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Report of the ICES Advisory Committee on Fishery Management, Advisory Committee on the Marine Environment and Advisory Committee on Ecosystems, 2006

Book 6
North Sea

International Council for the Exploration of the Sea

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BOOK 6

6 NORTH SEA

6.1 Ecosystem overview

6.1.1 Ecosystem Components

Sea bed topography and substrates

The topography of the North Sea can broadly be described as having a shallow (<50m) south-eastern part, which is sharply separated by the Doggerbank from a much deeper (50-100m) central part that runs north along the British coast. The central northern part of the shelf gradually slopes down to 200m before reaching the shelf edge. Another main feature is the Norwegian Trench running in the east along the Norwegian coast into the Skagerrak with depths up to 500m. Further to the east, the Norwegian trench abruptly ends, and the Kattegat is of similar depth as the main part of the North Sea.

The substrates are dominated by sands in the southern and coastal regions and fine muds in deeper and more central parts. Sands become generally coarser to the east and west, with patches of gravel and stones existing as well. In the shallow southern part, concentrations of boulders may be found locally, originating from transport by glaciers during the ice ages. This specific hard-bottom habitat has become scarcer, because boulders caught in beam trawls are often brought ashore. The area around, and to the west of the Orkney/Shetland archipelago is dominated by course sand and gravel. The deep areas of the Norwegian trench are covered with extensive layers of fine muds, while some of the slopes have rocky bottoms. Several underwater canyons extend further towards the coasts of Norway and Sweden.

A number of sand banks across the North Sea qualify for protection under the EU habitats directive, mainly along the UK coast, eastern Channel, the approaches to the Skagerrak and the Dogger Bank. Extensive biogenic reefs of Lophelia have recently been mapped along the Norwegian coastline in the eastern Skagerrak, while Sabellaria reefs have been reported in the south, although their distribution and extent is not known. Gravels also qualify for protection, but comprehensive maps at a total North Sea scale are not readily available.

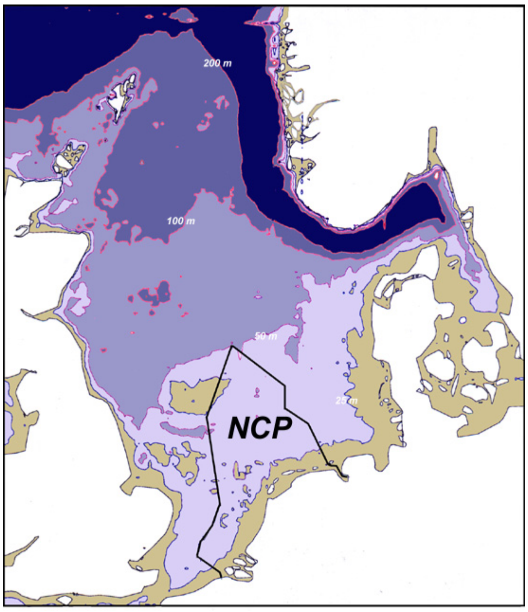

Figure 6.1.1 Bathymetry (left) of the North Sea (source – RIVO- alternative from ICES).

Circulation patterns

Circulation in the North Sea is classically presented as an anticlockwise gyre driven mainly by wind forcing. However, empirical observations as well as modelling results indicate that the pattern may be reversed temporally as a result of wind forcing, or split into two separate gyres in the north and south. Circulation may even cease for limited times (Kauker & von Storch 2000). Such changes and their timings may be important for specific life history stages of various species because they can, for instance, affect the transport of eggs and larvae to specific nursery areas or feeding conditions.

The main inflow is of relatively warm (at least during winter) and more saline North Atlantic water along the shelf break into the Norwegian Trench and also around the Shetland and Orkney Islands. Changes in zooplankton and fish distributions have been linked to the strength of these inflows. Atlantic water also enters into the southern North Sea, via the Channel (Hughes & Lavin, 2004). The Kattegat and eastern Skagerrak are strongly influenced by brackish surface water entering from the Baltic that follows the Swedish coast and turns west along southern Norway. However, the bottom water layer is of oceanic origin and runs below the brackish water layer in the opposite direction. Residence time of North Sea water is estimated to be in the order of one year. The general circulation pattern is shown in Figure 6.1.2.

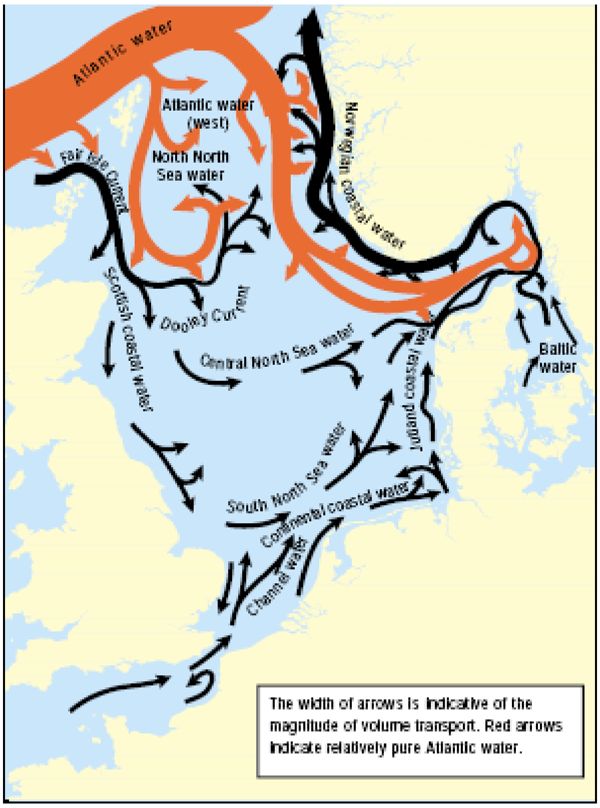

Figure 6.1.2 General circulation pattern in the North Sea. Copied from Regional QSR II (after Turrell et al., 1992)

There are a number of frontal systems (e.g. Fair Isle, Flamborough, Frisian front and Skagerrak), but they vary considerably in time and space depending on wind forcing, current strength and the physical properties of the different water masses. Tidal currents are strong in the southern North Sea, especially the coastal regions.

Physical and chemical oceanography

North Sea oceanographic conditions are mainly determined by the inflow of saline Atlantic water through the northern entrances and to a lesser degree through the Channel. These waters mix with river runoff in coastal regions and the lower-salinity Baltic outflow through the Kattegat. The temperature of surface waters is largely controlled by local solar heating and atmospheric heat exchange, while temperature in the deeper waters of the northern North Sea is influenced largely by the inflow of Atlantic water. Figure 6.1.3. shows average bottom temperatures in winter and summer for 1997-2002.

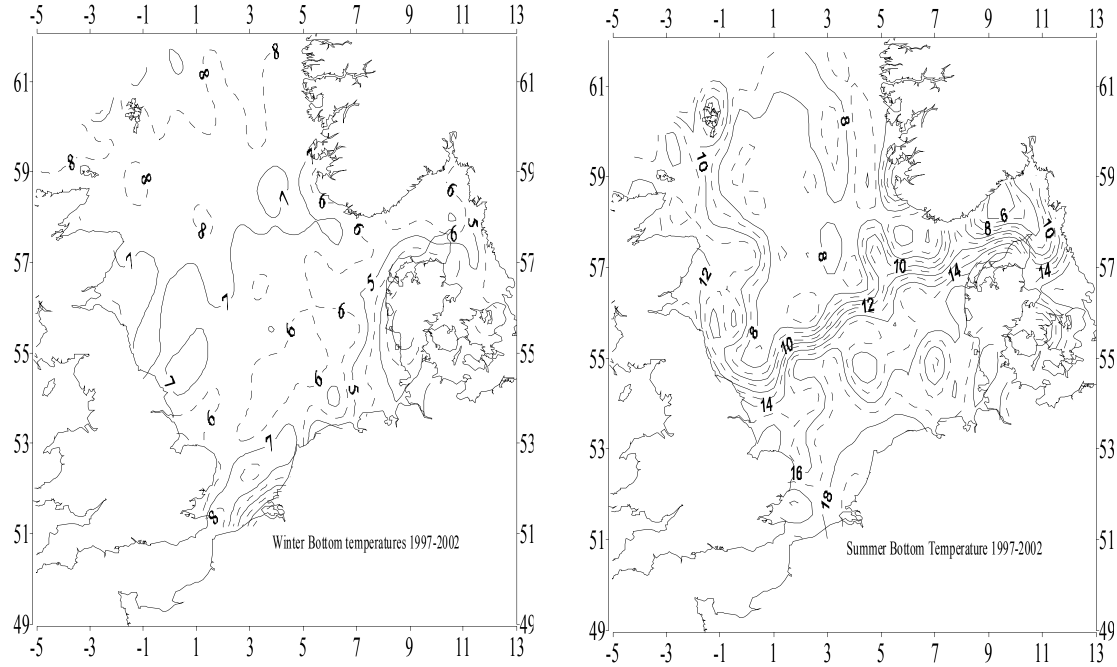

Figure 6.1.3 Average distribution of winter (left) and summer (right) bottom temperatures (courtesy ICES).

The salinity and the temperature variations generally reflect the influence of the North Atlantic Oscillation (NAO) on the movement of Atlantic water into the North Sea and the ocean-atmosphere heat exchange. Numerical model simulations show strong differences in the circulation depending on the state of the NAO. A balance of tidal mixing and local heating force the development of a seasonal stratification from April/May to September in most parts of the North Sea. This stratification is absent in the shallower waters of the southern North Sea throughout the summer. The extent and duration of this mixed area is probably an important environmental factor for fish in this area

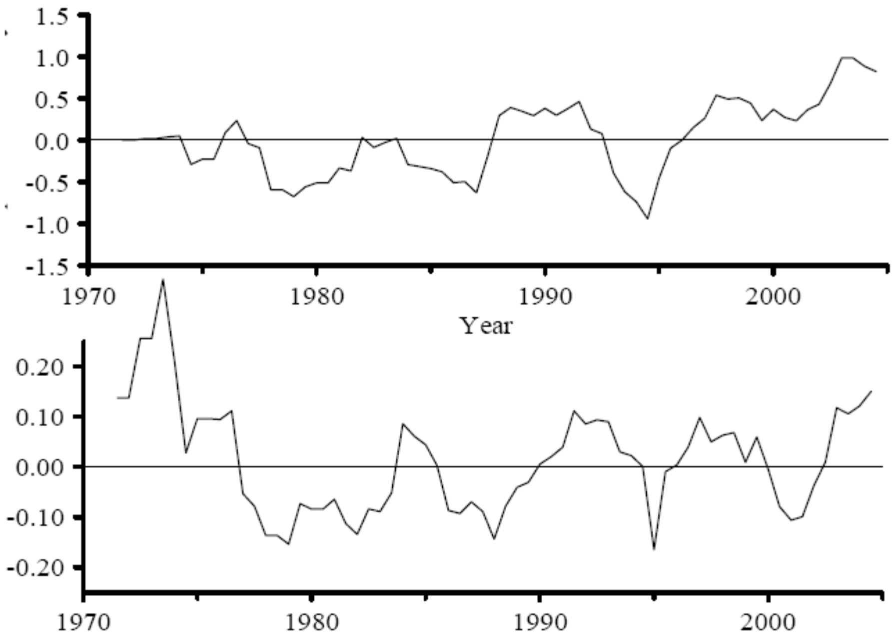

Figure 6.1.4 Temperature and salinity anomalies in the Fair Isle Current (FIC) entering the North Sea from the North Atlantic

Recently, the NAO index (Hurrell winter index) was weak after a strong negative in 2001. The ICES Annual Ocean Climate Status Summary (IAOCSS) for 2003/04 suggests that it may have been negative in the winter of 2004/05 as in the previous winter (Hughes & Lavin 2005).

The long-term temperature and salinity anomalies in the Atlantic waters flowing into the North Sea with the Faire Isle current provide a broadly similar cyclical behaviour up to the late 1990s (Figure 6.1.4). However, in more recent years the two signals appear to diverge, with relatively high temperatures persisting during years showing a marked decline in salinity (Hughes & Lavin 2005).

Both 2003 and 2004 were both unusually warm years, particularly in August and September. The inflowing Atlantic water was also warmer than the long term mean. The temperature anomalies can be overstated however. While in 2003 August was the warmest on record since 1968, the pattern was closer to average from December 2002 to May 2003. Surface salinity levels also rose in recent years but from a recent low value to close to the long term average. Initial indications from a coastal monitoring site in the north western North Sea suggest that summer temperatures in 2004 did not quite reach the extremes of 2003; however, Norwegian stations suggest similar or higher summer temperatures, at least in the Atlantic inflow. (www.marlab.ac.uk/FRS.web/Delivery/display_standalone.aspx?contentid=1166).

In 2005 SST in the North Sea was close to the long term mean for the first eight months of the year, but showed strong positive anomalies in September to December (source http://www.bsh.de/en/index.jsp). This increased temperature late in the year was also evident in deeper waters as well as in surface waters. In December 2005 the temperature on the Torungen-Hirtshals section in the Skagerrak was 2-4^{o}C above normal in the top 50m, and across the entire section the temperature was above normal (Figure 6.1.5)

On a station on the section we find water of Atlantic origin at 150m depth (Figure 6.1.6.). Here the temperature was about 0.5^{o}C above normal throughout the year and except for January the salinity was 0.2 above normal. This shows that he inflowing Atlantic Water to the North Sea was warmer and more saline than usual.

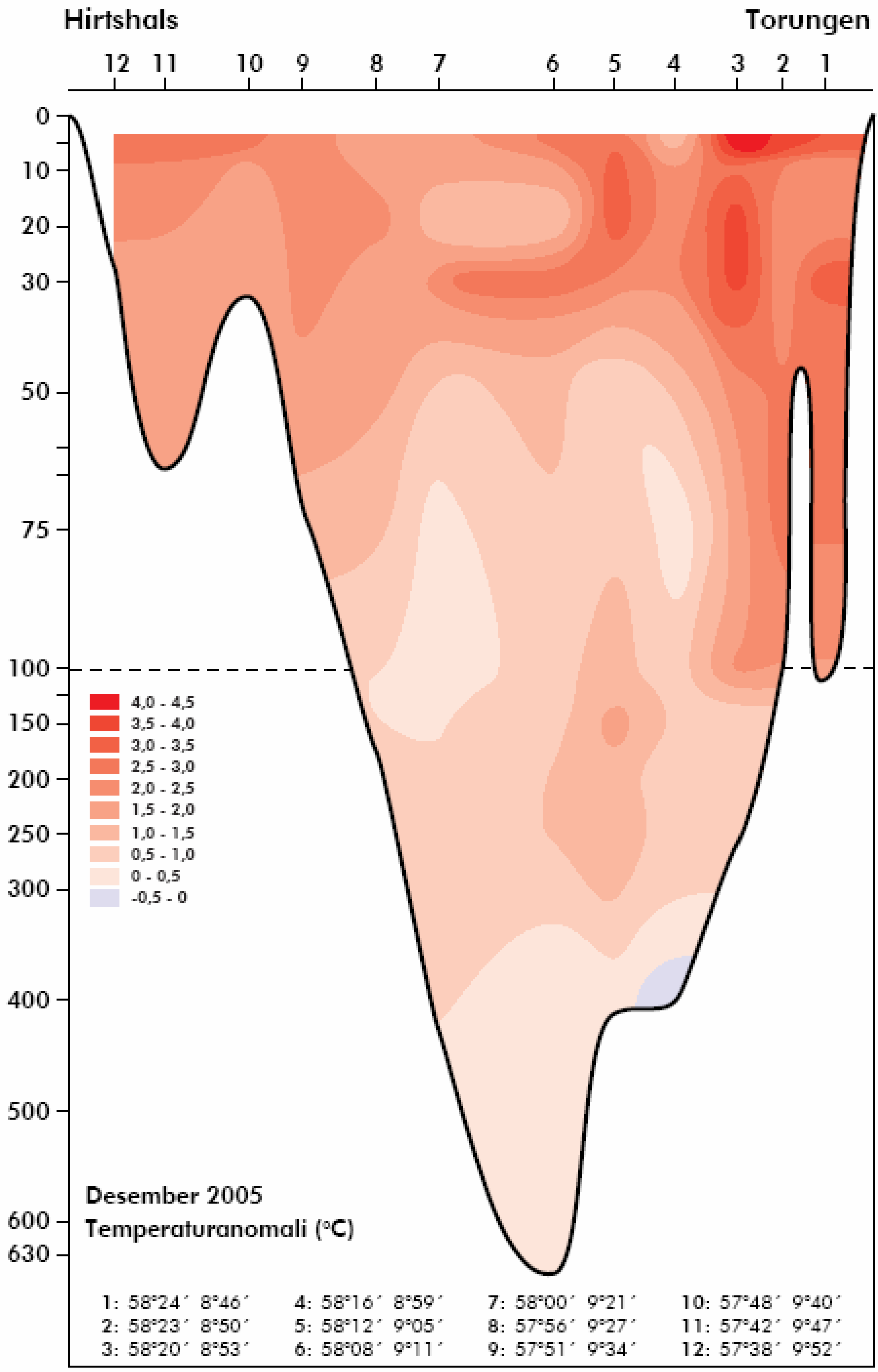

Figure 6.1.5 Temperature deviation (from the norm 1960-1987) along the Torungen-Hirtshals section in December 2005.

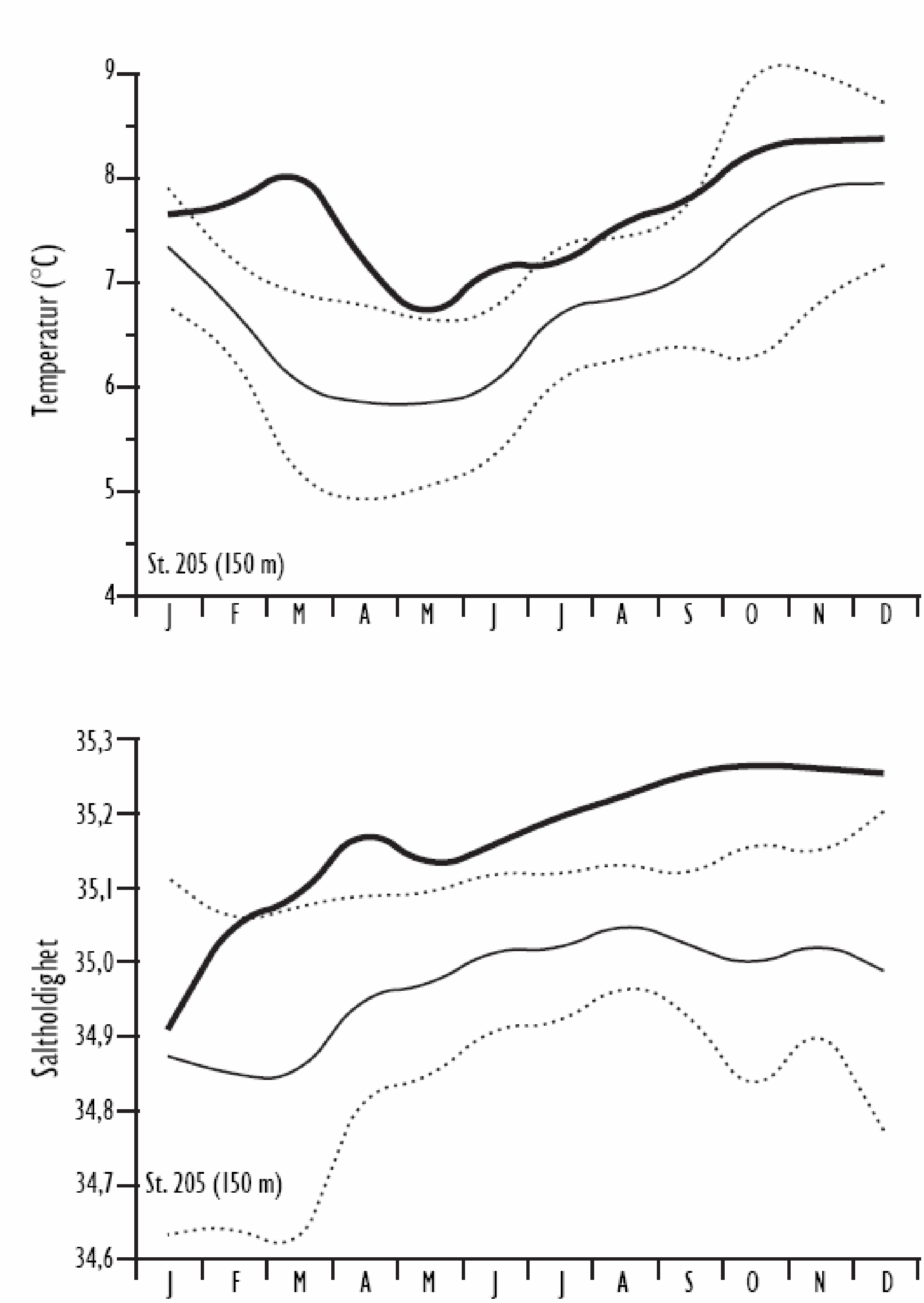

Figure 6.1.6 Temperature and salinity at 150 m depth based on monthly observations in 2005, 10 km off Torungen lighthouse near Arendal. Long term mean (thin line) and standard deviation (dotted lines) for the period 1961–1990.

Surface salinity also rose in the recent years but from a recent low value to close to the long term average. Near bottom salinity in the north western North Sea showed higher values in the summer of 2004 than in previous years (Figure 6.1.7)

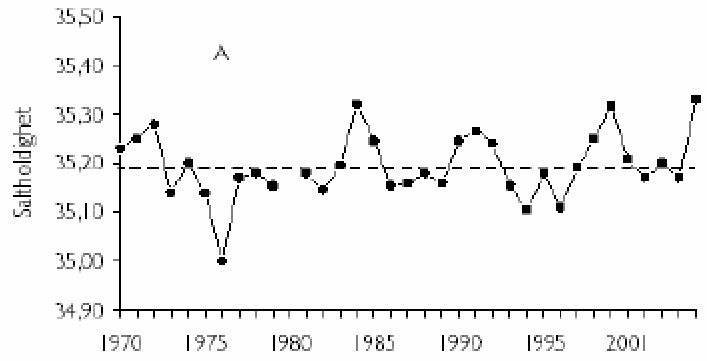

Figure 6.1.7 Salinity near bottom in the north-western part of the North Sea in the summers of 1970-2004.

Several southern species have increased in abundance, even to the extent that a directed fishery for striped red mullet and sea bass is developing.

There is considerable eutrophication in some areas of the North Sea, particularly in the Wadden Sea area, the southern part of the Kattegatt and coastal part of the Skagerrak, as well as shallow waters and estuaries along the UK and European mainland coast. Below the halocline, decomposition of organic matter has occasionally caused oxygen deficiency during late summer/autumn. This phenomenon is linked to enhanced primary productivity but may locally be a natural process, especially in enclosed inshore areas such as the Kattegatt, fjords and estuaries. However, oxygen deficiency is accelerated by large scale eutrophication (Karlsson et al. 2002).

See also the general text on major climatic and oceanographic features in a separate section on the NE Atlantic (Section 2.1).

Major climatic and oceanographic features

See general text on this topic in separate section on the NE Atlantic (Section 2.1).

Phytoplankton

Primary productivity is dominated by diatoms and dinoflagellates. Up to the 1970s primary production classically followed a spring/autumn bloom pattern. This is borne out by Continuous Plankton Recorder (CPR) “greenness” values. Since the 1970s this separation has become increasingly blurred and primary production has been continuous over much of the year and also over a longer period (Hughes & Lavin 2004). This longer and less bipolar productivity has led to a much greater primary production in all recent years, associated with a reduction in diatom production and an increase in dinoflagelates. Both trends appear to be continuing in the most recent years. Theoretically this should provide more food at the base of the food web (SAHFOS 2003). After the recent changes, the primary productivity in the North Sea can be considered as stronger and lasting longer than in adjacent Atlantic waters.

Zooplankton

Zooplankton production is dominated by copepods and euphausids, both important food items for many key commercial stocks. Changes in the zooplankton community have been linked to Atlantic inflow patterns across the twentieth century (Reid et al 2003). CPR and other data sources show that the abundance of copepods (particularly Calanus finmarchicus) has declined severely in the last 10 years. (Heath et al 1999 and www.marlab.ac.uk/ FRS.web/Uploads/ Documents/Zooplankton.pdf). This decline shows a strong link to the NAO through spring wind patterns and the volume of cold bottom water in the Faroe-Shetland Channel rather than to conditions in the North Sea per se. The relative proportions of C. finmarchicus to C. helgolandicus also have changed markedly, the former dominating up to the 1970s (representing around 70% of the zooplankton biomass) and the latter since 1995. C. helgolandicus prefers warmer waters and is generally a smaller and less profitable prey than C. finmarchicus. These trends appear to be continuing (Figure 6.1.8) and links have been made with cod and flatfish recruitment (Beaugrand et al 2003, Beaugrand 2004) see Figure 6.1.9. and herring growth and migration patterns (REF). The CPR data also show a reduction in euphausid availability. However no changes have been recorded in the total zooplankton biomass and in total copepod abundance (e.g. northern North Sea areas B1 and B2; SAHFOS 2004, Heath 2005). The overall picture is one of a changing community structure Figure 6.1.10.

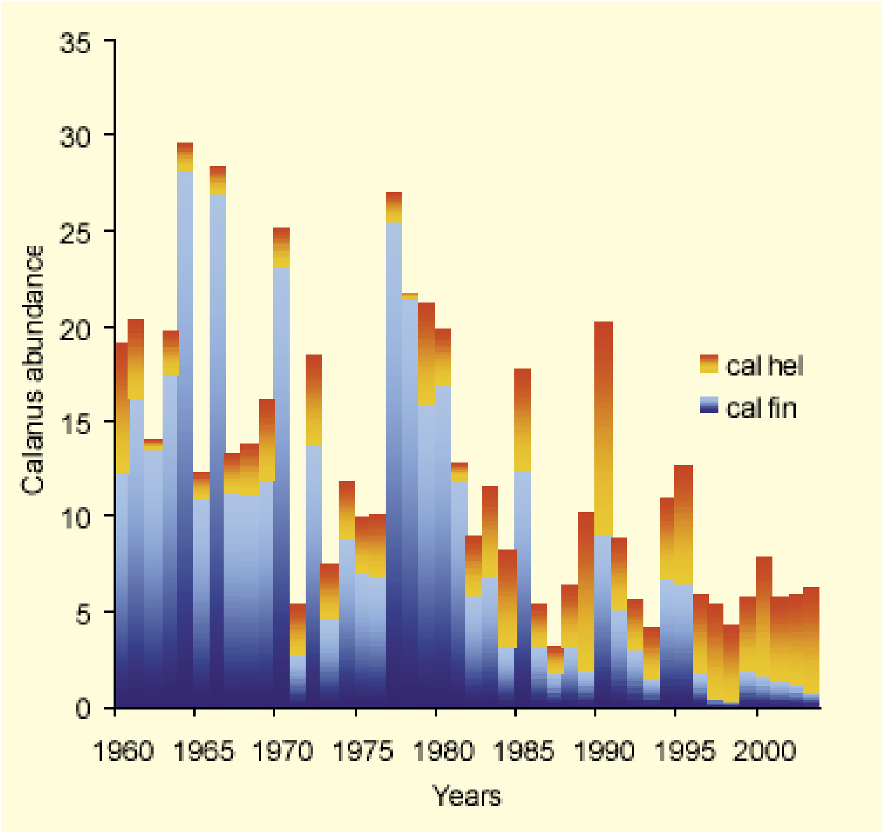

Figure 6.1.8. The abundance of *Calanus* populations in the North Sea from 1960 to 2003. The percentage ratio of *Calanus finmarchicus* (blue) and *Calanus helgolandicus* (red) are shown in relation to total Calanus abundance in each annual bar. From www.sahfos.org, Ecological Status 2004/5

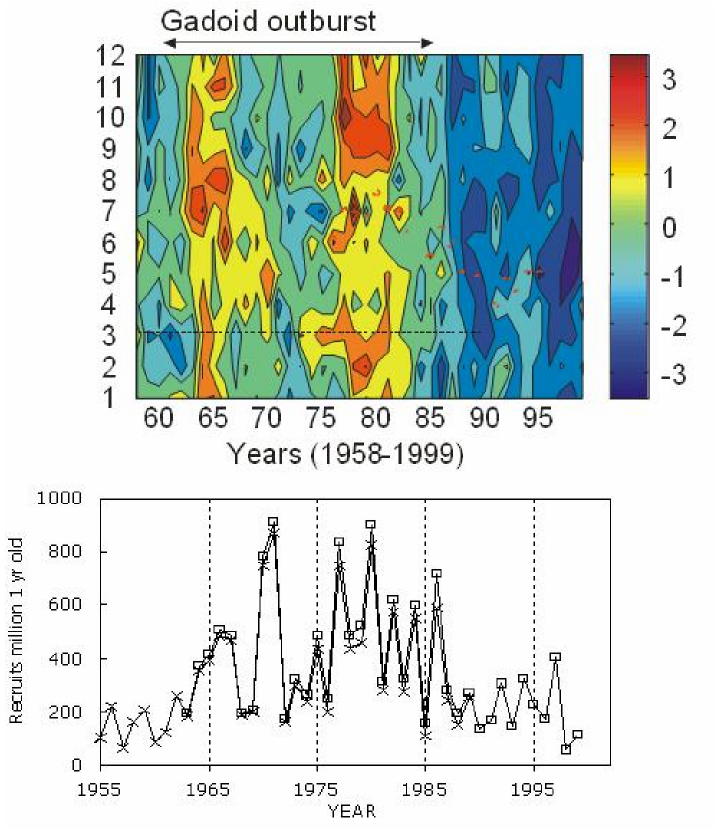

Figure 6.1.9 Top; long-term monthly changes (1958-1999) in the Beaugrand et al. (2003) plankton index. A negative anomaly in the index indicates a low value for Calanus finmarchicus, euphausiids, mean size of calanoid copepods with the exception of C. helgolandicus (opposite pattern) and Pseudocalanus spp. (no relationship). A positive anomaly indicates a high abundance of prey (and prey of suitable size). The lower plot shows cod recruitment (in decimal logarithm) in the North Sea. The period of the Gadoid Outburst is also indicated. Source; SAHFOS 2003 - modified, from Beaugrand et al. (2003).

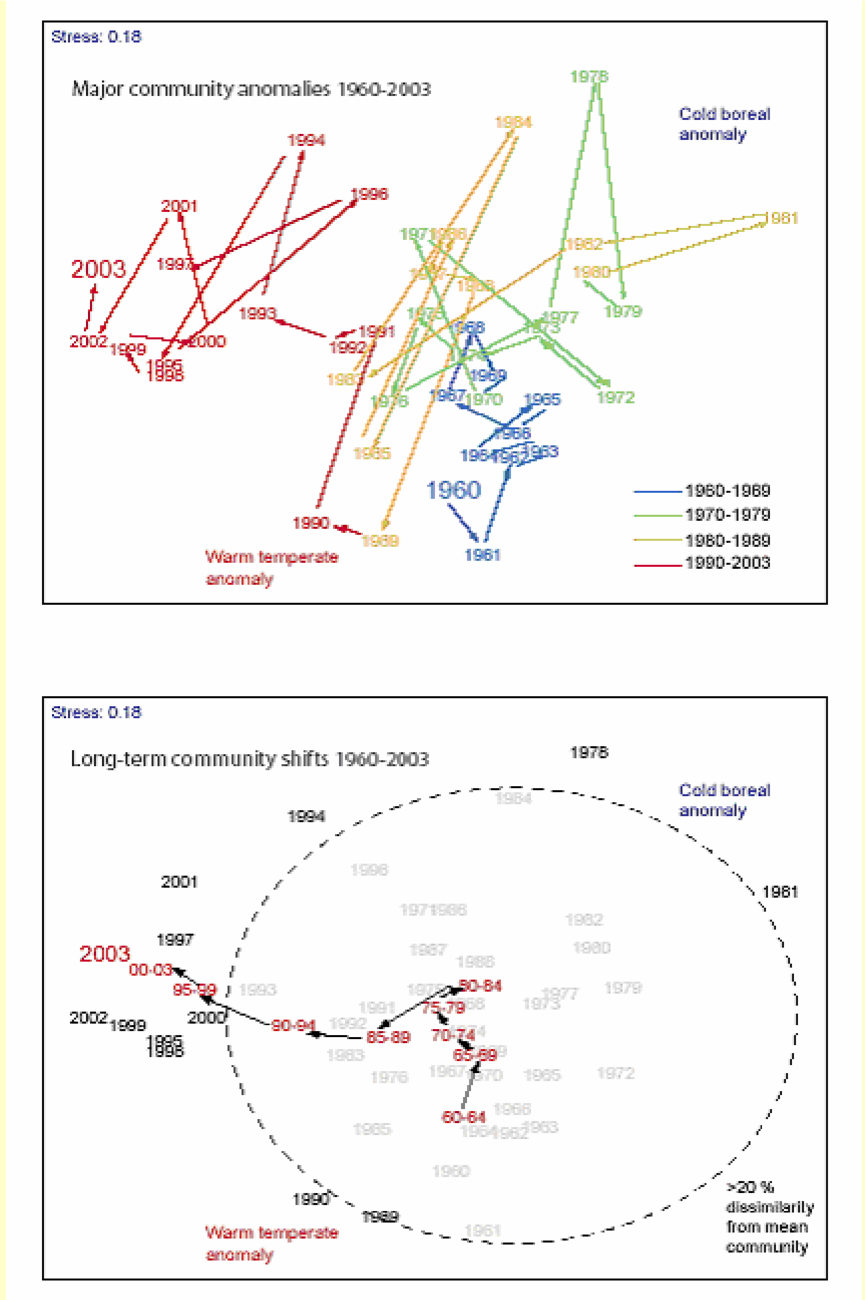

Figure 6.1.10 Multi-dimensional scaling plot of the annual zooplankton community structure in the central North Sea from 1960-2003 showing major structural shifts (top figure) and five-year community averages (bottom figure). Similarity matrix based on Bray-Curtis and log (x+1) transformations. From www.sahfos.org, Ecological Status 2004

Benthos and larger invertebrates

The 50m, 100m and 200m depth contours broadly define the boundaries between the main benthic communities in the North Sea, with local community structure further modified by sediment type (Künitzer et al., 1992; Callaway et al., 2001). Descriptions of the spatial distribution of infaunal and epifaunal invertebrates show that the diversity of infauna and epifauna is lower in the southern North Sea than in central and northern North Sea. However, large-scale spatial gradients in biomass are less pronounced. Bottom temperature, sediment type and trawling intensity have been identified as the main environmental variables affecting community structure. Epifaunal communities are dominated by free living species in the south and sessile species in the North.

Reliable information on trends in biomass of benthic species is largely lacking. Although there is a large body of evidence that towed bottom gears kill off large quantities of benthic animals and direct effects are undoubtedly large, the long-term impact is unknown.

Large-scale discarding of a variety of macrobenthos species occurs in the mixed demersal trawl fisheries, particularly in the beam-trawl fishery for sole and plaice and the otter-trawl fishery for Norway lobsters. These fisheries alter the biomass, production, size structure and diversity of benthic communities, with the intensity and patchiness determining the aggregate impacts (ICES 1999). In areas with periodical oxygen deficiency e.g. in the Kattegatt, the benthic fauna is affected by mortality or reduced growth (Diaz and Rosenberg 1995). This may in turn cause shortage of food for demersal fish.

Directed fisheries exist for Nephrops norvegicus, Pandalus borealis and brown shrimp Crangon crangon.

Fish community

Dominant species

Estimates of the total biomass of North Sea fish in the 1980s were in the order of 12 million tonnes, 2/3 of which comprised of the major eleven exploited species (Daan et al, 1990). Throughout the year, the pelagic component is dominated by herring. Mackerel and horse mackerel are mainly present in the summer half year when they enter the area from the south and from the northwest. Dominating gadoid species are cod, haddock, whiting and saithe, whereas the main flatfish species are dab, plaice, long rough dab, lemon sole and sole. The major forage fish species are sandeels, Norway pout and sprat, but juvenile herring and gadoids also represent an important part of the forage stock. However, large annual variations in species composition occur as a consequence of natural fluctuations in recruitment success of the individual species.

The late 1960s up to the early 1980s were characterised by a sudden and yet unexplained increase in the abundance of large, commercially important gadoid species: the ‘gadoid outburst’. During this period, cod, haddock, whiting and saithe, all produced a series of strong year classes. The stocks of cod and whiting have been decreasing since then and especially cod is at the lowest level observed over the last century. North Sea herring and mackerel were heavily overfished in the 1960s and 1970s and the stocks collapsed. The herring stock has recovered following a closure of the fishery in the late 1970s. The North Sea mackerel stock has remained low. During the second half of the year North Sea mackerel mix with the Northeast Atlantic mackerel stock and are thus affected by the fishery for mackerel.

Over the last decade a number of so-called ‘southern’ species have increased which is probably a response to the increased water temperatures (Beare et al, 2004). However, many ‘northern’ species have also increased, although less markedly (Daan pers comm).

Size spectrum

Absolute numbers of both small fish belonging to all species and of demersal species with a low maximum length have steadily and significantly increased over large parts of the area during the last 30 years and the abundance of large fish has decreased (Daan et al., 2005). For comparison along the Swedish Skagerrak coast see Svedäng (2003). The best available explanation for this is the reduction of the predation pressure on juvenile fish and on species that remain small. This is as an indirect effect of overexploitation of the large predatory fish species.

Species Richness

Species richness in the North Sea is highest around the edges (particularly in Scottish waters, in the Southern Bight and in the Kattegat) and lowest in the central North Sea (Figure 6.1.11). The edge areas are frequently invaded by species from adjacent areas that are a-typical for the North Sea. Based on the IBTS surveys in February, species richness appears to have increased steadily over the last 30 years (Figure 6.1.12) and trends have been roughly comparable for northerly and southerly species.

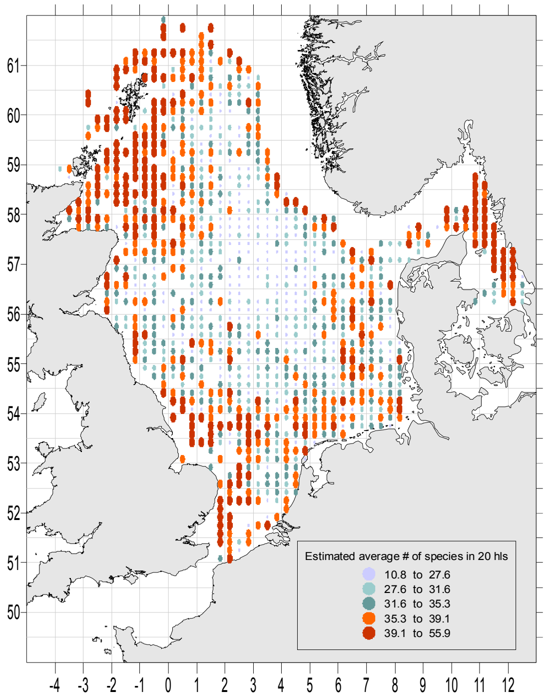

Figure 6.1.11 Spatial indices of species richness for all species

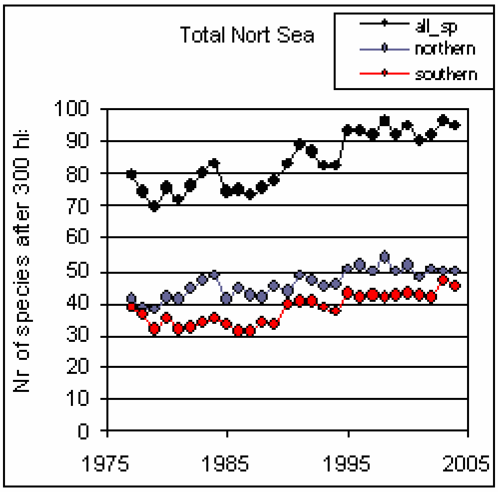

Figure 6.1.12 Species richness based on IBTS surveys.

