-	1,056[1]	128	France	16[6]	1,211
2002	-	5[2]	-	-	686[1]	220	1[2]	9[2,6]	921
2003	-	-	1	-	823[1]	140		4	968
2004[1]	-	-	-	-	1,157	213	-	12	1,382

[1] Provisional figures.
[2] Split on species according to reports to Norwegian authorities.
[3] Based on preliminary estimates of species breakdown by area.
[4] Includes former GDR prior to 1991.
[5] USSR prior to 1991.
[6] UK(E&W)+UK(Scot.)

Table 1.5.6.3 *Sebastes marinus*. Nominal catch (t) by countries in Division IIa.

Year	Faroe Islands	France	Germany[4]	Greenland	Ireland	Netherlands	Norway	Portugal	Russia[5]	Spain	UK (Eng. & Wales)	UK (Scotl.)	Total
1986[3]	29	2,719	3,319	-	-	-	18,708	-	2,195	-	10	11	26,991
1987[3]	250	1,553	2,967	-	-	-	14,715	-	800	-	170	7	20,462
1988					No species specific data presently available								
1989	3[2]	784[2]	412	-	-	-	18,833	-	912	-	93[2]	-	21,037
1990	273	1,684[2]	387	-	-	-	22,444	-	392	-	261	-	25,441
1991	152[2]	706[2]	678	-	-	-	13,835	-	534	-	268[2]	10[2]	16,183
1992	35[2]	1,294[2]	211	614	-	-	10,536	-	404	-	206[2]	2[2]	13,302
1993	115[2]	871[2]	473	14[2]	-	-	11,959	77[2]	940	-	431[2]	1[2]	14,881
1994	10[2]	697[2]	654[2]	5[2]	-	-	13,330	90[2]	1,030	-	129[2]	-	15,945
1995	8[2]	732[2]	328[2]	5[2]	1[2]	1	11,466	2[2]	405	-	158[2]	9[2]	13,115
1996	27[2]	671[2]	448[2]	34[2]	-	-	13,329	51[2]	449	5[2]	223[2]	98[2]	15,335
1997	-	974[2]	438	18[2]	5[2]	-	11,708	61[2]	1,199	36[2]	162[2]	22[2]	14,623
1998	-	494[2]	116[2]	33[2]	19[2]	-	14,326	6[2]	1,078	51[2]	85[2]	52[2]	16,260
1999	-	35[2]	210[2]	38[2]	7[2]	-	14,598	3[2]	976	7[2]	122[2]	34[2]	16,030
2000	17[2]	13[2]	159[2]	22[2]	-	-	11,038	16[2]	658	-		61[6]	11,984
2001	17[2]	30[2]	227[2]	17[2]	1[2]	-	8,023[1]	6[2]	612	1[2]	Iceland	103[2,6]	9,037
2002	17[2]	30[2]	37[2]	31[2]	-	-	7,680[1]	18[2]	192	2[2]	3[2]	32[2,6]	8,042
2003	8[2]	8[2]	121[2]	35[2]	-	89[2]	6,027[1]	6[2]	264		4[2]	130[2,6]	6,692
2004[1]	12[2]	4[2]	68[2]	20[2]	-	33[2]	5,071	5[2]	396	3[2]	30[2]	58[2,6]	5,699

[1] Provisional figures.
[2] Split on species according to reports to Norwegian authorities.
[3] Based on preliminary estimates of species breakdown by area.
[4] Includes former GDR prior to 1991.
[5] USSR prior to 1991.
[6] UK(E&W)+UK(Scot.)

Table 1.5.6.4 *Sebastes marinus*. Nominal catch (t) by countries in Division IIb.

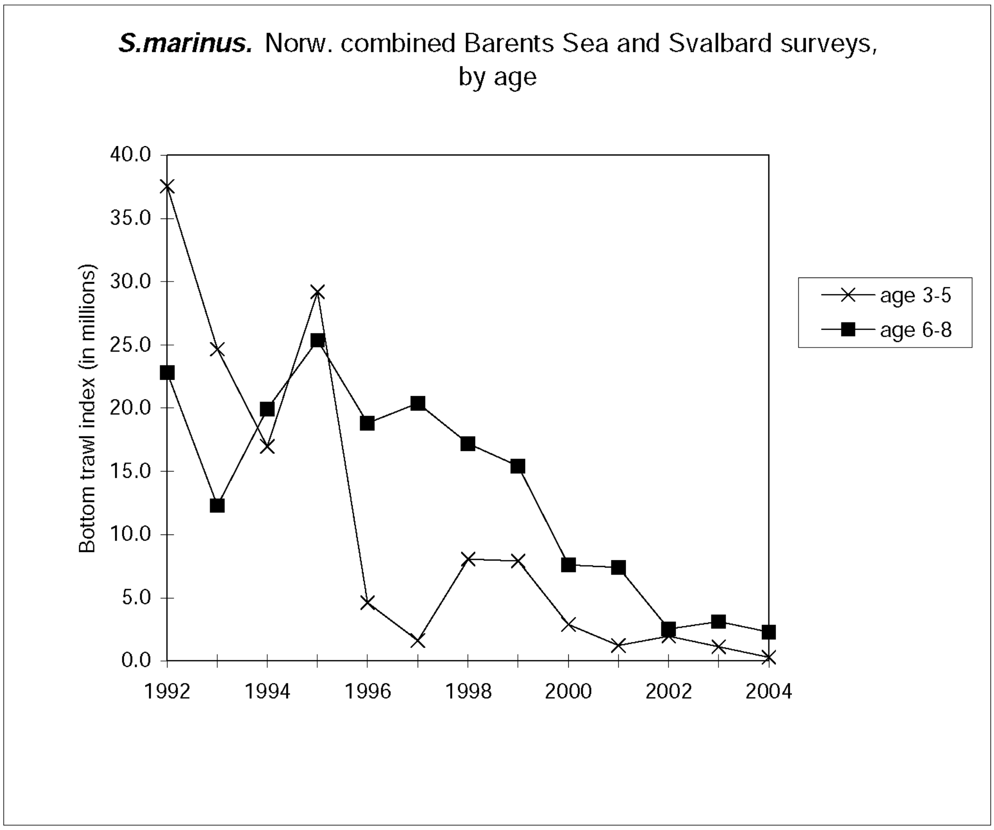
Year	Faroe Islands	Germany[5]	Greenland	Norway	Portugal	Russia[6]	Spain	UK(Eng. & Wales)	UK (Scotl.)	Total
1986	-									+
1987[4]	-	1533	-	-	-	-	-	-	-	1533
1988				No species specific data presently available						
1989	-	-	-	66	-	242	-	-	-	308
1990	-	-	1[2]	210	-	1157	-	-	-	1368
1991	-	303	-	44	-	426	-	-	-	773
1992	-	319	9[2]	2	5[2]	180	2	35[2]	-	552
1993	-	177	-	-	-	43	8[3]	10[2]	-	238
1994	-	282	-	18	-	60	4[3]	6[2]	1[2]	371
1995	-	187	-	103	7	33	-	-	-	330
1996	4	51[2]	-	27	5	136	76[2]	3[2]	-	302
1997	-	20	-	43	-	225	-	-	-	288
1998	-	10[2]	-	105	-	246	-	3[2]	-	364
1999	-	-	-	38	-	355	-	2[2]	-	395
2000	-	-	-	10	-	308	-	-	-	318
2001	-	-	-	79[1]	1[2]	223	-	-	-	303
2002	-	-	-	106[1]	16[2]	420	1[2]	-	5[2, 7]	548
2003	-	-	-	69[1]	-	75	-		-	144
2004[1]	-	-	-	98	-	113	-	-	-	211

[1] Provisional figures.
[2] Split on species according to reports to Norwegian authorities.
[3] Split on species according to the 1992 catches.
[4] Based on preliminary estimates of species breakdown by area.
[5] Includes former GDR prior to 1991.
[6] USSR prior to 1991.
[7]UK(E&W)+UK(Scot.)

Table 1.5.6.5 *Sebastes marinus* in Subareas I and II. Total international landings 1908-2003 (thous. tonnes).