The principal effects of fishing on the size and species composition of the fish community have been that as mortality rose, the mean size of individuals in the community dropped, and species with larger body sizes formed a smaller proportion of community biomass (Gislason & Sinclair 2000). This is reflected in the slopes of size spectra becoming steeper (Rice & Gislason 1996), reductions in the abundance of large species with low intrinsic rates of increase, such as many elasmobranches, (Walker & Heessen 1996; Walker & Hislop 1998), and increases in abundance of many smaller species (Greenstreet & Hall 1996; Heessen & Daan 1996; Greenstreet et al. 1998; Daan et al., 2003, 2005).

Biomass/abundance of crucial species in the food chain

Landings of Norway pout in 2003 were the lowest of the past two decades. Spawning biomass of sandeel was at the lowest level observed in 2004 (reference). Sandeels are an essential component of the diet of most piscivorous fish species as well as birds and marine mammals and their low abundance is therefore expected to have severe implications for the whole North Sea ecosystem.

Status of vulnerable species

Certain highly migratory species that have been fairly common historically in the North Sea have disappeared completely (e.g. tuna) or have become very rare (e.g. halibut). Recently species like hake and pollack in the Skagerrak and Kattegat are decreasing. The stocks of most elasmobranchs are at low levels. The spurdog (*Squalus acanthias*) was the most common shark species but is now considered to be depleted to approximately 5% of its virgin biomass in the whole Northeast Atlantic (Hammond & Ellis 2005). Species as porbeagle and tope have become rare. Most ray species are at low levels and have disappeared from large parts of the North Sea (Walker & Heessen, 1996). Spatial management measures have been proposed, and in some cases implemented to protect the remaining stocks.

Fish population structure

There is generally a lack of information about the population structure of many important fish species such as cod in the North Sea, Skagerrak and Kattegat, both in a genetic sense and with regards to spatial distribution of spawning aggregations. For instance, due to the disappearance of local spawning subpopulations of cod in the last 20 years, the North Sea spawning stock has become increasingly more important, for the recruitment of cod in the Kattegat-Skagerrak area (Svedäng 2003; Cardinale & Svedäng 2004).

Birds

About 2.5 million pairs of seabirds breed around the coasts of the North Sea, belonging to some 28 species. While most species breed in dense colonies along the coast, they make a very different use of the marine ecosystem, During the breeding season, some species depend on local feeding conditions within tens of km around their colony, while others may cover several hundreds of km during their foraging trips. Outside the breeding season, some species stay quite close to their breeding grounds whereas others migrate across the North Sea or elsewhere, even as far as the Antarctic. Feeding habits also diverge. Auks and cormorants dive from the surface, gannets and terns use plunge diving, and gulls feed mostly from the surface. A few (esp. skuas) are kleptoparasites (Dunnet et al., 1990). Their food resources vary accordingly, ranging from epiplankton to small schooling fish and discards. Because of all these differences, seabirds do not represent a homogeneous group that responds to fisheries in some specific way. A few species profit directly from human consumption fisheries, either discards or offal e.g. fulmars and gulls.

The current seasonal distributions, status and trends of these species are well known and documented in ICES (2003). Most have shown a marked increasing trend over the last century. Historically, auks and cormorants have been hunted, but are now protected in some areas (e.g. southern North Sea and Kattegat). Gulls have been controlled in many areas. Fulmars may have benefited from expansion in fishing. Skuas may have profited directly from the increase in population size of seabirds in general. On a shorter time scale, 12 out of 28 species show an increasing trend during the last decade and 4 a decreasing trend, while 4 appear to be stable and for another 4 the situation is unknown. Local breeding success of some species has been low in some recent years. This been related to a local shortage of forage fish. Although the industrial sandeel fishery has been blamed by some for this failure, there is only limited evidence to support this. The current view is that natural (or maybe climate-change induced) variation in sandeel recruitment is largely responsible. Nevertheless, industrial fishing at these times does not improve the situation and various restrictions have been implemented.

ICES has recommended that trends in breeding success within individual colonies of kittiwakes might serve as an index of seabird community health within the framework of Ecological Quality Objectives (EcoQO) proposed by OSPAR.

Mammals

Many cetacean and pinniped species have been observed within the North Sea, but most of these must be considered vagrants and only a few constitute typical representatives of the North Sea ecosystem.

Harbour Phoca vitulina and grey Halichoerus grypus seals have gone through large population changes over the past century. Both species typically inhabit coastal habitats, because they need haul out sites for pupping and weaning. However, they make extensive foraging trips into the open sea. Because of extensive hunting, followed by reduced reproduction rates owing to effects of contamination, the populations of harbour seals along the continental coast reached an all-time low in the 1970s. Subsequently, these populations have increased steadily at an annual rate of 4%, with two major interruptions in 1988 and 2002, when the populations were hit by outbreaks of the phocine distemper virus. Grey seals occur predominantly along the British coast and have been increasing also. In recent years, new colonies have been founded along the continental coast as well. Seals interact with various fishing operations, because they may feed on fish caught in passive gear, but also because they may be caught in various gears. Scottish fishers claim that the increasing grey seal population rather than their own activities is responsible for the reduced availability of commercial fish species and they advocate culling of seals.

Much less is known about the cetacean species inhabiting the North Sea. Population estimates derived from surveys made in 1994 are only available for harbour porpoise Phocoena phocoena (300 000), white-beaked dolphin Lagenorhynchus albirostris (7900), minke whale Balaenoptera acutorostrata (7300) and bottlenose dolphin Tursiops truncatus (120). New population figures will be available during 2006. Although trends are uncertain, harbour porpoise and bottlenose dolphin appear to have reduced ranges compared with the early 20th century. In terms of biomass, the minke whale is the most important marine mammal occurring and consumes small fish such as sandeel. Harbour porpoise is the second most important from a biomass perspective, and the North Sea may represent the most important habitat for this species on the planet.

The main concern about interactions with human activities is the by-catch in fishing operations and effects of contaminants. Specifically, the large by-catch of harbour porpoise in gill net fisheries has led to management measures.

Knowledge gaps

Many of the issues which arise in the North Sea, and for which additional research is necessary for improved scientific advice, are also issues in the other ecological areas. However, because of the greater availability of data and information for the North Sea, and the focused scientific effort historically and currently through, for example REGNS (ICES 2005), it may be appropriate to highlight the research needs for this area. Progress in this area should be viewed with regard to implications for other areas, however, and opportunities for collaborative and integrative work should be sought.

- Community ecology: what are the ecological effects of a diminishing size spectrum and a dominance of prey species like herring. Can these changes be readily reversed through management.
- Temperature preferences i.e. what are the effects of climate change on reproduction, egg mortality, growth, and the implications for changes stock population dynamics and distributions
- What are the consequences of the loss of meta-population structure and erosion of spawning aggregations in depleted populations.
- There should be better estimations of population fecundity, i.e. better understanding of reproduction biology including better estimates of maturity ogives, variation in maturation rates, the linkage between maturation and growth, temperature, for a more realistic view of stock productivity

Using this information, it is important to investigate and test management strategies which would be sustainable in the fact of these dynamic ecological conditions; how to preserve the productivity of the seas and have some revenues from fishing at the same time

6.1.2 Major environmental influences on ecosystem dynamics

No specific environmental signals were identified specifically to be considered in assessment or management in this area in 2006. It should be noted that SST across much of the North Sea was close to the mean from January to August 2005, but showed strong positive anomalies thereafter. In contrast the inflowing Atlantic water was well above average temperature and salinity throughout the year.

The observed low abundance of species that play an important role in the North Sea food web (Calanus, sandeels, and Norway pout) has persisted into 2005. It is still expected to have considerable impact on growth, maturation and possibly recruitment of a range of fish species and on the breeding success of seabirds.

Many North Sea fish stocks presently remain low or depleted (e.g. plaice and cod). Recruitment of some commercially important gadoids is at a low level and this has led to speculation that the ecosystem may be changing in an irreversible direction. However, there are preliminary indications of improved recruitment in some parts of the North Sea for haddock and possibly very localised recruitment of cod. Thus far these should not be taken as indicating a major recovery in gadoid recruitment in the North Sea. There is an increase in a number of southern species e.g. anchovy (*Engraulis encrasicola*) and red mullet (*Mullus surmulletus)*. In the latter case there is a new fishery developing.

6.2 Human impacts on the ecosystem

6.2.1 Fishery effects on benthos and fish communities

Large scale discarding is known to occur in the mixed demersal trawl fisheries in the North Sea. In the roundfish fishery (cod, haddock) discards will mainly consist of small sized specimens of the target species. In the flatfish (plaice, sole) and the Nephrops fisheries there is also discarding of a variety of macrobenthos species.

Bottom trawling modifies the biomass, production, size structure and diversity of benthic communities, with the intensity and patchiness of bottom trawling disturbance determining the aggregate impacts (ICES 1999). One recent estimate suggests that beam trawling in the southern and central North Sea beam trawl fleets reduces total benthic biomass by 39% and benthic production by 15% relative to the unfished state (Hiddink et al. in press), but similar estimates are not available for most other fleets. Historically trawling effort has not been homogeneous, with effort greatly concentrated in preferred fishing grounds. Cumulative trawling impacts would increase if trawling effort were spread more homogeneously or relocated, particularly to more vulnerable habitats, because the first impacts of trawling on a previously untrawled community are greater than subsequent effects (Duplisea et al., 2002). For example, the cod box closure of 2001 led to the beam trawl vessels fishing in previously unimpacted areas (Rijnsdorp *et al* 2001), and led to a greater reduction in the total productivity of benthic communities (Dinmore et al., 2003).

Closed areas and/or seasons generally result in effort redistribution, which may lead to increased fishery impacts on benthic communities and vulnerable habitats or species. This should be taken into account when evaluating proposed closed areas or seasons.

The principal effects of fishing on the size and species composition of the North Sea fish community has been that as fishing mortality increased, the mean size of individuals in the community decreased, and species with larger body sizes formed a smaller proportion of community biomass (Gislason & Sinclair 2000). This is reflected in the steeper slopes of size spectra (Rice & Gislason 1996), reductions in the abundance of large species, such as many elasmobranches, with low intrinsic rates of increase (Walker & Heessen 1996; Walker & Hislop 1998), increases in abundance of many smaller species (Greenstreet & Hall 1996; Heessen & Daan 1996; Greenstreet et al. 1998; Daan et al., 2003, 2005). The changes in size composition of the fish community could change the predation mortality among species and sizes of fish. Changes in size composition of species and communities due to overfishing can also affect population fecundity both directly (reduction of larger, more fecund spawners), and indirectly (earlier maturation at smaller sizes).

Recent studies (Rochet et al., 2005), based on IBTS data from the southern north sea 1990-2000, developed a diagnostic based on indicators for 13 fish populations and the fish community. The study demonstrated deteriorating trends in the populations and a stable community status (i.e. not improving with reference to the start of the time-series in 1990). The overall conclusion was for a deteriorating situation.

The long-term effects of an eroded population structure must be considered. The differences between the various subpopulations may be behavioural or genetic, but go unobserved by both the fishermen and regulators who believe there is a gradual decline in one big stock while in fact they are witnessing the successive disappearance of a series of sub-populations. Fishing also has differential effects on species with contrasting life histories (Jennings et al. 1999), with many large and vulnerable species subject to unsustainable mortality rates when taken as bycatch in mixed fisheries. Management should take account of the status of these species, and ensure that fishing mortality on bycatch species does not exceed estimates of sustainable mortality for vulnerable species (e.g. Pope et al., 2000).

Increased effort and landings in the unregulated fishery for witch in the Skagerrak

As and when exploited species become depleted fisheries may move to other areas or species. Examination of Swedish landings of witch (*Glyptocephalus cynoglossus*) in the Skagerrak and the northern Kattegat indicate that this fishery has increased between 1997 to 2004. Several fisheries (Pandalus, Nephrops and mixed demersal trawling) land witch and the directed fishery (landings>30% witch) have increased. During the same period the spatial extent of the fishery has also increased and landings are now registered from five ICES rectangles in the Norwegian Trench. This species is long lived (~30 yrs), slow growing and matures late (5-6 years) so it is likely to be easily overfished. By-catches and discards in the directed witch-fishery include cod and vulnerable species of elasmobranchs e.g. skates and rays and piked dogfish. The development of this fishery in the Skagerrak is an illustration that the fishery impact on the ecosystem is sequential. Although the major moves may be towards more productive/short lived/lower trophic level species, some may also direct long-lived species traditionally not targeted e.g. because of low economic value.

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6.3 Assessments and advice

6.3.1 Assessments and advice regarding protection of biota and habitats

ICES has not in 2006 provided advice regarding protection of biota and habitats.

6.3.2 Assessments and advice regarding fisheries

Effects of fishing on the ecosystem

Sandeel and Norway pout

The ecosystem effects of industrial fisheries are discussed in the Report of the ICES Advisory Committee on Ecosystems, June 2003, Section 11 (*ICES Cooperative Research Report No. 262*). The direct effects of industrial fishing that have been identified on other species fished for human consumption, e.g. haddock and whiting, are relatively small in comparison to the effects of directed fisheries for human consumption species. Sandeel is an important prey species for many marine predators. However, the information on the effects of fisheries targeting these stocks (sandeel, Norway pout, sprat) is still relatively scant, and further analysis of the ecological impacts of these fisheries is required. The effects of variation in the sizes of most industrial stocks on their predators are also poorly known. The importance of these species in the food-web and the potential indirect effects of fishing are discussed in Sections 6.1–2.

North Sea skates and rays

Elasmobranchs have been shown generally to have life history traits which enable them to sustain only low fishing mortality, and some species of skates and rays are widely thought to have relatively high catchabilities in fishing gears. These two, the vulnerability to capture and the low rates of sustainable mortality, have been proposed as major factors in the severe decline in the common skate from the Irish Sea and similar trends in a variety of other skates and rays. In 1998 ICES (WGECO) reported life history-based estimates of the maximum total mortality rate that were sustainable for five species of rays (common skate *Dipturus batis* – 0.38, thornback ray *Raja clavata* – 0.5, spotted ray *Raja montagui* – 0.54, cuckoo ray *Raja naevus* – 0.58, and starry ray *Raja radiata* – 0.87). In that report, ICES also reported that recent estimates of total mortality from survey catch data were greater than the theoretical sustainable mortality rates for three of the five species, and could not be estimated for a fourth, because this species was reduced to such a low abundance that current mortality rates could not be estimated. ICES (1997) advised some specified areas of the North Sea be closed to gears with a high bycatch of these species.

Recently ICES has developed and implemented analytical methods for estimating at least relative catchability of different fish species to different fishing gears (WGFE 2004). ICES is also in the process of changing the form of advice to advise on fleet-based effort levels consistent with the single-species catch boundaries of the suite of species taken by the fishery. When the methods of estimating catchability have been applied to skates and rays, the combination of fleet-based effort advice and gear-specific catchabilities will allow estimates of the maximum fleet-specific effort levels that can be exerted without exceeding the sustainable mortality rates for skates and rays. Then it will be possible to integrate the fishery- and fleet-based catch advice with the need to ensure that impacts on non-target species are also sustainable.

Mixed fisheries and fisheries interactions

Demersal fisheries in the area are mixed fisheries, with many stocks exploited together in various combinations in different fisheries. In these cases management advice must consider both the state of individual stocks and their simultaneous exploitation in demersal fisheries. Stocks in the poorest condition, particularly those which suffer from reduced reproductive capacity, become the overriding concern for the management of mixed fisheries, where these stocks are exploited either as a targeted species or as a bycatch.

The exploitation of sole and plaice are closely connected as they are caught together in fisheries mainly targeting sole, which are more valuable. This means that the minimum mesh size is decided on the basis of the more valuable species, resulting in substantial discards of undersized plaice. The mixed fisheries for flatfish is dominated by a mixed beam trawl fishery using 80-mm mesh in the southern North Sea where up to 80% in number of all plaice caught are being discarded. Measures to reduce discarding in the mixed beam trawl fishery would greatly benefit the plaice stock and future yields. In order to improve the selection pattern, mesh size increases or configuration changes (i.e. square mesh), would help reduce the discards. However, this would result in a short-term loss of marketable sole. Readjustment of minimum landing sizes corresponding to an improved selection pattern could be considered.

Roundfish are caught in otter trawl and seine fisheries, with a 120-mm minimum mesh size. This is a mixed demersal fisheries with more specific targeting of individual species in some areas and/or seasons. Cod, haddock, and whiting form the predominant roundfish catch in the mixed fisheries, although there can be important bycatches of other species, notably saithe and anglerfish in the northern and eastern North Sea and of *Nephrops* in the more offshore *Nephrops* grounds. Cod and whiting also comprise a bycatch in the beam trawl fisheries. Static gear fisheries with mesh sizes generally in excess of 140 mm are also used to target cod. Saithe in the North Sea are mainly taken in a directed trawl fishery in deeper water near the northern shelf edge and the Norwegian Deeps. There is little bycatch of other demersal species associated with this directed fishery.

The effect of recent changes in mesh-size (120 mm for cod) is not apparent in the recent catch compositions of most of the roundfish. This could be partly explained by a reallocation of fishing effort from the cod fishery to other fisheries where a smaller mesh size is allowed and for which the limitation of number of days at sea are less restrictive.

Discards remain high in most of the fisheries (whiting, haddock, plaice, and cod). Any improvements to gear selectivity which would contribute to a reduction of catches of small fish must take into account the effect on the other species within the mixed fishery. For instance, mesh enlargement in the flatfish fishery would reduce the catch of undersized plaice, but would also result in short-term loss of marketable sole. An increase in the minimum landing size of sole could provide an incentive to fish with larger mesh sizes and therefore mean a reduction in the discarding of plaice.

Nephrops fisheries take place in discrete areas that comprise an appropriate muddy seabed sediment. Targeted *Nephrops* fisheries on these grounds are taken predominantly in trawls with mesh sizes of between 70 mm and 100 mm using single- or multiple-rig trawls. UK legislation prohibits the use of meshes less than 100 mm in most of its twin-trawl *Nephrops* fishery, particularly in the offshore areas. *Nephrops* fishing grounds vary from small, localised inshore grounds to more offshore large areas such as the Fladen Ground in the northern North Sea, and while there is bycatch and discarding of other demersal species associated with *Nephrops*, the general nature of these fisheries and their bycatch can vary widely. Prior to the increase in minimum mesh size (MMS) in 2003, a significant proportion of the vessels reporting *Nephrops* also recorded significant catches of other whitefish species. These vessels used 100-mm mesh in order to avoid catch composition regulations. However, following the mesh size increases almost all of these vessels switched to 80-mm mesh to avoid losses of *Nephrops*. This is likely to have resulted in increased discards because of lower selection and high grading due to catch composition regulations associated with the mesh size. There is a desperate need to obtain selection patterns similar to a 120-mm mesh codend while still retaining *Nephrops* (Graham and Ferro, 2004). Solutions could, e.g., include modifications to the square mesh panel construction and location.

Small-mesh industrial fisheries for sandeel and Norway pout occur separately in the North Sea. Sandeel fisheries take place throughout the North Sea in areas defined by the appropriate sandy seabed sediment. These fisheries have a low bycatch rate of important demersal species. Fishing for Norway pout takes place in the northern and northeastern North Sea and has higher bycatch rates of other species such as haddock and whiting. This impact has been considerably reduced since the mid-1990s.

The available national logbook data suggest that landed bycatch of fish for human consumption from the *Pandalus* fisheries in Skagerrak and the Norwegian deep amounts to 10–15% of landed shrimp. In the Fladen Ground fishery for *Pandalus* (Danish logbook records) this bycatch varies from 8% to 20 % relative to shrimp landings.

Single-stock exploitation boundaries and critical stocks

The state and the limits to exploitation of the individual stocks are presented in the stock sections. The state of stocks and single-stock exploitation boundaries are summarised in the table below.

Stock	State of the stock			ICES considerations in relation to single-stock exploitation boundaries			Upper limit corresponding to single-stock exploitation boundary Tonnes or effort in 2007 and % reduction in F.
	Spawning biomass in relation to precautionary limits	**Fishing mortality in relation to precautionary limits**	**Fishing mortality in relation to high long-term yield**	**In relation to agreed management plan**	**in relation to high long-term yield**	**in relation to precautionary limits**	
Cod in the North Sea, Eastern Channel and Skagerrak	Reduced reproductive capacity	Uncertain	Overexploited	Total removals (landings, discards, and unaccounted removals) in 2007 of 35 000 t.		The fisheries for cod be closed until an initial recovery of the cod SSB has been proven	**Zero TAC**
Cod in Kattegat	Reduced reproductive capacity	Uncertain	Uncertain	Even with no fishing in 2007, the SSB in 2008 is expected to remain below $B_{lim.}$		There should be no fishing on this stock in 2007**.**	**Zero TAC**
Haddock in the North Sea and Division IIIa	Full reproductive capacity	Harvested sustainably	Overexploited	Landings of less than 55 400 t in 2007	F is above F0.1	The target fishing mortality in the management plan is in accordance with the precautionary approach.	**TAC 55 400 t**
Whiting in the North Sea and Eastern Channel	unknown	unknown	unknown	Unknown	Unknown	Total human consumption landings in 2007 should not be allowed to increase above the recent (2003–2005) average of 15 100 t.	**TAC <15 100 t**
Saithe in the North Sea, Division IIIa and Subarea VI	Full reproductive capacity	Harvested sustainably	Appropriate	F at 0.3 corresponds to landings of 136 000 t in 2007.	F is above $\mathbf{F}_{0.1}$. Fishing at $\mathbf{F}_{0.1}$ is expected to lead to landings of 51 000 t in 2007.	Human consumption landings of about 170 000 t in 2007, where the SSB is expected to remain above $\mathbf{B}_{pa}$ (200 000 t) in 2008.	TAC 136 000 t.
Anglerfish in Division IIIa, Subareas IV and VI	unknown	unknown	unknown	No management plan.	Unknown	The effort in this fishery should not be allowed to increase and the fishery must be accompanied by mandatory programmes to collect catch and effort data on both target and bycaught fish.	**No effort increase**
Plaice in the North Sea	At risk of reduced reproductive capacity	Harvested sustainably	Overexploited		F is above $\mathbf{F}_{max}$	Human consumption landings of less than 32 000 t in 2007, which is expected to rebuild SSB to the $\mathbf{B}_{pa}$ (=230 000 t) in 2008. .	**TAC < 32 000 t.**
Plaice in the Eastern Channel	Unknown	Unknown	Unknown	No management plan.	Not defined	Landings in 2007 at 4000 t; average of landings from the last three years (2003–2005).	**TAC<4000 t**
Plaice in Division IIIa	Unknown	Unknown	Unknown	No management plan	Unknown	Maintain the current TAC of 9600 t for 2007.	**TAC < 9 600 t.**
Sole in Division IIIa	Full reproductive capacity	Unkown	Unknown			Keep catches below those recently observed (average of 2002-2005) 740 t.	**TAC 740 t**
Sole in the North Sea	Risk of reproductive capacity	Risk of being harvested unsustainably	Overexploited	No management plan	F is above $\mathbf{F}_{0.1}$.	Landings of less than 10 800 t in 2007, which is expected to lead to an SSB above $\mathbf{B}_{pa}$ (=35 000 t) in 2008.	**TAC<10 800 t.**
Sole Eastern Channel	Full reproductive capacity	Harvest sustainably	Overexploited	No management plan	F is above $\mathbf{F}_{0.1}$ Fishing at $\mathbf{F}_{0.1}$ is expected to lead to landings in 2007 of 2400 t	Landings of less than 6440 t in 2007, which is expected to lead to a 13% decrease in SSB in 2008.	**TAC < 6440 t.**

Stock	State of the stock			ICES considerations in relation to single-stock exploitation boundaries			Upper limit corresponding to single-stock exploitation boundary Tonnes or effort in 2007 and % reduction in F.
	Spawning biomass in relation to precautionary limits	**Fishing mortality in relation to precautionary limits**	**Fishing mortality in relation to high long-term yield**	**In relation to agreed management plan**	**in relation to high long-term yield**	**in relation to precautionary limits**	
Sandeel North Sea	Reduced reproductive capacity	F reference points are not defined	Unknown	No management plan	Management of fisheries should try to prevent further local depletion of sandeel aggregations, particularly in areas where predators congregate.	The fishery should remain closed until information is available which assures that the stock can be rebuilt to $\mathbf{B}_{pa}$ by 2008.	**zero TAC and in-year considerations**
Norway pout North Sea	Reduced reproductive capacity	F reference points are not defined	F reference points are not defined	No management plan.	Unknown	The fishery should be closed until information, which assures that the stock will be above $\mathbf{B}_{pa}$ at the beginning of 2008 is available.	**zero TAC and in-year considerations**
Pandalus stocks							**Advice to come in November 2006**
Autumn spawning herring in the North Sea, VIId and IIIa	Full reproductive capacity	At risk of being harvested unsustainably	Overexploited	F(adult) = 0.25, F(juv)=0.12, Catches around 350 000 t. See scenarios		Reduce $\mathbf{F}_{0-1}$ (~0.05) F2-6 (~ 0.20) to bring SSB back to B_{pa} in 2008. Catches in the order of 275,000 t across all fleets (see scenarios).	**Catches around 275 000 t (all fleets) TAC fleet A around 240 000 t.**
Spring spawning herring in Subdivisions 22-24 and IIIa	Unknown	Unknown	Unknown		The current fishing mortality exceeds the fishing mortality associated with $F_{0.1}$.	Fishing mortality should not be allowed to increase. Landings of 99 000 t in 2007.	**TAC 99 000 t**
Sprat in the North Sea	unknown	unknown	unknown				**Only in-year advice**
Mackerel in the North Sea	Unknown	Unknown	Unknown			ICES advises that the existing measures to protect the North Sea spawning component remain in place.	**No fishing for mackerel in IIIa and IVb,c**
Horse mackerel in the North Sea	Unknown	Unknown	Unknown			limit the catches to be below the 1982–1997 average of 18 000 t	**TAC < 18 000 t**
Rays and skates in the North Sea	Unknown	Unknown	Unknown			The stocks of common skate and thornback rays are depleted. Target fisheries should not be permitted, and by-catch in mixed fisheries should be reduced to the lowest possible level. If the fisheries for rays continue to be managed with a common TAC for all ray species, this TAC should be set at zero for 2007	**Minimal bycatch. Zero TAC.**
Spurdog	Unknown	Unknown	Unknown			No target fisheries, and by-catch in be reduced to the lowest possible level. A TAC should cover all areas where spurdog are caught in the northeast Atlantic. This TAC should be set at zero for 2007.	**Low bycatch. Zero TAC.**
Nephrops in Division IIIa (FU 3+4)	Unknown	Unknown	Unknown	No management plan	Unknown	ICES recommends that fishing effort for fleets targeting *Nephrops* should not be allowed to increase.	**No increase in effort**
Nephrops in Norwegian Deep (FU 32)	Unknown	Unknown	Unknown	No management plan	Unknown	Information on this stock is considered inadequate to provide advice based on precautionary limits.	**No increase in effort**

Stock	State of the stock			ICES considerations in relation to single-stock exploitation boundaries			Upper limit corresponding to single-stock exploitation boundary Tonnes or effort in 2007 and % reduction in F.
	Spawning biomass in relation to precautionary limits	**Fishing mortality in relation to precautionary limits**	**Fishing mortality in relation to high long-term yield**	**In relation to agreed management plan**	**in relation to high long-term yield**	**in relation to precautionary limits**	
Nephrops in Divisions IVa, Noup (FU 10) and Moray Firth (FU 9)	Unknown	Unknown	Unknown	No management plan	Unknown	No increase in effort. The harvest ratio no more than 15%. Landings of less than 2400 tonnes for the Moray Firth stock. The fishery in Noup stock should be less than 240 t.	**Moray Firth < 2400 t.** **Noup <240 t.** **No increase in effort**
Nephrops in Fladen Ground (FU 7) Division IVa	Unknown	Unknown	Unknown	No management plan	Unknown	No increase in effort. The harvest ratio no more than 7.5%. Landings of less than 10 882 tonnes for the Fladen stock. Catches in adjacent squares should be limited to 105 t	**Fladen <10 882 t.** **Adjacent squares <105 t.** **No increase in effort**
Nephrops in Firth of Forth (FU 8) and Farn Deep (FU 6) Division IVb	Unknown	Unknown	Unknown	No management plan	Unknown	No increase in effort. The harvest ratio no more than 15%. Landings of less than 3500 tonnes for the Farn Deeps stock and 1500 tonnes for Firth of Forth stock. Other statistical squares less than 600 t.	**Farn deeps < 3500 t.** **Firth of Forth < 1500 t.** **Other squares < 600 t.** **No increase in effort**
Nephrops in Botney Gut/Silver Pit (FU 5) and Off Horn Reef (FU 33) Division IVbc	Unknown	Unknown	Unknown	No management plan	Unknown	ICES recommends that the level of exploitation, i.e. effort on these stocks should not be increased.	**No increase in effort**

Identification of critical stocks

The table above identifies the stocks where spawning stock biomass is at reduced reproductive capacity (cod in the North Sea, Eastern Channel, and Skagerrak, cod in Kattegat, sandeel and Norway pout in the North Sea) and/or where fishing mortality indicates unsustainable harvesting of the stock (cod in the North Sea, Eastern Channel, and Skagerrak, cod in Kattegat).

These stocks are the overriding concerns in the management of all demersal fisheries:

- For cod in the North Sea, Eastern Channel, and Skagerrak, and for cod in Kattegat, it is not possible to identify any non-zero catch which will be compatible to the precautionary approach. ICES therefore recommends a zero catch;
- For sandeel and Norway pout in the North Sea ICES recommends that the fishery should remain closed until information is available which assures that the stock can be rebuilt to $\mathbf{B}_{pa}$ by 2008. For sandeel, the information on which this could be based includes a survey in December 2006 and exploratory fishing in April 2007. For Norway pout the IBTS survey in February 2007 will provide the information.
- For sole in the North Sea, which is at risk of being harvested unsustainably, ICES recommends that catch should be less than 10 800 t in order to allow SSB to reach $\mathbf{B}_{pa}$ in 2008.

There is also concern about the overexploitation of North Sea herring, caused by the serial poor recruitment and increase in fishing effort. ICES recommends that the catch of herring should be reduced to around 275 000 tonnes from all fleets, implying a TAC of approximately 240 000 t for fleet A and a bycatch of 5000-9000 tonnes for fleet B.[1]

There is concern about the stocks of spurdog, porbeagle, and most other rays species taken as bycatch in fisheries directed towards other species.

Advice for fisheries management

Fisheries in Division IIIa (Skagerrak–Kattegat), in Subarea IV (North Sea), and in Division VIId (Eastern Channel) should in 2007 be managed according to the following rules, which should be applied simultaneously:

Demersal fisheries

- **with minimal bycatch or discards of cod;**
- **implement TACs or other restrictions that will curtail fishing mortality for those stocks mentioned above for which reduction in fishing pressure is advised;**
- **within the precautionary exploitation limits for all other stocks (see text table above);**
- **where stocks extend beyond this area, e.g. into Division VI (saithe and anglerfish) or are widely migratory (Northern hake), taking into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits;**
- **with minimum bycatch of spurdog, porbeagle, and thornback ray and skate.**

Pelagic fisheries exploiting herring (western Baltic spring-spawning and North Sea autumn-spawning stocks), mackerel, and horse mackerel

- **with minimal bycatch or discards of cod;**
- **with minimal catch of North Sea mackerel, respecting the closed season;**
- **within the precautionary exploitation limits for the herring stocks, taking into account the exploitation of herring in the western Baltic (Subdivisions 22–24);**
- **where stocks extend beyond this area, e.g. widely migratory species (NEA mackerel and blue whiting), taking into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits.**

Fisheries with small meshed gears for industrial purposes

- **with minimal bycatch of cod and other fish used for human consumption;**

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[1] **Fleet A**: Directed herring fisheries with purse seiners and trawlers (with 32-mm minimum mesh size) in the North Sea. Bycatches in industrial fisheries by Norway are included. **Fleet B**: Herring taken as bycatch in the small-mesh fisheries in the North Sea (with mesh size less than 32 mm).

- **without fishing for Norway pout or sandeel except if the fisheries are reopened on the basis of information that they will rebuild to B_{pa};**
- **within the single-stock exploitation limits for all other stocks (see text table above).**

Management considerations

ICES notes that this advice presents a strong incentive to fisheries to avoid catching species that are identified as critical stocks. Industry-initiated programmes to pursue such 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 critical stocks are fully and credibly reported. Such programmes could be considered in the management of these fisheries.

Reductions in fishing mortalities have been advised for several demersal stocks in the North Sea. Fishing mortality is generally high but for some stocks there are now indications that fishing mortality has been decreasing in recent years. This is consistent with the observed decrease in fishing effort due to days-at-sea regulations and decommissioning in the major fleets. ICES reiterates that required reductions in fishing mortality can only be achieved if significant reductions in effort are included in management, and effective deterrents to discarding are implemented. Extensive discarding occurs in most fisheries on roundfish, flatfish, and *Nephrops* in the North Sea. These discards are largely small and juvenile fish. They always result in foregone potential yield, and for depleted stocks they are a serious impediment to rebuilding.

Most stocks are harvested well above the level of fishing mortality which, at the current fishing pattern, is expected to achieve high long-term yield and low risk of depletion of production potential.

Short-term implications

The catch options that would apply if single stocks could be exploited independently of others are summarized in the table above. However, many stocks are exploited in mixed fisheries. Mixed fisheries management options should 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, which is also the basis for the scientific advice presented above.

Information on the mix of demersal species is presented in Figures 6.3.2.1–5. They show 2005 landings by species and by gear, and for each gear and by mesh-sizes.

Exploratory fleet-based modelling of technical interactions was performed in 2006. However, further development and integration are still needed before ICES is in a position to present scenarios of the effects of various combinations of fleet effort.

The extent to which the stocks are taken in the same fisheries has not been quantified on basis of available data. The existing information suggests that the stocks are caught together to a high (H), medium (M), low (L) extent, or not at all (0), as indicated in the table below. The information in the table relates to catches and the linkage is thus also indicated as high in cases where the catches of most of one stock taken in a fishery with another stock is discarded.

		Interactions															
		Cod 347d	**Cod katt.**	**Had 34**	**Whg 47d**	**Sai 346**	**Ang 346**	**Ple 4**	**Ple 7d**	**Ple 3a**	**Sol 3a**	**Sol 4**	**Sol 7d**	**San 4**	**Nop 4**	**Nep stocks**	**Pan stocks**
Main gears	Cod 347d		0L	H	H	M	??	M	M	M	M	M	M	L0	L	HM	M
	Cod kattegat	BT, OT		L	0	0	??	0	0	M	M	0	0	00	0	M	0
	Had 34	OT			H	M	??	L	0	L	L	L	0	L0	L	M	M
	Whg 47d	OT				M	??	M	M	0	0	M	M	0L	L	M	??M
	Sai 346	OT					??	L	0	L	L	L	0	L0	L	L	??M
	Ang 346																M
	Ple 4	BT		OT	BT	OT	??		0	0	0	H	0	L	L	L	0
	Ple 7d	BT			BT, OT		??			0	0	0	H	0L	L	L	0
	Ple 3a	BT, OT	BT, OT	OT			??				H	0	0	0	0	L	0
	Sol 3a	BT,OT,GN	BT,OT,GN	OT	BT, OT					BT		0	0	0	0	L	0
	Sol 4	BT		OT	BT	OT		BT					0	0	0	L	0
	Sol 7d	BT			BT				BT					0	0	L	0
	San 4	Ind		Ind	Ind	Ind									M	0	0
	Nop 4	Ind		Ind	Ind	Ind								Ind		0	0L
	Nep. stocks																M
	Pan. stocks																

H; the stocks are taken together in most fisheries where they are taken and their fisheries linkage is therefore high; M: the stocks are taken together in some but not all important fisheries and their fisheries linkage is therefore medium; L: the stocks are taken together in some fisheries but are mainly caught independently of each other and their fisheries linkage is therefore low; 0: the stocks are never or only rarely caught together and they are thus not linked in the fisheries; na: information not available.

Gears: BT = beam trawl, OT = Otter trawl, GN = gill net

Regulations in force and their effects

An emergency measure (Council Regulation (EC) No. 259/2001) involving the closure of a large area of the North Sea was implemented from 14 February to 30 April 2001 to all fishing vessels using gears likely to catch cod. Analysis of the effectiveness of the emergency measures indicated that the closure had an insignificant effect upon the spawning potential for cod in 2001. The redistribution of the fishery, especially along the edges of the box coupled to the increases in proportional landings from January and February appeared to have been able to negate the potential benefits of the box. The conclusion from the study was that the box would have to be extended in both space and time to be more effective (see: ICES 2004). The emergency measure has not been adopted after 2001.

EU technical regulations in force in 2003 and 2004 are contained in Council Regulation (EC) No. 850/98 and its amendments. The regulation prescribes the minimum target species' composition for different mesh size ranges. In 2001, haddock in the whole of NEAFC region 2 was a legitimate target species for towed gears with a minimum codend mesh size of 100 mm. As part of the cod recovery measures, the EU and Norway introduced additional technical measures from 1 January 2002 (EC No. 2056/2001). The basic minimum mesh size for towed gears for cod from 2002 was 120 mm, although in a transitional arrangement until 31 December 2002, vessels were allowed to exploit cod with 110-mm codends, provided that the trawl was fitted with a 90-mm square mesh panel and the catch composition of cod retained on-board is not greater than 30% by weight of the total catch. From 1 January 2003, the basic minimum mesh size for towed gears for cod was 120 mm. The minimum mesh size for vessels targeting haddock in Norwegian waters is also 120 mm. There is some indication of the effect of mesh size regulations in the sudden increase in weight-at-age in the human consumption component for age 2 haddock. However, a shift in exploitation pattern at the early ages has not been observed. This may be confounded by the shift to smaller-mesh fisheries (80-mm mixed *Nephrops*) by some fleet segments that previously fished for a mix of fish and *Nephrops* using 100 mm. This shift was also encouraged by the differences in effort allocation between the 80- and 120-mm fleets, where the smaller-mesh fishery was awarded a higher proportion of days per month. It is likely that this may have increased discarding due to the lower selectivity and high grading to comply with catch composition regulations.

Minimum landings sizes are in effect for several North Sea species. The minimum landing size for cod in Subarea IV and Divisions IIIa and VIId is 35 cm; in Denmark it is 40 cm. In addition, size restrictions occur in flatfish fisheries. The minimum landing size of North Sea plaice is 27 cm. This minimum landing size results in high discard rates in the mixed flatfish fishery with beam trawls using 80-mm mesh size. The minimum landing size of North Sea sole is 24 cm.