Year	Landings '000 t	Year	Landings '000 t
1908	0.65	1957	51.61
1909	1.00	1958	33.12
1910	1.03	1959	28.07
1911	1.01	1960	31.77
1912	1.01	1961	26.73
1913	0.81	1962	22.82
1914	1.14	1963	28.10
915	1.31	1964	26.55
1916	1.46	1965	24.31
1917	1.16	1966	25.63
1918	1.11	1967	17.73
1919	1.51	1968	13.35
1920	1.17	1969	24.07
1921	1.83	1970	12.82
1922	1.47	1971	13.82
1923	1.94	1972	17.73
1924	2.21	1973	21.44
1925	2.72	1974	27.27
1926	3.19	1975	39.13
1927	4.47	1976	48.58
1928	1.95	1977	39.51
1929	5.28	1978	31.74
1930	5.29	1979	26.48
1931	5.88	1980	23.41
1932	6.10	1981	20.83
1933	9.59	1982	16.37
1934	15.86	1983	19.26
1935	17.69	1984	28.38
1936	21.03	1985	29.48
1937	34.59	1986	30.20
1938	39.17	1987	24.08
1939	21.87	1988	25.91
1940	2.29	1989	23.23
1941	1.68	1990	28.07
1942	1.43	1991	19.04
1943	1.02	1992	16.19
1944	0.92	1993	16.65
1945	0.56	1994	18.12
1946	3.57	1995	15.62
1947	14.88	1996	18.04
1948	20.00	1997	17.51
1949	22.36	1998	19.16
1950	25.56	1999	18.99
1951	45.30	2000	14.46
1952	56.17	2001[1]	10.55
1953	34.83	2002[1]	9.51
1954	35.78	2003[1]	7.80
1955	35.47	2004[1]	7.29
1956	43.38	Average	17.24

[1] Preliminary



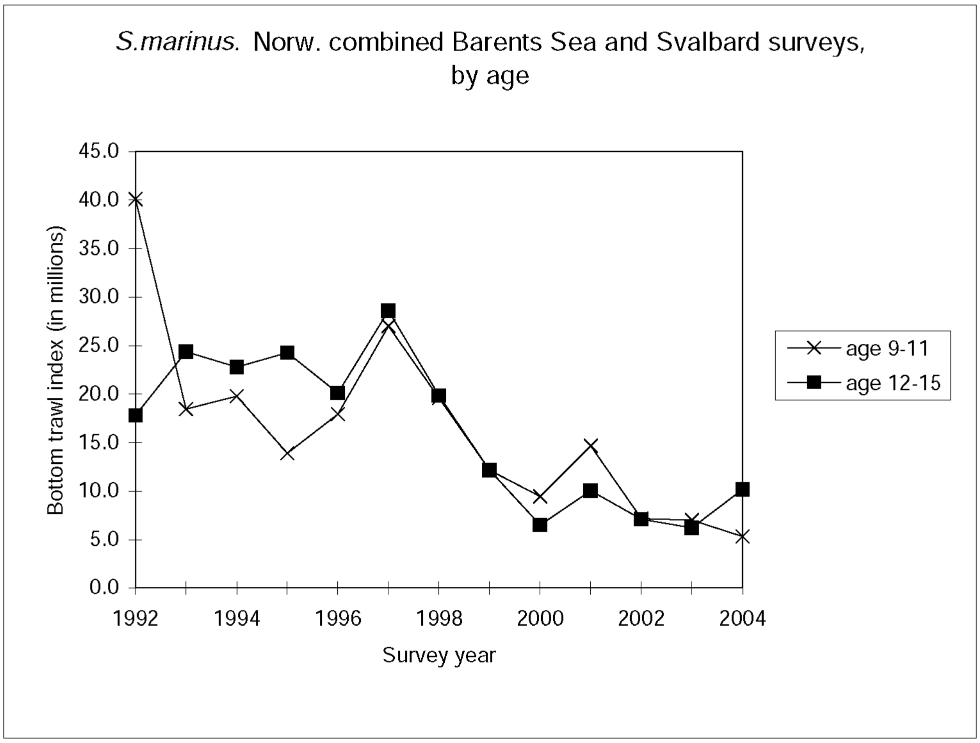


Figure 1.5.6.1. *Sebastes marinus*. Abundance indices (by age) when combining the Norwegian bottom trawl surveys 1992–2004 in the Barents Sea (winter) and at Svalbard (summer/fall).

1.5.7 Greenland halibut in Subareas I and II

State of the stock

Spawning biomass in relation to precautionary limits	Fishing mortality in relation to precautionary limits	Fishing mortality in relation to highest yield	Fishing mortality in relation to agreed target	Comment
Unknown	Unknown	Overexploited	Not applicable	

In the absence of defined reference points, the status of the stock cannot be evaluated with regard to these. The tentative assessment indicates that SSB has been low since the late 1980s, but a slight increase is indicated in recent years. Fishing mortality in recent years is estimated to be below the long-term average. Recruitment has been stable at a low level throughout the 1980s – 1990s.

Management objectives

No explicit management objectives have been established for this stock.

Reference points

No precautionary reference points have been established for this stock. Due to problems in age readings, it is not possible to estimate fishing mortality reference points in absolute terms.

Single-stock exploitation boundaries

Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential and considering ecosystem effects

The current estimated fishing mortality is above fishing mortalities that would lead to high long-term yields. This indicates that long-term yield will increase at Fs well below the historic values. Fishing at such lower mortalities would lead to higher SSB and, therefore, lower risks of reducing stock productivity.

Exploitation boundaries in relation to precautionary limits

The stock has remained at a relatively low size in the last 25 years at catch levels of 15 000–25 000 t. In order to increase the SSB, catches should be kept well below that range. Catches for 2006 should not increase above the recent average of 13 000 t as advised in 2004, to allow for continued increase in the spawning stock.

Management considerations

The stock has been at a low level for several years and it is a long-lived species, which can only sustain low exploitation. The stock is indicated to have increased in recent years both in a tentative assessment and in fishery-independent surveys (see Figure 1.5.7.1). During this period, catches in that fishery have been around 13 000 t. The indication is therefore that the stock has been able to sustain a fishery of that size while still increasing. Given the state of the stock and the paucity of information, the fishery should not be increased further until there is better information and firm evidence of a larger stock size.

Additional management measures to control catches, e.g. TACs covering all catches, area closures, and reduced by-catch limits, need to be introduced and enforced effectively.

Factors affecting the fisheries and the stock

Regulations and their effects

Since 1992, the fishery has been regulated by allowing a directed fishery only by small coastal longline and gillnet vessels. Bycatches of Greenland halibut in the trawl fisheries have been limited by permissible bycatch per haul and allowable bycatch retention limit onboard the vessel. Since 2004, the bycatch is only limited by a catch retention limit onboard the vessel at any time, and this has led to a 160% increase in the Norwegian trawl catch.

The regulations enforced in 1992 reduced the total landings of Greenland halibut by trawlers from 20 000 t to about 6000 t. Since then and until 1998, annual trawler landings have varied between 5000 and 8000 t without any clear trend attributable to changes in allowable bycatch. However, the increase of trawler landings in 1999 and again in 2004 may be attributable to the less restrictive bycatch regulations. Landings of Greenland halibut from the directed longline and gillnet fisheries have also increased in recent years to well above the level of 2500 t set by the Norwegian authorities. This is attributed to the increased difficulties of regulating a fishery that only lasts for a few weeks.

Environment

Greenland halibut occur over a wide range of depths (from 20 to 2200 m) and temperatures (from -1.5 $^{\circ}$C to 10°C). Young Greenland halibut occur mostly in the northeastern Barents Sea (Spitsbergen archipelago and further east to Franz Josef Land) where the presence of adult Greenland halibut or other predators appears minimal. Therefore, Greenland halibut mortality after settling in the area is low and stable, and driven mainly by environmental factors.

Scientific basis

Data and methods

An analytical assessment was based on commercial catch-at-age data, two survey series, and one experimental commercial CPUE series.

Uncertainties in assessment and forecast

The assessment continues to be uncertain due to age-reading problems and lack of contrast in the data. The age-reading issue is being addressed and should be largely resolved for future years, but corrections to past years are required. Nevertheless, it is considered that the assessment reflects the stock trends reasonably well.

Comparison with previous assessment and advice

In comparison to last year's assessment, recent trends are similar.

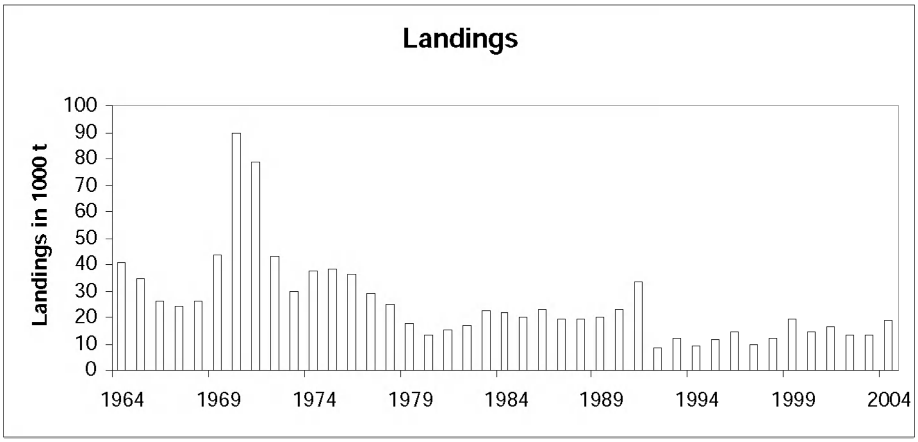
Source of information

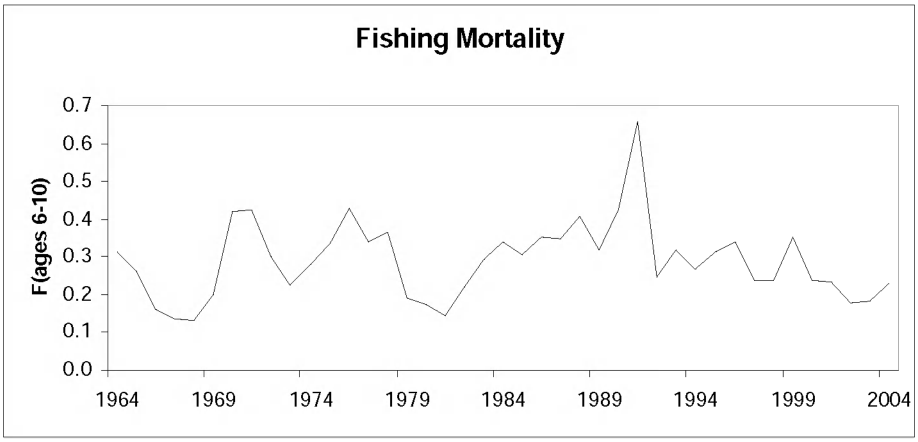
Report of the Arctic Fisheries Working Group, 19–28 April 2005 (ICES CM 2005/ACFM:20)

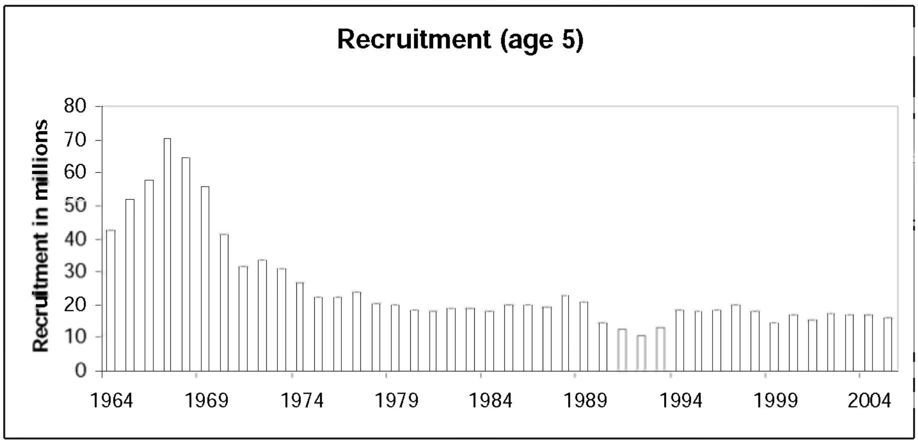
Year	ICES Advice	Predicted catch corresp. to advice	Agreed TAC	Official landings	ACFM landings
1987	Precautionary TAC	-	-	19	19
1988	No decrease in SSB	19	-	20	20
1989	F = F(87); TAC	21	-	20	20
1990	F = F (89); TAC	15	-	23	23
1991	F at $\mathbf{F}_{med}$; TAC; improved expl. pattern	9	-	33	33
1992	Rebuild SSB(1991)	6	7[1]	9	9
1993	TAC	7	7[1]	12	12
1994	F < 0.1	< 12	11[1]	9	9
1995	No fishing	0	2.5[2]	11	11
1996	No fishing	0	2.5[2]	14	14
1997	No fishing	0	2.5[2]	10	10
1998	No fishing	0	2.5[2]	13	13
1999	No fishing	0	2.5[2]	19	19
2000	No fishing	0	2.5[2]	14	14
2001	Reduce catch to rebuild stock	< 11	2.5[2]	16	16
2002	Reduce F substantially	< 11	2.5[2]	13	13
2003	Reduce catch to increase stock	< 13	2.5[2]	13	13
2004	Do not exceed recent low catches	< 13	2.5[2]	19	19
2005	Do not exceed recent low catches	< 13	2.5[2]		
2006	Do not exceed recent low catches	< 13			

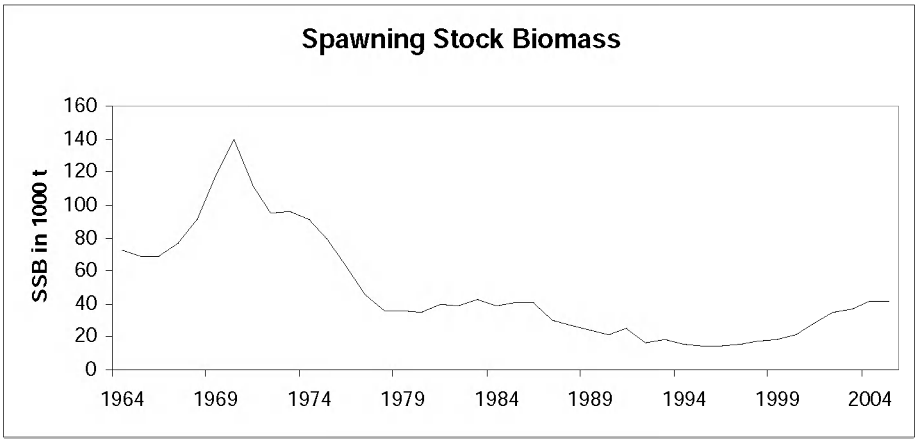
Weights in '000 t.

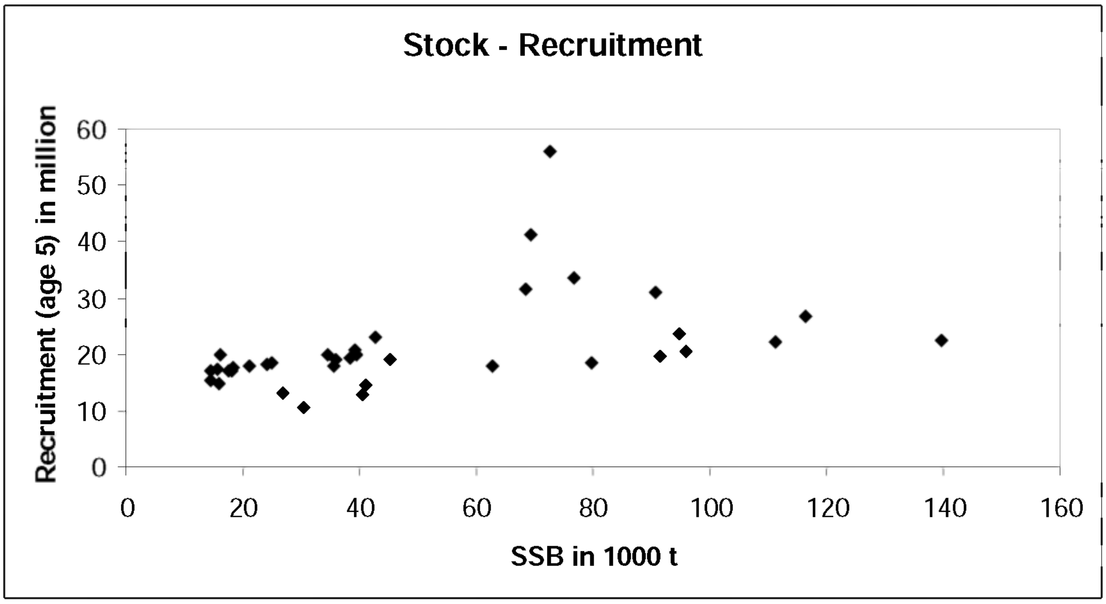
[1]Set by Norwegian authorities. [2]Set by Norwegian authorities for the non-trawl fishery; allowable bycatch in the trawl fishery is additional to this.

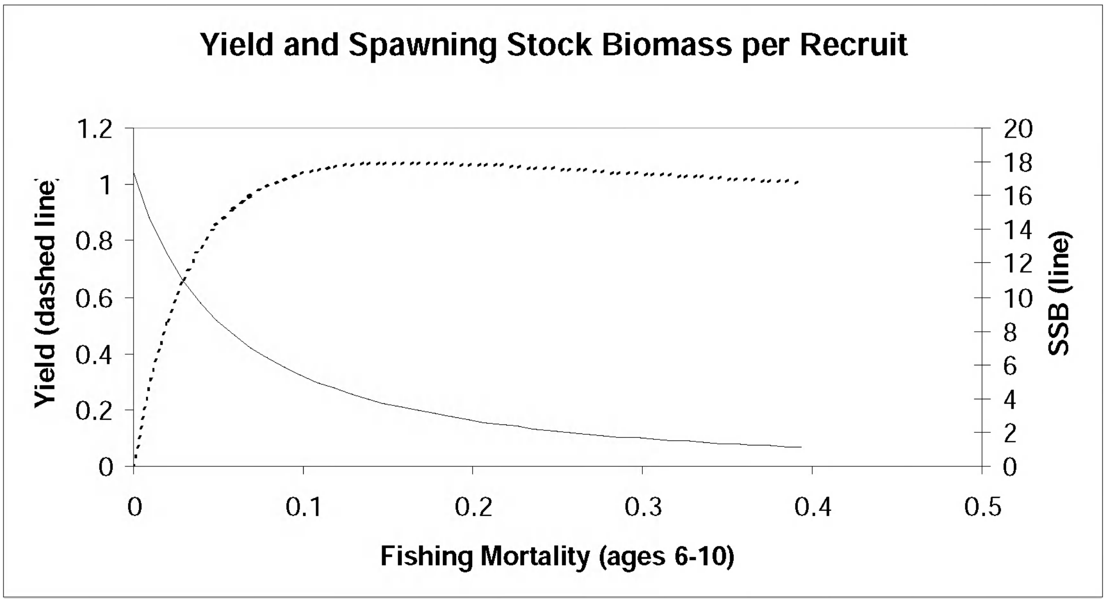

Landings
Landings in 1000 t
100
90
80
70
60
50
40
30
20
10
0
1964
1969
1974
1979
1984
1989
1994
1999
2004