Effort restrictions in the EC were introduced in 2003 (EC 2341/2002, Annex XVII, amended in EC 671/2003). Effort restriction measures were revised for 2004 (EC 2287/2003, Annex V). Preliminary analysis of fishing effort trends in the major fleets exploiting demersal stocks indicates that fishing effort in those fleets has been decreasing since the mid-1990s due to a combination of decommissioning and days-at-sea regulations. The decrease in effort is most pronounced in the years 2002 and beyond. However, effort restrictions combined with higher fuel costs have resulted in effort being shifted towards coastal fisheries. It is likely that this will increase discard rates because of the presence of small plaice in these areas.

A cod protection area has been implemented for 2004 only (EC 2287/2003, amended in EC 867/2004) which defined the conditions under which certain stocks, including haddock, could be caught in Community waters. A maximum of 35% of the haddock TAC in 2004 could be taken from within the cod protection area. For UK a special permit was introduced that was needed to fish for haddock in the cod protection area. Although this management scheme was proposed to permit additional haddock to be caught in 2004, the uptake of the special permit has been relatively low.

In 2004 agreement was reached within the EU on a formal cod recovery plan that will be operational during the TAC and management decision processes of 2004, effectively rendering the plan operational in 2005. Details of it are given in Council Regulation (EC) 423/2004. Technical measures applicable to the flatfish fishery in the North Sea included mesh size regulations, minimum landing size, gear restrictions, and a closed area (the plaice box). Mesh size regulations for towed gears require that vessels fishing North of 55°N (or 56°N east of 5°E, since January 2000) should have a minimum mesh size of 100 mm, while to the south of this limit, where the majority of the plaice fishery takes place, an 80-mm mesh is allowed. In the fishery with fixed gears a minimum mesh size of 100 mm is required. Mesh enlargement would reduce the catch of undersized plaice and cod, but would also result in loss of marketable sole. An increase in the minimum landing size of sole could provide an incentive to fish with larger mesh sizes and therefore a reduction in the discarding of plaice and juvenile cod.

In addition to this, since 2002 a small part of the North Sea plaice fishery is affected by the additional cod recovery plan (EU regulation 2056/2001) that prohibits trawl fisheries with a mesh size <120 mm in the area to the north of 56°N. The aggregated beam length of beam trawls is limited to 24 m. In the 12-nautical mile zone the maximum aggregated beam-length is 9 m in the plaice box. The plaice box has been enforced since 1989, and the area was closed in all quarters since 1995. The closed area applies to vessels using towed gears, but vessels smaller than 300 HP, including the small-mesh fishery for *Crangon,* are exempted from the regulation. An evaluation of the plaice box (Grift *et al.*, 2004) has indicated that: “From trends observed it was inferred that the Plaice Box has likely had a positive effect on the recruitment of plaice, but that its overall effect has decreased since it was established. There are two reasons to assume that the Plaice Box has a positive effect on the recruitment of plaice: 1) at present, the Plaice Box still protects the majority of undersized plaice. Approximately 70% of the undersized plaice are found in the Plaice Box and in the Wadden Sea, and despite the changed distribution, densities of juvenile plaice inside the box are still higher than outside; 2) In the 80-mm fishery, discard percentages in the box are higher than outside. Because more than 90% of the plaice caught in the 80-mm fishery in the box are discarded, any reduction in this fishery would reduce discard mortality. There is, however, no proof of a direct relationship between total discard mortality and recruitment.”

The Dutch beam trawl fleet has reduced in number of vessels and shifted towards two categories of vessels: 2000 HP (the maximum engine power allowed) and 300 HP (the maximum engine power for vessels that are allowed to fish within the 12-mile coastal zone and the plaice box). A substantial part of the vessels have been replaced by vessels in other countries (England, Scotland, Germany, Belgium). Overall capacity and effort of North Sea beam trawl vessels appears to have decreased since 1995.

A management plan has been implemented in 1999 for the North Sea herring fishery. The management plan had been changed in 2004 (15% cap on TAC change). The management plan consists of restraining fishing mortality and keeping the stock above threshold levels. ICES has examined the performance of this revised harvest control rule. ICES considers that the strict application of the TAC change limit of 15% (rule number 5) is not consistent with the Precautionary Approach in a situation like the present when four consecutive weak year classes are recruiting to the population. The harvest control rule is in accordance with the Precautionary Approach if paragraph 6 is invoked sufficiently early to ensure that there is less than 5% chance of SSB falling below $\mathbf{B}_{\mathrm{lim}}$ in 10 years, even in the case of several consecutive weak year classes. Assuming that paragraph 6 would be invoked when TAC constraints would lead to SSB falling below $\mathbf{B}_{\mathrm{pa}}$, it is considered that the revised HCR is in accordance with the Precautionary Approach.

Information from the fishing industry

Results from the North Sea fishers’ survey on how they perceive the state of each North Sea stock were considered on a stock-by-stock basis.

Quality of assessments and uncertainties

The level of biological sampling of the commercial landings of roundfish, flatfish, herring, and mackerel is relatively good and has been maintained. However, a major drawback in the available data is that they mostly refer to the landed component of the catch for most species. Discard data have traditionally only been used directly in assessments for haddock and whiting, with the majority of whiting discards based on a historical series only for one country. Several countries now collect discard data on a recurrent basis. Discards data are included in the assessments of North Sea cod, plaice, haddock, and whiting. It is noted that the inclusion of discards appears to reduce potential biases but may increase the uncertainties in the assessment (noise), because discards sampling is often rather scanty. In order to be able to include discards into an assessment, when discards have only been sampled in recent years, assumptions have to be made about the historical part of the time-series. These assumptions could compromise the reliability of the assessment that is based on them.

Data on catch and effort are available for many fisheries, but it is uncertain how reliably these data reflect trends in effective effort, i.e. nominal effort after corrections for technological improvements or changes in efficiency. Restrictive management measures (TACs) have also resulted in changes in the fishing practice of some fleets and redirected their effort to other species. In a number of cases this has lead to abandoning the use of time-series of commercial CPUE data in the assessments (cod, haddock, whiting, plaice), although the time-series of CPUE are still presented in the working group reports.

In recent years there has been misreporting of roundfish landings associated with restrictive quotas. Substantial underreporting of cod landings is estimated to have occurred between 1993 and 2003. Additionally, misreporting the catch area may have created problems for species groups such as those in the Eastern Channel. The consequence of the reporting problems in landings may have led to retrospective problems in analytical assessments. These retrospective problems lead to further uncertainty in short-term forecasts.

For North Sea cod, unallocated removals from the fishery are estimated by the assessment model. These unallocated removals estimates could potentially include components due to increased natural mortality and discarding as well as unreported landings. It is, however, assumed that these removals originate from fishing activities.

Several series of research vessel survey indices are available for most species. Quarterly data were available from the International Bottom Trawl Survey for a period of 6 years (1991–1996) and these were used in the assessment of some stocks. This survey has covered quarters 1 and 3 since then. For herring and mackerel the spawning stock sizes are estimated by annual larvae and acoustic surveys (herring) or intermittent egg surveys (mackerel). Lack of any fisheries-independent surveys for sandeels has resulted in analytical problems with potential auto-correlation between catch and fisheries-dependent indices in the model. Changes in English and Scottish surveys in the time-series has resulted in the use of a split time-series for several species (e.g. haddock), which has improved the residual patterns in the assessment.

Multispecies considerations are incorporated in the assessments and the forecasts for the North Sea stocks of cod, haddock, whiting, herring, sprat, sandeel, and Norway pout. In those cases average natural mortalities by age estimated by multispecies assessments were incorporated in the assessments. Incorporation of time-variable natural mortalities from a multispecies assessment model into the single-species assessments has been carried out as a sensitivity analysis of the assessments.

Sources of information

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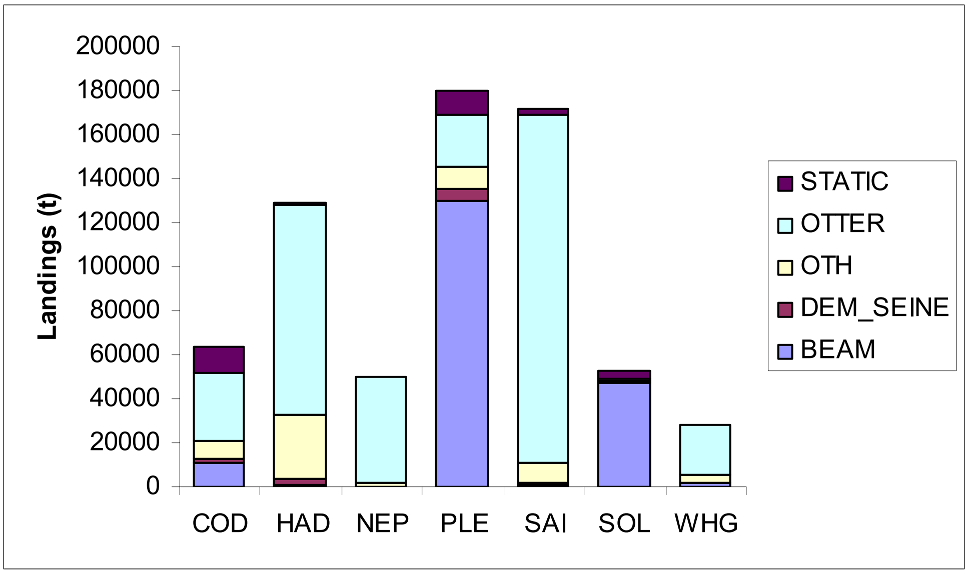


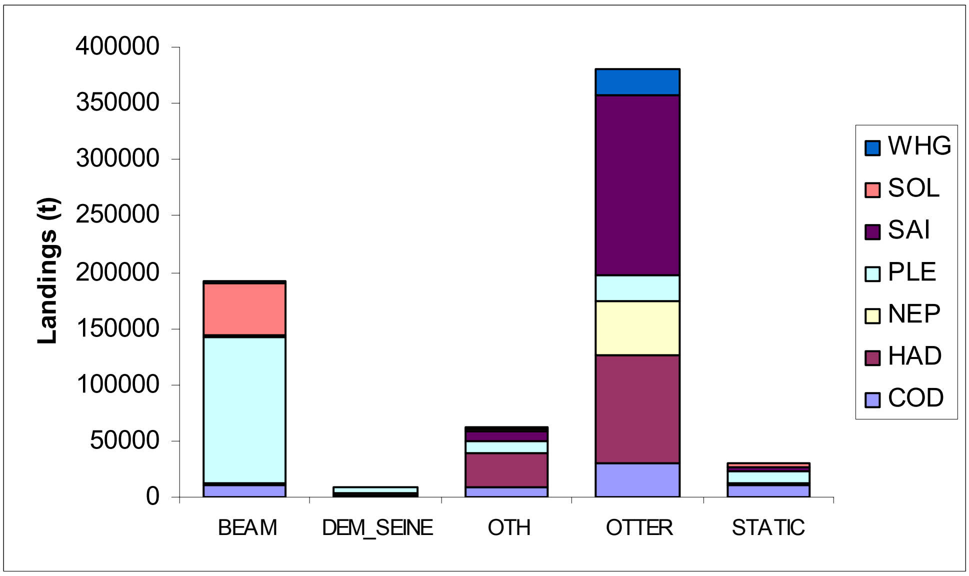
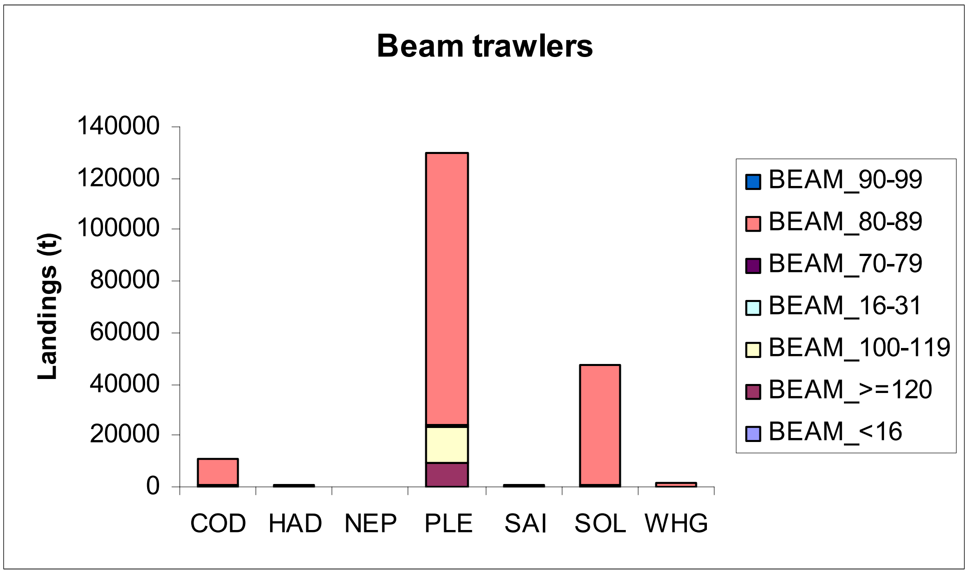


Figure 6.3.2.1 Landings of North Sea demersal species in 2005 disaggregated by gear-type. Data are landings from the North Sea only as supplied to STECF by Belgium, Denmark, France, Germany, the Netherlands, and the UK and used with permission. Data supplied by Norway are also included.



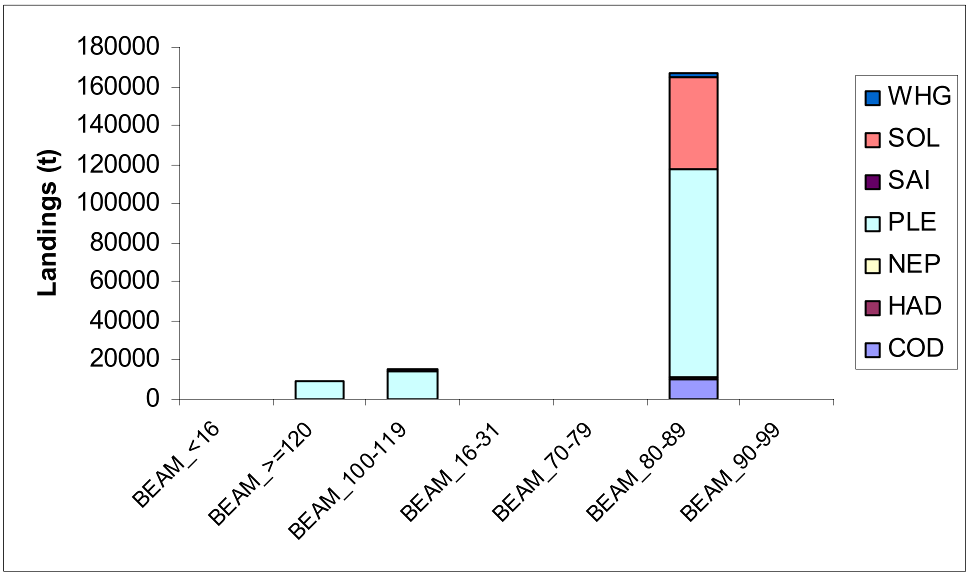
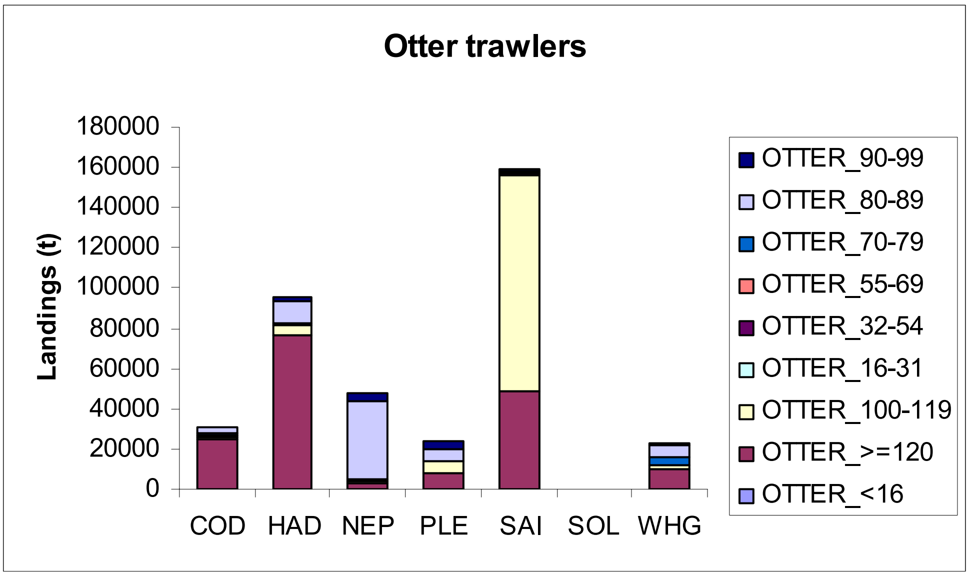


Figure 6.3.2.2 Landings of North Sea demersal species in 2005 by beam trawlers disaggregated by mesh-size category. Data are landings from the North Sea only as supplied to STECF by Belgium, Denmark, France, Germany, the Netherlands, and the UK and used with permission. Data supplied by Norway are also included.



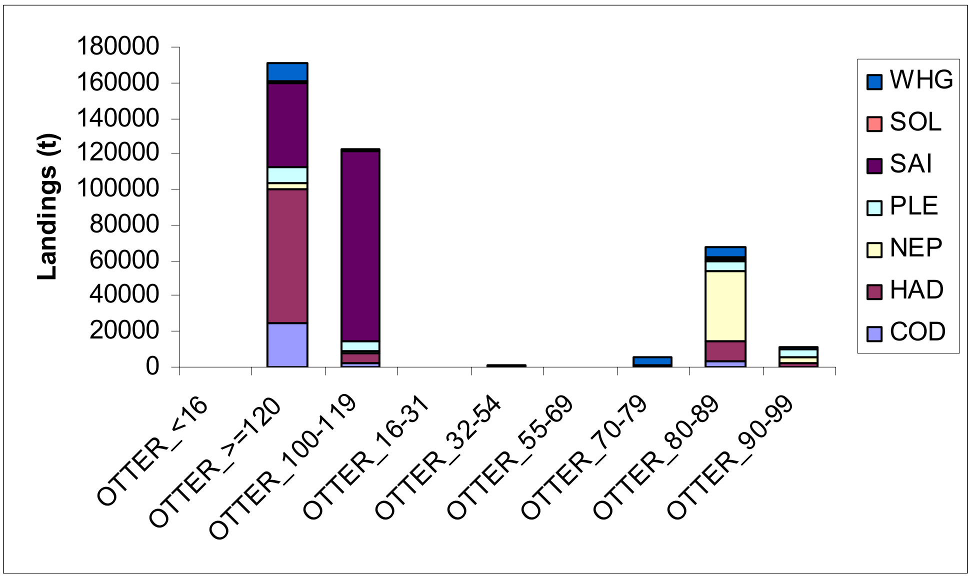
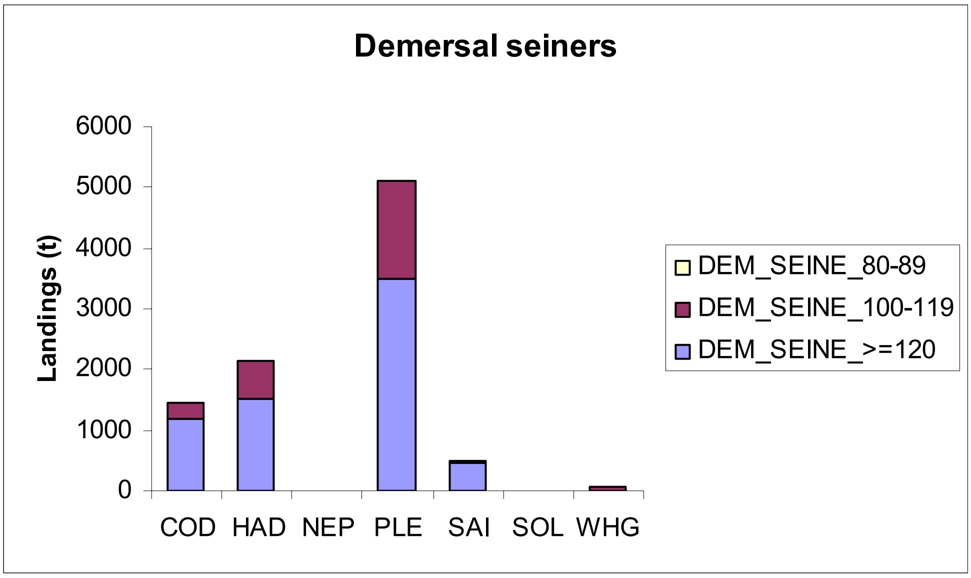


Figure 6.3.2.3 Landings of North Sea demersal species in 2005 by otter trawlers disaggregated by mesh-size category. Data are landings from the North Sea only as supplied to STECF by Belgium, Denmark, France, Germany, the Netherlands, and the UK and used with permission. Data supplied by Norway are also included.



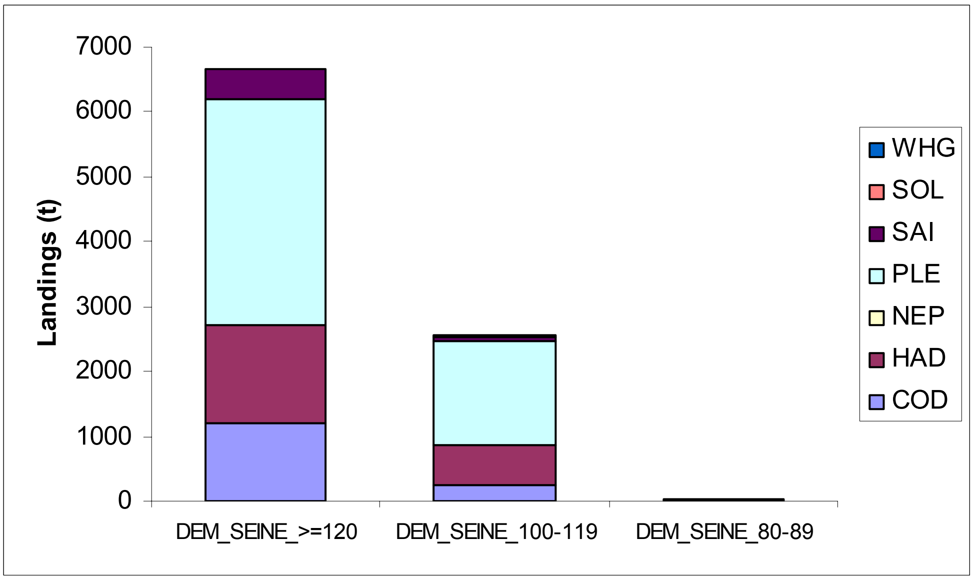
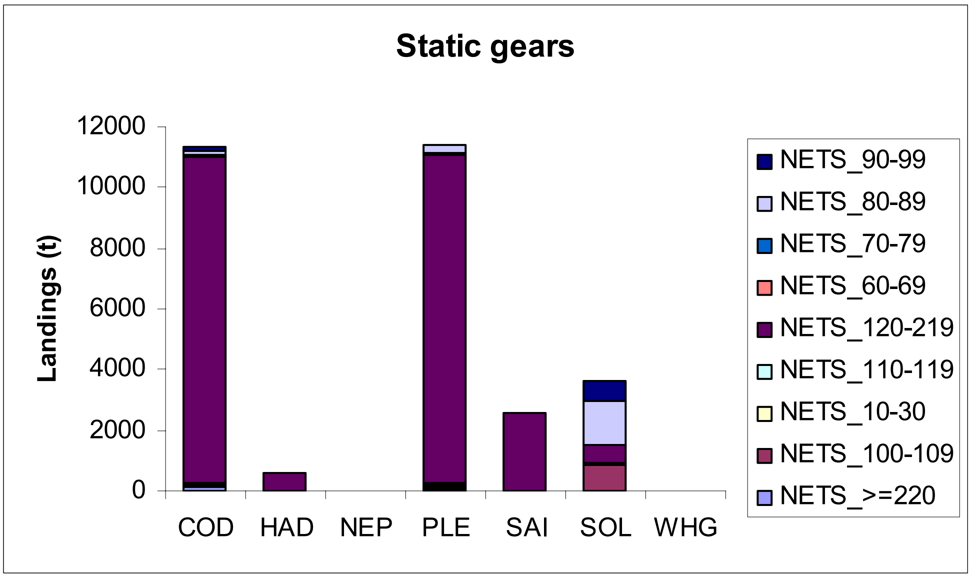


Figure 6.3.2.4 Landings of North Sea demersal species in 2005 by demersal seiners disaggregated by mesh-size category. Data are landings from the North Sea only as supplied to STECF by Belgium, Denmark, France, Germany, the Netherlands, and the UK and used with permission. Data supplied by Norway are also included.



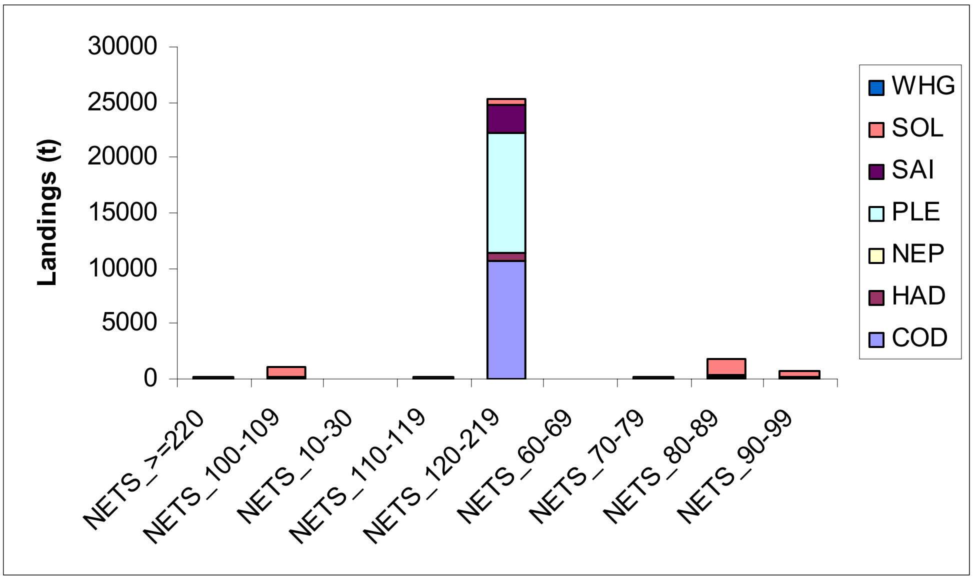


Figure 6.3.2.5 Landings of North Sea demersal species in 2005 by static gears disaggregated by mesh-size category. Data are landings from the North Sea only as supplied to STECF by Belgium, Denmark, France, Germany, the Netherlands, and the UK and used with permission. Data supplied by Norway are also included.

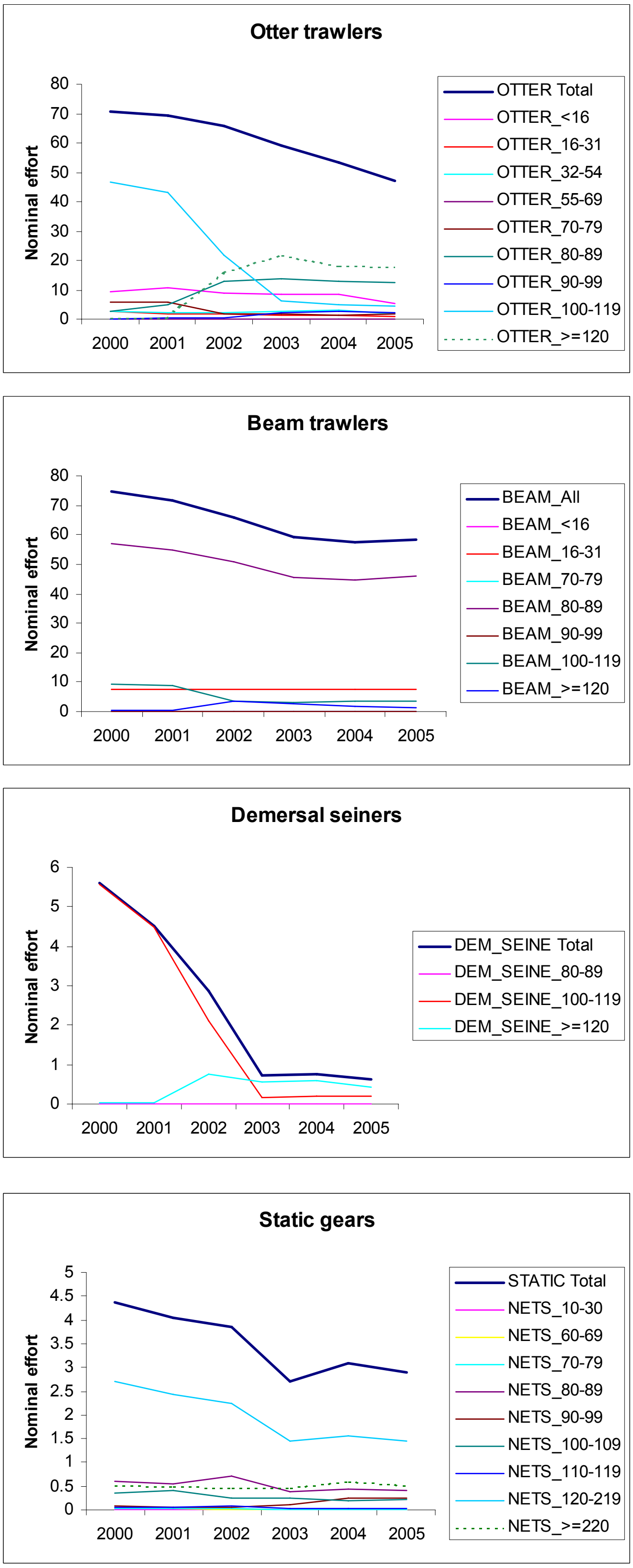


Figure 6.3.2.6. Recent trends in nominal effort (10^6 kilowatt days) by gear type in the North Sea. Data are effort in the North Sea only as supplied to STECF by Belgium, Denmark, France, Germany, the Netherlands, and the UK and used with permission.

Table 6.3.2.1 Species composition in the Danish and Norwegian small-meshed fisheries in the North Sea of the catches landed for reduction (1000 tonnes). Data provided by WG members. The category "other" is subdivided by species in Table 6.3.2.2.

Year	Sandeel	Sprat	Herring	Norway pout	Blue whiting	Haddock	Whiting	Saithe	Other	Total
1974	525	314	-	736	62	48	130	42		1857
1975	428	641	-	560	42	41	86	38		1836
1976	488	622	12	435	36	48	150	67		1858
1977	786	304	10	390	38	35	106	6		1675
1978	787	378	8	270	100	11	55	3		1612
1979	578	380	15	320	64	16	59	2		1434
1980	729	323	7	471	76	22	46	-		1674
1981	569	209	84	236	62	17	67	1		1245
1982	611	153	153	360	118	19	33	5	24	1476
1983	537	88	155	423	118	13	24	1	42	1401
1984	669	77	35	355	79	10	19	6	48	1298
1985	622	50	63	197	73	6	15	8	66	1100
1986	848	16	40	174	37	3	18	1	33	1170
1987	825	33	47	147	30	4	16	4	73	1179
1988	893	87	179	102	28	4	49	1	45	1388
1989	1039	63	146	162	28	2	36	1	59	1536
1990	591	71	115	140	22	3	50	8	40	1040
1991	843	110	131	155	28	5	38	1	38	1349
1992	854	214	128	252	45	11	27	-	30	1561
1993	578	153	102	174	17	11	20	1	27	1083
1994	769	281	40	172	11	5	10	-	19	1307
1995	911	278	66	181	64	8	27	1	15	1551
1996	761	81	39	122	93	5	5	0	13	1119
1997	1091	99	15	126	46	7	7	3	21	1416
1998	956	131	16	72	72	5	3	3	24	1283
1999	678	166	23	97	89	4	5	2	40	1103
2000	655	191	24	176	98	8	8	6	21	1187
2001	810	156	21	59	76	6	7	3	14	1152
2002	804	142	26	73	107	4	8	8	15	1186
2003	303	175	16	18	139	1	3	8	18	681
2004	324	193	19	12	107	1	2	7	29	692
2005	172	207	23	1	101	0	1	6	13	524
Avg 75-05	694	196	59	207	66	11	32	7	32	1294

Year quarter	Sandeel	Sprat	Herring	Norway pout	Blue whiting	Haddock	Whiting	Saithe	Other	Total
1998 q1	37	7	7	13	11	1	0	0	5	80
1998 q2	754	1	2	8	12	2	1	0	4	784
1998 q3	153	60	4	29	38	2	1	2	9	298
1998 q4	12	63	4	23	12	0	0	0	6	121
1999 q1	14	14	4	8	23	1	1	1	8	74
1999 q2	507	2	4	22	30	1	2	1	8	577
1999 q3	139	129	10	41	18	1	2	0	7	347
1999 q4	17	21	6	25	17	1	1	0	18	106
2000 q1	10	42	1	9	13	1	0	0	5	82
2000 q2	581	2	4	17	32	3	2	0	4	646
2000 q3	63	133	10	30	39	2	3	6	5	291
2000 q4	0	15	8	119	14	2	3	0	8	169
2001 q1	12	40	2	20	15	1	1	0	3	94
2001 q2	462	1	2	10	32	3	1	2	4	517
2001 q3	314	44	4	4	12	1	2	0	5	386
2001 q4	22	72	13	24	16	1	2	0	2	152
2002 q1	11	5	6	8	18	0	0	0	2	50
2002q2	772	0	3	5	19	1	2	0	4	806
2002q3	21	71	8	31	46	1	3	5	4	189
2002q4	0	66	10	28	24	1	2	3	6	141
2003 q1	3	18	1	2	14	0	0	1	5	45
2003 q2	239	1	2	4	42	0	1	1	3	292
2003 q3	57	56	4	5	56	0	1	4	4	188
2003 q4	4	100	9	7	28	0	1	2	6	157
2004 q1	2	1	4	1	19	0	0	1	12	41
2004 q2	273	0	2	1	33	0	1	1	5	315
2004 q3	50	55	5	4	37	0	0	2	7	160
2004 q4	0	136	9	6	18	0	0	2	5	177

Table 6.3.2.2 Sum of Danish and Norwegian North Sea bycatch (tonnes) landed for industrial reduction in the small-meshed fisheries by year and species (excluding saithe, haddock, and whiting accounted for in Table 6.3.2.1).

Species	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Gadus morhu	544	710	1092	1404	2988	2948	570	1044	1052	876
Scomber scor	4	534	2663	6414	8013	5212	7466	4631	4386	3576
Trachurus tra	22789	16658	7391	18104	22723	14918	5704	6651	6169	4886
Trigla sp.	0	888[2]	45342[2]	5394[2]	9391[2]	2598[2]	5622[2]	4209	1593	1139
Limanda lima	187	3209	4632	3781	7743	4706	5578	3986	4871	528
Argentina spp	8714	5210	3033	1918	778	2801	3434	2024	2874	2209
Hippoglossoic	59	718	1173	946	2160	1673	1024	1694	1428	529
Pleuronectes	34	119	109	372	582	566	1305	218	128	143
Merluccius me	349	165	261	242	290	429	28	359	109	10
Trisopterus m	0	68[3]	0	5[2]	48[2]	121[2]	79[2]	111	36	0
Molva molva[3]	51	1	40	39	37	13	65	10	28	0
Glyptocephalu	236[3]	132	341	44	255[3]	251[3]	1439[3]	195[3]	246	40
Gadiculus arg	1210	729	3043	2494	741	476	801	0	0	0
Others	31715[1]	3853	3604	3670	3528	3154	4444	4553	4106	5141
Total	65892	32994	72724	44827	59277	39866	37559	29685	27026	19077

Species	1995	1996	1997	1998	1999	2000	2001	2002[2]	2003	2004
Gadus morhu	955	366	1688	1281	532	383	192	29	49	44
Scomber scor	2331	2019	3153	1934	2728	2443	1749	1260	2549	6515
Trachurus tra	2746	2369	3332	2576	5116	5312	1159	2338	5791	10272
Trigla sp.	2091	897	2618	1015	2566	1343	2293	1071	847	1101
Limanda lima	1028	1065	2662	6620	4317	441	1441	321	596	386
Argentina spp	292	3101	2604	5205	3580	333	397		1376	786
Hippoglossoic	617	339	1411	2229	1272	493	431	112	208	174
Pleuronectes	33	90	73	91	88	64	56	51	28	1
Merluccius me	0	3625	2364	33	211	231	167	6	301	423
Trisopterus m	9	30	181	261	922	518	0	196	5	91
Molva molva[3]	0	0	31	31	125	19	49	0	42	169
Glyptocephalu	0	97	394	860	437	154	246	58	437	286
Gadiculus arg	0	7	248	248	387	532	942	459	993	1550
Others	5158	50	749	5405	17931	8927	301	2226	4888	6953
Total	15260	14055	21508	27787	40211	21192	12523	8127	20115	28750

Species	2005
Gadus morhu	22
Scomber scor	2195
Trachurus tra	5226
Trigla sp.	597
Limanda lima	287
Argentina spp	1348
Hippoglossoic	61
Pleuronectes	38
Merluccius me	254
Trisopterus m	0
Molva molva[3]	34
Glyptocephalu	87
Gadiculus arg	909
Others	1964
Total	13022

[1]DK cod and mackerel included. [2]Only DK catches. [3]N catches. DK catches in "Others". [4]Until 1995 N catches only. DK catches in "Others".

Table 6.3.2.3. Danish bycatch landings of cod, haddock and saithe in 1993–2005 from small-meshed fisheries in the North Sea. Landings (tonnes) used for reduction purposes.

Cod	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Sandeel fishery	70	79	288	375	202	51	56	7	12	5	10	2
Sprat fishery	493	174	23	40	11	7	4	4	0	11	3	16
Norway pout fishery	201	680	4	242	161	11	0	81	3	3	1	
Blue whiting fishery	0		24	37	20	28	0	0	14	0	0	
"Others" fishery	14	23	2	94	6	4	1	4	1	2	1	
Total	778	956	341	789	400	101	61	97	30	21	16	18

Haddock	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Sandeel fishery	528	534	1,600	524	202	364	1,226	1,557	220	103	33	0
Sprat fishery	685	1,097	18	11	6	62	66	223	27	15	0	4
Norway pout fishery	1,399	4,766	1,774	1,454	251	318	1,734	1,252	1,545	16	57	13
Blue whiting fishery	10		153	205	66	195	258	218	133	59	16	
"Others" fishery	71	349	77	137	218	117	40	42	183	96	10	0
Total	2,693	6,745	3,622	2,331	744	1,055	3,324	3,292	2,108	289	116	18

Whiting	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Sandeel fishery	1,392	3,322	1,909	2,143	902	2,121	1,539	2,761	1,397	444	653	261
Sprat fishery	4,352	10,386	784	107	673	1,088	2,107	1,700	2,238	1,105	333	545
Norway pout fishery	3,121	7,291	1,373	2,235	178	331	2,935	1,559	1,675	265	232	
Blue whiting fishery	0		126	113	83	169	71	217	123	30	0	
"Others" fishery	187	4,422	22	173	112	116	89	184	127	63	0	19
Total	9,053	25,422	4,214	4,771	1,948	3,825	6,740	6,420	5,560	1,907	1,218	825

Saithe	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Sandeel fishery	0	0	40	0		28		1	0	30	14	
Sprat fishery	11	297	0	0				3	0	0	0	7
Norway pout fishery	135	490	84	209			116	22	246	0	0	7
Blue whiting fishery	0		20	80	11	8	2	84	72	17	51	
"Others" fishery	0	542	0	40	1	4	2	7	109	69	0	
Total	146	1,329	144	329	12	40	120	117	427	116	65	14

All species	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Sandeel fishery	611,554	644,473	622,211	761,963	624,925	514,047	551,008	637,518	628,205	274,854	291,445	150,426
Sprat fishery	314,970	344,309	107,243	103,523	145,978	171,757	208,641	170,862	167,472	194,210	200,907	234,251
Norway pout fishery	111,208	140,550	76,390	104,499	33,515	29,361	135,196	47,788	54,980	9,020	8,980	16,867
Blue whiting fishery	419		34,857	13,181	46,052	51,060	34,129	26,038	27,052	21,320	20,295	100102
"Others" fishery	19,480	48,936	8,882	14,554	17,893	26,945	7,433	10,554	8,503	6,184	10,298	6,944
Total	1,057,632	1,178,268	849,584	997,719	868,363	793,169	936,408	892,760	886,212	505,588	531,925	508,590

Table 6.3.2.4. Quarterly Danish bycatch landings of cod, haddock, and saithe in 2005 from small-meshed fisheries in the North Sea. Landings (tonnes) used for reduction purposes.

Cod	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery		2			2
Sprat fishery			9	7	16
Norway pout fishery					
"Others" fishery					
Total		2	9	7	18

Haddock	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery		0	0		0
Sprat fishery			1	3	4
Norway pout fishery		13			13
"Others" fishery			0		0
Total		14	1	3	18

Whiting	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery		260	1		261
Sprat fishery	1		369	175	545
Norway pout fishery					
"Others" fishery	1		18		19
Total	2	260	387	175	825

Saithe	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery					
Sprat fishery				7	7
Norway pout fishery			7		7
"Others" fishery					
Total			7	7	14

All species	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery		145,877	4,549		150,426
Sprat fishery	13,754		118,919	101,577	234,251
Norway pout fishery	9,720	7,018	129		16,867
"Others" fishery	1,551		5,394		6,944
Total	25,025	152,895	128,991	101,577	408,488

Table 6.3.2.5 Landings ('000 t) of demersal, pelagic, and industrial species from the North Sea. For some species Divisions IIIa and/or VIId have been included.

	Cod	Cod	Haddock	Haddock	Whiting	Whiting	Saithe	Saithe	Sole	Plaice	Norway pout	Sandeel	Sprat	Herring autumn spawners	Mackerel	Horse mackerel NS stock	Demersal	Pelagic	Industrial	Total
Type	dem	ib	dem	ib	dem	ib	dem	ib	dem	dem	i	i	i	p	p	p				
landings/catch	lndgs	lndgs	lndgs	lndgs	lndgs	lndgs	lndgs	lndgs	lndgs	lndgs	lndgs	lndgs	lndgs	catch	catch	catch				
Area	3a,4,7d	3a,4,7d	4	4	4,7d	4,7d	3a,4	3a,4	4	4	3a,4	4	4	3a,4,7d	3a,4	3a4bc7d				
1970	226	n/a	525	180	83	115	163	59	20	130	238	191	51	563	322	12	1147	897	834	2878
1971	328	n/a	235	32	61	72	218	35	24	114	305	382	95	520	244	32	980	796	921	2697
1972	354	n/a	193	30	64	61	248	28	21	123	445	359	92	498	189	8	1003	695	1015	2713
1973	239	n/a	179	11	71	90	229	31	19	130	346	297	228	484	327	42	867	853	1003	2723
1974	214	n/a	150	48	81	130	267	42	18	113	736	524	314	275	298	31	843	604	1794	3241
1975	205	n/a	147	41	84	86	271	38	21	108	560	428	641	313	263	10	836	586	1794	3216
1976	234	n/a	166	48	83	150	295	67	17	114	437	488	622	175	306	9	909	490	1812	3211
1977	209	n/a	137	35	78	106	217	6	18	119	390	786	304	46	260	1	778	307	1627	2712
1978	297	n/a	86	11	97	55	163	3	20	114	270	787	398	11	149	5	777	165	1524	2466
1979	270	n/a	83	16	107	59	134	2	23	145	329	578	380	25	153	1	762	179	1364	2305
1980	294	n/a	99	22	101	46	142		16	140	483	729	323	71	88	2	792	161	1603	2556
1981	335	n/a	130	17	90	67	145	1	15	140	239	569	209	175	67	7	855	249	1102	2206
1982	303	n/a	166	19	81	33	185	5	22	155	395	611	153	275	35	4	912	314	1216	2442
1983	259	n/a	159	13	88	24	197	1	25	144	451	537	88	387	41	8	872	436	1114	2422
1984	228	n/a	128	10	86	19	214	6	27	156	393	669	77	429	44	29	839	502	1174	2515
1985	215	n/a	159	6	62	15	222	8	24	160	205	622	50	614	50	27	842	691	906	2439
1986	204	n/a	166	3	64	18	202	1	18	165	178	848	16	671	244	25	819	940	1064	2823
1987	216	n/a	108	4	68	16	177	4	17	154	149	825	32	792	302	12	740	1106	1030	2876
1988	184	n/a	105	4	56	49	140	1	22	154	110	893	87	888	338	24	661	1250	1144	3055
1989	140	n/a	76	2	45	36	117	1	22	170	168	1039	63	787	282	33	570	1102	1309	2981
1990	125	n/a	51	3	47	50	100	8	35	156	152	591	73	646	305	19	514	970	877	2361
1991	102	n/a	45	5	53	38	115	1	34	148	193	843	112	657	366	12	497	1035	1192	2724
1992	114	n/a	70	11	52	27	104		29	125	300	855	124	716	367	15	494	1098	1317	2909
1993	122	0.66	80	11	53	20	118	1	31	117	184	579	200	671	391	14	521	1076	996	2592
1994	111	0.78	80	5	49	10	115		33	110	182	786	320	571	472	6	498	1049	1304	2851
1995	136	0.96	75	8	47	27	124	1	30	98	241	918	357	579	322	17	510	918	1553	2981
1996	126	0.34	76	5	41	5	120	0	23	82	166	777	137	275	213	19	468	507	1090	2065
1997	124	0.79	79	7	36	7	110	3	15	83	170	1137	103	264	229	20	447	513	1428	2388
1998	146	0.4	77	5	29	3	107	3	21	71	80	1004	164	392	270	31	451	693	1259	2403
1999	96	0.1	66	4	30	5	114	3	25	81	92	735	188	363	313	37	412	713	1027	2152
2000	71	0.06	47	9	28	8	88	6	23	81	184	699	196	388	305	48	338	741	1102	2181
2001	50	0.1	41	8	25	7	95	3	20	82	66	862	170	363	340	46	313	749	1116	2178
2002	55	0.03	59	4	22	7	117	8	16	70	77	811	144	372	395	23	339	790	1051	2179
2003	32 *	0.05	45	1	16	3	102	8	18	66	25	326	177	480	358	32	279	870	540	1689
2004	27 *	0.04	49	1	8	1	100	7	19	61	14	362	194	567	317	35	264	919	579	1761
2005	29 *	0.02	48	0	15	1	116	6	16	56	2	172	207	664	252	30	280	946	388	1614

hc = for human consumption, ib = industrial by catch, i = for industrial purposes, p = pelagic, dem = demersal.
* nominal landings only, WG estimate of catch not available

Table 6.3.2.6 North Sea landings and discards by species and country in **2004** as estimated by the working group (data for 2005 were not made avaiable to ICES).

	COD_NS		HAD_NS		PLE_NS		POK_NS		SOL_NS		WHG_NS		Total Land	Total Disc
country	Land	Disc	Land	Disc	Land	Disc	Land	Disc	Land	Disc	Land	Disc		
BEL	1501	72	368	166	4519	2044	44	3	1603	139	305	137	8340	2560
DEN	7962	382	5252	2364	13731	6211	10511	643	609	53	76	34	38141	9687
ENG	2214	106	1561	703	7224	3268			483	42	659	296	12141	4415
FRA	1971	95	1105	497	258	117	21550	1318	724	63	8813	3957	34421	6046
GER	2106	101	1679	756	3802	1720	9015	551	752	65	332	149	17686	3342
NED	2303	110	141	64	28224	12767			13462	1166	1492	670	45622	14777
NOR	4987	239	2304	1037	1967	890	61690	3772	125	11	38	17	71111	5966
SCO	7692	369	31105	14004	6768	3061	4711	288	250	22	5630	2528	56155	20271
SWE	510	24	147	66									657	91
Grand Total	31246	1498	43661	19657	66492	30077	107520	6575	18008	1560	17345	7788	284273	67155

6.3.3 Special requests

6.3.3.1 In-year dvice on Norway pout

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	Reference points not defined	Reference points not defined	

Based on the most recent estimates of SSB, ICES classifies the stock as suffering from reduced reproductive capacity (stock biomass is estimated to be below $\mathbf{B}_{lim}$ in 2006). Estimated fishing mortality has decreased in recent years and was zero in 2005 due to the closure of the fishery. Recruitment has been low very low in 2003-2004.The 2005 year class is above average.

Management objectives

There are no explicit and specific management objectives for this stock.

Reference points (unchanged since 1997)

	ICES considers that:	**ICES proposed that:**
Precautionary approach reference points	$\mathbf{B}_{lim}$ is 90 000 t	$\mathbf{B}_{pa}$ be set at 150 000 t
	$\mathbf{F}_{lim}$ not defined	$\mathbf{F}_{pa}$ not defined
Target reference points		$\mathbf{F}_{y}$ not defined

Technical basis

$\mathbf{B}_{lim}$: lowest observed biomass in the late 1980s.	$\mathbf{B}_{pa}$: Below average recruitment when SSB is less than 150 000 t

Single stock exploitation boundaries

Exploitation boundaries in relation to existing management plans

There is no agreed management plan for this stock.

Exploitation boundaries in relation to precautionary limits

The 2005 yearclass of Norway pout is estimated to be above average. This yearclass has the potential to rebuild the stock to above Bpa in 2007 if a prudent harvest strategy is followed. ICES considers that a small fishery for Norway pout could be allowed in 2006 with a maximum TAC of 95 000 t.

Exploitation boundaries in relation to mixed fisheries and ecosystem considerations

The cod stock in the North Sea is very low and consequently there is a need to prevent by-catches of cod in non-directed fisheries.

There is a need to ensure that the stock remains high enough to provide food for a variety of predator species (e.g. cod, whiting and saithe). The lower the catch will be in 2006, the more will be available to predator fish.

Short-term implications

Outlook for 2006

The short-term forecast is based on quarterly timesteps an assumed recruitment of the 2006 year class at 25% of the long term arithmetic mean and an assumed zero fishing mortality the first two quarters of 2006.

F 2006	Landings 2006	SSB 2007
0	0	205
0.07	17	195
0.15	34	186
0.22	49	177
0.30	65	168
0.37	79	160
0.44	93	153
0.52	106	145
0.59	119	138
0.66	131	132
0.74	143	126
0.81	154	120
0.88	165	114

Weights in 000 t.
Shaded scenarios are considered inconsistent with the Precautionary Approach.

Management considerations

The stock at the beginning of 2006 is still estimated to be below B_{lim} due to the very weak 2003 and 2004 year classes. The EU and Norway agreed to close the fishery in 2005 and 2006. The current advice is an in-year update of the advice provided in October 2005 and uses the most recent catch and survey data.

Demersal fisheries in the North Sea are mixed fisheries, with many stocks exploited together in various combinations in different fisheries. In these cases management advice must consider both the state of individual stocks and their simultaneous exploitation in demersal fisheries. Stocks at reduced reproductive capacity should be the overriding concern for the management of mixed fisheries where these stocks are exploited either as a targeted species or as a bycatch.

Small-mesh industrial fisheries for Norway pout takes place in the northern and north-eastern North Sea and has bycatches of haddock, whiting, herring and blue whiting. Some cod is also taken as a by-catch, predominantly at ages 0 and 1.

The 1st and 3rd quarter IBTS surveys provide relatively good indicators of the year-class strengths and the size of the stock. This information is now being used as real-time monitoring of this stock.

Ecosystem considerations

The population dynamics of Norway pout in the North Sea and Skagerrak are very dependent on changes caused by recruitment variation and variation in predation mortality (or other natural mortality causes). Recruitment is highly variable and influences SSB and TSB rapidly due to the short life span of the species. With present fishing mortality levels in recent years the status of the stock is more determined by natural processes and less by the fishery.

Norway pout is an important prey item to predatory fish species (cod, whiting and saithe), mostly at age 1.

Scientific basis

Data and methods

A seasonal assessment methods (SXSA) is used that takes into account the seasonality in fishery and the most recent survey data.

Comparative assessment with the SXSA and the SMS assessment models gave consistent trends in stock dynamics.

Uncertainties in assessment and forecast

Quantative estimates of uncertainty can be derived from the SMS model which indicates that the abundance of the 2005 year class is estimated with a CV of 40% and the 2007 SSB with a CV of 34%. These CVs are higher than for most other assessment stocks. The 1st and 3rd quater IBTS surveys are good and consistent indicators of year class strength

Studies presented to the working group in 2001 indicate that natural mortality may be higher than is currently assumed in the assessment model. Mortality due to predation is highest at age 1. Non-predation mortality on Norway pout increases with age and is very high for age 2 and older fish.

Comparison with previous assessment and advice

The estimates of the SSB, recruitment and the average fishing mortality are consistent with the estimates of previous year's assessment.

Sources of information

Nielsen, J.R. and Vinther, M. (2006) An update assessment of Norway pout (April 2006). *Working paper* to the Working Group on the Assessment of Demersal stocks in the North Sea and Skagerrak (WGNSSK, 5-14 September 2006)

Sparholt, H., L. I. Larsen and J. R. Nielsen (2002b). "Non-predation natural mortality of Norway pout (Trisopterus esmarkii) in the North Sea." ICES Journal of Marine Science 59(6): 1276.

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Norway pout in the North Sea (Subarea IV)

Year	ICES Advice	Predicted catch corresp. to advice	Agreed TAC[1]	Official Landings	ACFM landings
1987	No advice	-	200	215	147
1988	No advice	-	200	187	102
1989	No advice	-	200	276	167
1990	No advice	-	200	212	140
1991	No advice	-	200	223	155
1992	No advice	-	200	335	255
1993	No advice	-	220	241	176
1994	No advice	-	220	214	176
1995	Can sustain current F	-	180	289	181
1996	Can sustain current F; take bycatches into consid.	-	220	197	122
1997	Can sustain current F; take bycatches into consid.	-	220	155	133
1998	Can sustain current F; take bycatches into consid.	-	220	72	62
1999	Can sustain current F; take bycatches into consid.	-	220	93	85
2000	Can sustain current F; take bycatches into consid.	-	220	182	175
2001	Can sustain current F; take bycatches into consid.	-	211	63	57
2002	Can sustain current F; take bycatches into consid.	-	198	93	74
2003	Can sustain current F; take by-catches into consid.		198	24	21
2004	The stock is in risk of decreasing below Blim.		198	16	14
2005	Fishery should be closed		0	0	0
2006	Allow maximum catch of 95 000 t.	95	-	-	-

[1] IIa(EU), IIIa, IV(EU). Weights in '000 t.

Norway pout in Skagerrak (Division IIIa)

Year	ICES Advice	Official landings	ACFM landings
1987	No advice		2
1988	No advice		8
1989	No advice	17	5
1990	No advice	41	12
1991	No advice	49	38
1992	No advice	84	45
1993	No advice	37	8
1994	No advice	24	7
1995	No advice	68	50
1996	No advice	58	36
1997	See advice for North Sea	35	29
1998	See advice for North Sea	11	13
1999	See advice for North Sea	7	8
2000	See advice for North Sea	15	10
2001	See advice for North Sea	14	7
2002	See advice for North Sea	4	3
2003	See advice for North Sea	4	3
2004	See advice for North Sea	0.2	0.3
2005	See advice for North Sea	0	0
2006	See advice for North Sea		

Weights in '000t

Norway pout. Stock summary (landings, fishing mortality, recruitment and SSB)

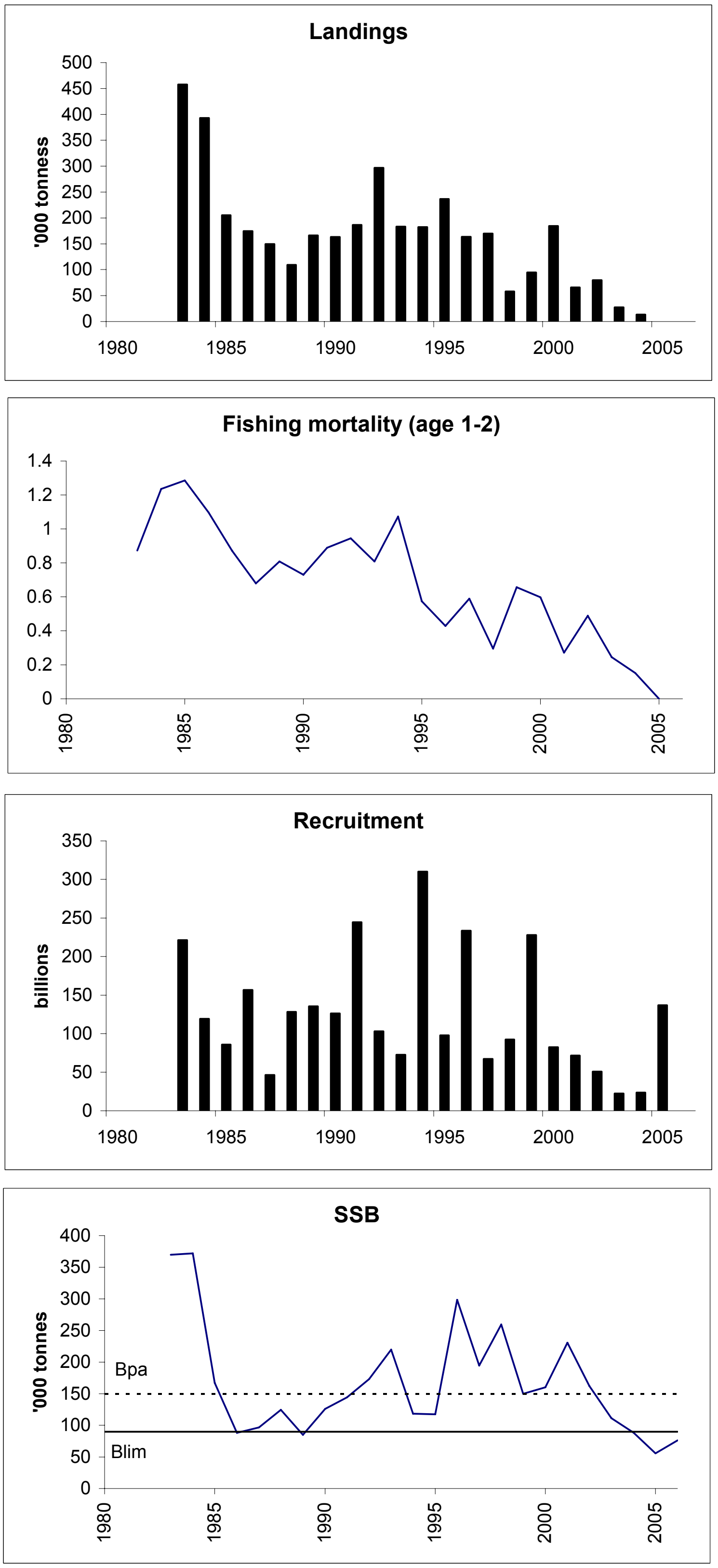

Table 6.3.3.1.1 Norway pout in Sub-area IV and Division IIIa

Year	Recruitment Age 0 thousands	SSB tonnes	TSB tonnes	Landings tonnes	Mean F Ages 1-2
1983	221,203	369,903	1,904,837	457,600	0.87
1984	119,204	372,151	1,147,015	393,010	1.24
1985	85,743	167,320	641,993	205,100	1.29
1986	156,654	87,936	721,060	174,300	1.10
1987	46,380	96,378	588,918	149,300	0.87
1988	128,169	124,564	572,111	109,300	0.68
1989	135,378	84,903	767,681	166,400	0.81
1990	126,067	125,859	737,470	163,300	0.73
1991	244,326	144,297	1,089,724	186,600	0.89
1992	102,886	172,773	1,051,669	296,800	0.95
1993	72,548	219,767	621,119	183,100	0.81
1994	310,323	118,373	1,090,381	182,000	1.07
1995	97,753	117,479	1,203,421	236,800	0.57
1996	233,308	298,493	1,132,348	163,800	0.43
1997	67,298	194,640	1,027,808	169,700	0.59
1998	92,401	259,614	640,572	57,700	0.30
1999	227,998	149,942	993,785	94,500	0.66
2000	82,366	160,311	1,039,963	184,400	0.60
2001	71,591	230,634	608,832	65,600	0.27
2002	50,843	162,286	474,315	80,000	0.49
2003	22,225	111,582	295,029	27,100	0.25
2004	23,363	88,342	201,249	13,500	0.15
2005	137,010	55,644	482,010	0	0.00
2006		76,097			
Average	124,132	170,139	827,535	163,474	0.68
Geometric mean	*101,481*				

6.3.3.2 In-year advice on Sprat

In 2006, EC requested in-year advice on North Sea Sprat. ICES provided the advice in May 2006 together with the prospectives for the fisheries in 2007. This advice can be found in Section 6.4.20 (Sprat in the North Sea Subarea IV).

6.3.3.3 Harvest control rules for North Sea haddock (Subarea IV and Division IIIa)

ICES has received a request from the European Community (EC) and Norway:

"Background

The European Community and Norway have agreed to exploit the stock of North Sea haddock on the basis of a TAC consistent with a fishing mortality rate of no more than 0.3 for appropriate age-groups. However, scientific advice from ICES has led to unexpectedly large variations in the forecast catch that corresponds to this fishing mortality rate.

It is also relevant that for the stock the stability of catches (according to ICES estimates) may be substantially greater than the stability of the adopted TACs.

The detailed request is as follows:

Develop and evaluate the consequences of alternative options and methods to provide improved stability in TACs, while maintaining the fishing mortality rate on the stock on average close to the level decided by managers, and avoiding a high risk of depletion of the spawning biomass outside safe biological limits.

ICES should develop these options and alternative methods on its own initiative, but should also evaluate the consequences of applying a 15% limit on inter-annual variation in TACs."

ICES' response

The evaluation of the options and methods to provide improved stability in TACs indicates that a target fishing mortality of 0.3 with a 15% limit on inter-annual variation in TACs leads to a low risk to B_{lim} (around 5%). Increasing the target fishing mortality above 0.3 leads to an increased risk. ICES evaluated options through simulation studies, for details see the Technical Annex below.

Technical Annex to the ICES' response

In 1999 the EU and Norway have *"agreed to implement a long-term management plan for the haddock stock, which is consistent with the precautionary approach and is intended to constrain harvesting within safe biological limits and designed to provide for sustainable fisheries and greater potential yield."*.

The agreement was updated in November 2004:

'The plan shall consist of the following elements:

1. *Every effort shall be made to maintain a minimum level of Spawning Stock Biomass (SSB) greater than 100,000 tonnes (B_{lim}).*
2. *For 2005 and subsequent years the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of no more than 0.30 for appropriate age groups (F_{target}).*
3. *Should the SSB fall below a reference point of 140,000 tonnes ¡Bpa, the fishing mortality rate referred to under paragraph 2, shall be adapted in the light of scientific estimates of the conditions then prevailing. Such adaptation shall ensure a safe and rapid recovery of SSB to a level in excess of 140,000 tonnes.*
4. *In order to reduce discarding and to enhance the spawning biomass of haddock, the Parties agreed that the exploitation pattern shall, while recalling that other demersal species are harvested in these fisheries, be improved in the light of new scientific advice from inter alia ICES.*
5. *A review of this arrangement shall take place no later than 31 December 2006.*
6. *This arrangement enters into force on 1 January 2005.'*

ICES has previously stated that the agreed Precautionary Approach reference points in the management plan are consistent with the precautionary approach, provided they are used as lower boundaries on spawning stock biomass (SSB), and not as targets.

This evaluation of the options and methods to provide improved stability in TACs with respect to the existing management plan has been carried out using simulation models. Important issues for the evaluation 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 (such as limit on year-to-year variation in catch), and performance measures for harvest control rules (such as yield, stock size, probability of SSB<$\mathbf{B}_{lim}$, and annual variation in catches).

Reference points

	ICES considers that:	ICES proposed that:
Limit reference points	$\mathbf{B}_{lim}$ is 100 000 t.	$\mathbf{B}_{pa}$ be set at 140 000 t.
	$\mathbf{F}_{lim}$ is 1.0.	$\mathbf{F}_{pa}$ be set at 0.7.
Target reference points	Target F according to the management plan is 0.3.	

Model

The simulation model consists of an operating model and a simulated management procedure. The operating model simulates the underlying “true” haddock population. The simulated management procedure consists of the stock assessment process and the management decisions that are taken on the basis of the perceived states of the stock. Fifty iterations of 20 years have been simulated for each HCR. Each of the iterations had a different simulated recruitment time-series. Within each HCR, iteration and year, the assessment incorporated uncertainties on measurements of catch (CV = 0.1), and on the relationship between survey data and true stock size (CV = 0.2).

Recruitment estimation

The recruitment pattern of North Sea haddock which produces sporadic strong year classes is an important feature of the stock dynamic. Therefore, recruitment in the simulation is generated by a composite distribution, which produces a series of poor-to-moderate recruitments punctuated by two high recruitments that are at least two years apart. Examples of recruitment time-series generated for the simulations are given in Figure 6.3.3.3.1.

HCR Scenarios

Several different scenarios were evaluated:

- Target F = 0.2 with ±15% limit on interannual TAC variation.
- Target F = 0.3 with ±15% limit on interannual TAC variation.
- Target F = 0.4 with ±15% limit on interannual TAC variation.
- Target F = 0.5 with ±15% limit on interannual TAC variation.

Results of the evaluation

Given the ±15% limit on interannual TAC variation, occasional runs of low recruitment (and therefore biomass) can lead to F much higher than the target F, especially with target F = 0.4 and 0.5. The ability of management to achieve the target F is larger when a low target F is used.

Most HCRs produce stable landings and SSB, but the lower target F leads to a general trend of increasing SSB.

Figure 6.3.3.3.2 illustrates the distributions of stock dynamics from simulations applying a target fishing mortality of 0.3 with a 15% limit on inter-annual variation in TACs.

The risk of falling below biomass reference points or exceeding F reference points for each HCR is summarised in Figure 6.3.3.3.3. The risks of B < Blim for each HCR are compared in Figures 6.3.3.3.4 and 6.3.3.3.5 and can be summarised as follows:

- Target F = 0.2 with TAC constraint ±15%: maximum risk 0%, mean risk ~0%.
- Target F = 0.3 with TAC constraint ±15%: maximum risk 12%, mean risk 5%.
- Target F = 0.4 with TAC constraint ±15%: maximum risk 30%, mean risk 17%.
- Target F = 0.5 with TAC constraint ±15%: maximum risk 38%, mean risk 23%.

Conclusions

A target $F = 0.3$ with TAC constraint ±15% leads to a low risk (5%) of $B < B\text{lim}$ over the next 20 years. The simulations are sensitive to the target F used and increasing the target F increases the risk.

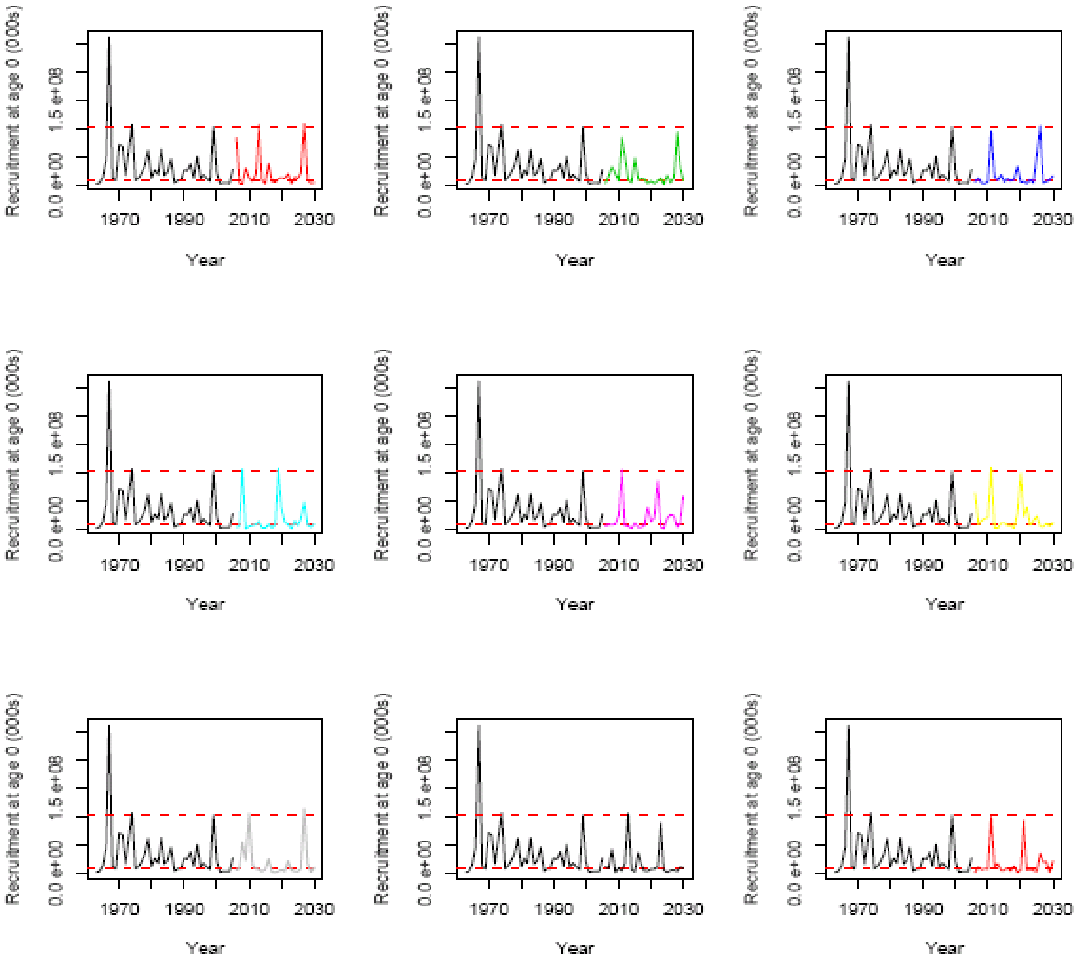

Figure 6.3.3.3.1 Examples of some recruitment time-series generated by the model.

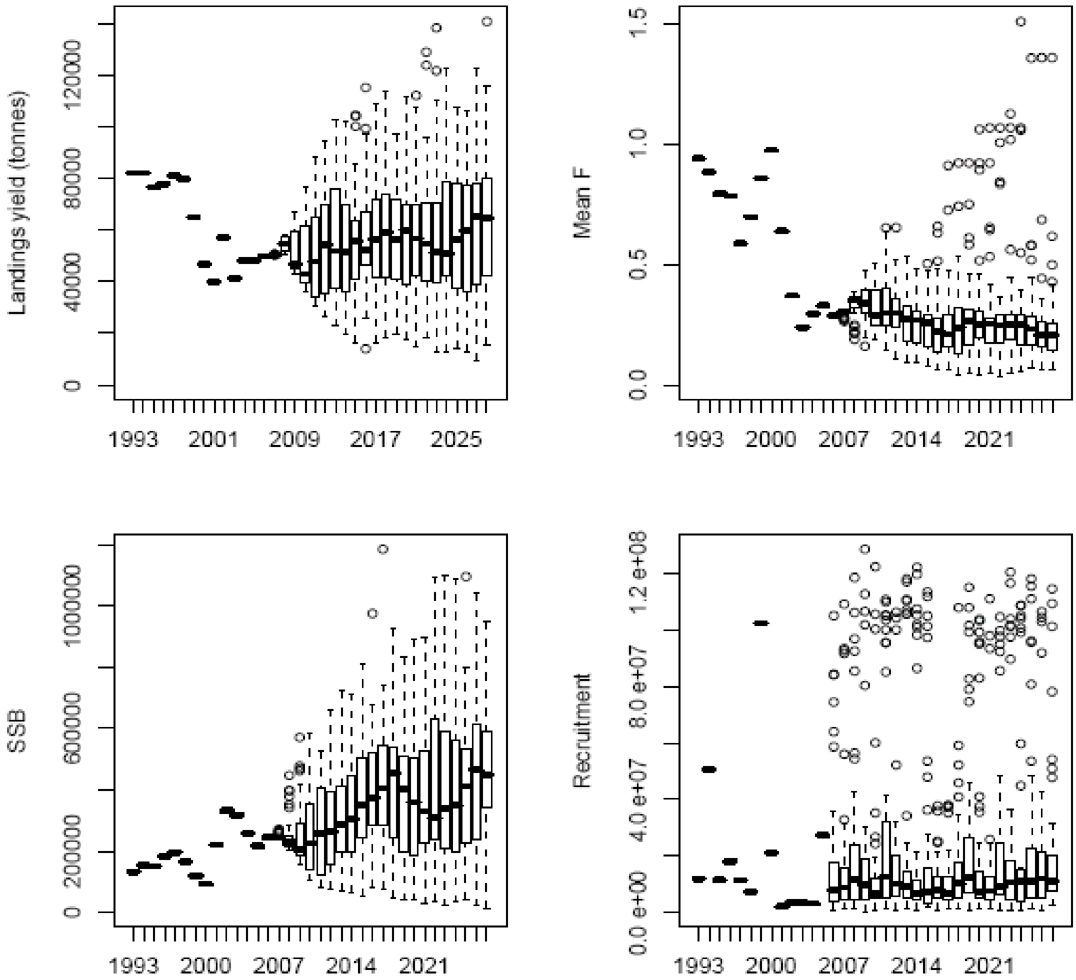

Figure 6.3.3.3.2 Box-and-whisker time-series summaries for simulation 2 (target $F = 0.3$, TAC constraint ±15%). Solid lines give medians (50th %ile) of distributions of estimates for each year, boxes show approximate first and third quartiles (25th and 75th %ile), while whiskers and points indicate outliers.