Fishing Mortality
F(ages 6-10)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1964
1969
1974
1979
1984
1989
1994
1999
2004


Recruitment (age 5)
Recruitment in millions
80
70
60
50
40
30
20
10
0
1964
1969
1974
1979
1984
1989
1994
1999
2004


Spawning Stock Biomass
SSB in 1000 t
160
140
120
100
80
60
40
20
0
1964
1969
1974
1979
1984
1989
1994
1999
2004


Stock - Recruitment
Recruitment (age 5) in million
60
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
SSB in 1000 t


Yield and Spawning Stock Biomass per Recruit
Yield (dashed line)
1.2
1
0.8
0.6
0.4
0.2
0
20
18
16
14
12
10
8
6
4
2
0
SSB (line)
0
0.1
0.2
0.3
0.4
0.5
Fishing Mortality (ages 6-10)

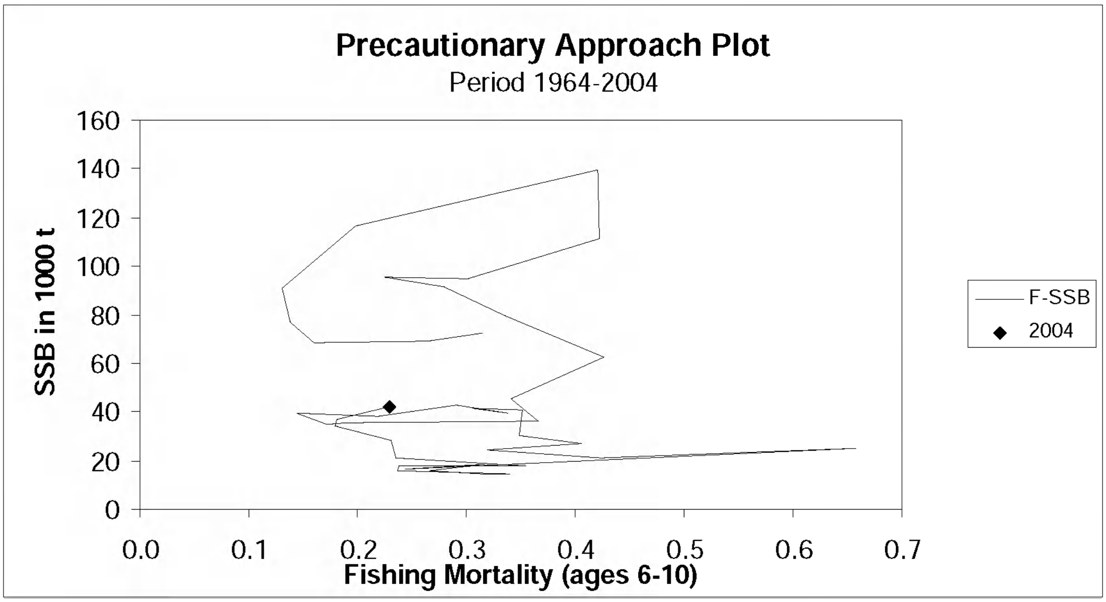

Precautionary Approach Plot
Period 1964-2004
SSB in 1000 t
160
140
120
100
80
60
40
20
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Fishing Mortality (ages 6-10)
F-SSB
2004

Table 1.5.7.1 Greenland halibut. Nominal catch (t) by countries (Subarea I, Divisions IIa and IIb combined) as officially reported to ICES.

Year	Denmark	Estonia	Faroe Isl.	France	Germany	Greenland	Iceland	Ireland	Lithuania
1984	0	0	0	138	2,165	0	0	0	0
1985	0	0	0	239	4,000	0	0	0	0
1986	0	0	42	13	2,718	0	0	0	0
1987	0	0	0	13	2,024	0	0	0	0
1988	0	0	186	67	744	0	0	0	0
1989	0	0	67	31	600	0	0	0	0
1990	0	0	163	49	954	0	0	0	0
1991	11	2,564	314	119	101	0	0	0	0
1992	0	0	16	111	13	13	0	0	0
1993	2	0	61	80	22	8	56	0	30
1994	4	0	18	55	296	3	15	5	4
1995	0	0	12	174	35	12	25	2	0
1996	0	0	2	219	81	123	70	0	0
1997	0	0	27	253	56	0	62	2	0
1998	0	0	57	67	34	0	23	2	0
1999	0	0	94	0	34	38	7	2	0
2000	0	0	0	45	15	0	16	0	0
2001[1]	0	0	0	122	58	0	9	1	0
2002[1]	0	219	0	6	42	22	0	0	0
2003[1]	0	0	459	2	18	14	0	1	0
2004[1]	0	0	0	0	9	0	9	0	0

Year	Norway	Poland	Portugal	Russia[3]	Spain	UK (E&W)	UK (Scot.)	Total
1984	4,376	0	0	15,181	0	23	0	21,883
1985	5,464	0	0	10,237	0	5	0	19,945
1986	7,890	0	0	12,200	0	10	2	22,875
1987	7,261	0	0	9,733	0	61	20	19,112
1988	9,076	0	0	9,430	0	82	2	19,587
1989	10,622	0	0	8,812	0	6	0	20,138
1990	17,243	0	0	4,764[2]	0	10	0	23,183
1991	27,587	0	0	2,490[2]	132	0	2	33,320
1992	7,667	0	31	718	23	10	0	8,602
1993	10,380	0	43	1,235	0	16	0	11,933
1994	8,428	0	36	283	1	76	2	9,226
1995	9,368	0	84	794	1,106	115	7	11,734
1996	11,623	0	79	1,576	200	317	57	14,347
1997	7,661	12	50	1,038	157[2]	67	25	9,410
1998	8,435	31	99	2,659	259[2]	182	45	11,893
1999	15,004	8	49	3,823	319[2]	94	45	19,517
2000	9,083	3	37	4,568	375[2]	111	43	14,297
2001[1]	10,896[2]	2	35	4,694	418[2]	100	30	16,365
2002[1]	7,011[2]	5	16	5,584	178[2]	41	28	13,161
2003[1]	8,347[2]	5	19	4,384	230[2]	41	58	13,578
2004[1]	13,796[2]	1	51	4,662	186[2]	49	0	18,762

[1] Provisional figures.
[2] Working Group figures.
[3] USSR prior to 1991.

Table 1.5.7.2 Greenland halibut. Nominal catch (t) by countries in Subarea I as officially reported to ICES.

Year	Estonia	Faroe Islands	Fed. Rep. Germany	France	Greenland	Iceland	Ireland	Norway	Poland	Russia[3]	Spain	UK (E & W)	UK (Scot.)	Total
1984	-	-	-	-	-	-	-	593	-	81	-	17	-	691
1985	-	-	-	-	-	-	-	602	-	122	-	1	-	725
1986	-	-	1	-	-	-	-	557	-	615	-	5	1	1,179
1987	-	-	2	-	-	-	-	984	-	259	-	10	+	1,255
1988	-	9	4	-	-	-	-	978	-	420	-	7	-	1,418
1989	-	-	-	-	-	-	-	2,039	-	482	-	+	-	2,521
1990	-	7	-	-	-	-	-	1,304	-	321[2]	-	-	-	1,632
1991	164	-	-	-	-	-	-	2,029	-	522[2]	-	-	-	2,715
1992	-	-	+	-	-	-	-	2,349	-	467	-	-	-	2,816
1993	-	32	-	-	-	56	-	1,754	-	867	-	-	-	2,709
1994	-	17	217	-	-	15	-	1,165	-	175	-	+	-	1,589
1995	-	12	-	-	-	25	-	1,352	-	270	84	-	-	1,743
1996	-	2	+	-	-	70	-	911	-	198	-	+	-	1,181
1997	-	15	-	-	-	62	-	610	-	170	-[2]	+	-	857
1998	-	47	+	-	-	23	-	859	-	491	-[2]	2	-	1,422
1999	-	91	-	-	13	7	-	1,101	-	1,203	-[2]	+	-	2,415
2000	-	-	+	-	-	16	-	1,021	+	1,169	-[2]	1	-	2,206
2001[1]	-	-	-	-	-	9	-	925[2]	+	951	-[2]	2	-	1,887
2002[1]	-	-	3	-	-	+	-	791[2]	-	1,167	-[2]	+	-	1,961
2003[1]	-	48	+	+	2	+	1	949[2]	1	735	+[2]	+	+	1,674
2004[1]	-	-	-	-	-	+	-	760[2]	-	633	-[2]	3	-	1,397

[1]Provisional figures.
[2] Working Group figures.
[3] USSR prior to 1991.

Table 1.5.7.3 Greenland halibut. Nominal catch (t) by countries in Division IIa as officially reported to ICES.