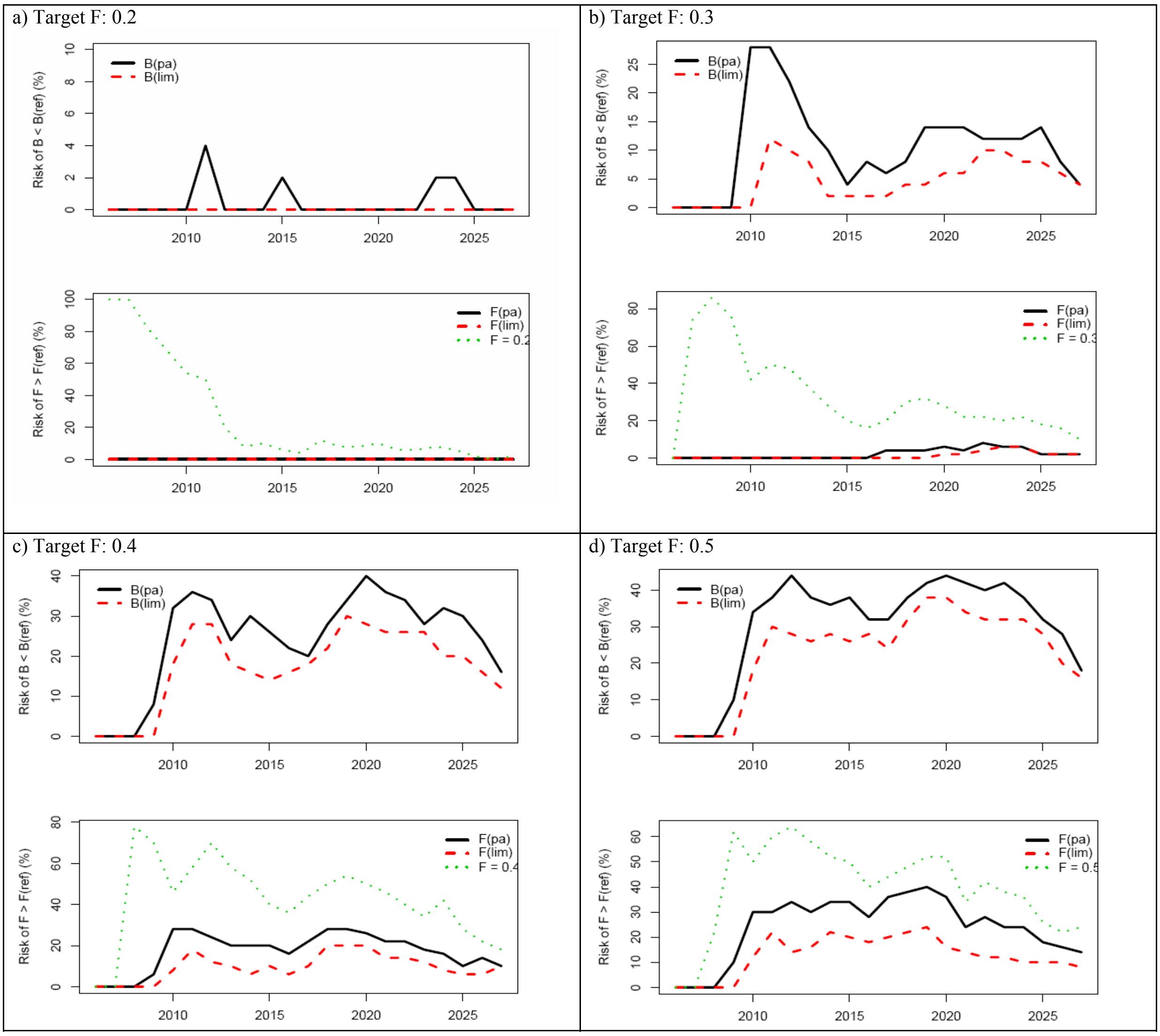

Figure 6.3.3.3.3 Risk summaries for HCR with target F = 0.2, 0.3, 0.4, 0.5 (a-d). For each HCR, upper plot: percentage of iterations in each year for which By < Bpa (solid black line) and By < Blim (dashed red line). Lower plot: percentage of iterations in each year for which Fy > Fpa (solid black line), Fy > Flim (dashed red line), and Fy>Ftarget (dotted green line)

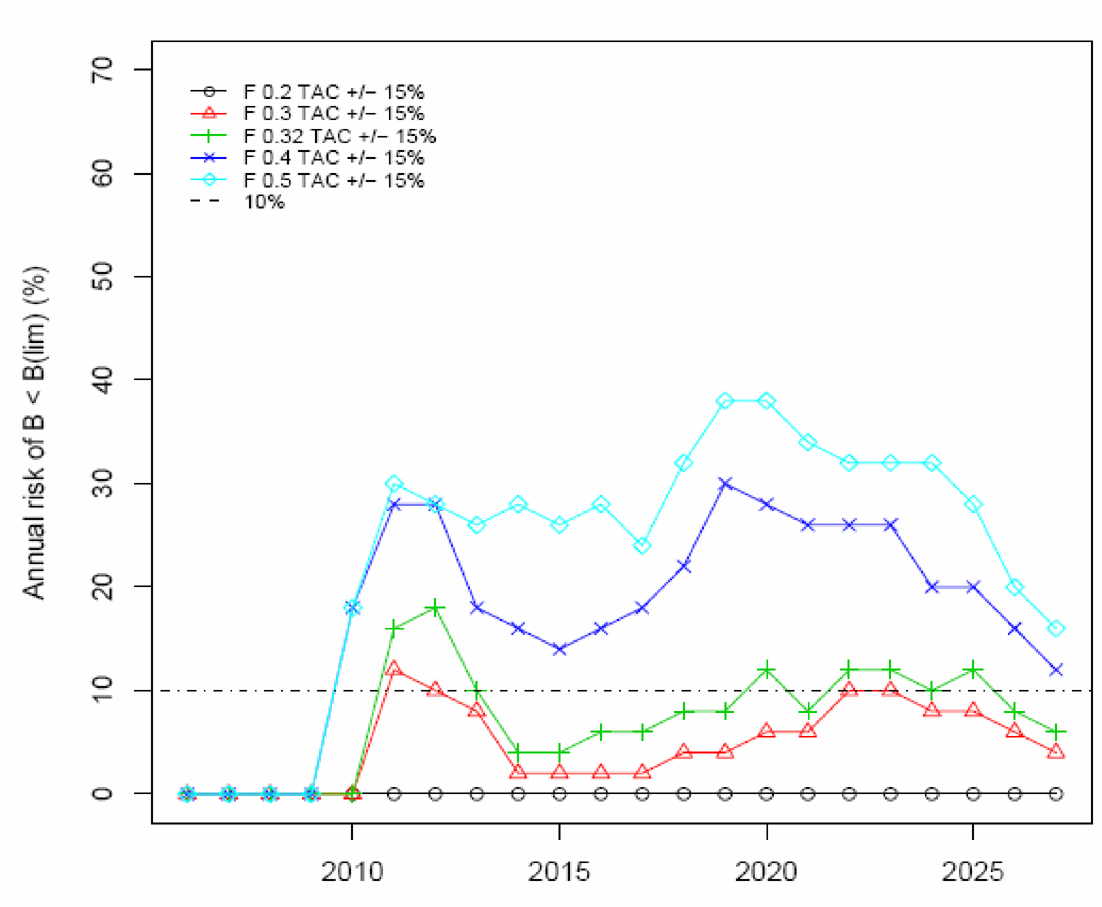

Figure 6.3.3.3.4 Annual percentage risk of B < Blim from simulations run under different HCRs

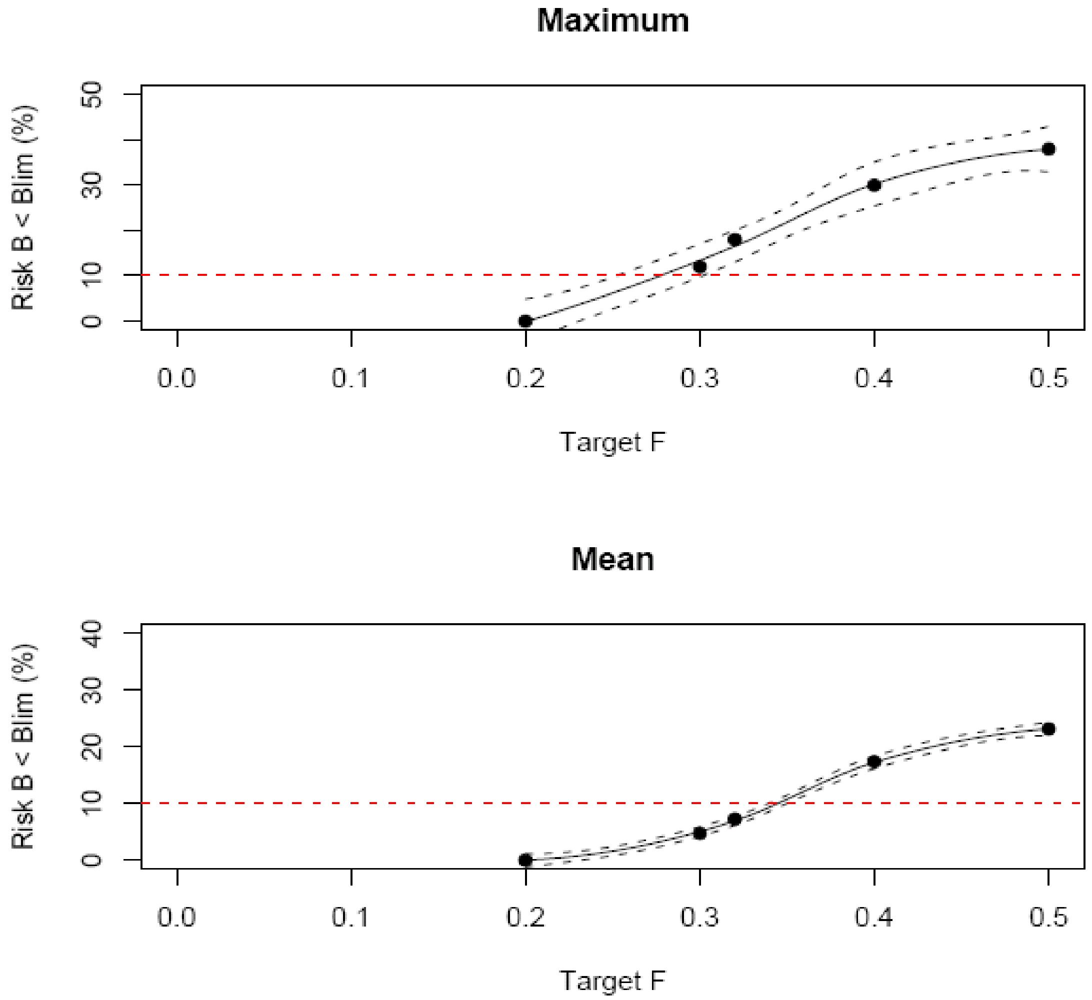

Figure 6.3.3.3.5 Maximum (upper) and mean (lower) percentage risk of B < Blim from simulations run under different HCRs

6.3.3.4 Answer to special request on sandeel

The European Community and Norway have requested ICES for "*advice on management measures for the sandeel and Norway pout fisheries in the North Sea and Skagerrak in 2007*".

The request for ICES advice on management measures concerning sandeel is quoted below:

a. Harvest control rules for sandeel in the North Sea and Skagerrak that:

i. Allow the Maximum Sustainable Yields to be obtained and are consistent with the precautionary approach.

ii. Prevent any local depletion of sandeel aggregations, and

iii. Take into account the function of sandeel in the ecosystem.

It may be expected that the management of the sandeel fishery will include the setting of preliminary catch and/or fishing effort limits at beginning of the year until scientific information is available allowing for the fixing of the final maximum fishing effort and/or catch levels. The harvest rules should therefore include rules for setting preliminary and final fishing effort levels (expressed as a percentage of the reference level in kW-days) and/or catch levels.

b. The monitoring systems and assessment methodologies required to implement the advised harvest control rules;

c. The possible negative effects on the reproductive success and incoming year class strength due to bottom towed gears undertaking fisheries other than sandeel fisheries and operating on the various sandeel fishing grounds during the spawning season; and

d. The possible effects of bottom towed gears on the alteration of physical and biological characteristics of the sandeel essential habitats as well as whether and how any such alterations may affect the dynamic of the sandeel stock.

ICES is requested to submit its report on points a) and b) by October 2006.

The present section deals with the request for sandeel. Norway pout will be dealt with in Section 6.3.3.5.

ICES response

a) Harvest control rules for sandeel in the North Sea and Skagerrak

MSY and the precautionary approach

$\mathbf{F}_{max}$ is not well defined for sandeel. Simulations based on a reasonable stock–recruitment relationship indicate a maximum yield of about 5–600 thousand tonnes at F near 0.7 (Figure 6.3.3.4.1). At such fishing mortality the risk of falling below $\mathbf{B}_{lim}$ is high (about 45%). Therefore, an F-based strategy that aims for maximum yield is not consistent with the precautionary approach.

A spawner escapement strategy that aims at a surviving annual amount of spawners equal to $\mathbf{B}_{pa}$ (or having a high probability of being above $\mathbf{B}_{lim}$) could be considered as an appropriate alternative to the fixed-F strategy. This requires a management procedure like the one that has been in operation since 2004 where a real-time estimate of recruits has been obtained using information from surveys during winter and spring, and from a restricted exploratory fishery in April and early May.

Local depletion of sandeel aggregations

Sandeel is sedentary once it has settled to the bottom and confines itself to specific grounds where the bottom conditions are favourable. The exchange of sandeel between different grounds takes place mainly in early life stages. In the Norwegian economical zone fishery is known to cause local depletion of sandeels. The low stock size increases the risk of local depletion, which is a matter of concern. There is therefore a need to monitor the stock situation and the fishery at a finer spatial scale, and to restrict the fishery on grounds that show signs of depletion. The present knowledge on defining subpopulations is too limited to recommend specific management measures for 2007, which can fully take the population structure into account, but work is proceeding on defining local sub-populations so that the scale of "local depletion" can be quantified and be made operational for a North Sea-wide implementation.

Closing the fishery on 1 August will enhance the possibilities for the 0-group to contribute to the local aggregations and to repopulate earlier depleted grounds.

Function of sandeel in the ecosystem

Localised depletion of sandeel aggregation at a distance less than 100 km from seabird colonies may affect some bird species, especially black-legged kittiwake and sandwich tern. The more opportunistic feeding marine mammal and fish species may be less vulnerable to local sandeel depletion.

Evaluation of generic harvest control rules for sandeel

A spawner escapement strategy that aims at a surviving annual amount of spawners equal to $\mathbf{B}_{pa}$ (or having a high probability of being above $\mathbf{B}_{lim}$) could be considered as an appropriate harvest strategy for a short-lived species like sandeel. This requires a management procedure like the one that has been in operation since 2004 where a real-time estimate of recruits has been obtained using information from surveys during winter and spring, and from a restricted exploratory fishery. Several *ad hoc* STECF working groups have attempted to define and evaluate harvest control rules for sandeel in the North Sea. The "*ad hoc* Working Group on Sandeel Fisheries" (STECF, 2005) held in November 2005 did a comprehensive evaluation of the present real-time monitoring system applied to the Danish fishery. The main conclusion was that the EC real-time monitoring system would likely rebuild and maintain the population above $\mathbf{B}_{lim,}$ with 95% probability.

ICES has considered alternative management schemes which would enable a more stable fishery while simultaneously achieving the $\mathbf{B}_{lim}$ criterion with a high probability.

ICES carried out simulations using the SMS model (Stochastic Multi Species model; Lewy and Vinther, 2004). The approach was consistent with the framework for evaluation of management strategies as described by the ICES Study Group on Management Strategies (SGMAS; ICES, 2005, 2006a). Details of the SMS implementation of the HCRs can be found in STECF (2005). The method incorporates the fact that decisions on, e.g. TAC are taken on the basis of imperfect knowledge. The approach does not simulate the full annual cycle of assessment and projection but instead assumes that the true stock size can be "observed" with some bias and noise. It is this "perceived" stock that is the basis for the application of the HCR.

Three types of scenario's for harvest control rules are presented (Figure 6.3.3.4.1):

1. Maximum sustainable yield scenarios with constant fishing mortality
2. Escapement strategy and relation to assessment bias
3. Escapement strategy and relation to bias in real-time estimates

Scenarios 2 and 3 used a TAC-ceiling of 400 000 t as an additional element in the HCR.

The MSY-constant F scenario indicates that the maximum yield of 550 kt is achieved with an F at 0.7 (Figure 6.3.3.4.1a). Such a fishing mortality gives a high probability that SSB is below $\mathbf{B}_{lim}$. Fishing mortality at 0.4 gives a yield of around 475 kt and a 95% probability of SSB>$\mathbf{B}_{lim}$. An F at 0.4 can be considered as $\mathbf{F}_{MSY}$ given the current SSB reference values.

The escapement and assessment bias scenario explores the sensitivity of the escapement strategy to different levels of assessment bias (Figure 6.3.3.4.1b). Median F, yield, and SSB are relatively stable and independent of the bias level but the probability of SSB being below $\mathbf{B}_{lim}$ increases with increasing bias. The probability of SSB being below $\mathbf{B}_{lim}$ is more than 5% when the assessment bias factor is larger than 1.4, and 10% for a bias factor of 2.0.

Results for the explorations of bias in the real-time monitoring (Figure 6.3.3.4.1c) are very similar to the results from the assessment bias scenario.

Overall, the evaluations show that the risk of the stock falling below $\mathbf{B}_{lim}$ in the escapement strategy is sensitive to the bias in the assessment and to the bias in the recruitment estimate from the real-time monitoring. However, the actual process of estimating stock size (assessment) or recruitment (from real-time monitoring) could not be included in the evaluations. The absolute level of bias in these variables in the standard assessment process cannot be determined (because there is no estimate of the "true stock" available). Therefore, the results of the evaluations are useful at a generic and strategic level, but they cannot be used to derive a specific Harvest Control Rule for 2007. For this reason, the harvest control rule given below must be viewed as a **suggestion** only.

ICES notes that the issue of local depletion could not be handled in the simulations and that this prevents a full evaluation of the proposed management approaches for sandeel.

Suggested management procedure for 2007

Based on the generic results of the evaluations of potential harvest control rules for sandeel, ICES suggests a spawner-escapement strategy for 2007. The following conditions should apply:

1. The aim of management in 2007 should be to rebuild SSB in 2008 above $\mathbf{B}_{lim}$ with a high (95%) probability;
2. The total kilowatt-days for fisheries for sandeel in 2007 may initially be set at no more than 30% of the total kilowatt-days applied in 2005. This effort may be used for exploratory fishing in April and early May 2007;
3. A TAC for 2007 and the maximum number of kilowatt-days shall be determined, as early as possible based on advice from ICES on the size of the 2006 year class of North Sea sandeel in accordance with the following rules:
    a. TAC 2007= −597 + 4.073 × N1 (N_1 is the real-time estimate of age group 1 in billions, derived from an exploratory fishery in April and early May 2007; the TAC is expressed in 1000 t),
    b. If the TAC calculated in point 3a) exceeds 400 000 t the TAC shall be set at 400 000 t,
    c. The number of kilowatt-days for 2007 shall not exceed the effort in 2005;
4. The fishery shall be closed 1 August 2007.

The relationship between the TAC and the real-time recruitment estimate is conditional on the October 2006 assessment of age group 2 and older at the start of 2007 (Figure 6.3.3.4.3 and ICES, 2006b).

The real-time monitoring estimate should be based on a regression between CPUE observations and "bias-corrected" stock numbers at age 1. ICES has applied a bias correction to the assessment output by calculating a bias factor from the terminal estimates of a series of retrospective runs divided by the "true value" as estimated in the most recent assessment. The application of the bias factor gave a 50% lower estimate of SSB in 2007. ICES considers that the bias correction reduces the concern about assessment bias for management of the sandeel fishery in 2007.

Because ICES cannot fully evaluate whether the harvest control rule is consistent with the precautionary approach in the longer term, ICES presents the HCR as a suggestion only.

How to derive a real-time estimate of recruitment

The real-time monitoring system in 2005 and 2006 used a regression between historical CPUE and stock estimates from the 2004 assessment. Data points from years with more than 300 billion 1-groups were excluded from the regression to reduce the effects of very strong year classes on the regression. Based on this regression, the real-time monitoring showed a tendency to overestimate the stock in the most recent years (assuming that the analytical assessment provides the true stock size).

To reduce the possible bias in the real-time monitoring, ICES considers that the basis for the regression should be updated and should include the period 2004–2005, which is characterized by a very low stock size and a relatively low fishing effort. Data from 2006 should be left out due to the very uncertain estimate of the stock size in the terminal year of the assessment. In addition, ICES proposes to leave out years with a very high SSB (SSB>1000 kt). In years with high abundance of older fish and relatively low abundance of 1-group, the fishery is targeting fishing grounds with a high proportion of older fish and therefore the CPUE of the 1-group will underestimate the recruitment. Figure 6.3.3.4.2 presents the proposed regression between CPUE and recruitment and the historical performance in predicting year-class strength. The proposed new regression methodology requires a higher CPUE for a given recruitment estimate compared to the regression used in the real-time monitoring 2005–2006. More information on the performance of the regression analysis can be found in Annex 1 to this document.

ICES recognizes that there is still a lack of generality in the approach to derive a real-time estimate of recruitment of sandeel. The proposed regression approach is considered a useable approach for 2007, but it would require a more extensive analysis for future applications.

b) monitoring systems and assessment methodologies required to implement the advised harvest control rules

Fisheries dependent information on sandeel abundance

The real-time monitoring of sandeel in 2004–2006 was based on catch rates from the Danish commercial fishery at the beginning of the fishing season. Catch rate (tonnes per day at sea, standardised to 200 GT vessel) were obtained for each fishing trip from logbooks and transformed into a CPUE of 1-group sandeel based on biological samples from most of the landings. DIFRES collated data on a weekly basis and distributed the results to UK fisheries institutes (CEFAS and FRS) for information and review. When sufficient data was available to give a consistent estimate of CPUE a group of Danish and UK scientists performed an evaluation to provide a management proposal. STECF in turn evaluated this information and provided the final TAC advice within a few days, making the advice available by mid-May.

The Norwegian Ministry of Fisheries and Coastal Affairs decided that the results from a limited monitoring fishery in the Norwegian EEZ should be used as basis for an opening of the sandeel fishery in 2006. IMR was to develop methodology and to suggest re-opening criteria. There was an experimental fishery in weeks 16–18 with six commercial vessels. In two out of three weeks the vessels could fish on their preferred fishing grounds, while one week of fishery was on a fishing ground selected by IMR. The purpose of this design was to obtained CPUE and spatial distribution of the stock. Based on the results, IMR advised that the sandeel fishery in 2006 should remain closed for the rest of 2006.

There is a need to develop an integrated approach between the EC and Norway to the real-time monitoring using fishery-dependent data.

Fisheries-independent information on sandeel abundance

Fisheries-independent time-series (surveys) of sandeel abundance are being developed at present, but the time-series are still too short and the methodology is not fully established. Therefore, these surveys alone do not provide reliable estimates of sandeel abundance.

A range of surveys have been carried out by Danish, English, German, Norwegian, and Scottish research institutes in the past. These field investigations have been focused on answering specific questions about the biology of sandeel in smaller localised areas rather than investigating the overall changes in sandeel abundance.

In recent years, research has also focused on survey designs that may provide abundance indices of sandeels for the use of stock assessment. Different sampling devices and approaches have been used, e.g.:

- sampling of juvenile and adult sandeels from the water column with demersal and pelagic trawls and acoustic measuring techniques;
- sampling of the pelagic life stages with different types of larval sampling devises;
- sampling of post-settled fish from the seabed using different types of seabed sampling devises, demersal trawls, and dredges.

There has not been a systematic comparison of all the different sampling approaches. Greenstreet *et al.* (2006) compared methods for measuring abundance of post-settled sandeels (juvenile and older sandeels) based on survey data and commercial CPUE data from the Firth of Forth area. This analysis showed that in order to provide unbiased estimates of sandeel abundance, survey indices of sandeels must take account of the highly variable fraction of sandeels that may reside in the seabed during the time of survey.

Four research institutes (FRS, DIFRES, CEFAS, and IMR) have employed a modified scallop dredge to obtain estimates of relative density of sandeels in the sand for some specific areas and times. This sampling approach is useful because sandeels tend to lie dormant in the sediment during the night and in late autumn and winter. DIFRES has collected information about relative abundance and age/length distribution of post-settled sandeels on surveys since 1996 using this modified scallop dredge. Sampling has been standardized according to sampling time and locations since 2003. This allows the development of a time-series that can be used as relative abundance estimates of post-settled sandeels. Sampling is carried out at the end of the year when sandeels have commenced their winter dormancy period and when the catchability of the gear is largest. Sampling is carried out at 28 fixed positions at known sandeel habitats situated on the most important fishing banks in the North Sea (from the Little Fisher Bank in the northeastern North Sea to the Dogger Bank area in the southwestern North Sea). This survey was able to detect the increase in local abundance of sandeels from 2005 to 2006. DIFRES will continue the dredge survey in December 2006.

The Norwegian Institute of Marine Research (IMR) has planned to conduct two surveys in 2007 to further develop the survey methodology and to measure the abundance of 1-group and older sandeels in April/May, and the abundance of 0-group sandeels in August/September. During these surveys a multi-frequency echo-sounder is used to identify and measure the abundance of sandeels in the free water-masses during daytime. A VanVeen grab and a modified scallop dredge are used to sample sandeels in the seabed during night. This survey approach was tested during a preliminary survey in April/May 2005 and 2006 and in July/August 2006.

Conclusions

ICES has evaluated several harvest control rules for sandeel in the North Sea and Skagerrak and the evaluations showed that the risk of the stock falling below $\mathbf{B}_{\text{lim}}$ in an escapement strategy is sensitive to the bias in the assessment and to the bias in the recruitment estimate from the real-time monitoring. However, the actual process of estimating stock size (assessment) or recruitment (from real-time monitoring) was not included in the evaluations and the results of the evaluations are therefore useful at a generic and strategic level. The issue of local depletion could not be handled in the simulations and this prevented a full evaluation of the proposed management approaches for sandeel.

ICES suggests a real-time management for 2007, targeted at rebuilding SSB above $\mathbf{B}_{pa}$ in 2008. The relation between the estimate of the 2006 year class and catch opportunities is shown in Figure 6.3.3.4.3 (lower panel). The real-time monitoring estimate should be based on "bias-corrected" VPA estimated stock numbers and CPUE observations, including data up to 2005 but excluding years with very high SSB (> 1 million tonnes).

Further development of survey methodology and time-series for fisheries-independent information should be continued, to allow the use of such data in a real-time monitoring of sandeel. Fisheries-independent data are not fully developed for use in 2007 and CPUE data from the commercial fishery should therefore be used as the basis for estimating the abundance of the 1-group sandeel. CPUE data should be obtained from all the main fishing nations for sandeel. An integrated approach between the EC and Norway on how to sample and combine national CPUE should be developed before the start of the fishery in 2007.

ICES cannot fully evaluate whether the harvest control rule for 2007 is consistent with the precautionary approach in the longer term. Therefore, ICES presents the HCR for 2007 as a suggestion only.

Sources of information

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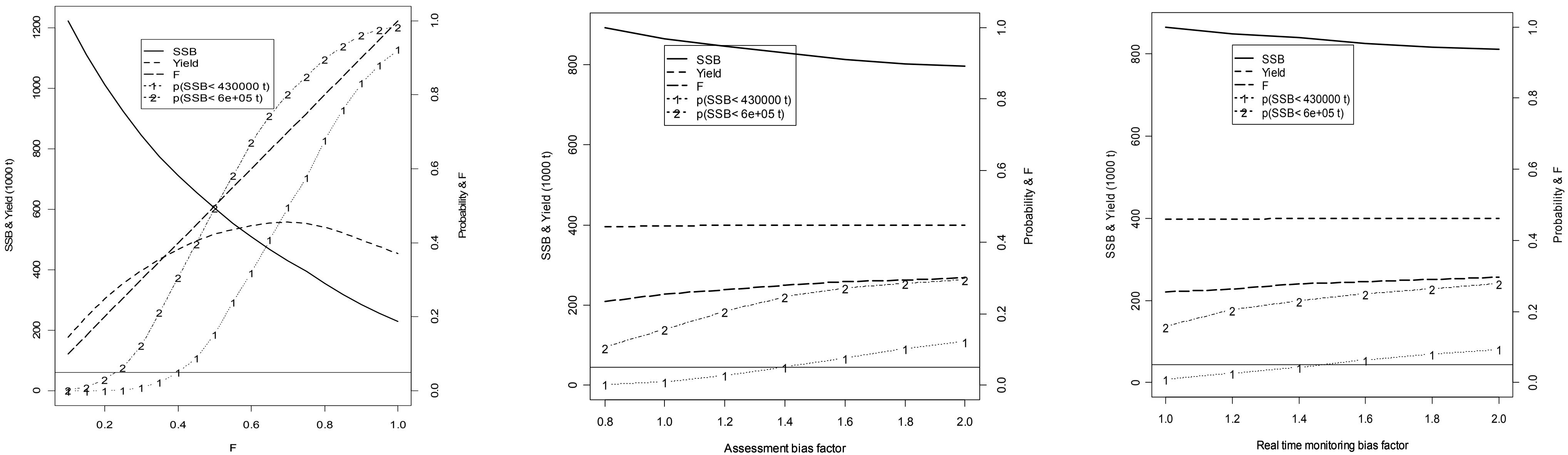


a) MSY, constant F strategy.

Assessment uncertainty: 25%CV, no bias	SSB-R: Hockey stick, Stochastic
Real-time uncertainty: no	Real-time F: none
Cap F: none	Target SSB: none
Cap TAC: none	

b) Assessment bias scenario.

Assessment uncertainty: 25%CV, bias factor in the range 0.8 to 2.0	SSB-R: Hockey stick, Stochastic
Real-time uncertainty: 35%CV, no bias	Real-time F: 0.18
Cap F: 0.65	Target SSB: 600 kt (**B_{pa}**)
Cap TAC: 400 kt	

c) Real-time bias scenario.

Assessment uncertainty: 25%CV, no bias	SSB-R: Hockey stick, Stochastic
Real-time uncertainty: 35%CV, bias factor in the range 1.0 to 2.0	Real-time F: 0.18
Cap F: 0.65	Target SSB: 600 kt (**B_{pa}**)
Cap TAC: 400 kt	

Figure 6.3.3.4.1 Effect of managing North Sea sandeel with (a) a range of fixed F strategies, (b) assessment bias at F=0.18, and (c) real-time monitoring bias. Median values of SSB, yield, and F together with the probability of a SSB below **B_{pa}** (600 kt) or **B_{lim}** (430 kt). The metrics are presented for the population at equilibrium.

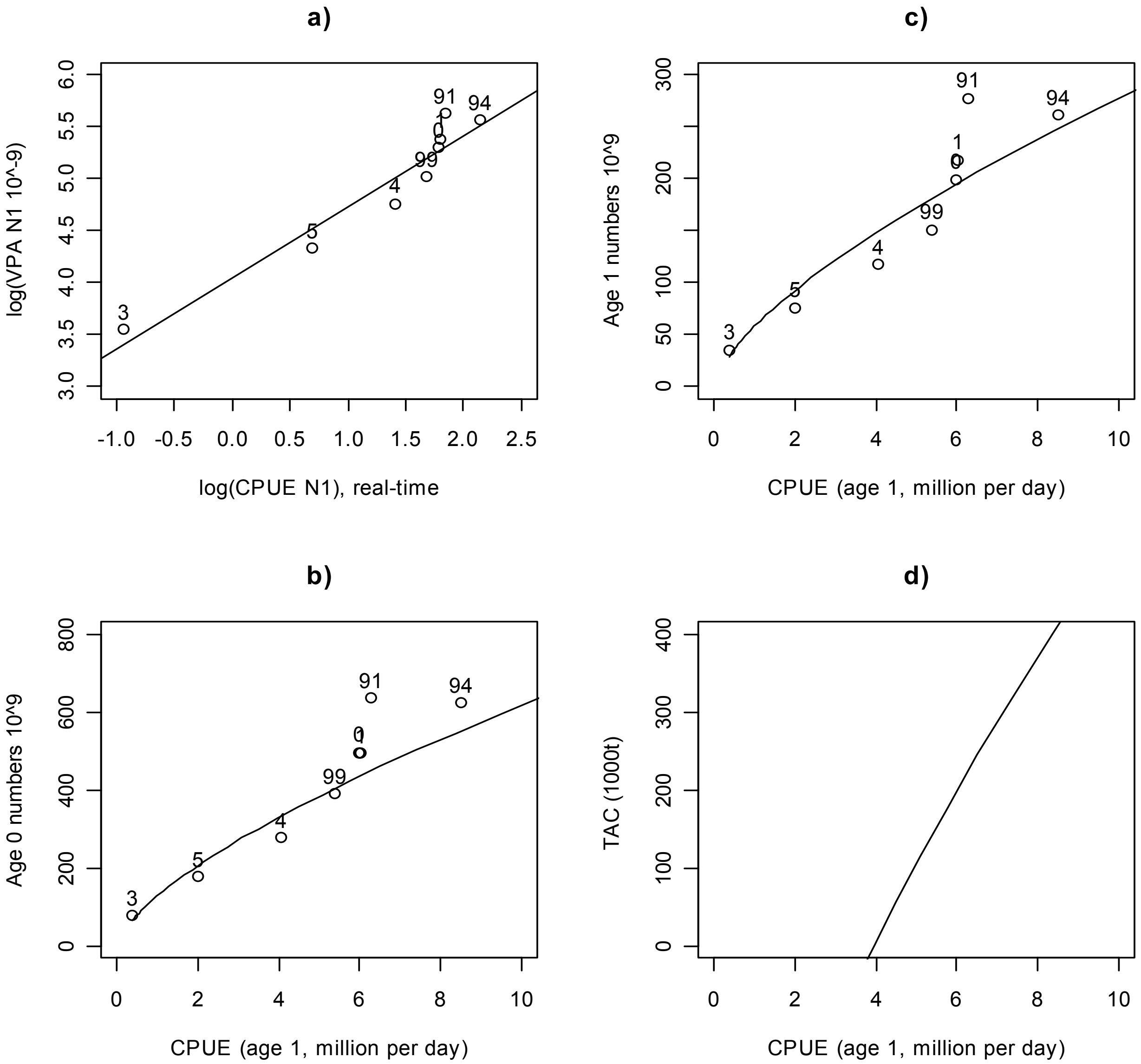


Figure 6.3.3.4.2. North Sea sandeel.

Panel a) log of stock numbers (age 1) from stock assessment this year against observed log of CPUE of age 1. Labels in all plots give the year of CPUE observation.

Panel b) VPA estimate of 0-groups of against values of CPUE of age 1 of the same year class. The solid line is derived from the regression in panel a).

Panel c) VPA estimate of age 1 against values of CPUE.

Panel d) TAC in 2007 as a function of CPUE in 2007 using the minimum escapement strategy as presented in Figure 6.3.3.4.3.

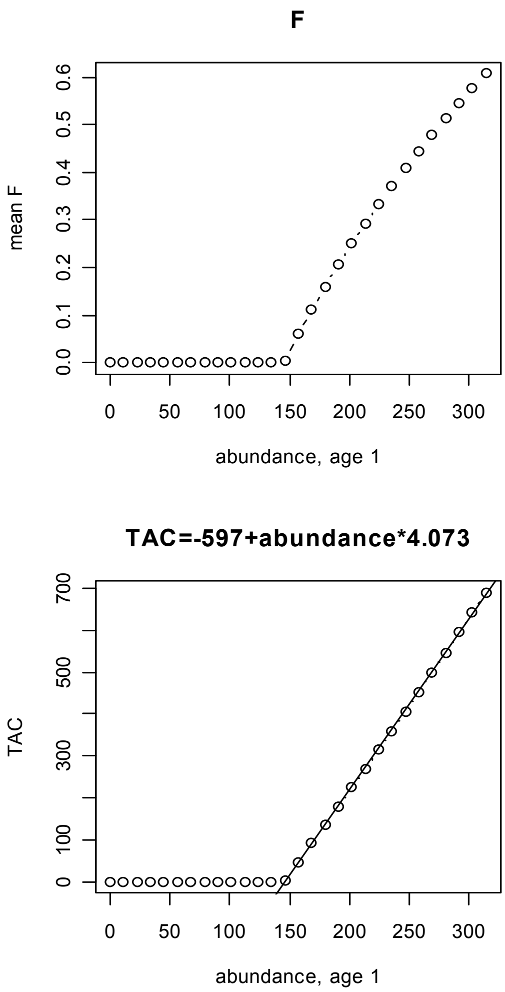


Figure 6.3.3.4.3 **North Sea sandeel.** Upper panel: Relation between F and real-time estimate of age 1 numbers using a minimum escapement strategy, leaving SSB in 2008 above $\mathbf{B}_{pa}$. Lower panel: converts F into a TAC value and shows a fitted regression line through TAC values > 0.

Annex 1: History of regression analysis on CPUE and recruitment

An initial suggestion by the assessment working group (WGNSSK) for the regression between CPUE and recruitment was to base it on observations from 2003–2005. Closer analysis of this regression is presented below, including an argumentation of why a different basis should be used.

Figure 6.3.3.4.4 presents different scenarios for the regression between CPUE and recruitment:

1. A regression based on the 2004 assessment and historical CPUE data. This regression was used in the 2005 and 2006 real-time monitoring.
2. A regression using the 2006 assessment (but excluding the year 2006) and historical CPUE data.
3. A regression using the 2006 assessment and CPUE data but only for the years 2003–2005.

Panel a) of the figure shows that using an updated regression with all available data points gives a smaller intercept compared to the regression based on 2004 data. The intercept decreases further when just data from 2003-2005 are used.

Using the regression based on 2003–2005 data underestimates the recruitment for all years except 2003 and 2004, which are on the line. The maximum CPUE for the years included in the graphs was 8.3 million 1-group per day fishing (observed in 1994). The highest CPUE in week 17 for the full time-series 1986–2006 has been observed in 2002 with a CPUE of 9.5 million per day. Such a record high CPUE would result in a TAC advice that is slightly above 100 000 t (panel d) if regression no. 3 were used. This is despite the fact that the year class 2001 was the second highest since 1986. Such a low TAC advice would be in contrast to the ICES forecast where a recruitment slightly below average would permit a fishery of 300 000 t in 2007.

ICES considers that the updated data series should be used for the regression (regression no. 2). The assessment configuration was changed in 2005, leading to a better stock estimate. The most recent CPUE data should be included because they represent the present situation with low stock size and low effort.

None of the regressions catch the relation between CPUE and stock size very well (panel b and c). All the regressions only include data from years where the age-1 stock size was low or at average. This was done after criticism from STECF, pointing out that there was a high risk of overestimating the stock at low stock sizes. By excluding large year classes from the regression, the estimate at low stock sizes becomes conservative and the risk of overestimating the recruitment at low CPUE is small. The drawback is that recruitment is underestimated when CPUE is around or above average.

The poor relations between CPUE and VPA estimate may be due to a change in exploitation pattern which is dependent on the available biomass of 1-group and older fish. For years with a very high SSB and a low biomass of the 1-group, the fishery will target banks where the density of older fish is high. The CPUE of 1-group sandeel will then be a poor measure of recruitment. The fishery in 1987, 1988, 1996, and 1998 represents years with a high SSB (above 1 000 000 t) and a rather low abundance of the 1-group.

A range of sensitivity tests showed that the actual SSB level for excluding a data point from the regression had a limited effect of the relation between CPUE and TAC. However, the statistical precision of the regression improves significantly when data years with SSB>1000 kt are excluded. For 2007, it is most likely that the SSB will be very low and the fishery will have to target the 1-group. To let the recruitment ~ CPUE regression reflect this situation, ICES proposes to use a regression between CPUE and recruitment where data points from years with SSB>1000 kt are not used. This regression is presented in Figure 6.3.3.4.2 with data up to week 17.

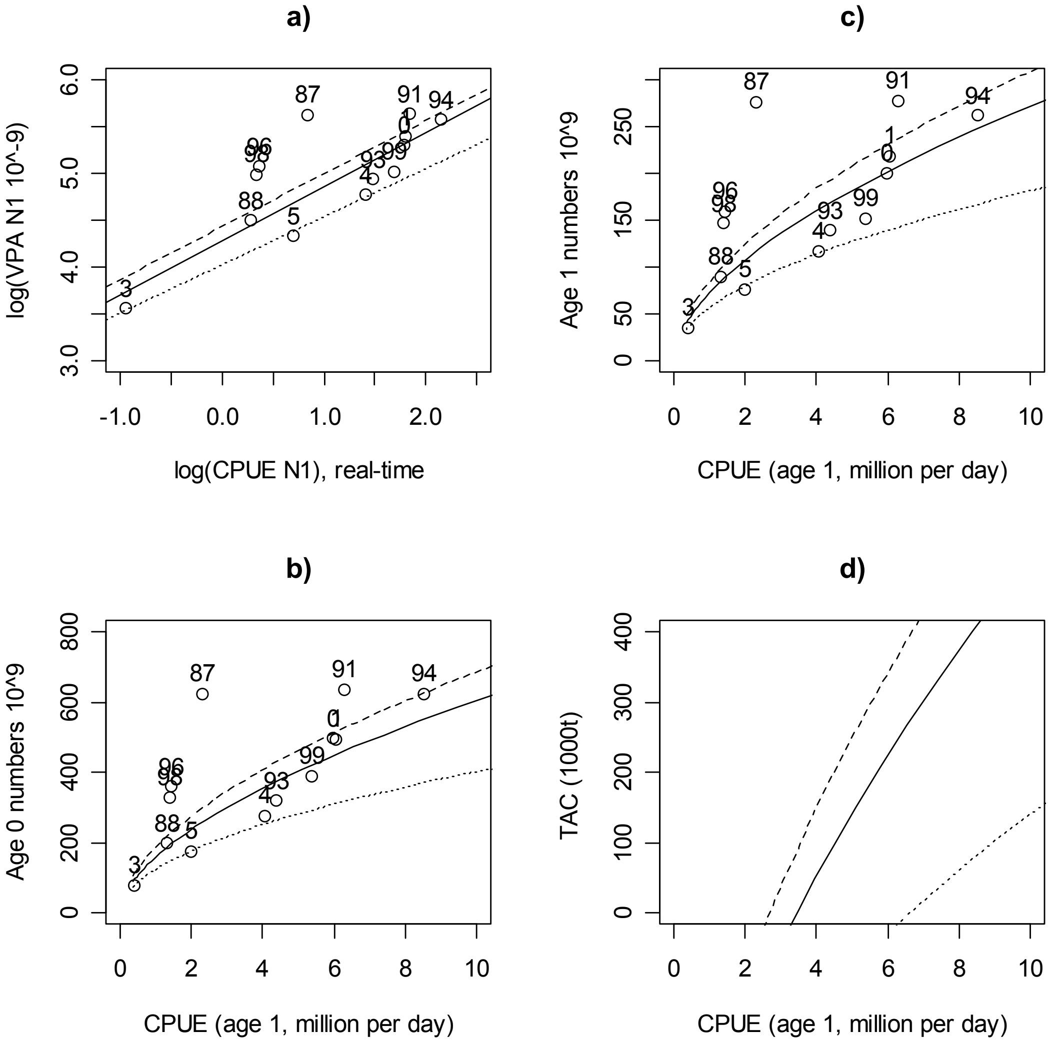


Figure 6.3.3.4.4 Sandeel in the North Sea

Panel a) Log of stock numbers (age 1) estimated by VPA this year against observed log of CPUE of age 1 using data for week 17 in the years up to and including 2004. CPUE for 2005 is for week 19, where a stable CPUE was obtained. Labels in all plots give the year of CPUE observation.
The upper dashed line shows the regression applied for the real-time monitoring in 2005–2006. This regression was based on the 2004 assessment.
The middle solid line is the regression line using all data points in the plot.
The lower dotted line is the regression using data from the most recent years 2003–2005.

Panel b) Stock numbers (age 0) derived from real-time CPUE of age 1 (and an assumed mortality of age 0 at 0.8) and the regressions presented in panel a).

Panel c) Stock numbers (age 1) derived from real-time CPUE of age 1 and the regressions presented in panel a).

Panel d) TAC in 2007 as a function of CPUE of age 1 and the regressions presented in panel a).

6.3.3.5 Norway pout

The European Community and Norway have requested ICES for advice on management measures for the sandeel and Norway pout fisheries in the North Sea and Skagerrak in 2007.

This Section deals with the request for Norway pout. Sandeel are covered in Section 6.3.3.4.

The request to ICES concerning Norway pout was as follows:

Harvest control rules for Norway pout in the North Sea and Skagerrak that:

Allow the Maximum Sustainable Yields to be obtained and are consistent with the precautionary approach; and

Take into account the function of Norway pout in the ecosystem

It may be expected that the management of the Norway pout fishery will include the setting of preliminary catch and/or fishing effort limits at the beginning of the year until scientific information is available in spring allowing for the final maximum fishing effort and/or catch levels to be fixed. The harvest rules should therefore include rules for setting preliminary and final fishing effort levels (expressed as a percentage of the reference level in kW-days) and/or catch levels.
The monitoring systems and assessment methodologies required to implement the advised harvest control rules.

Level of by-catches in Norway pout fisheries separated for Division IIIa and Sub-area IV; and

Appropriate technical measures, including possible closed areas, to reduce by-catches, in particular, of cod, haddock, saithe, whiting and herring.

a) Harvest control rules for Norway pout

ICES is suggesting harvest control rules for Norway pout that are based on in-year monitoring similar to the recommendation for Sandeel. The suggested HCR for 2007 is:

1. *According to the ICES advice (Section 6.4.22) the preliminary TAC for 2007 should be zero*
2. *A final TAC for 2007 shall be set during the first half of 2007 on the basis of advice from ICES in spring 2007 based on:*
    a) *allowing for the spawning stock in the beginning of 2008 to be above Bpa,*
    b) *the most recent survey information (namely the0-group estimate for 2006 from the Q3 (2006) IBTS survey, and the 1-group estimate for 2007 from the Q1 (2007) IBTS survey),*
    c) *complete catch information from 2006 and*
    d) *an assumed recruitment of the 2007 year class of 25% of the long-term geometric mean*

Comments:

Norway pout is a short-lived species, and catches are dominated by 1-group fish. Significant amounts of 0-group fish may be caught towards the end of 2007. The only information in autumn 2006 about the number of 1-group in the start of 2007 is the 0-group index from the autumn of the previous year from the Q3 Scottish groundfish survey. The number of 0-group entering the stock in 2007 will have to be assumed, and a suitable candidate for this 25% of the long-term geometric mean. On this basis a preliminary TAC can be calculated such that the stock can be shown to exceed Bpa in 2008.

The in-year update cycle again refers to the rebuilding of the spawning stock in the beginning of 2008 to above Bpa and using the then-available information from the spring surveys and from the 2006 catches and from the assumed recruitment for the 2007 0-group. The most recent survey information refers to the IBTS quarter 3 indices from 2006 and the IBTS quarter 1 indices from 2007. The 1-group index from the IBTS quarter 1 survey is particularly important for the revised forecast. The reason for using the conservative assumption of 25% of the long-term mean is that the recruitment seems to have changed to a lower level in recent years.

Evaluation of the suggested HCR

EU and Norway have requested ICES to advise on harvest rules for Norway pout, primarily as a two-stage rule with an initial precautionary TAC and a mid-year revision. ICES has not been able to evaluate the suggested HCR for its performance in relation to the precautionary approach, due to lack of available experts.

ICES suggests that evaluation of the proposed HCR should occur in a separate process. Within the two-stage harvest rule there are a multitude of designs that should be explored, in order to find the best possible rule with respect to low risk, high yield and practical implementation. Hence, the evaluation should cover:

A range of annual decision cycles

Evaluation of feasible sources of information, including the use of survey data directly without full annual analytic assessments.

Evaluation of the uncertainty in the information underlying the decision at each stage in the annual cycle

Variability in recruitment, growth maturation and possibly in natural mortality

The trade-off between high long term yield and stable conditions for the industry.

The likely tool for simulations will be the SMS software, developed by DIFRES. Other existing software will require substantial work to adapt to the needs for Norway pout, where a quarterly time scale is mandatory. The delay in the response to the request is mostly caused by the limited capacity by people who have the necessary insight both in the stock and in the software that has to be used.

Scientists from DIFRES and IMR will in February 2007 outline a plan for simulations to be done and how to amend the software. The results will be considered in a short meeting in April 2007 shortly after which time the advice will be released.

b) monitoring systems and assessment methodologies required to implement the advised harvest control rules.

Because there is no final advised harvest control rule, ICES has not been able to address item b) of the request

c) By-catches in Norway pout fisheries

Demersal fisheries in the North Sea are mixed fisheries, with many stocks exploited together in various combinations in different fisheries. Small-mesh industrial fisheries for Norway pout and blue whiting take place in the northern and northeastern North Sea and have by-catches of haddock, whiting, herring and saithe. Some cod is also taken as a by-catch, predominantly at ages 0 and 1.

Existing by-catch regulations:

In the agreed EU Council and EU-Norway agreement, by-catch regulations in the small meshed fishery (16-31mm in mesh size) have been established (e.g. EU Regulation No 850/98, EU 1998). The catch retained on board must consist of:

at least 90% of any mixture of two or more target species, or

at least 60% of any one of the target species, and no more than 5% of any mixture of cod, haddock, saithe, and no more than 15% of any mixture of certain other by-catch species.

The EU TAC regulation prescribes that a maximum by-catch of 40% herring is allowed in the Norway pout fishery.

By-catch levels from landings statistics

Tables 6.3.2.1-6.3.2.2 presented recent (2002-2005) by-catch levels by species in Danish and Norwegian small meshed industrial trawl fishery in the North Sea and Skagerrak targeting Norway pout and Blue whiting. For Norway the landings used for human consumption purposes in the small meshed fishery can only be allocated to industrial fishery for the last two years. Due to low Norway pout landings in recent years the Norwegian by-catch estimates are uncertain.

Factors affecting by-catch levels in commercial fishing trials during 2005

Danish-Norwegian fishing trials were performed in autumn 2005 to explore by-catch- levels in the small meshed industrial trawl fishery in the North Sea targeting Norway pout. The trial fishery was performed by two Norwegian commercial trawlers and a Danish commercial trawler.

The trial fishery was carried out in autumn 2005 within traditional periods and areas for fishery on Norway pout. The Norwegian vessels conducted trials in the area vest of Egersund on the edge of the Norwegian Trench and the Danish vessel conducted trials at Fladen Ground. The Norwegian vessels conducted both day and night fishery while the Danish vessel only fished during daytime. The skipper at the Danish vessel decided the positions and fishing design on some of the hauls and the rest of the hauls were allocated in two selected ICES statistical squares. Because the trial fishery was conducted during a period when the fishery was closed and partly took place in areas normally closed to Norway pout fishing, the results may not be directly comparable to a "normal fishery" situation. Only daytime hauls were used in the interpretation of the results.

The general finding is that the by-catch ratio is high in the Norway pout fishery but the results also indicate that fishermen can minimize the by-catch ratio by targeting in the fishery (temporal-temporal targeting, way of fishing, etc.). The investigations show no general spatio-temporal patterns in the by-catch ratio although there are geographical and diurnal differences in the species composition of the by-catch.

With regard to diurnal differences in the catch rates of Norway pout and by-catches of other species, the few results at present indicate significant catches of Blue whiting during night hauls. The rest of the by-catch species show no diurnal differences

The relation between by-catch and depth could not be determined from the trial fishery.

d) Appropriate technical measures to reduce by-catches

Regulation of temporal-temporal effort allocation (closed seasons and areas):

The above investigations indicate some spatio-temporal differences in catch levels by species. However, these patterns are only based on results from pilot investigations. Knowledge about spatio-temporal patterns in catch rates of target and by-catch species in the fishery are not sufficient to implement management measures on spatio-temporal allocation of fishing effort with the aim to reduce by-catches.

During the 1960s a significant small meshed fishery developed for Norway pout in the northern North Sea. This fishery was characterized by relatively large by-catches, especially of haddock and whiting. In order to reduce by-catches of juvenile roundfish, the "Norway pout box" was introduced where fisheries with small meshed trawls were banned. The "Norway pout box" has been closed for industrial fishery for Norway pout since 1977 onwards (EC Regulation No 3094/86). The box includes roughly the area north of 56° N and west of 1° W. In the Norwegian economic zone, the Patch bank has been closed since 2002. It is not possible to quantify the effects of the Norway pout box on catch rates of target and by-catch species or on the effects on the stocks (EU 1985, 1987a, 1987b; ICES-NPS 1979).

Gear technological by-catch reduction devices:

Investigations of gear specific selective devices and gear modifications to reduce by-catch in the small meshed Norway pout fishery have been performed in a number of studies. Early Scottish and Danish attempts to separate haddock, whiting and herring from Norway pout by using separator panels, square mesh windows, and grids were all relatively unsuccessful. More recent Faeroese experiments with grid devices have been more successful. A 74 % reduction of haddock was estimated (Zachariassen and Hjalti, 1997) and 80% overall reduction of the by-catch (ICES-SGGSS 1998).

Eigaard and Holst (2004) found that trawl gears with a sorting grid with a 24 mm bar distance in combination with a 108 mm (nominal) square mesh window improved the selectivity of the trawl with catch weight reductions of haddock and whiting of 37 and 57% but also with a 7 % loss of Norway pout. The study showed that application of these reduction percents to the historical level of industrial by-catch in the North Sea lowered on average the yearly haddock by-catch from 4.3 to 2.7% of the equivalent spawning stock biomass. For whiting the theoretical reduction was from 4.8 to 2.1%. The purpose of the sorting grid was to remedy the by-catch of juvenile gadoids in the industrial fishery for Norway pout, while the purpose of square mesh window was to retain larger marketable consume fish species otherwise sorted out by the grid.

Kvalsvik et al. (2006) carried out experimental fishing during 1998-1999 on commercial vessels to evaluate grid systems and two different mesh sizes (10mm or 24mm) in the grid section. A grid with a bar space of 22mm and various bar thicknesses was used. They showed that in the 1998 trials, 95% (weight) of the by-catch species was sorted out with a 33% loss of the industrial target species. The loss of Norway pout was around 10%. With the 1999 trials they found that 62% of the by-catch species were sorted out and the loss of target species was 22% with a loss of Norway pout of 6%. The selectivity parameters for haddock showed a sharp size selection in the grid system.

In conclusion, recent experiments with grid devices indicate a substantial reduction in by-catch of saithe, whiting, cod, ling, hake, mackerel, herring, haddock and tusk. The reduction in haddock by-catch was lowered by the presence of many small individuals of the strong 1999 year class. The loss of Norway pout at around 10% or less when using a grid with a 22-24 mm bar distance. There was also a considerable loss of other industrial species: blue whiting, Argentine and horse mackerel. The Danish experiment indicates that it is possible to retain larger valuable consume fish species by using a square mesh panel in combination with a grid. Selectivity parameters have been estimated for haddock, whiting and Norway pout. These can be used for simulation scenarios including estimates of the effect of changing the bar distance in the grid.

A general problem for implementing sorting grids in industrial fisheries is the sheer size of the catches. Durability and strength of the grid devices used under full commercial conditions is very important and needs further attention.

References

Eigaard, O.R. and Holst, R. 2004. The effective selectivity of a composite gear for industrial fishing: a sorting grid in combination with a square mesh window. Fish. Res. Vol. 68 no. 1-3, pp. 99-112. July 2004.

Kvalsvik, K., Huse. I., Misund, O.A. and Gamst, K. 2006. Grid selection in the North Sea industrial trawl fishery for Norway Pout: Efficient size selection reduces bycatch. Fish. Res. Vol. 75, no. 2, pp. 248-263. February 2006.

Zachariassen, K. and Jakupsstovy, S. H. 1997. Experiments with grid sorting in an industrial fishery at the Faroes. Working paper WGFTFB, ICES. Available from the Fisheries Laboratory of the Faroes, Thorshavn, April 1997.

Table 6.3.2.1 Species composition in the Danish and Norwegian small-meshed fisheries in the North Sea of the catches landed for reduction (1000 tonnes). Data provided by WG members. The category "other" is subdivided by species in Table 6.3.2.2.

Year	Sandeel	Sprat	Herring	Norway pout	Blue whiting	Haddock	Whiting	Saithe	Other	Total
1974	525	314	-	736	62	48	130	42		1857
1975	428	641	-	560	42	41	86	38		1836
1976	488	622	12	435	36	48	150	67		1858
1977	786	304	10	390	38	35	106	6		1675
1978	787	378	8	270	100	11	55	3		1612
1979	578	380	15	320	64	16	59	2		1434
1980	729	323	7	471	76	22	46	-		1674
1981	569	209	84	236	62	17	67	1		1245
1982	611	153	153	360	118	19	33	5	24	1476
1983	537	88	155	423	118	13	24	1	42	1401
1984	669	77	35	355	79	10	19	6	48	1298
1985	622	50	63	197	73	6	15	8	66	1100
1986	848	16	40	174	37	3	18	1	33	1170
1987	825	33	47	147	30	4	16	4	73	1179
1988	893	87	179	102	28	4	49	1	45	1388
1989	1039	63	146	162	28	2	36	1	59	1536
1990	591	71	115	140	22	3	50	8	40	1040
1991	843	110	131	155	28	5	38	1	38	1349
1992	854	214	128	252	45	11	27	-	30	1561
1993	578	153	102	174	17	11	20	1	27	1083
1994	769	281	40	172	11	5	10	-	19	1307
1995	911	278	66	181	64	8	27	1	15	1551
1996	761	81	39	122	93	5	5	0	13	1119
1997	1091	99	15	126	46	7	7	3	21	1416
1998	956	131	16	72	72	5	3	3	24	1283
1999	678	166	23	97	89	4	5	2	40	1103
2000	655	191	24	176	98	8	8	6	21	1187
2001	810	156	21	59	76	6	7	3	14	1152
2002	804	142	26	73	107	4	8	8	15	1186
2003	303	175	16	18	139	1	3	8	18	681
2004	324	193	19	12	107	1	2	7	29	692
2005	172	207	23	1	101	0	1	6	13	524
Avg 75-05	694	196	59	207	66	11	32	7	32	1294

Year quarter	Sandeel	Sprat	Herring	Norway pout	Blue whiting	Haddock	Whiting	Saithe	Other	Total
1998 q1	37	7	7	13	11	1	0	0	5	80
1998 q2	754	1	2	8	12	2	1	0	4	784
1998 q3	153	60	4	29	38	2	1	2	9	298
1998 q4	12	63	4	23	12	0	0	0	6	121
1999 q1	14	14	4	8	23	1	1	1	8	74
1999 q2	507	2	4	22	30	1	2	1	8	577
1999 q3	139	129	10	41	18	1	2	0	7	347
1999 q4	17	21	6	25	17	1	1	0	18	106
2000 q1	10	42	1	9	13	1	0	0	5	82
2000 q2	581	2	4	17	32	3	2	0	4	646
2000 q3	63	133	10	30	39	2	3	6	5	291
2000 q4	0	15	8	119	14	2	3	0	8	169
2001 q1	12	40	2	20	15	1	1	0	3	94
2001 q2	462	1	2	10	32	3	1	2	4	517
2001 q3	314	44	4	4	12	1	2	0	5	386
2001 q4	22	72	13	24	16	1	2	0	2	152
2002 q1	11	5	6	8	18	0	0	0	2	50
2002q2	772	0	3	5	19	1	2	0	4	806
2002q3	21	71	8	31	46	1	3	5	4	189
2002q4	0	66	10	28	24	1	2	3	6	141
2003 q1	3	18	1	2	14	0	0	1	5	45
2003 q2	239	1	2	4	42	0	1	1	3	292
2003 q3	57	56	4	5	56	0	1	4	4	188
2003 q4	4	100	9	7	28	0	1	2	6	157
2004 q1	2	1	4	1	19	0	0	1	12	41
2004 q2	273	0	2	1	33	0	1	1	5	315
2004 q3	50	55	5	4	37	0	0	2	7	160
2004 q4	0	136	9	6	18	0	0	2	5	177

Table 6.3.2.2 Sum of Danish and Norwegian North Sea bycatch (tonnes) landed for industrial reduction in the small-meshed fisheries by year and species (excluding saithe, haddock, and whiting accounted for in Table 6.3.2.1).

Species	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Gadus morhu	544	710	1092	1404	2988	2948	570	1044	1052	876
Scomber scor	4	534	2663	6414	8013	5212	7466	4631	4386	3576
Trachurus tra	22789	16658	7391	18104	22723	14918	5704	6651	6169	4886
Trigla sp.	0	888'[2]'	45342'[2]'	5394'[2]'	9391'[2]'	2598'[2]'	5622'[2]'	4209	1593	1139
Limanda lima	187	3209	4632	3781	7743	4706	5578	3986	4871	528
Argentina spp	8714	5210	3033	1918	778	2801	3434	2024	2874	2209
Hippoglossoid	59	718	1173	946	2160	1673	1024	1694	1428	529
Pleuronectes	34	119	109	372	582	566	1305	218	128	143
Merluccius m	349	165	261	242	290	429	28	359	109	10
Trisopterus m	0	68'[3]'	0	5'[2]'	48'[2]'	121'[2]'	79'[2]'	111	36	0
Molva molva[3]	51	1	40	39	37	13	65	10	28	0
Glyptocephalu	236'[3]'	132	341	44	255'[3]'	251'[3]'	1439'[3]'	195'[3]'	246	40
Gadiculus arg	1210	729	3043	2494	741	476	801	0	0	0
Others	31715'[1]'	3853	3604	3670	3528	3154	4444	4553	4106	5141
Total	65892	32994	72724	44827	59277	39866	37559	29685	27026	19077

Species	1995	1996	1997	1998	1999	2000	2001	2002'[2]'	2003	2004
Gadus morhu	955	366	1688	1281	532	383	192	29	49	44
Scomber scor	2331	2019	3153	1934	2728	2443	1749	1260	2549	6515
Trachurus tra	2746	2369	3332	2576	5116	5312	1159	2338	5791	10272
Trigla sp.	2091	897	2618	1015	2566	1343	2293	1071	847	1101
Limanda lima	1028	1065	2662	6620	4317	441	1441	321	596	386
Argentina spp	292	3101	2604	5205	3580	333	397		1376	786
Hippoglossoid	617	339	1411	2229	1272	493	431	112	208	174
Pleuronectes	33	90	73	91	88	64	56	51	28	1
Merluccius m	0	3625	2364	33	211	231	167	6	301	423
Trisopterus m	9	30	181	261	922	518	0	196	5	91
Molva molva[3]	0	0	31	31	125	19	49	0	42	169
Glyptocephalu	0	97	394	860	437	154	246	58	437	286
Gadiculus arg	0	7	248	248	387	532	942	459	993	1550
Others	5158	50	749	5405	17931	8927	301	2226	4888	6953
Total	15260	14055	21508	27787	40211	21192	12523	8127	20115	28750

Species	2005
Gadus morhu	22
Scomber scor	2195
Trachurus tra	5226
Trigla sp.	597
Limanda lima	287
Argentina spp	1348
Hippoglossoid	61
Pleuronectes	38
Merluccius m	254
Trisopterus m	0
Molva molva[3]	34
Glyptocephalu	87
Gadiculus arg	909
Others	1964
Total	13022

[1]DK cod and mackerel included. [2]Only DK catches. [3]N catches. DK catches in "Others". [4]Until 1995 N catches only. DK catches in "Others".

6 Stock Summaries (North Sea)

6.4.1 Cod in the Kattegat

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	Uncertain	Uncertain	Uncertain	The stock is depleted with low SSB and low recruitment in recent years. The stock size is not precisely known, but is indicated to be below $\mathbf{B}_{\text{lim}}$. The present level of fishing mortality is uncertain but there are indications that it remains high.

All available data indicate the SSB to be in the range of the historically lowest stock estimates and below the value currently set for $\mathbf{B}_{\text{lim}}$, though the exact estimate for SSB is uncertain due to unreliable catch data. Recruitment has been low in recent years.

The fishing mortality has generally exceeded 1.0 since the early 1980s. The present estimate of fishing mortality is considered uncertain due to unreliable catch data; however, there are indications from survey analyses that it remains high.

Management objectives

The European Commission has enacted a Council Regulation (EC) No 423/2004 which establishes measures for the recovery of cod stocks:

Article 3. Purpose of the recovery plan: The recovery plan (…) shall aim to increase the quantities of mature fish to values equal to or greater than 10 500 t (Cod in the Kattegat)

Article 4. Reaching of target levels: Where the Commission finds, on the basis of advice (…), that for two consecutive years the target level for any cod stock concerned has been reached, the Council shall decide by (…) to remove that stock from the scope of this Regulation (…).

Article 5. Setting of TACs: A TAC shall be set in accordance with Article 6 where the quantities of mature cod have been estimated by the STECF, in the light of the most recent report of ICES, to be equal to or above the minimum level of 6 400 t (Cod in the Kattegat)

Article 6. Procedure for setting TACs: (1) Each year, the Council shall decide (…) on a TAC for the following year for each of the depleted cod stocks. (2) The TACs shall not exceed a level of catches which a scientific evaluation (…) has indicated will result in an increase of 30 % in the quantities of mature fish in the sea at the end of the year of their application, compared to the quantities estimated to have been in the sea at the start of that year. (3) The Council shall not adopt a TAC whose capture is predicted (…) to generate in its year of application a fishing mortality rate greater than 0.60 (Cod in the Kattegat). (4) (…). (5) Except for the first year of application of this Article: (a) where the rules provided for in paragraphs 2 or 4 would lead to a TAC which exceeds the TAC of the preceding year by more than 15 %, the Council shall adopt a TAC which shall not be more than 15 % greater than the TAC of that year; or (b) where the rules provided for in paragraphs 2 or 4 would lead to a TAC which is more than 15 % less than the TAC of the preceding year, the Council shall adopt a TAC which is not more than 15 % less than the TAC of that year.

Article 7. Setting TACs in exceptional circumstances. Where the quantities of mature fish of any of the cod stocks concerned have been estimated by the STECF, in the light of the most recent report of the ICES, to be less than the quantities set out in Article 5, the following rules shall apply: (a) Article 6 shall apply where its application is expected to result in an increase in the quantities of mature fish at the end of the year of application of the TAC to a quantity equal to or greater than the quantity indicated in Article 5; (b) where the application of Article 6 is not expected to result in an increase in the quantities of mature fish at the end of the year of application of the TAC to *a quantity equal to or greater than the quantity indicated in Article 5, the Council shall decide (...) on a TAC for the following year that is lower than the TAC resulting from the application of the method described in Article 6.*

Article 8. Fishing effort limitations and associated conditions: (1) The TACs referred to in Chapter III shall be complemented by a system of fishing effort limitation based on the geographical areas and groupings of fishing gear, and the associated conditions for the use of these fishing opportunities specified in Annex V to Council Regulation (EC) No 2287/ 2003 of 19 December 2003 fixing for 2004 the fishing opportunities and associated conditions for certain fish stocks and groups of fish stocks, applicable in Community waters and, for Community vessels, in waters where catch limitations are required. (2) Each year, the Council shall decide by a qualified majority, on the basis of a proposal from the Commission, on adjustments to the number of fishing days for vessels deploying gear of mesh size equal to or greater than 100 mm in direct proportion to the annual adjustments in fishing mortality that are estimated by ICES and STECF as being consistent with the application of the TACs established according to the method described in Article 6.

This plan has not yet been evaluated by ICES. The management plan requires annual predictions of spawning stock size, which is not available given the recent poor catch data. In that situation a management plan that does not require such precision should be considered.

Reference points

	ICES considers that:	**ICES proposed that:**
Precautionary Approach reference points	$\mathbf{B}_{lim}$ is 6400 t.	$\mathbf{B}_{pa}$ be set at 10 500 t.
	$\mathbf{F}_{lim}$ is 1.0.	$\mathbf{F}_{pa}$ be set at 0.6.

Technical basis:

$\mathbf{B}_{lim}$: lowest observed SSB.	$\mathbf{B}_{pa}$: $\mathbf{B}_{lim}$*exp(1.645*0.3).
$\mathbf{F}_{lim}$: The spawning stock has declined steadily since the early 1970s at fishing mortality rates averaging F = 1.0. $\mathbf{F}_{lim}$ is tentatively set equal to F = 1.0.	$\mathbf{F}_{pa}$: $\mathbf{F}_{lim}$*exp(-1.645*0.3).

Single stock exploitation boundaries

Exploitation boundaries in relation to existing management plans

The management plan requires annual predictions of spawning stock size which are not available given the recent poor catch data. However, even with no fishing in 2007, the SSB in 2008 is expected to remain below 6400 t ($\mathbf{B}_{lim}$).

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

ICES has not considered these aspects for this stock.

Exploitation boundaries in relation to precautionary limits

Taking into account the current perception of the stock abundance, fishing at any level will involve a risk of further depletion of the stock. There should therefore be no fishing on this stock in 2007.

Conclusion on exploitation boundaries

Implementation of the management plan requires a reliable assessment which is not available because of the poor quality of the catch data. Therefore, ICES concludes that the exploitation boundaries for this stock should be based on the precautionary limits. Accordingly, there should be no fishing on this stock in 2007.

Short-term implications

Outlook for 2008

Even with no fishing in 2007, the stock is expected to remain below $\mathbf{B}_{lim}$.

Management considerations

The effect of the present management measures are difficult to evaluate due to uncertainties in the catch information. There is evidence of misreporting of catches (non-reporting and misreporting by fishing area) as well as significant discarding of marketable cod. The decline in the catch data quality is related to the restrictive TAC presently in place. Discarding is claimed to have increased to achieve compliance with the quota regulations (incl. highgrading), but the available information shows a decline in the most recent years. The new effort control system to be introduced in 2007 is aimed at reducing mis- and underreporting as well as discarding.

Management plan evaluations

The recovery plan agreed upon in 2004 has not yet been evaluated by ICES. However, the plan requires annual predictions of spawning stock size, which is not available given the recent poor catch data. In that situation, a management plan that does not require such precision should be considered.

Ecosystem considerations

The SSB of cod in Kattegat has declined steadily from around 35 000 tonnes in the 1970s, to around 5000–6000 tonnes in the 1990s. This decline seems associated with the disappearance of separate spawning aggregations/subpopulations in Kattegat. The disappearance of spawning components or subpopulations is of concern for the reproductive capacity of this stock and the ability of the stock to rebuild.

Factors affecting the fisheries and the stock

Regulations and their effects

The TAC is implemented by period rations for individual vessels. Ration sizes have been very low in recent years, whi leading to increased discarding of marketable cod and increasing the incentive for misreporting.

The recovery plan, agreed upon in 2004, implied increased fishery control focusing on the cod landings, for example by introducing strict rules for carrying and landing cod in Kattegat. It is expected that the increased control effort has improved reporting in the most recent year, but the effect is difficult to evaluate.

Changes in fishing technology and fishing patterns

An effort ceiling system supplementing the TAC regulation was introduced for the demersal fisheries in Kattegat in 2004.

Since 2004, the use of trawl with codend mesh sizes below 90 mm in the *Nephrops* fisheries has only been permitted if the trawl is equipped with a separator grid. This has resulted in a substantial decline of effort in this gear category.

The environment

Recent analysis of the possible effect of environment and climate change on this stock has shown that fishing mortality has been the major driver on the long-term dynamics of the stock.

Information from the fishing industry

The fishing industry noted that the official landing figures do not adequately reflect the actual catch as considerable discarding (high grading) as well as mis- and non-reporting of cod catches has taken place in the most recent years.

Scientific basis

Data and methods

Due to the uncertainties in the official landing data in most recent years, the assessment (Figure 6.4.1.2) is not reliable in most recent years. A survey-based analysis highlights the long-term trend and indicates that the fishing mortality in the recent years remains high (Figure 6.4.1.1).

Preliminary estimates on discard rates have been compiled by Denmark and Sweden and these data indicate high numbers of discards, especially for younger age-groups. Discarding seems to have been at a lower level since 2002.

Uncertainties in assessment and forecast

The impact on the assessment of misreporting and discarding of cod was investigated through sensitivity analysis. Uncertainties in catch figures propagate into mortalities and SSB estimates. The mortality and SSB estimates are only indicative of historical trends (Figure 6.4.1.2).

Comparison with previous assessment and advice

The overall perception of the state of the stock is unchanged compared to last year, the available information indicates that the SSB is below $\mathbf{B}_{\mathrm{lim}}$. Therefore, the advice is similar to last year. ICES concluded in 2005 that ”Even with no fishing in 2006 it is likely that the stock will remain below $\mathbf{B}_{\mathrm{lim}}$.” A similar conclusion is reached for the effect of fishing in 2007 and SSB in 2008.

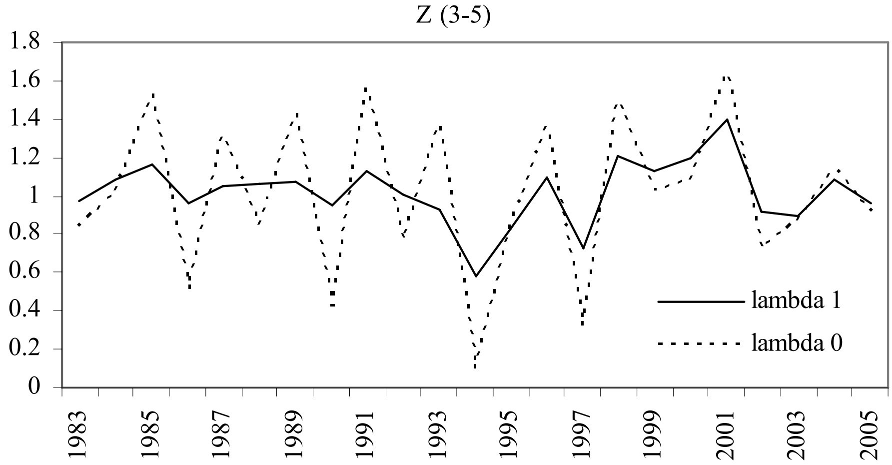
Because of the uncertainties of the catch information, the assessment cannot be used as basis for a catch forecast and it is no longer possible to estimate the fishing mortality with sufficient precision to classify the state of the stock in relation to precautionary limits.

Source of information

Report of the Baltic Fisheries Assessment Working Group. Rostock, 18–27 April 2006 (ICES CM 2006/ACFM:24).

Year	ICES Advice	Single-stock exploitation boundaries	Predicted catch corresp. to advice	Predicted catch corresp. to single-stock exploitation boundaries	Agreed TAC	ACFM Catch
1987	Reduction in F		< 13.0		15.5	11.5
1988	Reduction in F		< 15.0		15.0	5.5
1989	TAC		10.0		12.5	8.6
1990	TAC		7.0		8.5	5.9
1991	TAC		6.3		6.65	6.8
1992	30% reduction in fishing effort		-		6.65	6.3
1993	Limit fishing effort to 70% of 1991 effort		-		6.8	7.2
1994	Reduction in catch from 1991–1992		< 6.3–6.8		6.7	7.8
1995	Precautionary TAC based on recent catches		6–7		6.7	8.2
1996	30% Reduction in fishing effort from 1994 level		-		7.7	6.1
1997	Fishing effort should not exceed 70% of the 1994 level		-		8.5	9.5
1998	Fishing effort should not exceed 70% of the 1994 level		-		7.5	6.8
1999	F = 0.6		4.5		6.3	6.6
2000	At least 40% reduction in F		6.4		7.0	4.9
2001	$F = \mathbf{F}_{pa} = 0.6$		4.7		6.2	3.9
2002	No fishery		0		2.8	2.3
2003	No fishery		0		2.3	2.0
2004	No fishery		0		1.363	1.4
2005	No fishery	No fishery	0	0	1.0	1.1
2006	No fishery	No fishery	0	0	0.85	
2007	No fishery	No fishery	0	0		

Weights in ‘000 t.



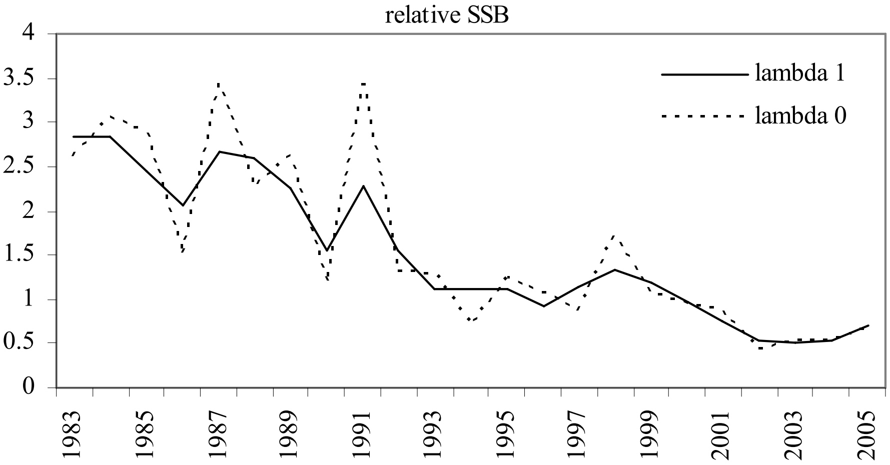


Figure 6.4.1.1 Estimates of fishing mortality (Z for ages 3–5) and relative SSB from an analysis based solely on surveys. Lambda refers to a smoothing parameter (1 = smoothing; 0 = no smoothing).

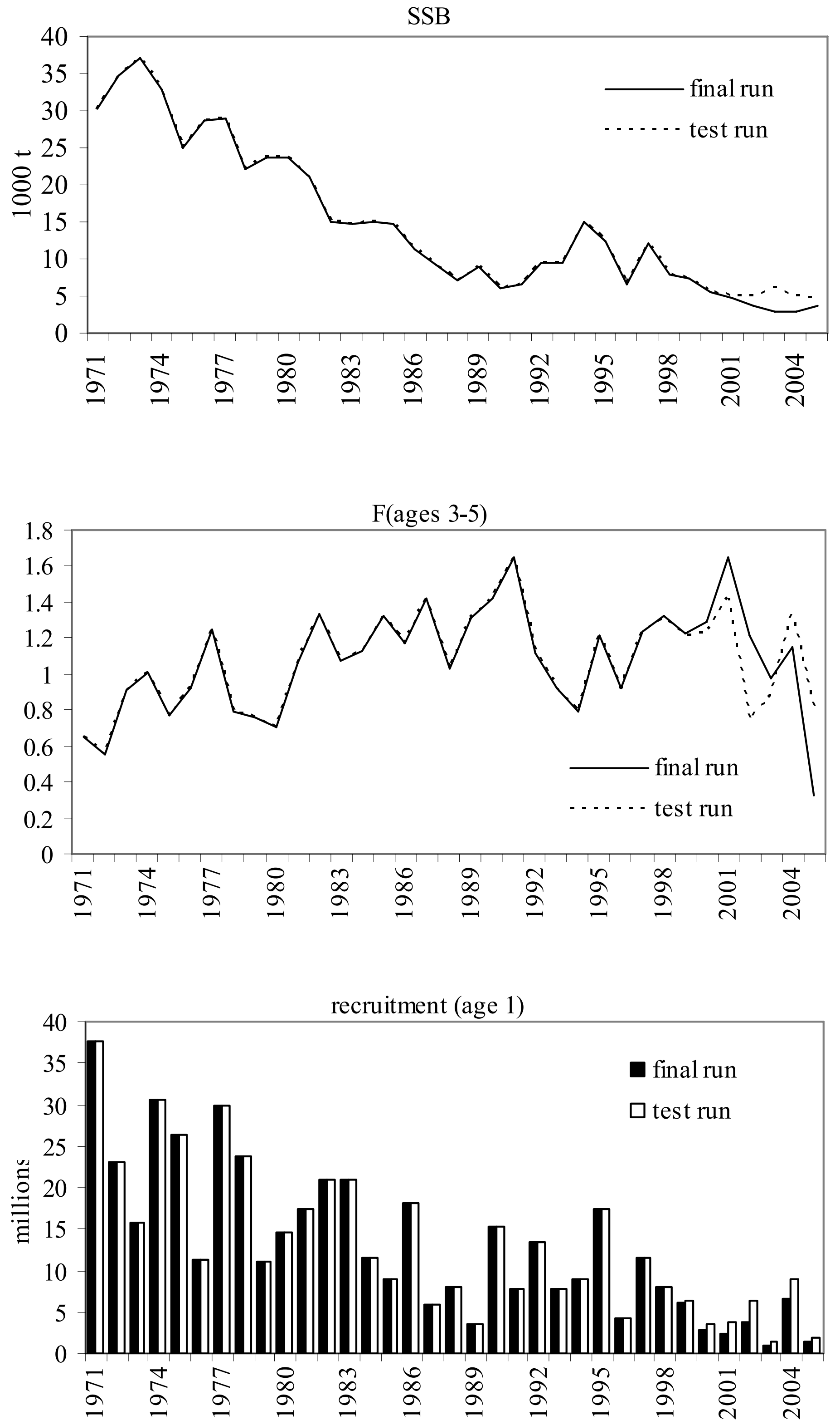


Figure 6.4.1.2 Comparison of stock dynamics resulting from assessments assuming that catches are accurate (final run) and assuming 2000 t of unreported catches in 2003–2005 (test run).

Table 6.4.1.1 Cod in Kattegat. Landings (in tonnes) 1971-2005.

Year	Kattegat			Total
	Denmark	Sweden	Germany[2]	
1971	11,748	3,962	22	15,732
1972	13,451	3,957	34	17,442
1973	14,913	3,850	74	18,837
1974	17,043	4,717	120	21,880
1975	11,749	3,642	94	15,485
1976	12,986	3,242	47	16,275
1977	16,668	3,400	51	20,119
1978	10,293	2,893	204	13,390
1979	11,045	3,763	22	14,830
1980	9,265	4,206	38	13,509
1981	10,693	4,380	284	15,337
1982	9,320	3,087	58	12,465
1983	9,149	3,625	54	12,828
1984	7,590	4,091	205	11,886
1985	9,052	3,640	14	12,706
1986	6,930	2,054	112	9,096
1987	9,396	2,006	89	11,491
1988	4,054	1,359	114	5,527
1989	7,056	1,483	51	8,590
1990	4,715	1,186	35	5,936
1991	4,664	2,006	104	6,834
1992	3,406	2,771	94	6,271
1993	4,464	2,549	157	7,170
1994	3,968	2,836	98	7,802 [3]
1995	3,789	2,704	71	8,164 [4]
1996	4,028	2,334	64	6,126 [5]
1997	6,099	3,303	58	9,460 [6]
1998	4,207	2,509	38	6,835
1999	4,029	2,540	39	6,608
2000	3,285	1,568	45	4,897
2001	2,752	1,191	16	3,960
2002	1,726	744 [1]	3	2,470
2003	1,441	603 [8]	1	2,045
2004	827	575	1	1,403
2005	608	336	10	1,070 [7]

[1] The Swedish landings for 2002 were revised at the very end of the WG-meeting and the assessment results are calculated using an initial value of 610 tonnes.

[2] Landings statistics incompletely split on the Kattegat and Skagerrak.

[3] Including 900 t reported in Skagerrak.

[4] Including 1.600 t misreported by area.

[5] Excluding 300 t taken in Sub-divisions 22–24.

[6] Including 1.700t reported in Sub-division 23.