Year	Estonia	Faroe Islands	France	Fed. Rep. Germ.	Greenland	Iceland	Ireland	Norway	Poland	Portugal	Russia[5]	Spain	UK (E & W)	UK (Scot.)	Total
1984	-	-	138	265	-		-	3,703	-	-	5,459	-	1	-	9,566
1985	-	-	239	254	-		-	4,791	-	-	6,894	-	2	-	12,180
1986	-	6	13	97	-		-	6,389	-	-	5,553	-	5	1	12,064
1987	-	-	13	75	-		-	5,705	-	-	4,739	-	44	10	10,586
1988	-	177	67	150	-		-	7,859	-	-	4,002	-	56	2	12,313
1989	-	67	31	104	-		-	8,050	-	-	4,964	-	6	-	13,222
1990	-	133	49	12	-		-	8,233	-	-	1,246[2]	-	1	-	9,674
1991	1,400	314	119	21	-		-	11,189	-	-	305[2]	-	+	1	13,349
1992	-	16	108	1	13[4]		-	3,586	-	15[3]	58	-	1	-	3,798
1993	-	29	78	14	8[4]		-	7,977	-	17	210	-	2	-	8,335
1994	-	-	47	33	3[4]		4	6,382	-	26	67	+	14	-	6,576
1995	-	-	174	30	12[4]		2	6,354	-	60	227	-	83	2	6,944
1996	-	-	219	34	123[4]		-	9,508	-	55	466	4	278	57	10,744
1997	-	-	253	23	-[4]		-	5,702	-	41	334	1[2]	21	25	6,400
1998	-	-	67	16	-[4]		1	6,661	-	80	530	5[2]	74	41	7,475
1999	-	-	-	20	25[4]		2	13,064	-	33	734	1[2]	63	45	13,987
2000	-	-	43	10	-[4]		+	7,536	-	18	690	1[2]	65	43	8,406
2001[1]	-	-	122	49	-[4]	9	1	8,740[2]	-	13	726	5[2]	56	30	9,751
2002[1]	-	-	7	9	22[4]	4	-	5,780[2]	-	3	849	-[2]	12	28	6,714
2003[1]	-	390	2	5	12[4]	+	+	6,778[2]	+	10	1,762	14[2]	5	58	9,036
2004[1]	-	-	-	4	-[4]	9	-	11,656[2]	-	24	810	4[2]	7	-	12,514

[1]Provisional figures.
[2]Working Group figure.
[3]As reported to Norwegian authorities.
[4]Includes Division IIb.
[5] USSR prior to 1991.

Table 1.5.7.4 Greenland halibut. Nominal catch (t) by countries in Division IIb as officially reported to ICES.

Year	Denmark	Estonia	Faroe Isl.	France	Fed. Rep. Germ.	Ireland	Lithuania	Norway	Poland	Portugal	Russia[4]	Spain	UK (E&W)	UK (Scot.)	Total
1984	-	-	-	-	1,900	-	-	80	-	-	9,641	-	5	-	11,626
1985	-	-	-	-	3,746	-	-	71	-	-	3,221	-	2	-	7,040
1986	-	-	36	-	2,620	-	-	944	-	-	6,032	-	+	-	9,632
1987	+	-	-	-	1,947	-	-	572	-	-	4,735	-	7	10	7,271
1988	-	-	-	-	590	-	-	239	-	-	5,008	-	19	+	5,856
1989	-	-	-	-	496	-	-	533	-	-	3,366	-	-	-	4,395
1990	-	-	23[2]	-	942	-	-	7,706	-	-	3,197[2]	-	9	-	11,877
1991	11	1,000	-	-	80	-	-	14,369	-	-	1,663[2]	132	+	1	17,256
1992	-	-	-	3[2]	12	-	-	1,732	-	16	193	23	9	-	1,988
1993	2[3]	-	-	2[3]	8	-	30[3]	649	-	26	158	-	14	-	889
1994	4	-	1[3]	8[3]	46	1	4[3]	881	-	10	41	1	62	2	1,061
1995	-	-	-	-	5	-	-	1,662	-	24	297	1,022	32	5	3,047
1996	+	-	-	-	47	-	-	1,204	-	24	912	196	39	+	2,422
1997	-	-	12	-	33	2	-	1,349	12	9	534	156[2]	46	+	2,153
1998	-	-	10	-	18	1	-	915	31	19	1,638	254[2]	106	4	2,996
1999	-	-	3	-	14	-	-	839	8	16	1,886	318[2]	31	-	3,115
2000	-	-	-	2	5	-	-	526	3	19	2,709	374[2]	46	-	3,685
2001[1]	-	-	-	+	9	-	-	1,231[2]	2	22	3,017	413[2]	42	-	4,736
2002[1]	-	219	-	+	30	6	-	440[2]	5	11	3,568	178[2]	29	-	4,486
2003[1]	+	+	21	-	13	-	-	620[2]	4	9	1,887	216	35	+	2,805
2004[1]	-	-	-	-	5	-	-	1,380[2]	1	26	3,219	182[2]	39	-	4,851

[1]Provisional figures.
[2]Working Group figure.
[3]As reported to Norwegian authorities.
[4] USSR prior to 1991.

Table 1.5.7.5 Greenland halibut in Subareas I & II.

Year	Recruitment Age 5 thousands	SSB tonnes	Landings tonnes	Mean F Ages 6-10
1964	42840	72644	40391	0.3146
1965	51686	69254	34751	0.2643
1966	57828	68557	26321	0.1601
1967	70443	76709	24267	0.1376
1968	64280	90723	26168	0.1309
1969	55932	116540	43789	0.1988
1970	41112	139620	89484	0.4204
1971	31550	111283	79034	0.4223
1972	33555	94880	43055	0.3019
1973	31061	95795	29938	0.2252
1974	26642	91519	37763	0.2787
1975	22539	79760	38172	0.3360
1976	22097	62686	36074	0.4264
1977	23686	45322	28827	0.3409
1978	20591	35937	24617	0.3659
1979	19699	35652	17312	0.1911
1980	18600	34653	13284	0.1720
1981	17874	39585	15018	0.1445
1982	18932	38428	16789	0.2188
1983	18986	42789	22147	0.2912
1984	17816	39249	21883	0.3384
1985	19928	41169	19945	0.3054
1986	19874	40612	22875	0.3513
1987	19439	30359	19112	0.3490
1988	22990	26830	19587	0.4056
1989	20752	24114	20138	0.3184
1990	14538	21063	23183	0.4234
1991	12672	25004	33320	0.6568
1992	10557	16157	8602	0.2441
1993	12966	18279	11933	0.3165
1994	18336	15853	9226	0.2667
1995	17880	14459	11734	0.3148
1996	18477	14450	14347	0.3400
1997	20025	15713	9410	0.2371
1998	17752	17478	11893	0.2382
1999	14787	18025	19517	0.3538
2000	16991	21187	14437	0.2355
2001	15370	28181	16307	0.2316
2002	17449	34469	13161	0.1801
2003	17045	36898	13578	0.1812
2004	17048	42083	18761	0.2289
2005		41730		
Average	25443	48231	25370	0.2892

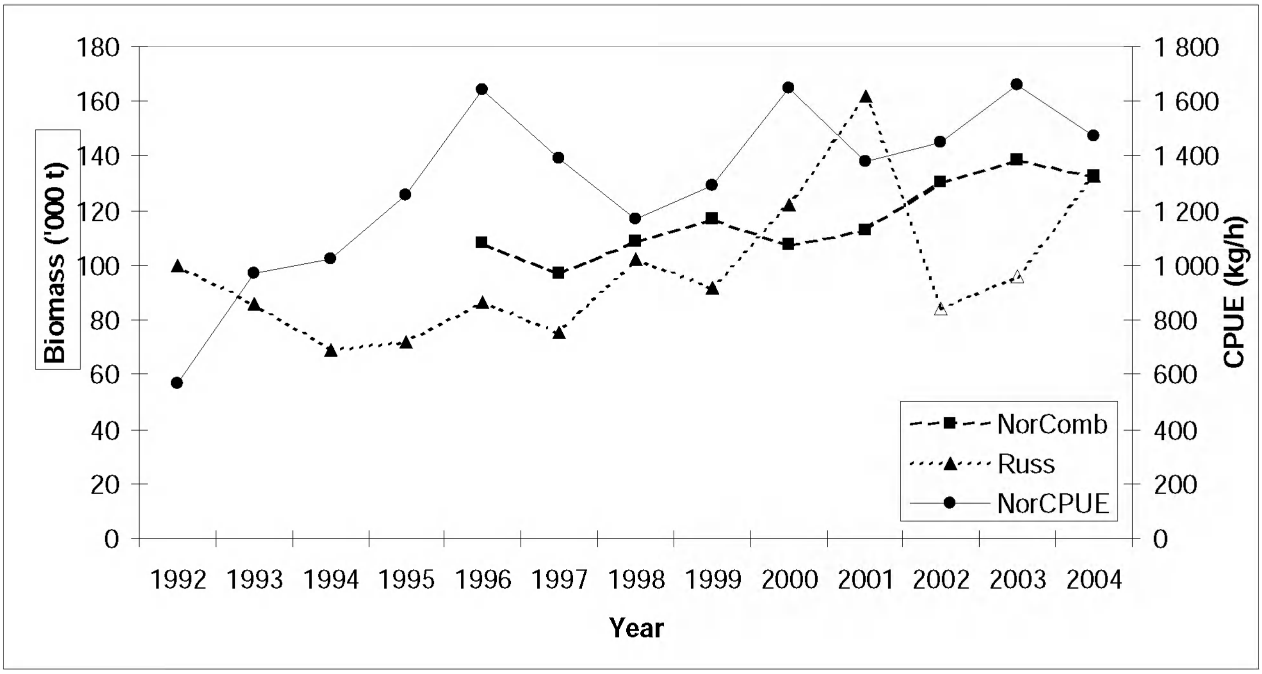


Figure 1.5.7.1 Biomass estimates from the survey series for Greenland halibut in Subareas I and II. The surveys are the Norwegian Combined survey (NorComb) which are from the Norwegian bottom trawl survey in August in the Barents Sea and Svalbard, the Norwegian Greenland halibut survey in August along the continental slope, and the Norwegian bottom trawl survey in August–September north and east of Svalbard. The Russian bottom trawl survey (Russ) in October–December is also provided, as are the Norwegian commercial catch rates (NorCPUE). The points identified with open symbols in the Russian series are not considered to be indicative of changes in biomass.