[7] Including 116 t reported as pollack

[8] the catch reported to the EU exceeds the catch reported to the WG by 40%

6.4.2 Cod in Subarea IV (North Sea), Division VIId (Eastern Channel), and Division IIIa (Skagerrak)

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 management target	Comment
Reduced reproductive capacity	Harvested unsustainably	Overexploited	Above target	

ICES classifies the stock as being harvested unsustainably and suffering reduced reproductive capacity. SSB is well below the $\mathbf{B}_{\mathrm{lim}}$ of 70 000 t. Fishing mortality has shown a decline since 2000 and is currently estimated to be around $\mathbf{F}_{\mathrm{lim}}$. The 2001–2004 year classes are all estimated to have been well below average; the 2005 year class is estimated from surveys to be more abundant, but still below average.

Management objectives

In 2005 the EU and Norway have renewed their initial agreement from 1999 and *"agreed to implement a long-term management plan for the cod stock, which is consistent with the precautionary approach and is intended to provide for sustainable fisheries and high yield.*

Once the stock of cod has been measured for the current year and for the previous year as no longer being at risk of reduced reproductive capacity, the plan will come into operation on 1 January of the subsequent year.

The plan shall consist of the following elements:
1. *Every effort shall be made to maintain a minimum level of Spawning Stock Biomass (SSB) greater than 70,000 tonnes (B_{lim}).*
2. *Where the SSB is estimated to be above 150,000 tonnes the parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate that maximises long term yield. The parties agreed to use F=0.4 on appropriate age groups.*
3. *Where the rule in paragraph 2 would lead to a TAC which deviates by more than 15% from the TAC for the preceding year, the Parties shall fix a TAC that is neither more than 15% greater nor 15% less than the TAC of the preceding year.*
4. *Should the SSB of cod fall below 150 000t (B_{pa}) the Parties shall decide on a TAC that is lower than that corresponding to the application of the rules in paragraphs 2 and 3.*
5. *The Parties may where considered appropriate reduce the TAC by more than 15% compared to the TAC of the preceding year.*
6. *This plan shall be subject to triennial review, the first of which will take place before 1 January 2009, including appropriate adaptations to the target mortality rate specified in paragraph 2.*

The main changes between this and the plan of 1999 is the reduction of a target F to 0.4, and a limitation of the change of the TAC between years of 15%. ICES has not evaluated the consistency of the new management plan with the precautionary approach.

The recovery plan adopted by the EU Council in 2004, is still to be fully implemented. Details of it are given in Council Regulation (EC) 423/2004:

Article . This Regulation establishes a recovery plan for the following cod stocks (hereinafter referred to as "depleted cod stocks"):

(a) cod in the Kattegat;
(b) cod in the North Sea, in the Skagerrak and the eastern Channel;
(c) cod to the west of Scotland;
(d) cod in the Irish Sea.

Article 2.Definitions of geographical areas
For the purposes of this Regulation, the following definitions of geographical areas shall apply:
(a) "Kattegat" means that part of division III a, as delineated by ICES, that is bounded on the north by a line drawn from the Skagen lighthouse to the Tistlarna lighthouse, and from this point to the nearest point on the

Swedish coast, and on the south by a line drawn from Hasenore to Gnibens Spids, from Korshage to Spodsbjerg and from Gilbjerg Hoved to Kullen;
(b) "North Sea" means ICES subarea IV and that part of ICES division III a not covered by the Skagerrak and that part of ICES division II a which lies within waters under the sovereignty or jurisdiction of Member States;
(c) "Skagerrak" means that part of ICES division III a bounded on the west by a line drawn from the Hanstholm lighthouse to the Lindesnes lighthouse and on the south by a line drawn from the Skagen lighthouse to the Tistlarna lighthouse and from that point to the nearest point on the Swedish coast;
(d) "eastern Channel" means ICES division VII d;
(e) "Irish Sea" means ICES division VII a;
(f) "west of Scotland" means ICES division VI a and that part of ICES division V b which lies within waters under the sovereignty or jurisdiction of Member States.

Article 3. Purpose of the recovery plan: The recovery plan (...) shall aim to increase the quantities of mature fish to values equal to or greater than 150 000 t (Cod in the North Sea, Skagerrak and eastern Channel)

Article 4: Reaching of target levels. Where the Commission finds, on the basis of advice (...), that for two consecutive years the target level for any cod stock concerned has been reached, the Council shall decide by (...) to remove that stock from the scope of this Regulation (...)

Article 5: Setting of TACs. A TAC shall be set in accordance with Article 6 where the quantities of mature cod have been estimated by the STECF, in the light of the most recent report of ICES, to be equal to or above the minimum level of 70 000 t (Cod in the North Sea, Skagerrak and eastern Channel).

Article 6: Procedure for setting TACs. (1.) Each year, the Council shall decide (...) on a TAC for the following year for each of the depleted cod stocks. (2.) The TACs shall not exceed a level of catches which a scientific evaluation (...) has indicated will result in an increase of 30 % in the quantities of mature fish in the sea at the end of the year of their application, compared to the quantities estimated to have been in the sea at the start of that year. (3.) The Council shall not adopt a TAC whose capture is predicted (...) to generate in its year of application a fishing mortality rate greater than 0.65 (Cod in the North Sea, Skagerrak and eastern Channel). (4.) (...) (5.) Except for the first year of application of this Article: (a) where the rules provided for in paragraphs 2 or 4 would lead to a TAC which exceeds the TAC of the preceding year by more than 15 %, the Council shall adopt a TAC which shall not be more than 15 % greater than the TAC of that year; or (b) where the rules provided for in paragraphs 2 or 4 would lead to a TAC which is more than 15 % less than the TAC of the preceding year, the Council shall adopt a TAC which is not more than 15 % less than the TAC of that year.

Article 7: Setting TACs in exceptional circumstances. Where the quantities of mature fish of any of the cod stocks concerned have been estimated by the STECF, in the light of the most recent report of the ICES, to be less than the quantities set out in Article 5, the following rules shall apply: (a) Article 6 shall apply where its application is expected to result in an increase in the quantities of mature fish at the end of the year of application of the TAC to a quantity equal to or greater than the quantity indicated in Article 5; (b) where the application of Article 6 is not expected to result in an increase in the quantities of mature fish at the end of the year of application of the TAC to a quantity equal to or greater than the quantity indicated in Article 5, the Council shall decide (...) on a TAC for the following year that is lower than the TAC resulting from the application of the method described in Article 6.

Article 8. Fishing effort limitations and associated conditions. (1.) The TACs referred to in Chapter III shall be complemented by a system of fishing effort limitation based on the geographical areas and groupings of fishing gear, and the associated conditions for the use of these fishing opportunities specified in Annex V to Council Regulation (EC) No 2287/2003 of 19 December 2003 fixing for 2004 the fishing opportunities and associated conditions for certain fish stocks and groups of fish stocks, applicable in Community waters and, for Community vessels, in waters where catch limitations are required. (2.) Each year, the Council shall decide by a qualified majority, on the basis of a proposal from the Commission, on adjustments to the number of fishing days for vessels deploying gear of mesh size equal to or greater than 100 mm in direct proportion to the annual adjustments in fishing mortality that are estimated by ICES and STECF as being consistent with the application of the TACs established according to the method described in Article 6.

ICES has previously concluded that a precautionary recovery plan must include an adaptive element, implying that fisheries for cod remain closed until an initial recovery of the cod SSB has been proven. Such an element is not included in the existing plan. ICES therefore considers the recovery plan as not consistent with the precautionary approach.

Reference points

	ICES considers that:	ICES proposed that:
Limit reference points	$\mathbf{B}_{lim}$ is 70 000 t.	$\mathbf{B}_{pa}$ be set at 150 000 t.
	$\mathbf{F}_{lim}$ is 0.86.	$\mathbf{F}_{pa}$ be set at 0.65.
Target reference points		Not defined.

Yield and spawning biomass per Recruit (from ACFM 2004).
F-reference points

	Fish Mort Ages 2–4	Yield/R	SSB/R
Average last 3 years (2003–2005)	0.92		
$\mathbf{F}_{max}$	0.201	0.628	2.767
$\mathbf{F}_{0.1}$	0.132	0.595	4.095
$\mathbf{F}_{med}$	0.791	0.355	0.292

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 $\mathbf{F}_{0.1}$–$\mathbf{F}_{max}$.

Technical basis

$\mathbf{B}_{lim} = \mathbf{B}_{loss}$ **(~1995)** = 70 000 t.	$\mathbf{B}_{pa}$ = Previous MBAL and signs of impaired recruitment below 150 000 t.
$\mathbf{F}_{lim} = \mathbf{F}_{loss}$ = 0.86.	$\mathbf{F}_{pa}$ = Approx. 5th percentile of $\mathbf{F}_{loss}$ and implies an equilibrium biomass > $\mathbf{B}_{pa}$.

Single-stock exploitation boundaries

Exploitation boundaries in relation to existing management plans

$\mathbf{B}_{lim}$ cannot be reached with a 30% increase in SSB. The management plan stipulates that in such cases a TAC should be set allowing $\mathbf{B}_{lim}$ to be reached within one year. Simulations indicate that this could be achieved with 50% probability if F were reduced to 30% of the current F, corresponding to total removals (landings, discards, and unaccounted removals) in 2007 of 35 000 t. ICES is unable to translate this figure into a TAC with the required precision.

Exploitation boundaries in relation to precautionary limits

Given the low stock size and recent poor recruitment, the stock cannot be rebuilt to $\mathbf{B}_{pa}$ in 2008 even with a zero catch. Simulations indicate that with the recent poor recruitment, a zero catch would be required in 2007 and 2008 to achieve the rebuilding of the stock to $\mathbf{B}_{pa}$ by 2009.

Conclusions regarding exploitation boundaries

Because the existing recovery plan does not include the elements or measures necessary for rebuilding the stock at the current SSB (well below $\mathbf{B}_{lim}$), ICES continues to advise on exploitation boundaries in relation to precautionary limits and recommends that the fisheries for cod be closed until an initial recovery of the cod SSB has been proven. Any catches that are taken in 2007 will prolong the recovery to $\mathbf{B}_{pa}$.

Short-term implications

Outlook for 2007

With zero catch in 2007 in all fisheries, SSB in 2008 could rise above $\mathbf{B}_{\lim}$, but would still be well below $\mathbf{B}_{pa}$.
Median values only are presented in the catch option table.
Basis: $\mathbf{F}_{sq} = \mathbf{F}_{03\text{-}05}$ scaled to $\mathbf{F}_{05} = 0.86$; $\mathbf{F}_{06} = 0.85\ \mathbf{F}_{sq}$; R06 = 1999 YC, R07–08 = re-sampled from 1997–2004 YC, SSB(2007) =35.7; Removals (2006) = 53.7.

Rationale	Total Removals (2007)	Basis	F total (2007)	SSB (2008)	%SSB change 1)
Zero catch	0.0	F=0	0.0	92.3	+159%
Plan	35.0	$\mathbf{F}_{sq}$ * 0.334	0.29	70.0	+96%
Status quo	40.9	$\mathbf{F}_{sq}$ * 0.4	0.34	66.2	+85%
	46.7	$\mathbf{F}_{sq}$ * 0.468 (Plan)	0.40	62.5	+75%
	49.3	$\mathbf{F}_{sq}$ *0.5	0.43	60.9	+71%
	60.2	$\mathbf{F}_{sq}$ *0.638	0.55	54.5	+53%
	63.0	$\mathbf{F}_{sq}$ *0.680	0.58	52.6	+47%
	66.1	$\mathbf{F}_{sq}$ *0.723	0.62	50.8	+42%
	68.9	$\mathbf{F}_{sq}$ *0.765	0.65	49.1	+38%
	74.5	$\mathbf{F}_{sq}$ *0.85	0.73	45.9	+29%

Weights in ‘000 t.

Total removals in 2003–2005 have been estimated to consist of 50% official landings, 10% discards, and 40% unaccounted removals. These proportions cannot be predicted for the future.

Management considerations

Although the current SSB and fishing mortality are uncertain, it is clear that the stock has been reduced to a level at which productivity is impaired and the biological dynamics of the stock are difficult to predict. The assessment indicates that the stock is well below $\mathbf{B}_{\lim}$ and at or near its lowest observed level.

In the past years, emergency measures have been taken and a recovery plan has been implemented with the aim of reversing the declining trend in SSB and increasing the spawning stock above $\mathbf{B}_{\lim}$. Even if these measures may have contributed to some reduction in fishing mortality, they have not lead to a demonstrable increase in the spawning stock biomass.

The officially reported landings in 2005 were 28 700 t and the estimated discards from these landings in 2005 were 6300 t, giving a total of 35 000 t. Surveys indicate that the year classes are depleting faster than one would expect from these estimated catches and point to unaccounted removals in the order of 25–50% of the reported catch. There is no documented information on the source of these unaccounted removals, but it is assumed that these removals originate in fishing activities. Plausible contributions to these unaccounted removals are discards of catches in excess of the quota, and mis- and underreporting of catches. This would indicate that the management system is insufficient to control the catches effectively.

Assessment estimates and reports from some fisheries indicate that historically, quota restrictions have not been effective in controlling the catch of cod. Since 1992, TACs were set by managers to substantially reduce F and discarding, and were accompanied by an increasing number of technical measures and effort limitations (since 2003) imposed on the fisheries targeting cod. However, effort restrictions in the smaller mesh size fisheries, which have significant discards, have been less stringent. Recent reports (2006) from the fishery indicate that the current restrictions are beginning to control the level of bias in landings, but increased levels of discarding are also being recorded. Discarding rates are expected to increase in 2006 with the entry of the 2005 year class to the fishery. The effect of significant unaccounted removals will mitigate the effect expected from the recovery plan. Management of cod fisheries must deal with the combined effects of unreliable catch data and the inability of management to control catch. As long as these two interrelated conditions persist for fisheries which catch North Sea cod, rebuilding cannot be achieved.

During the last five years an average of 85% (83% in 2005) of the international landings in numbers consisted of juvenile cod aged 1-3. Because the fishery is at present so dependent on incoming year classes, fishing mortalities on these year classes is high, and 95% of a year class is taken before it has spawned for the first time. At the same time, the unbalanced age structure of the stock reduces its reproductive capacity even if a sufficient SSB were reached, as first-time spawners reproduce less successfully than older fish. Both factors are believed to have contributed to the reduction in recruitment of cod. Recovery and management plans should take this into consideration.

Cod are taken by towed gears in mixed demersal fisheries, which include haddock, whiting, *Nephrops*, plaice, and sole. They are also taken in directed fisheries using fixed gears. Mixed fishery advice is further elaborated in Section 6.3.

Cod catch in Division VIId is managed by a TAC for Divisions VIIb–k,VIII, IX, X, and CECAF 34.1.1, (i.e. the TAC covers a small proportion of the North Sea cod stock together with cod in Divisions VIIe–k). Cod taken in Division VIId should be included with the North Sea cod TAC.

Factors affecting the fisheries and the stock

See Section 6.3 on mixed fisheries.

The effects of regulations

An emergency measure (Council Regulation (EC) 259/2001) involving the closure of a large area of the North Sea was implemented from 14 February to 30 April 2001 to all fishing vessels using gears likely to catch cod. Analysis of the effectiveness of the emergency measures indicated that the closure had an insignificant effect upon the spawning potential for cod in 2001. The redistribution of the fishery, especially along the edges of the box coupled to the increases in proportional landings from January and February appeared to have been able to negate the potential benefits of the box. The box would have to be extended in both space and time to be more effective (see: ICES 2004). This emergency measure has not been adopted after 2001.

EU technical regulations in force in 2003 and 2004 are contained in Council Regulation (EC) 850/98 and its amendments. The regulation prescribes the minimum target species composition for different mesh size ranges. In 2001, cod in the whole of NEAFC region 2 was a legitimate target species for towed gears with a minimum codend mesh size of 100 mm. As part of the cod recovery measures, the EU and Norway introduced additional technical measures from 1 January 2002 (EC 2056/2001). The basic minimum mesh size for towed gears for cod from 2002 was 120 mm, although in a transitional arrangement until 31 December 2002, vessels were allowed to exploit cod with 110-mm codends provided that the trawl was fitted with a 90-mm square mesh panel and the catch composition of cod retained on-board was not greater than 30% by weight of the total catch. From 1 January 2003, the basic minimum mesh size for towed gears targeting cod was 120 mm. The minimum mesh size for vessels targeting cod in Norwegian waters is also 120 mm.

Effort restrictions in the EC were introduced in 2003 (EC 2341/2002, Annex XVII, amended in EC 671/2003). Effort restriction measures were revised for 2004 (EC 2287/2003, Annex V). Preliminary analysis of fishing effort trends in the major fleets exploiting North Sea cod indicates that fishing effort in those fleets has been decreasing since the mid-1990s due to a combination of decommissioning and days-at-sea regulations. The decrease in effort is most pronounced in the years 2002 and beyond.

A cod protection area has been implemented in 2004 (EC 2287/2003, amended in EC 867/2004) which defined the conditions under which certain stocks, including haddock, could be caught in Community waters (see Figure 6.4.2.7). A maximum of 35% of the haddock TAC in 2004 could be taken from within the cod protection area. For UK a special permit was required to fish for haddock in the cod protection area. Although this management scheme was proposed to permit additional haddock to be caught in 2004, the requests for special permits were relatively few. This cod protection area was only in force in 2004.

In 2004 agreement was reached within the EU on a formal recovery plan that operated during the TAC and management decision processes of 2004, effectively rendering the plan operational in 2005 (EC 423/2004). Details of the recovery plan are presented above.

The minimum landing size for cod in Subarea IV and Divisions IIIa and VIId is 35 cm; in Denmark it is 40 cm.

Despite these measures, the fishing mortality on cod in the North Sea has remained high (0.8–1.0), and no signs of recovery could be noted.

Changes in fishing technology and fishing patterns

The expected benefits from the increase in mesh size to 120 mm are not apparent from the available data. The effect of this increase is confounded by the transfer of effort from the fleets fishing with mesh sizes >120 mm to fleets fishing with mesh sizes between 70 and 99 mm, i.e. fishing for *Nephrops*. The regulation differentiates between the number of fishing days allowed when fishing for *Nephrops* or when fishing for other demersal species (>120 mm). Fishing for

Nephrops with the smaller mesh allowed more days at sea than fishing with larger meshes.

Information presented to ICES indicated that the UK large mesh demersal trawl fleet category (>100 mm, 4A) has, in 2005, been reduced by decommissioning and days-at-sea regulations to 40% of the levels recorded in the EU reference year of 2001. There was a movement into the 70–90 mm sector to increase days at sea in 2002 and 2003, but the level of effort stabilised in 2004.

Scientific basis

Data and methods

The age-based assessment model (B-ADAPT) used landings and discards, calibrated with two survey indices (from IBTS quarter 1 and quarter 3 surveys). Because of the low abundance of cod which leads to high variance in the English and Scottish surveys, the IBTS quarter 3 survey (which incorporates these two UK surveys) was considered to provide less noisy indices and has been used in this year's assessment. For ICES Subarea IV and Divisions VIId, discards were estimated from the Scottish discards sampling program, raised to the total international fleet. Discards in Division IIIa were based on observers' estimates.

Because of unreliable information on landings and effort, commercial indices were not used in the assessment. Instead, the assessment uses only survey data for calibration. Quantities of additional "unallocated removals" were estimated by the model on the basis of the total mortality indicated by the survey. The unallocated removals estimates could potentially include components due to increased natural mortality and discarding as well as unreported landings. It is, however, assumed that these removals do originate in fishing activities. The estimates of the unallocated removals in 2002–2005 range between 35 and 100% in addition to the known catches.

A series of medium-term stochastic projections were used to evaluate management scenarios: a reduction in fishing mortality by 15% in 2006 (as a consequence of the 15% decrease in the 2006 TAC) followed by constant fishing at the 2006 level or a closure in 2007–2010. Tables 6.4.2.3–6 present the results of the stochastic projections.

Information from the fishing industry

The fishers' survey was evaluated. Signals from the survey suggest little change in fishable biomass in the southern and central North Sea, but increasing abundance in the northwestern North Sea. IBTS quarter 1 survey data have similar trends for the majority of the North Sea, but differ in their perception of the spatial extent of the increase in the north-west.

Uncertainties in assessment and forecast

SSB is estimated with a CV of 11% and the fishing mortality with a CV of 18%; however, these CVs do not account for all sources of uncertainty. The modelling approach assumes that all unaccounted removals result from fishing mortality, which cannot be verified. Estimating missing removals leads to additional uncertainty in the assessment. It is not possible to split the estimated missing removals into landings and discards in the future because this depends on the management measures that are implemented.

Comparison with previous assessment and advice

Last year's assessment was considered only indicative of trends in SSB and recruitment. This was partly because the surveys gave different perception of F in recent years due to the low abundance of cod, leading to high variance in the surveys. This year a combined survey was used instead, providing a signal that is less subject to noise due to combined sample numbers.

In addition, part of the uncertainty caused by the bias on the total catch has been removed this year, by incorporating a bootstrapping procedure to reduce the influence of sampling noise on the year-to-year variation in the estimates. Therefore, this year's assessment is considered as a reliable indication of stock size and fishing mortality.

The advice is consistent with previous years.

Sources of information

ICES (2006). Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, 5–14 September 2006 (ICES CM 2006/ACFM:35).

Report of the Subgroup on Resource Status (SGRST) of the Scientific, Technical and Economic Committee for Fisheries (STECF): Evaluation of recovery plans (Brussels, 20–22 March 2002, SEC(2002) 764).

Report of a two-day meeting of scientists from Norway and the Community on the evaluation of Harvest Control Rules for North Sea cod (Brussels, 18–19 March 2002).
ICES (2003). Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak. Copenhagen, 11–20 June 2002. ICES CM 2003/ACFM:02.
ICES (2004). Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak. Copenhagen, 9–18 September 2003. ICES CM 2004/ACFM:07.

Landings for each of the three parts of this combined assessment area and for the combined area are given in Table 6.4.2.1.

North Sea (Subarea IV)

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
1987	SSB recovery; TAC		100–125		175	167	182
1988	70% of F(86); TAC		148		160	142	157
1989	Halt SSB decline; protect juveniles; TAC		124		124	110	116
1990	80% of F (88); TAC		113		105	99	105
1991	70% of effort (89)				100	87	89
1992	70% of effort (89)				100	98	97
1993	70% of effort (89)				101	94	105
1994	Significant effort reduction				102	87	95
1995	Significant effort reduction				120	112	120
1996	80% of F(94) = 0.7		141		130	104	107
1997	80% of F(95) = 0.65		135		115	100	102
1998	F(98) should not exceed F(96)		153		140	114	122
1999	F = 0.60 to rebuild SSB		125		132	80	78
2000	F less than 0.55		<79		81	62	59
2001	lowest possible catch		0		48.6	42.3	41
2002	lowest possible catch		0		49.3	44.2	44.3
2003	Closure		0		27.3	27.4	NA
2004	Zero catch	Zero catch	0	0	27.3	23.4	NA
2005	Zero catch	Zero catch	0	0	27.3	23.9	NA
2006	Zero catch	Zero catch	0	0	23.2		NA
2007	Zero catch	Zero catch	0	0			

Skagerrak (Division IIIa)

Year	ICES Advice	Single-Stock Exploitation Boundaries	Predicted catch corresp. to advice	Predicted catch corresp. Single-Stock Exploitation Boundaries	Agreed TAC[1]	ACFM Landings[1]
1987	F = $\mathbf{F}_{max}$		<21		22.5	20.9
1988	Reduce F				21.5	16.9
1989	F at $\mathbf{F}_{med}$		<23		20.5	19.6
1990	F at $\mathbf{F}_{med}$; TAC; TAC		21.0		21.0	18.6
1991	TAC		15.0		15.0	12.4
1992	70% of F(90)				15.0	14.8
1993	Precautionary TAC				15.0	15.3
1994	No long-term gain in increased F + precautionary TAC				15.5	13.9
1995	If required precautionary TAC; link to North Sea				20.0	12.1
1996	If required precautionary TAC; link to North Sea				23.0	16.4
1997	If required precautionary TAC; link to North Sea				16.1	14.9
1998	If required precautionary TAC; link to North Sea		21.9		20.0	15.3
1999	F = 0.60 to rebuild SSB		17.9		19.0	11.0
2000	F less than 0.55		<11.3		11.6	9.3
2001	lowest possible catch		0		7.0	7.1
2002	lowest possible catch		0		7.1	7.5
2003	Closure		0		3.9	NA
2004	Zero catch	Zero catch	0	0	3.9	NA
2005	Zero catch	Zero catch	0	0	3.9	NA
2006	Zero catch	Zero catch	0	0	3.3	NA
2007	Zero catch	Zero catch	0	0		

[1] Norwegian fjords not included. Weight in '000 t.

Eastern Channel (Division VIId)

Year	ICES Advice	Single-Stock Exploitation Boundaries	Predicted catch corresp. to advice	Predicted catch corresp. to Single-Stock Exploitation Boundaries	Agreed TAC[1]	Official landings	ACFM landings
1987	Not assessed		-		-	9.4	14.2
1988	Precautionary TAC		-		-	10.1	10.7
1989	No increase in F; TAC		10.0[2]		-	n/a	5.5
1990	No increase in F; TAC		9.0[2]		-	n/a	2.8
1991	Precautionary TAC		3.0[2]		-	n/a	1.9
1992	If required, precautionary TAC		5.5[2]		-	2.7	2.7
1993	If TAC required, consider SSB decline		-		-	2.5	2.4
1994	Reduce F+ precautionary TAC				-	2.9	2.9
1995	Significant effort reduction; link to North Sea				-	4.0	4.0
1996	Reference made to North Sea advice				-	3.5	3.5
1997	No advice				-	7.2	7.0
1998	Link to North Sea		4.9		-	8.7	8.6
1999	F = 0.60 to rebuild SSB		4.0		-	n/a	6.9
2000	F less than 0.55		<2.5		-	3.6	2.3
2001	lowest possible catch		0		-	2.0	1.6
2002	lowest possible catch		0		-	1.6	3.1
2003	Closure		0		-	1.3	NA
2004	Zero catch	Zero catch	0	0	-	0.2	NA
2005	Zero catch	Zero catch	0	0	-	0.7	NA
2006	Zero catch	Zero catch	0	0			NA
2007	Zero catch	Zero catch	0	0			

[1] Included in TAC for Subarea VII (except Division VIIa). [2] Including VIIe. Weight in '000 t.

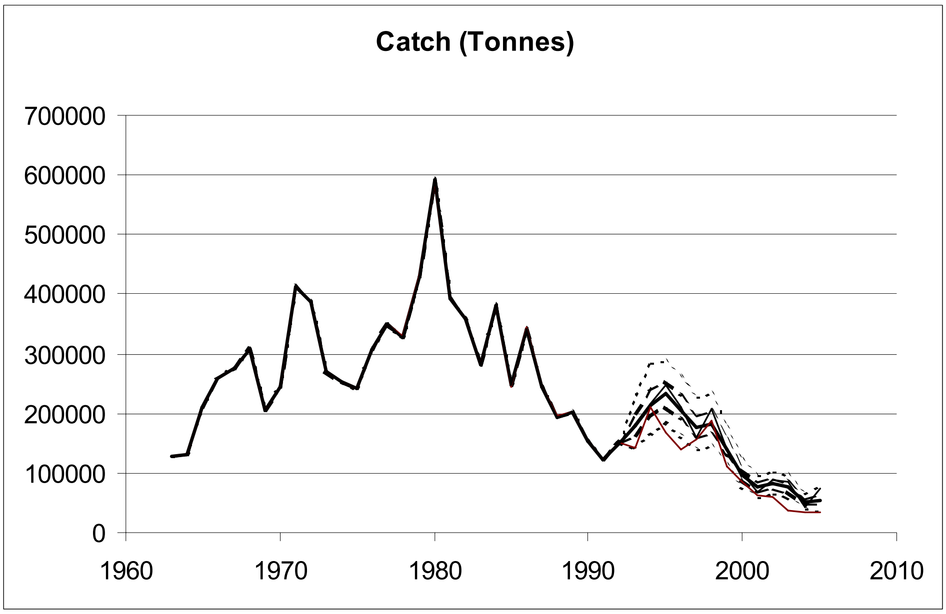


Figure 6.4.2.1 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Percentiles (5,25,50,75,95) of the estimated catch from the B-ADAPT model applied with smoothing. The solid line represents the recorded total catch.

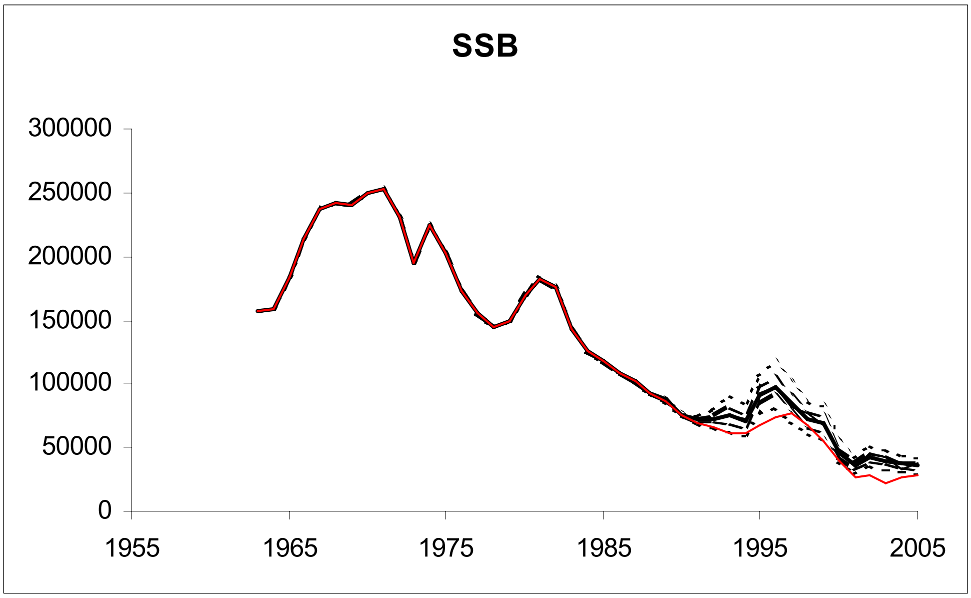


Figure 6.4.2.2 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Percentiles (5,25,50,75,95) of estimated SSB (in t) from the B-ADAPT model applied with smoothing. The lower line represents the SSB estimates under an assumption of exact catch-at-age.

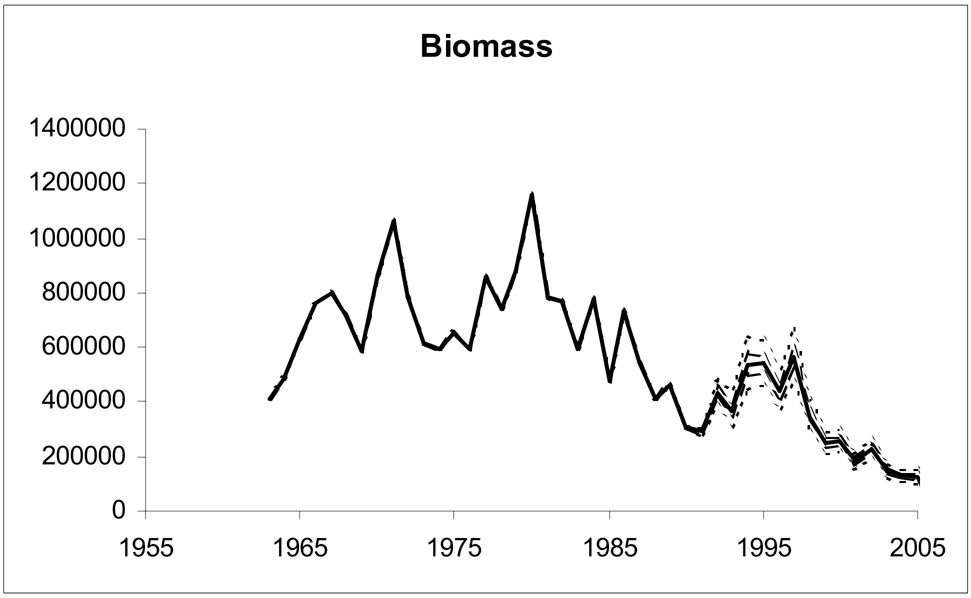


Figure 6.4.2.3 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Percentiles (5,25,50,75,95) of estimated total stock biomass (in t) from the B-ADAPT model applied with smoothing.

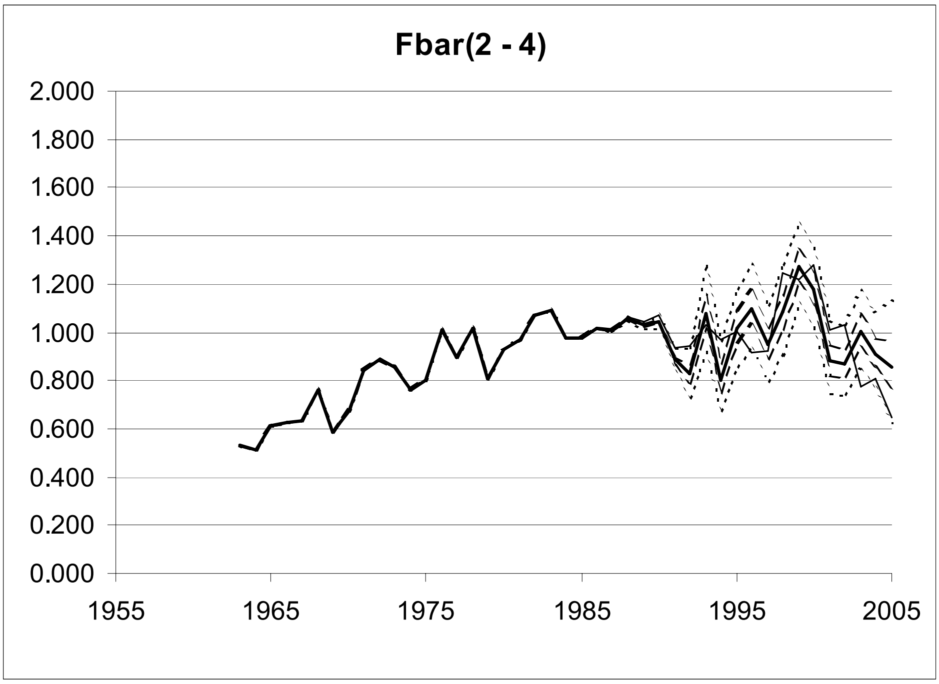


Figure 6.4.2.4 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: The percentiles (5,25,50,75,95) of estimated fishing mortality (average across ages 2–4) from the B-ADAPT model applied with smoothing. The lower solid line in the most recent years represents the estimates under an assumption of exact catch-at-age.

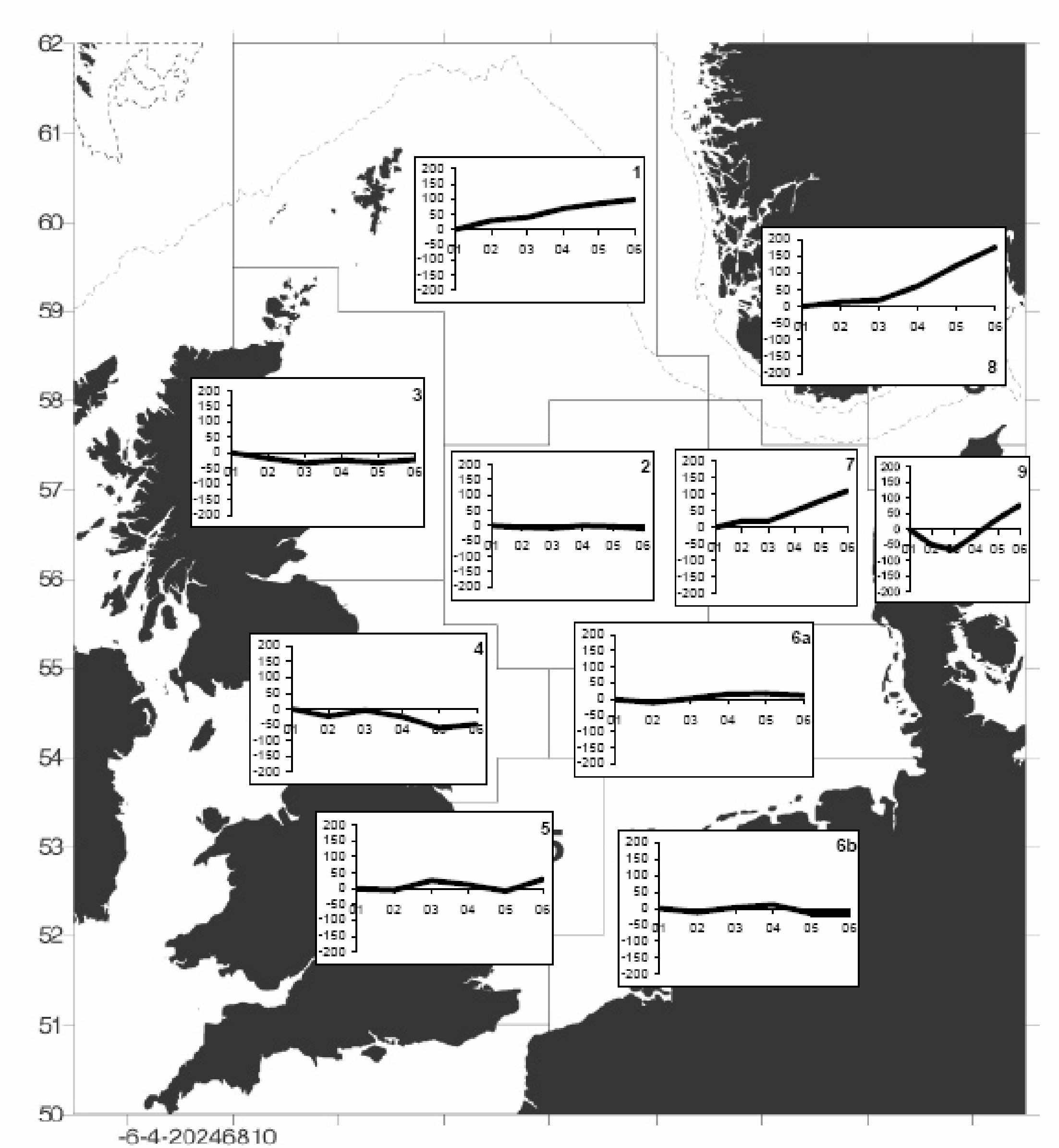


Figure 6.4.2.5 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Results from the 2006 fishers' North Sea Stock survey.