1.5.8 Barents Sea capelin (Subareas I and II, excluding Division IIa west of 5°W)

State of the stock

Spawning biomass in relation to precautionary limits	Fishing mortality in relation to precautionary limits	Fishing mortality in relation to highest yield	Comment
Reduced reproductive capacity	Not defined	Not defined	There was no commercial fishing in 2004/05. The fishery is managed according to a target escapement strategy.

Based on the most recent estimates of SSB and recruitment ICES classifies the stock as having reduced reproductive capacity. The maturing component in autumn 2005 was estimated to be 0.17 mill tonnes. SSB 1st April 2006 is predicted to be at 0.072 mill tonnes, which is far below $\mathbf{B}_{\text{lim}}$. The spawning stock in 2006 will consist of fish from the 2002 and 2003 year classes, but the 2003 year class will dominate. The survey estimate at age 1 of the 2004 year class is far below the long-term average. Observations during the international 0-group survey in August-September 2005 indicated that the size of the 2005 year class is somewhat below the long-term mean.

Management objectives

The fishery is managed according to a target escapement strategy, with a harvest control rule allowing (with 95% probability) the SSB to be above the proposed $\mathbf{B}_{\text{lim}}$, taking account of predation by cod. ICES considers the management plans to be consistent with the precautionary approach.

Reference points:

	ICES considers that:	ICES proposes that:
Precautionary Approach reference points	$\mathbf{B}_{\text{lim}}$ is set equal to 200,000 t.	$\mathbf{B}_{\text{pa}}$ not defined (not relevant).
	$\mathbf{F}_{\text{lim}}$ not defined (not relevant).	$\mathbf{F}_{\text{pa}}$ not defined (not relevant).
Target reference points		$\mathbf{F}_{\text{msy}}$ not defined (not relevant)

Single-stock exploitation boundaries

Exploitation boundaries in relation to existing management plans

Following the agreed management plan would imply zero catches in spring 2006, which is expected to lead to 72 000 t spawning stock biomass in 2006. This is below $\mathbf{B}_{\text{lim}}$ with a very high probability.

Short-term implications

Outlook for 2006

The spawning stock in 2006 is predicted from the acoustic survey in September 2005 and a model, which estimates maturity, growth and mortality (including predation by cod). The model takes account of uncertainties both in the survey estimate and in other input data. For any catch level in 2006, the probability of having an SSB below 200 000 t is above 95%. Only catches of mature fish have been considered.

Management considerations

For this stock, a $\mathbf{B}_{\text{lim}}$ equal to the value of the 1989 spawning stock biomass, which is the lowest SSB having produced an outstanding year class, is considered a good basis for such a reference point in a non-herring situation. The mean value of the 1989 spawning stock biomass is less than 100 000 t. However, the assessment method may not yet account for all sources of uncertainty, and there are inconsistencies in the data series. Thus, it may be appropriate to use a somewhat higher $\mathbf{B}_{\text{lim}}$. In recent years ICES has used a $\mathbf{B}_{\text{lim}}$ of 200 000 t.

The $\mathbf{B}_{\text{lim}}$ rule is intended to be a safeguard against recruitment failure. However, it is likely that the recruitment would be larger at a larger spawning stock, especially for moderately good recruitment conditions. In such a situation, a target-based control rule in addition to the $\mathbf{B}_{\text{lim}}$-based rule could be appropriate. The negative influence of herring on capelin recruitment should be included in the $\mathbf{B}_{lim}$-based rule if such a relationship can be described quantitatively. Adjustments of the harvest control rule should be investigated further to take the uncertainty in the predicted amount of spawners and the role of capelin as a prey for a range of predators into account.

Factors affecting the fisheries and the stock

The effects of regulations

Since 1979 the fishery has been regulated by a bilateral agreement between Norway and Russia (formerly USSR). The catches have been very close to the advice in all years since 1987.

The environment

The estimated annual consumption of capelin by cod has varied between 0.2 and 3.0 million t over the period 1984–2004. Young herring consume capelin larvae, and this predation pressure is thought to be one of the causes for the poor year classes of capelin in the periods 1984–1986, in 1992–1994, and from 2002. The abundance of herring in the Barents Sea is believed to stay at a high level in 2006.

Scientific basis

Data and methods

The assessment and stock history is based on joint Russian-Norwegian acoustic surveys during September each year. From 1998 onwards, a model incorporating predation from cod has been used for predicting SSB and for estimating the historical time-series of SSB.

Source of information

Report from the 2005 joint Russian-Norwegian meeting to assess the Barents Sea capelin stock, R/V G. O. Sars, September 28–30, 2005.

Year	ICES Advice	Recommended TAC	Agreed TAC	ACFM catch
1987	Catches at lowest practical level	0	0	0
1988	No catch	0	0	0
1989	No catch	0	0	0
1990	No catch	0	0	0
1991	TAC	1000[1]	900	933
1992	SSB > 4–500,000 t	834	1100	1123
1993	A cautious approach, SSB > 4–500,000 t	600	630	586
1994	No fishing	0	0	0
1995	No fishing	0	0	0
1996	No fishing	0	0	0
1997	No fishing	0	0	1
1998	No fishing	0	0	1
1999	SSB> 500,000 t	79[1]	80	101
2000	5% probability of SSB< 200,000 t	435[1]	435	414
2001	5% probability of SSB< 200,000 t	630[1]	630	568
2002	5% probability of SSB< 200,000 t	650[1]	650	651
2003	5% probability of SSB< 200,000 t	310[1]	310	282
2004	5% probability of SSB< 200,000 t	0	0	0
2005	5% probability of SSB< 200,000 t	0	0	1[2]
2006	5% probability of SSB< 200,000 t	0		

Weights in '000 t.
[1]Winter-spring fishery. [2]Research quota.

Table 1.5.8.1 Barents Sea CAPELIN. International catch ('000 t) as used by the Working Group.

Year	Winter				Summer-Autumn			Total
	Norway	Russia	Others	Total	Norway	Russia	Total	
1965	217	7	0	224	0	0	0	224
1966	380	9	0	389	0	0	0	389
1967	403	6	0	409	0	0	0	409
1968	460	15	0	475	62	0	62	537
1969	436	1	0	437	243	0	243	680
1970	955	8	0	963	346	5	351	1314
1971	1300	14	0	1314	71	7	78	1392
1972	1208	24	0	1232	347	11	358	1591
1973	1078	35	0	1112	213	10	223	1336
1974	749	80	0	829	237	82	319	1149
1975	559	301	43	903	407	129	536	1439
1976	1252	231	0	1482	739	366	1105	2587
1977	1441	345	2	1788	722	477	1199	2987
1978	784	436	25	1245	360	311	671	1916
1979	539	343	5	887	570	326	896	1783
1980	539	253	9	801	459	388	847	1648
1981	784	428	28	1240	454	292	746	1986
1982	568	260	5	833	591	336	927	1760
1983	751	374	36	1161	758	439	1197	2358
1984	330	257	42	628	481	367	849	1477
1985	340	234	17	590	113	164	278	868
1986	72	51	0	123	0	0	0	123
1987	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0
1991	528	156	20	704	31	195	226	929
1992	620	247	24	891	73	159	232	1123
1993	402	170	14	586	0	0	0	586
1994	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	1	1	1
1998	0	0	0	0	0	1	1	1
1999	46	32	0	78	0	23	23	101
2000	283	95	8	386	0	28	28	414
2001	368	180	8	557	0	11	11	568
2002	391	228	17	635	0	16	16	651
2003	190	93	0	282	0	0	0	282
2004	0	0	0	0	0	0	0	0
2005	1	0	0	1				

Table 1.5.8.2 Barents Sea CAPELIN. Stock summary table. Recruitment and total biomass are survey estimates back-calculated to 1 August (before the autumn fishing season). Maturing biomass is the survey estimate of fish above maturity length (14.0 cm). SSB is the median value of the modeled stochastic spawning stock biomass (after the winter/spring fishery). Weights in '000 t.

Year	Stock biomass August 1	Maturing biomass survey Oct. 1	Recruitment Age 1, August 1	Spawning stock biomass, assessment model	Landings
1965					224
1966					389
1967					409
1968					537
1969					680
1970					1314
1971					1392
1972	5831	2182			1592
1973	6630	1350	1140	33	1336
1974	7121	907	737	*	1149
1975	8841	2916	494	*	1439
1976	7584	3200	433	253	2587
1977	6254	2676	830	22	2987
1978	6119	1402	855	*	1916
1979	6576	1227	551	*	1783
1980	8219	3913	592	*	1648
1981	4489	1551	466	316	1986
1982	4205	1591	611	106	1760
1983	4772	1329	612	100	2358
1984	3303	1208	183	109	1477
1985	1087	285	47	*	868
1986	157	65	9	*	123
1987	107	17	46	34	0
1988	361	200	22	*	0
1989	771	175	195	84	0
1990	4901	2617	708	92	0
1991	6647	2248	415	643	929
1992	5371	2228	396	302	1123
1993	991	330	3	293	586
1994	259	94	30	139	0
1995	189	118	8	60	0
1996	467	248	89	60	0
1997	866	312	112	85	1
1998	1860	931	188	94	1
1999	2580	1718	171	382	106
2000	3840	2099	475	599	414
2001	3480	2019	128	626	568
2002	2145	1290	62	496	651
2003	700	280	112	427	282
2004	724	293	63	94	0
2005	389	174	33	122	1
Average	3466	1270	328	223	844

* Vanishing spawning stocks

Table 1.5.8.3 Barents Sea CAPELIN. Larval abundance estimate (10^{12}) in June, and 0-group index in August.

Year	Larval abundance	0-group area index	New 0-group Index (10^6 ind.)[1] Without K eff	With K eff
1980	-	502	217 454	809 193
1981	9.7	570	110 142	428 316
1982	9.9	393	181 125	611 698
1983	9.9	589	100 817	332 287
1984	8.2	320	73 228	168 660
1985	8.6	110	24 191	73 436
1986	0.0	125	13 519	56 472
1987	0.3	55	600	2 302
1988	0.3	187	28 826	92 075
1989	7.3	1300	258 741	881 764
1990	13.0	324	36 041	115 198
1991	3.0	241	55 879	164 819
1992	7.3	26	116	349
1993	3.3	43	257	776
1994	0.1	58	9 237	20 987
1995	0.0	43	614	2 067
1996	2.4	291	47 055	143 826
1997	6.9	522	57 585	196 013
1998	14.1	428	35 881	88 035
1999	36.5	722	88 855	294 999
2000	19.1	303	39 380	140 131
2001	10.7	221	5 212	19 895
2002	22.4	327	20 722	21 887
2003	11.9	630	130 672	458 890
2004	2.5	288	20 737	69 251
2005	8.8	348	47 256	154 692
Average	8.6	340	61 697	205 693

1.5.9 Northern Shrimp (*Pandalus borealis*) in ICES Subareas I (Barents Sea) and IIb (Svalbard Waters)

State of the stock

Spawning biomass in relation to precautionary limits	Fishing mortality in relation to precautionary limits	Fishing mortality in relation to highest yield	Fishing mortality in relation to agreed target	Comment
Unknown	Unknown			

The Russian commercial CPUEs (Figure 1.5.9.4) and Russian and Norwegian survey indices (Figure 1.5.9.2) indicate a decrease in the shrimp stock from 2003 to 2005. The Norwegian survey index for 2004 shows a reduction of 30% since 2003, and is now at the lowest level since 1987. The Russian survey index shows a reduction of 36% from 2002 to 2005. The spawning stock number (egg-bearing females) has been decreasing since 2002. The recruitment of one-year-old shrimp has been low but stable over the last two years, and the three-year-old shrimp show a reduction from 2003 to 2004. As the cod stock is still at a high level, the natural mortality is believed to remain high.

Management objectives

There are no explicit management objectives for this stock.

Reference points

There are no precautionary reference points.

Single-stock exploitation boundaries

Exploitation boundaries in relation to precautionary considerations

ICES recommends that a TAC should be implemented for 2006 and set no higher than the current catch level of 40 000 t.

Short-term implications

Outlook for 2006

As the time-series of surveys has ceased it is not possible to give a prediction for the stock. As the recruitment indices were low in 2004, the stock is expected to remain at a low level in 2006.

Factors affecting the fisheries and the stock

Survey indices since 1985 indicate that the shrimp biomass has varied cyclically without trend over that period. There is concern that use of the full potential effort of the fleet may lead to unsustainable catch rates. However, the current high fuel costs and low shrimp price seem to have a regulatory effect on the stock.

Scientific basis

Regulations and their effects

In the Svalbard area the shrimp fisheries are regulated by number of effective fishing days and number of vessels by country. In the Barents Sea and Svalbard area, Norwegian rules stipulate that the fisheries are to be regulated by smallest allowable shrimp size (a maximum 10% of the catch weight may consist of shrimp less than 15 mm carapace length, CL) and by provisions of the fishing licenses. The Russian Economic Zone TAC is established each year by Russian authorities. In the Barents Sea and the Svalbard area fishing grounds are closed if bycatch limits for cod, haddock, redfish or Greenland halibut are exceeded.

Changes in fishing technology and fishing patterns

Reported landings for all countries show a substantial increase in catches between 1995 (25 000 t) and 2000 (83 000 t) but have been considerably lower thereafter. Catch increases from 1994–1999 encouraged the fishery to invest in larger vessels and new technology.

The environment

Shrimp is an important prey for several fish species, especially cod. Consumption by cod significantly influences shrimp population dynamics. The estimated amount of shrimp consumed by cod is on average much higher than shrimp landings. The biomass of shrimp consumed by cod decreased considerably in recent years, see Fig. 1.5.9.3. However, it is shown that the cod consumption is overestimated.

Scientific basis

Data and methods

Commercial CPUE series are considered to be of acceptable quality although account will still have to be taken of the efficiency increase due to increased use of multi-rig trawls as well as other technical improvements.

The Russian and the Norwegian shrimp-survey time-series conducted since 1982 and 1984, respectively, have been discontinued. A joint ecosystem survey will collect shrimp data in the future. No calibration between the old and the new survey has been conducted.

No analytical assessment is available.

The natural mortality depends on predation and in particular of predation by cod. Therefore, any forecast would depend on the expected level of the cod stock.

Source of information

Report of the *Pandalus* Assessment Working Group, Halifax, 26 October–4 November 2005 (ICES CM 2006/ACFM:06).

Table 1.5.9.1 Nominal shrimp catches (t) by country (Subareas I and II combined). Data provided by ICES and Working Group members.

Year	Norway	Russia	Others	Total
1970	5508	0	0	5508
1971	5116	0	0	5116
1972	6772	0	0	6772
1973	6921	0	0	6921
1974	8008	0992	0	9000
1975	8197	0	2	8199
1976	9752	0548	0	10300
1977	6780	12774	4854	24408
1978	20484	15859	0	36343
1979	25435	10864	390	36689
1980	35061	11219	0	46280
1981	32713	10897	1011	44621
1982	43451	15552	3835	62838
1983	70798	29105	4903	104806
1984	76636	43180	8246	128062
1985	82123	32104	10262	124489
1986	48569	10216	6538	65323
1987	31353	6690	5324	43367
1988	32021	12320	4348	48689
1989	47064	12252	3432	62748
1990	54182	20295	6687	81164
1991	39663	29434	6156	75253
1992	39657	20944	8021	68622
1993	32663	22397	806	55866
1994	20116	7108	1063	28287
1995	19337	3564	2319	25220
1996	25445	5747	3320	34512
1997	29079	1493	5164	35736
1998	44792	4895	6103	55790
1999	52612	10765	12292[2]	75669
2000	55333	19596	8241[3]	83170
2001	43021	5875	8136[4]	57032
2002	48799	3802	8105[5]	60706
2003	34652	2776	2340[5]	39768
2004[1]	36188	2400	5002[6]	43590

[1] Preliminary data.
[2] Catches reported by Estonia, Faroe Islands, Germany, Greenland, Iceland, Lithuania, Portugal, Spain, and UK(Eng.Wal.NI).
[3] Catches reported by Estonia, Faroe Islands, Iceland, Lithuania, Portugal, Spain, and UK.
[4] Catches reported by Estonia, Faroe Islands, Lithuania, Portugal, Spain, and UK.
[5] Catches reported by Estonia, Faroe Islands, Lithuania, Spain, and UK.
[6] Catches reported by Estonia, Faroe Islands, Lithuania, Spain, and Portugal.

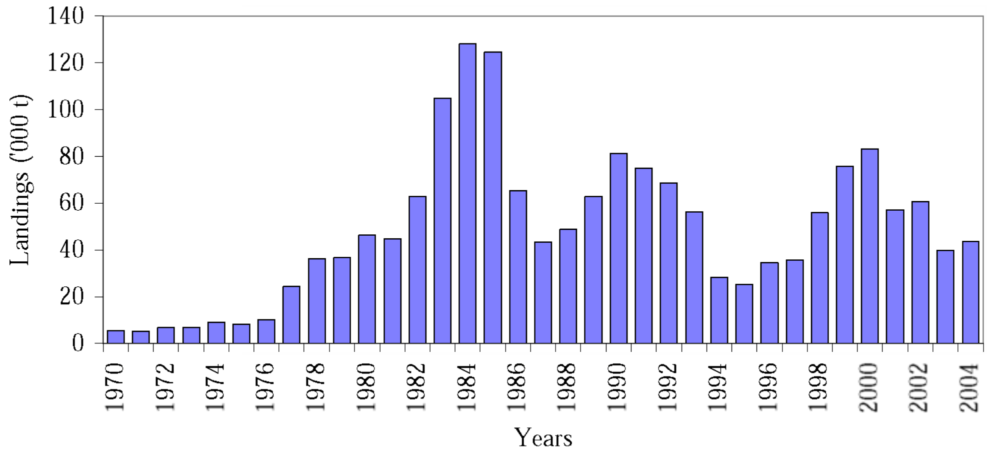


Figure 1.5.9.1 Total landings of *Pandalus* from the Barents Sea and the Svalbard area.

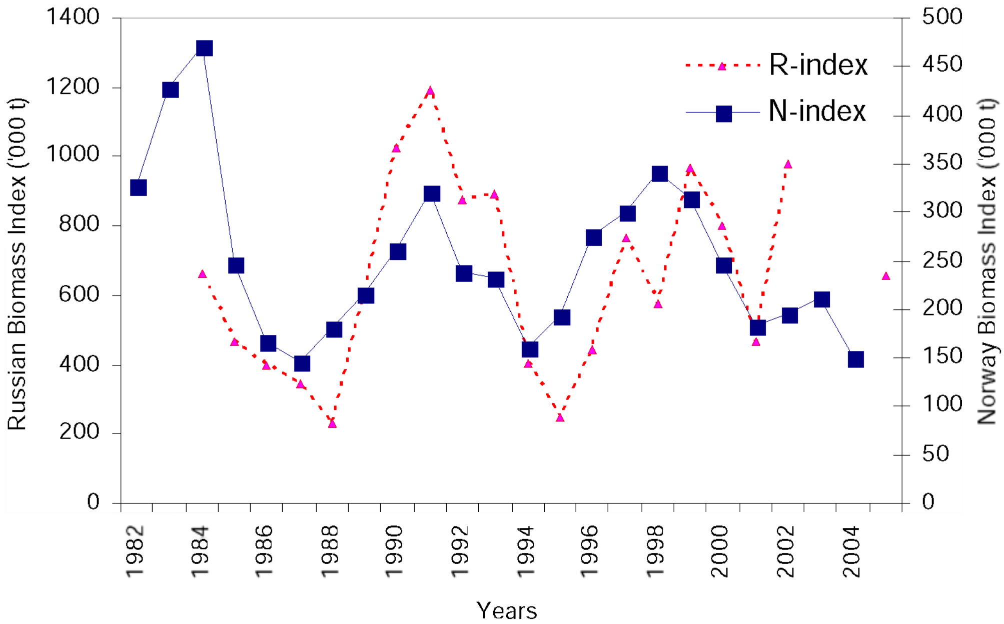


Figure 1.5.9.2 Shrimp biomass indices from Norwegian (N-index) and Russian (R-index) surveys in the Barents Sea and Spitsbergen area in 1982–2004.

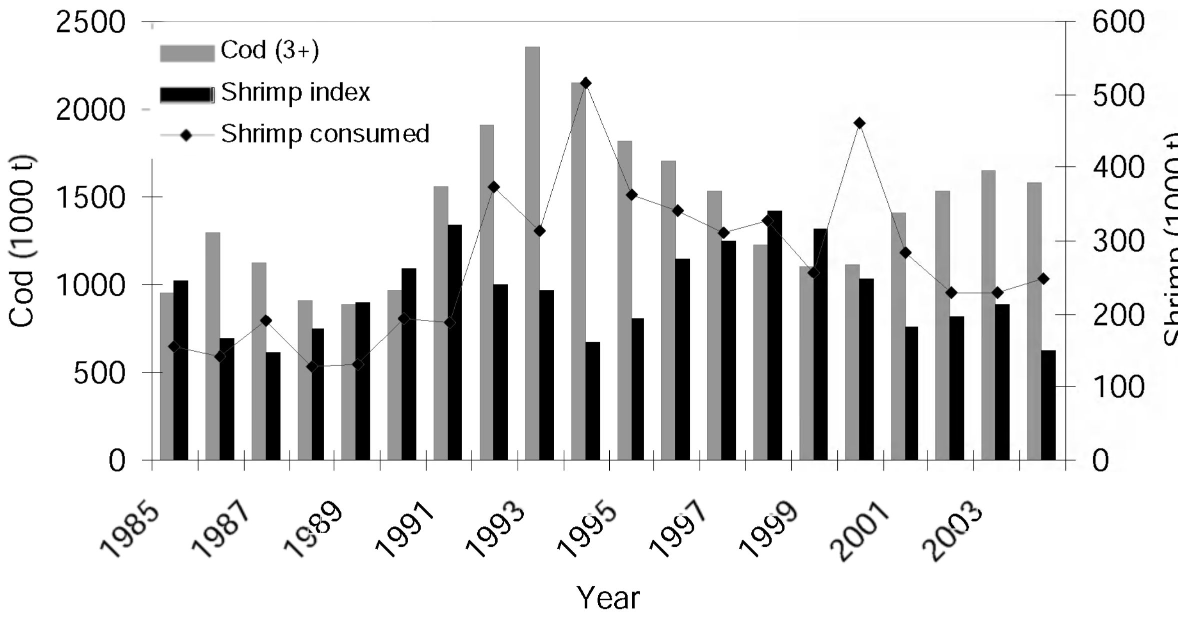


Figure 1.5.9.3 Biomass indices from the Norwegian surveys (cf. Fig.1.5.9.2), biomass estimate for cod (age 3 years and older) and the shrimp consumed by the cod in the Barents Sea.

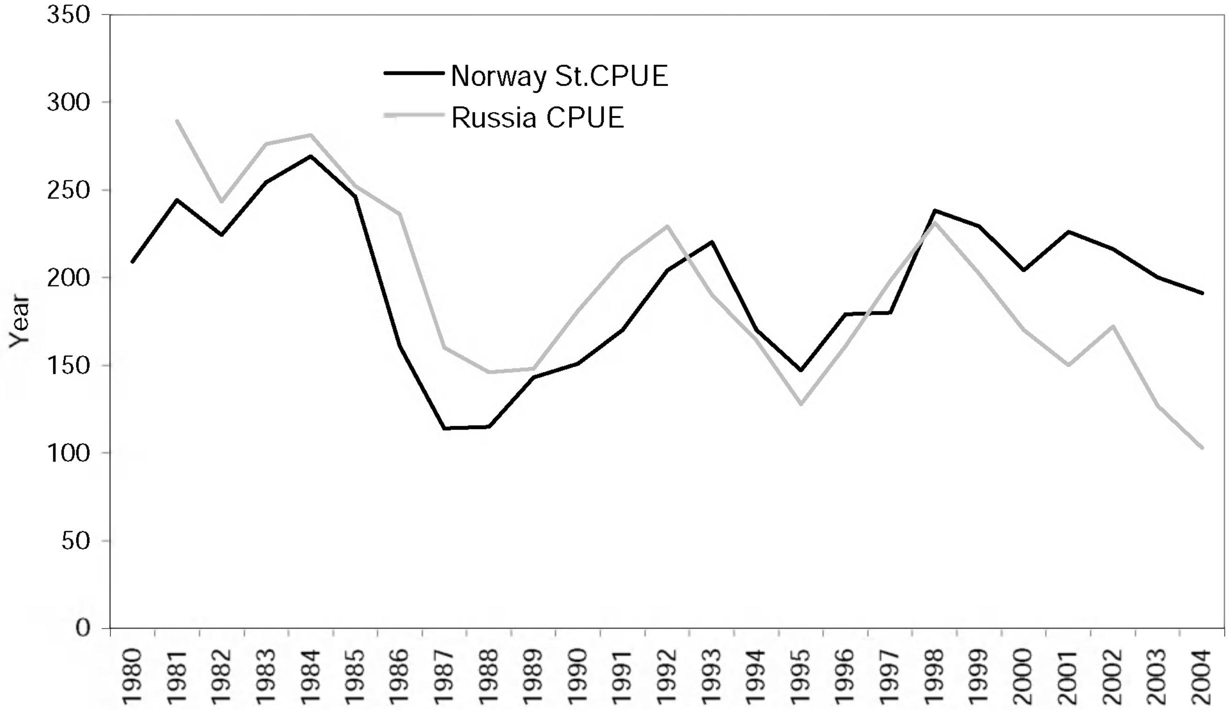


Figure 1.5.9.4 Norwegian standardised CPUE to vessels with 1000–1550hp and single trawl (Norway St. CPUE) and Russian CPUE (R-CPUE) for ICES Areas I, IIa, and IIb.