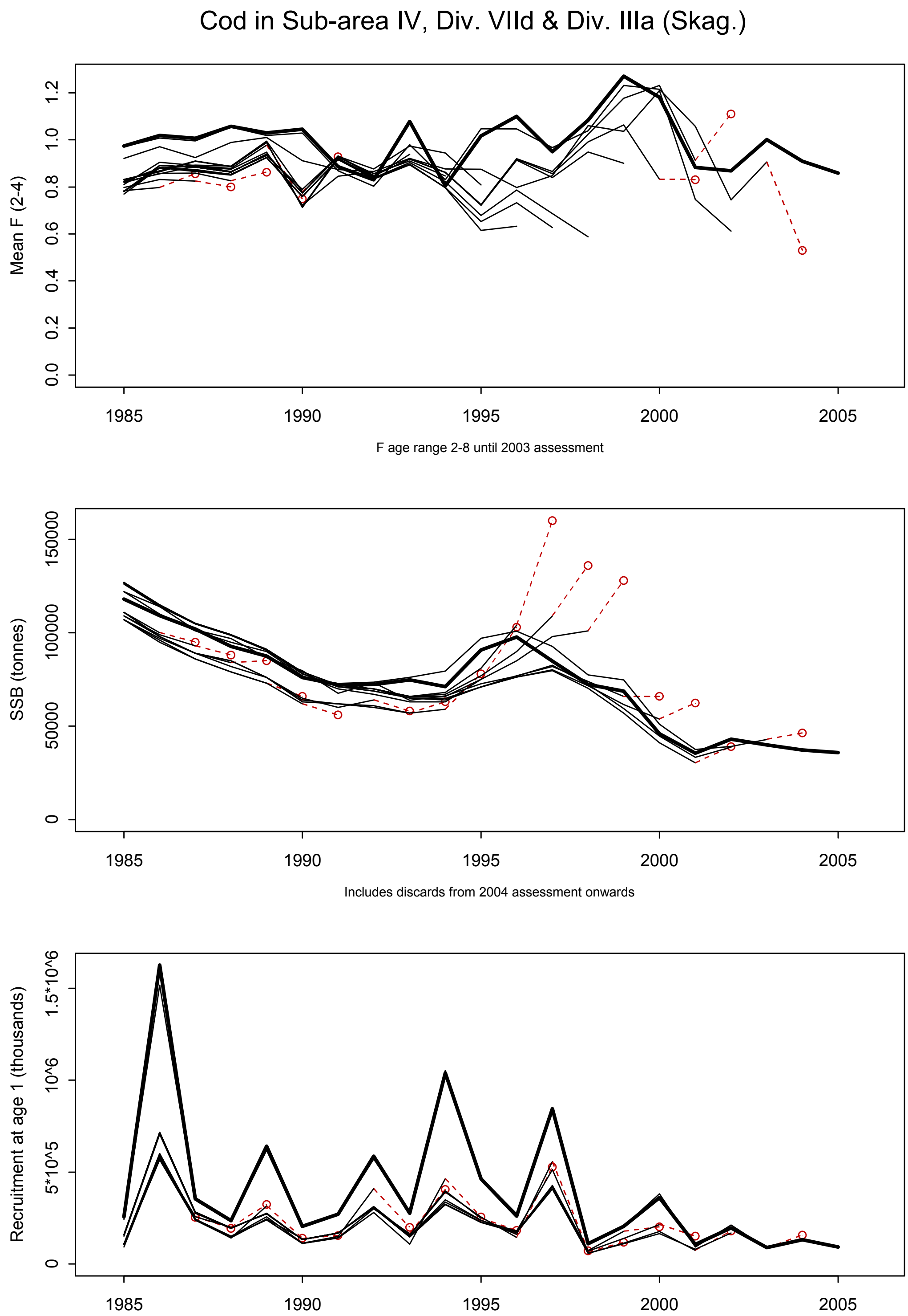


Figure 6.4.2.6 Cod in Subarea IV and Divisions IIIa and VIId. Historical performance of the assessment. Circles indicate forecasts.

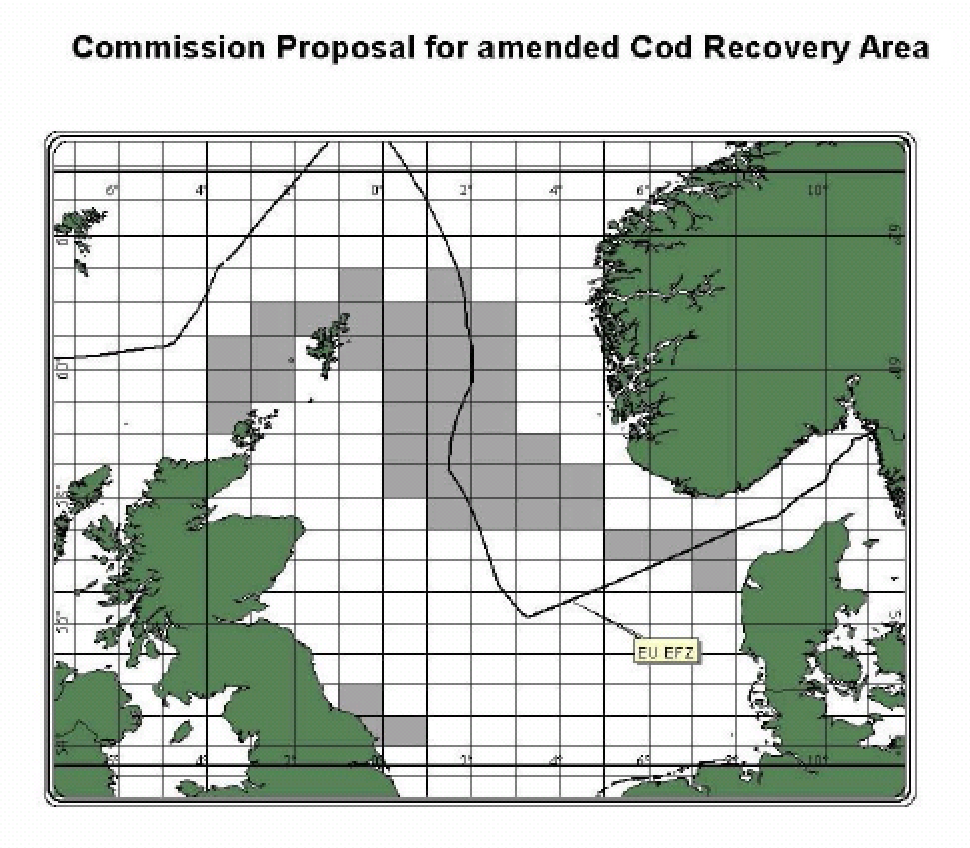


Figure 6.4.2.7 Cod in Subarea IV and Divisions IIIa and VIId. Protected areas according to EC 2287/2003, amended in EC 867/2004.

Table 6.4.2.1. Nominal landings (in tonnes) of COD in IIIa (Skagerrak), IV and VIId, 1986–2005 as officially reported to ICES and as used by the Working Group.

Subarea IV										
Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Belgium	6,604	6,693	5,508	3,398	2,934	2,331	3,356	3,374	2,648	4,827
Denmark	32,892	36,948	34,905	25,782	21,601	18,998	18,479	19,547	19,243	24,067
Faroe Islands	45	57	46	35	96	23	109	46	80	219
France	8,402	8,199	8,323	2,578	1,641	975	2,146	1,868	1,858	3,040
Greenland										9,457
Germany	7,667	8,230	7,707	11,430	11,725	7,278	8,446	6,800	5,974	
Netherlands	25,082	21,347	16,968	12,028	8,445	6,831	11,133	10,220	6,512	11,199
Norway	4,864	5,000	3,585	4,813	5,168	6,022	10,476	8,742	7,707	7,111
Poland	10	13	19	24	53	15	-	-	-	-
Sweden	839	688	367	501	620	784	823	646	630	709
UK (E/W/NI)	25,361	29,960	23,496	18,375	15,622	14,249	14,462	14,940	13,941	14,991
UK (Scotland)	45,748	49,671	41,382	31,480	31,120	29,060	28,677	28,197	28,854	35,848
United Kindom										
Total Nominal Catch	157,514	166,806	142,306	110,444	99,025	86,566	98,107	94,380	87,457	111,468
Unallocated landings	11,292	15,288	14,253	5,256	5,726	1,967	-758	10,200	7,066	8,555
WG estimate of total landings	**168,806**	**182,094**	**156,559**	**115,700**	**104,751**	**88,533**	**97,349**	**104,580**	**94,523**	**120,023**
Agreed TAC	**170,000**	**175,000**	**160,000**	**124,000**	**105,000**	**100,000**	**100,000**	**101,000**	**102,000**	**120,000**
	0.99	1.04	0.98	0.93	1.00	0.89	0.97	1.04	0.93	

Division VIId										
Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Belgium	650	815	486	173	237	182	187	157	228	377
Denmark	4	-	+	+	-	-	1	1	9	-
France	9,938	7,541	8,795	n/a	n/a	n/a	2,079	1,771	2,338	3,261
Netherlands	-	-	1	1	-	-	2	-	-	-
UK (E/W/NI)	830	1,044	867	562	420	341	443	530	312	336
UK (Scotland)	-	-	-	-	7	2	22	2	+	+
United Kingdom										
Total Nominal Catch	11,422	9,400	10,149	n/a	n/a	n/a	2,734	2,461	2,887	3,974
Unallocated landings	3,722	4,819	580	-	-	-	-65	-29	-37	-10
WG estimate of total landings	**15,144**	**14,219**	**10,729**	**5,538**	**2,763**	**1,886**	**2,669**	**2,432**	**2,850**	**3,964**

Division IIIa (Skagerrak) (not official statistics as these are only reported for the entire Division IIIa. The numbers below are as used by the WG)

Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Denmark	18,424	17,824	14,806	16,634	15,788	10,396	11,194	11,997	11,953	
Sweden	1,505	1,924	1,648	1,902	1,694	1,579	2,436	2,574	1,821	
Norway	174	152	392	256	143	72	270	75	60	
Germany	-	-	-	12	110	12	-	-	301	
Others	-	-	106	34	65	12	102	91	25	
Norwegian coast *	917	838	769	888	846	854	923	909	760	
Danish industrial bycatch *	997	491	1,103	428	687	953	1,360	511	666	
Total Nominal Catch	20,103	19,900	16,952	18,838	17,800	12,071	14,002	14,737	14,160	
Unallocated landings	0	0	0	-141	0	-12	0	0	-899	0
WG estimate of total landings	**20,103**	**19,900**	**16,952**	**18,697**	**17,800**	**12,059**	**14,002**	**14,737**	**13,261**	**12,109**
Agreed TAC	**29,000**	**22,500**	**21,500**	**20,500**	**21,000**	**15,000**	**15,000**	**15,000**	**15,500**	**20,000**

Subarea IV, Divisions VIId and IIIa (Skagerrak) combined

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Total Nominal Catch	189,039	196,106	169,407	n/a	n/a	n/a	114,843	111,578	104,504	127,551
Unallocated landings	15,014	20,106	14,833	-	-	-	-823	10,171	6,130	8,545
WG estimate of total landings	**204,053**	**216,212**	**184,240**	**139,936**	**125,314**	**102,478**	**114,020**	**121,749**	**110,634**	**136,096**

*The Danish industrial by-catch and the Norwegian coast catches are not included in the (WG estimate of) total landings of Division IIIa. n/a not available. **provisional.

Division IIIa (Skagerrak) landings not included in the assessment

Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Norwegian coast*						854	923	909	760	846
Danish industrial by-catch						953	1,360	511	666	749
Total						1,807	2,283	1,420	1,426	1,595

Table 6.4.2.1. cont'd. Nominal landings (in tonnes) of COD in IIIa (Skagerrak), IV and VIId, 1986–2005 as officially reported to ICES and as used by the Working Group.

Subarea IV										
Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Belgium	3,458	4,642	5,799	3,882	3,304	2,470	2,616	1,482*	1,615	1,715
Denmark	23,573	21,870	23,002	19,697	14,000	8,358	9,022	4,676	5,889	6,291
Faroe Islands	44	40	102	96		9	34	36		15
France	1,934	3,451	2,934*	1,750[1]*	1,222	717	1,777	617		515
Germany	8,344	5,179	8,045	3,386	1,740	1,810	2,018	2,048	2,212	2,648
Greenland								1,352		
Netherlands	9,271	11,807	14,676	9,068	5,995	3,574	4,707	2,305*	1,728	1,659
Norway	5,869	5,814	5,823	7,432	6,410	4,383*	4,994*	4,518*	3,205	2,886
Poland	18	31	25	19	18	18	39	35*		
Sweden	617	832	540	625	640	661	463	252	226	306
UK (E/W/NI)	15,930	13,413	17,745	10,344	6,543	4,087	3,112	2,213	1,889	1,364
UK (Scotland)	35,349	32,344	35,633	23,017	21,009	15,640	15,416	7,852	6,644	6,667
United Kindom										
Total Nominal Catch	104,407	99,423	114,324	79,316	60,881	41,727	44,198	27,386	23,408	24,065
Unallocated landings	2,161	2,746	7,779	-924	-1,114	-754	102	-1,539	141	-194
WG estimate of total landings	**106,568**	**102,169**	**122,103**	**78,392**	**59,767**	**40,973**	**44,300**	**25,847**	**23,549**	**23,870**
Agreed TAC	**130,000**	**115,000**	**140,000**	**132,400**	**81,000**	**48,600**	**49,300**	**27,300**	**27,300**	**27,300**
Division VIId										
Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Belgium	321	310	239	172	110	93	51	54*	47	50
Denmark	-	-	-	-	-	-	-			
France	2,808	6,387	7,788*		3,084	1,677	1,361	1,127		467
Netherlands	+	-	19	3	4	17	6	36*	14	9
UK (E/W/NI)	414	478	618	454	385	249	145	121	100	179
UK (Scotland)	4	3	1	-	-	-	-			
United Kingdom										
Total Nominal Catch	3,547	7,178	8,665	629	3,583	2,036	1,563	1,338	161	705
Unallocated landings	-44	-135	-85	6,229	-1,258	-463	1,534	-104	646	328
WG estimate of total landings	**3,503**	**7,043**	**8,580**	**6,858**	**2,325**	**1,573**	**3,097**	**1,234**	**807**	**1,033**
Division IIIa (Skagerrak)										
Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Denmark	13,573	12,164	12,340	8,734	7,683	5,901	5,524	3,070	3,039	3,613
Sweden	2,208	2,303	1608	1,909	1,350	1,035	1,716	509	495	824
Norway	265	348	303	345	301	134	146	193	133	
Germany	203	81	16	54	9	32	83	-		
Others	-	-	-	-	-	-	-	-		
Norwegian coast *	748	911	976	788	624	846	n/a	n/a	720	759
Danish industrial bycatch *	676	205	97	62	99	687	n/a	n/a	10	18
Total Nominal Catch	16,249	14,896	14,267	11,042	9,343	7,102	7,471	3,773	3,667	4,437
Unallocated landings	0	50	1,064	-68	-66	-16	-3	18	120	-632
WG estimate of total landings	**16,249**	**14,946**	**15,331**	**10,974**	**9,277**	**7,086**	**7,468**	**3,791**	**3,787**	**3,805**
Agreed TAC	**23,000**	**16,100**	**20,000**	**19,000**	**11,600**	**7,000**	**7,100**	**3,900**	**3,900**	**3,900**
Subarea IV, Divisions VIId and IIIa (Skagerrak) combined										
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Total Nominal Catch	124,203	121,497	137,256	90,987	73,807	50,865	53,232	32,497	27,236	29,207
Unallocated landings	2,117	2,661	8,758	5,238	-2,438	-1,233	1,633	-1,625	907	-498
WG estimate of total landings	**126,320**	**124,158**	**146,014**	**96,225**	**71,369**	**49,632**	**54,865**	**30,872**	**28,143**	**28,708**

*The Danish industrial by-catch and the Norwegian coast catches are not included in the (WG estimate of) total landings of Division IIIa. n/a not available. **provisional. * Preliminary [1] includes IIa(EC)

Division IIIa (Skagerrak) landings not included in the assessment

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Norwegian coast*	748	911	976	788	624	846	n/a	n/a	720	759
Danish industrial by-catch	676	205	97	62	99	687	n/a	n/a	10	18
Total	1,424	1,116	1,073	850	723	1,533	0	0	730	777

Table 6.4.2.2 Cod in Subarea IV, Division VIId and Division IIIa.

	Landings	Discards	Catch (L+D)	Total estimated Removals
1985	214.6	31.5	246.1	247.0
1986	204.1	139.1	343.1	341.0
1987	216.2	27.8	244.1	244.8
1988	184.2	10.7	195.0	194.8
1989	139.9	62.1	202.1	202.6
1990	125.3	27.0	152.3	153.0
1991	102.5	18.6	121.0	121.2
1992	114.0	36.9	150.9	151.8
1993	121.7	21.9	143.6	178.0
1994	110.6	99.6	210.2	214.8
1995	136.1	32.2	168.3	233.1
1996	126.3	14.3	140.6	206.3
1997	124.2	33.6	157.8	175.9
1998	146.0	40.5	186.5	183.5
1999	96.2	14.2	110.4	139.7
2000	71.4	13.7	85.1	96.3
2001	49.7	13.9	63.6	77.2
2002	54.9	5.7	60.6	81.8
2003	30.9	6.4	37.2	75.7
2004	28.2	5.8	34.0	51.9
2005	28.7	6.3	35.0	54.7

Table 6.4.2.3 Cod 347d: B-ADAPT median stock and management metrics. Recuitment is in thousands and weights in tonnes. Note: CATCH values are model estimates of removals in addition to the assumed natural mortality.

Run title : North Sea/Skagerrak/Eastern Channel Cod
Tuning data. INCLUDES DISCARDS
At 12/09/2006 8:34

B_ADAPT Median values

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	CATCH	YIELD/SSB	FBAR 2- 4
1963	228540	413071	157257	128686	0.818	0.534
1964	399443	482315	158695	130740	0.824	0.510
1965	600416	630354	184554	210237	1.139	0.611
1966	708510	759390	213361	259416	1.216	0.626
1967	612282	800508	236547	276387	1.168	0.636
1968	262676	718662	242373	305911	1.262	0.759
1969	228850	585188	240302	205510	0.855	0.587
1970	930946	866955	249236	243867	0.978	0.671
1971	1407998	1062013	252747	412264	1.631	0.841
1972	268139	780669	230917	387737	1.679	0.886
1973	471632	617157	195341	269139	1.378	0.857
1974	470719	596439	224052	253989	1.134	0.760
1975	876154	654859	202909	242349	1.194	0.803
1976	675946	593758	172324	307102	1.782	1.013
1977	1668615	854151	155895	349038	2.239	0.894
1978	528504	737068	144003	328585	2.282	1.015
1979	1350162	880983	149493	430688	2.881	0.810
1980	2566638	1159434	170284	590678	3.469	0.928
1981	544678	785346	181697	393451	2.165	0.970
1982	883780	771573	176435	359372	2.037	1.068
1983	425491	596833	142449	281696	1.978	1.092
1984	1409448	779630	125187	379974	3.035	0.975
1985	256980	478360	118028	247031	2.093	0.974
1986	1626335	732367	109157	341047	3.124	1.019
1987	354537	540585	101934	244809	2.402	1.007
1988	236236	410934	92697	194798	2.101	1.058
1989	641991	459350	87474	202639	2.317	1.031
1990	204418	311336	75969	153021	2.014	1.046
1991	270675	290415	72207	121204	1.679	0.886
1992	587019	430806	72303	151755	2.099	0.830
1993	276666	369565	74833	177953	2.378	1.079
1994	1040573	538389	71244	214793	3.015	0.804
1995	462448	541105	90769	233088	2.568	1.017
1996	260881	438423	97702	206286	2.111	1.100
1997	844543	562604	84833	175940	2.074	0.950
1998	111400	346435	72236	183470	2.540	1.083
1999	204579	249845	68702	139749	2.034	1.271
2000	361059	254951	45933	96271	2.096	1.181
2001	106642	180588	35504	77199	2.174	0.883
2002	196645	225017	43003	81842	1.903	0.868
2003	89481	148645	40023	75704	1.891	1.001
2004	132136	130128	37196	51913	1.396	0.910
2005	92139	128231	35855	54745	1.527	0.859
2006			31542			

Table 6.4.2.4 Cod 347d: B-ADAPT medium-term forecast for a 15% reduction in fishing mortality in 2006 held constant for 2007–2010.

	2005	2006	2007	2008
F2005 mult	1.000	0.850	0.850	0.850
F2006 mult	1.176	1.000	1.000	1.000

Fbar(2-4)	Year			
Percentile	2005	2006	2007	2008
0.05	0.62	0.53	0.53	0.53
0.25	0.76	0.64	0.64	0.64
0.5	0.86	0.73	0.73	0.73
0.75	0.96	0.82	0.82	0.82
0.95	1.10	0.93	0.93	0.93

SSB	Year			
Percentile	2005	2006	2007	2008
0.05	30500	25914	26113	30063
0.25	33626	28782	31343	38472
0.5	36144	31542	35655	45883
0.75	38966	34951	41202	54578
0.95	43318	39631	50032	69628

Removals	Year			
Percentile	2005	2006	2007	2008
0.05	38509	43349	62801	60545
0.25	47861	49389	69124	68234
0.5	54720	53748	74499	75526
0.75	63192	58424	79951	84443
0.95	76938	64909	89801	104971

P(SSBYear > SSB 2005)				
2006	2007	2008	2009	2010
0.18	0.49	0.78	0.92	0.90

In year SSB change			
	2005	2006	2007
Median	0.87	1.13	1.29
P25(y)/P75(y-1)	0.74	0.90	0.93

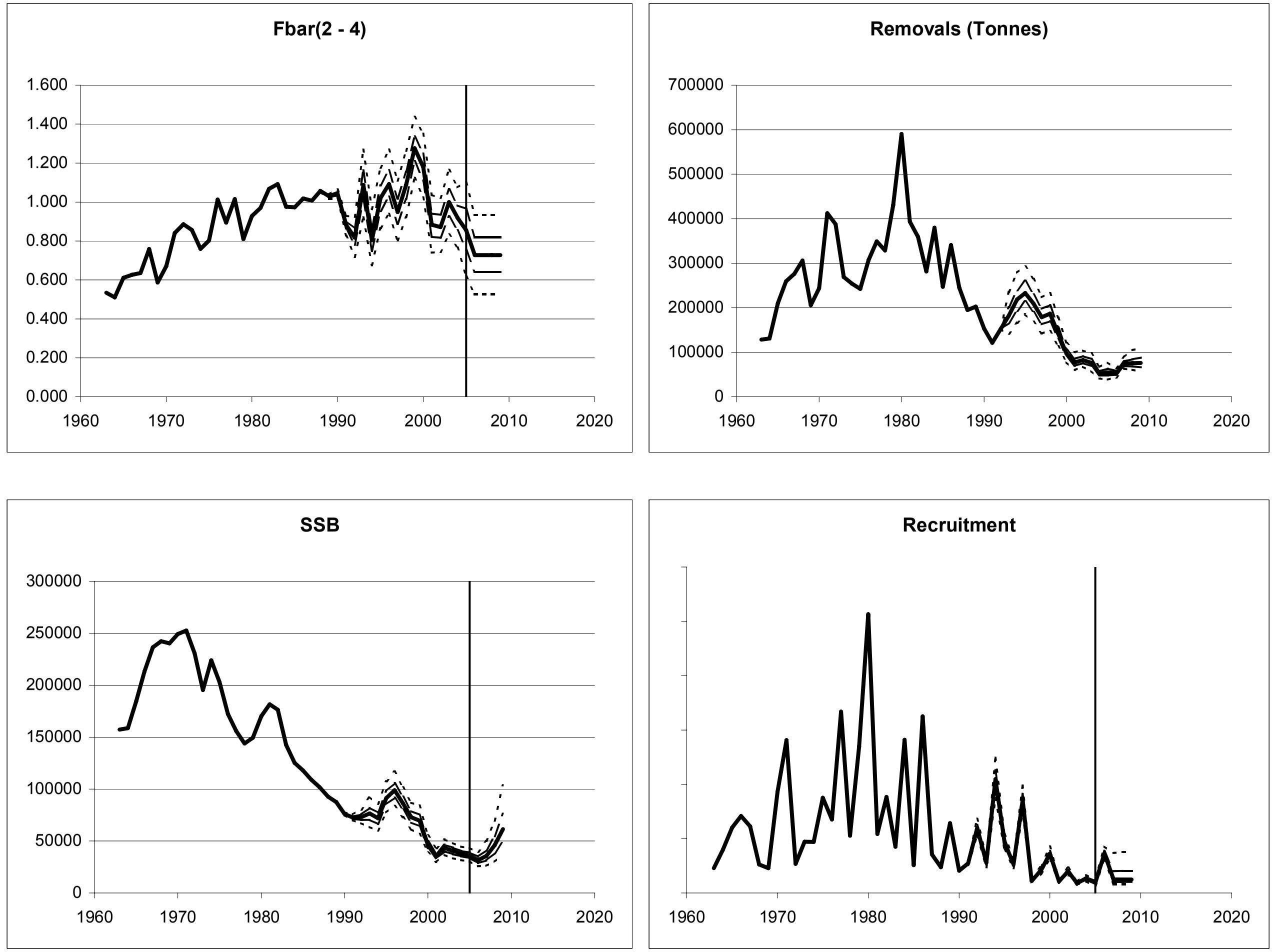


Table 6.4.2.5 Cod 347d: B-ADAPT medium-term forecast for a 15% reduction in fishing mortality in 2006 followed by a closure in 2007–2010.

	2005	2006	2007	2008
F multiplier	1.000	0.850	0.000	0.000

Fbar(2-4)	Year			
Percentile	2005	2006	2007	2008
0.05	0.63	0.53	0.00	0.00
0.25	0.76	0.65	0.00	0.00
0.5	0.86	0.73	0.00	0.00
0.75	0.96	0.82	0.00	0.00
0.95	1.10	0.93	0.00	0.00

SSB	Year			
Percentile	2005	2006	2007	2008
0.05	30581	25942	26455	72292
0.25	33467	29061	31808	84068
0.5	36032	31963	36058	92305
0.75	39262	34571	40972	101617
0.95	43747	39114	49019	116529

Catch	Year			
Percentile	2005	2006	2007	2008
0.05	37601	41136	0	0
0.25	48533	49406	0	0
0.5	55875	53738	0	0
0.75	63413	59952	0	0
0.95	77706	65238	0	0

P(SSBYear > SSB 2005)				
2006	2007	2008	2009	2010
0.04	0.11	0.23	0.23	0.23

In year SSB change		
2005	2006	2007
0.89	1.13	2.56

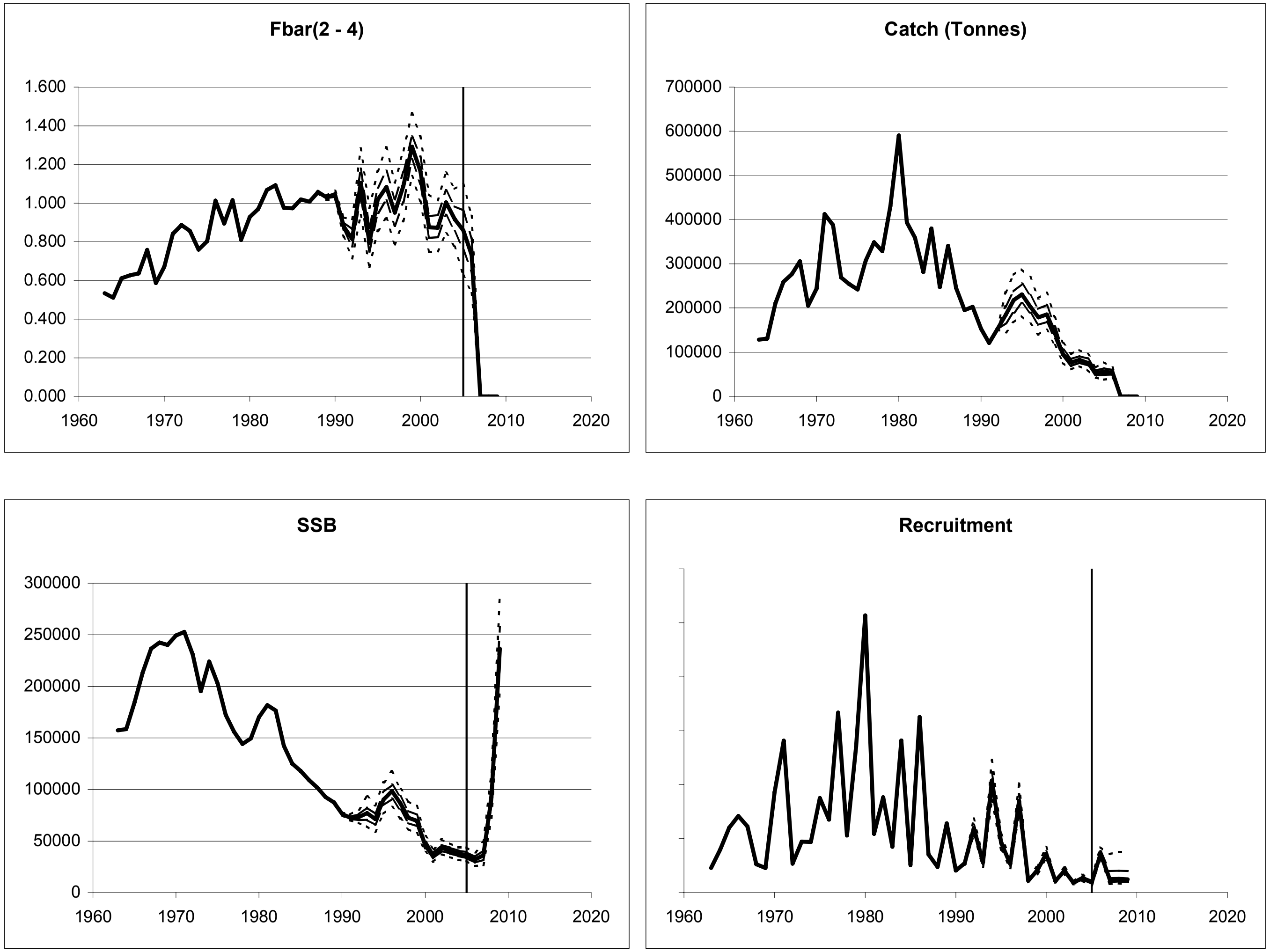


Table 6.4.2.6 Cod 347d: B-ADAPT medium-term forecast for a 15% reduction in fishing mortality in 2006 followed by further reductions in 2007 and held constant for 2008–2010.

	2005	2006	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
F2005 mult	1.000	0.850	0.850	0.850	0.765	0.765	0.723	0.723	0.680	0.680	0.638	0.638	0.500	0.500	0.000	0.000

Fbar(2-4)

Percentile	2005	2006	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
0.05	0.62	0.53	0.53	0.53	0.47	0.47	0.45	0.45	0.42	0.42	0.40	0.40	0.31	0.31	0.00	0.00
0.25	0.76	0.64	0.64	0.64	0.58	0.58	0.55	0.55	0.51	0.51	0.48	0.48	0.38	0.38	0.00	0.00
0.5	0.86	0.73	0.73	0.73	0.65	0.65	0.62	0.62	0.58	0.58	0.55	0.55	0.43	0.43	0.00	0.00
0.75	0.96	0.82	0.82	0.82	0.74	0.74	0.70	0.70	0.66	0.66	0.61	0.61	0.48	0.48	0.00	0.00
0.95	1.10	0.93	0.93	0.93	0.84	0.84	0.80	0.80	0.75	0.75	0.70	0.70	0.55	0.55	0.00	0.00

SSB

Percentile	2005	2006	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
0.05	30500	25914	26113	30063	26113	32805	26113	34262	26228	35766	26409	37460	26119	42949	26455	**72292**
0.25	33626	28782	31343	38472	31343	41530	31343	43226	31343	44997	31363	46849	31349	52719	31808	**84068**
0.5	36144	31542	35655	**45883**	35655	**49111**	35655	50788	35824	52642	35898	54453	35637	60901	36058	**92305**
0.75	38966	34951	41202	54578	41202	57892	41202	59679	41229	61599	41192	63545	41182	70194	40972	**101617**
0.95	43318	39631	50032	69628	50032	73354	50032	75135	49868	76698	49871	78512	50024	86512	49019	**116529**

Removals

Percentile	2005	2006	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
0.05	38509	43349	62801	60545	57912	59710	55314	58695	52760	57807	49452	56846	40951	50874	0	0
0.25	47861	49389	69124	68234	63776	66693	61077	65745	58187	64389	55431	63413	45449	57009	0	0
0.5	54720	53748	74499	75526	68948	73663	66110	72504	63012	70990	60247	69685	49287	62882	0	0
0.75	63192	58424	79951	84443	74181	82158	71145	80695	68053	79126	64883	77290	53146	69688	0	0
0.95	76938	64909	89801	104971	83112	101619	79466	99833	76108	97952	72942	96836	59774	85198	0	0

P(SSBYear > SSB 2005)															
2006	2007	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
0.18	0.49	0.92	0.90	0.97	0.96	0.98	0.98	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00

In year SSB change	2005	2006	2007	2007	2007	2007	2007	2007	2007
Median	0.87	1.13	1.29	1.38	1.42	1.47	1.52	1.71	2.56
P25(y)/P75(y-1)	0.74	0.90	0.93	1.01	1.05	1.09	1.14	1.28	2.05

Table 6.4.2.6 Conttinued. B-ADAPT medium-term forecast for a 15% reduction in fishing mortality in 2006 followed by further reductions in 2007 and held constant for 2008–2010.

	2005	2006	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
F2005 mult	1.000	0.850	0.500	0.500	0.468	0.468	0.400	0.400	0.300	0.300	0.000	0.000

Fbar(2-4)

Percentile	2005	2006	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
0.05	0.62	0.53	0.31	0.31	0.29	0.29	0.24	0.24	0.18	0.18	0.00	0.00
0.25	0.76	0.64	0.38	0.38	0.35	0.35	0.30	0.30	0.23	0.23	0.00	0.00
0.5	0.86	0.73	0.43	0.43	**0.40**	**0.40**	0.34	0.34	0.26	0.26	0.00	0.00
0.75	0.96	0.82	0.48	0.48	0.45	0.45	0.39	0.39	0.29	0.29	0.00	0.00
0.95	1.10	0.93	0.55	0.55	0.51	0.51	0.44	0.44	0.33	0.33	0.00	0.00

SSB

Percentile	2005	2006	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
0.05	30500	25914	26119	42949	26123	44411	26020	47908	26033	52648	26239	71790
0.25	33626	28782	31349	52719	31352	54265	31124	57469	31446	62916	31699	83806
0.5	36144	31542	35637	60901	35646	62542	35827	66152	35852	**72010**	36029	92269
0.75	38966	34951	41182	70194	41172	71767	41160	75688	41244	81321	40914	101576
0.95	43318	39631	50024	86512	50020	88074	50095	91475	50329	97820	49016	116518

Removals

Percentile	2005	2006	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
0.05	38509	43349	40951	50874	38695	48909	33149	44241	26168	36978	0	0
0.25	47861	49389	45449	57009	42992	55097	37498	50327	29249	42088	0	0
0.5	54720	53748	49287	62882	46694	60794	40889	55854	31839	46783	0	0
0.75	63192	58424	53146	69688	50394	67413	44342	62040	34523	51654	0	0
0.95	76938	64909	59774	85198	56537	82494	49550	74963	38700	62356	0	0

P(SSBYear > SSB 2005)											
2006	2007	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
0.18	0.49	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

In year SSB change	2005	2006	2007	2007	2007	2007	2007
Median	0.87	1.13	1.71	1.75	1.85	2.01	2.56
P25(y)/P75(y-1)	0.74	0.90	1.28	1.32	1.40	1.53	2.05

6.4.3 Haddock in Subarea IV (North Sea) and Division IIIa (Skagerrak–Kattegat)

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 management target	Comment
Full reproductive capacity	Harvested sustainably	Overexploited	Close to target	

Based on the most recent estimate of SSB and fishing mortality, ICES classifies the stock as having full reproductive capacity and being harvested sustainably. SSB in 2005 is estimated at 256 000 t and is estimated to have decreased to around 230 000 t in 2006. SSB is well above the $\mathbf{B}_{pa}$. The 2001–2004 year classes are all estimated to be well below average, while the 2005 year class is above the long-term geometric mean. Indications are that the 2006 year class is low. Fishing mortality in 2005 is estimated at 0.32, which is well below $\mathbf{F}_{pa}$.

Management objectives

In 1999 the EU and Norway have *"agreed to implement a long-term management plan for the haddock stock, which is consistent with the precautionary approach and is intended to constrain harvesting within safe biological limits and designed to provide for sustainable fisheries and greater potential yield."*.
The agreement was updated in November 2004:

"The plan shall consist of the following elements:

1. *Every effort shall be made to maintain a minimum level of Spawning Stock Biomass (SSB) greater than 100,000 tonnes (Blim).*
2. *For 2005 and subsequent years the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of no more than 0.30 for appropriate age groups.*
3. *Should the SSB fall below a reference point of 140,000 tonnes (Bpa), the fishing mortality rate referred to under paragraph 2, shall be adapted in the light of scientific estimates of the conditions then prevailing. Such adaptation shall ensure a safe and rapid recovery of SSB to a level in excess of 140,000 tonnes.*
4. *In order to reduce discarding and to enhance the spawning biomass of haddock, the Parties agreed that the exploitation pattern shall, while recalling that other demersal species are harvested in these fisheries, be improved in the light of new scientific advice from inter alia ICES.*
5. *A review of this arrangement shall take place no later than 31 December 2006.*
6. *This arrangement enters into force on 1 January 2005.*

ICES considers that the agreed Precautionary Approach reference points in the management plan are consistent with the precautionary approach, provided they are used as lower boundaries on SSB, and not as targets. An evaluation of the management plan will be presented in November 2006.

Reference points

	ICES considers that:	**ICES proposed that:**
Limit reference points	$\mathbf{B}_{lim}$ is 100 000 t.	$\mathbf{B}_{pa}$ be set at 140 000 t.
	$\mathbf{F}_{lim}$ is 1.0.	$\mathbf{F}_{pa}$ be set at 0.7.
Target reference points	Target F according to the management plan is 0.3.	

Yield and spawning biomass per Recruit (from the 2004 assessment)
F-reference points

	Fish Mort Ages 2-4	Yield/R	SSB/R
$\mathbf{F}_{sq}=\mathbf{F}_{2005}$	0.321		
$\mathbf{F}_{max}$	0.321	0.004	0.016
$\mathbf{F}_{0.1}$	0.202	0.004	0.024
$\mathbf{F}_{med}$	0.498	0.004	0.010

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 $\mathbf{F}_{0.1}$–$\mathbf{F}_{max}$.

Technical basis

$\mathbf{B}_{lim}$: Smoothed $\mathbf{B}_{loss}$.	$\mathbf{B}_{pa}$: 1.4*$\mathbf{B}_{lim}$.
$\mathbf{F}_{lim}$: 1.4* $\mathbf{F}_{pa}$.	$\mathbf{F}_{pa}$: implies a long-term biomass > $\mathbf{B}_{pa}$ and a less than 10% probability that SSB_{MT} < $\mathbf{B}_{pa}$.

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 fishing mortality is estimated at 0.32, which is above the rate expected to lead to high long-term yields ($\mathbf{F}_{0.1}$ = 0.20). Fishing at $\mathbf{F}_{0.1}$ is expected to lead to landings of 38 300 t in 2007.

Exploitation boundaries in relation to existing management plans

At the present SSB level, F should be below 0.3 to be in accordance with the management plan. This corresponds to landings of less than 55 400 t in 2007, which is expected to lead to an SSB of 291 100 t in 2008.

Exploitation boundaries in relation to precautionary reference points

The target fishing mortality in the management plan is in accordance with the precautionary approach.

Short-term implications

Outlook for 2007

Basis: F(2006) = F (2005); F (ages 2-4) = 0.32; R06=RCT3=11.0; R07-08 = (5 lowest in 1993–2002) = 8.1; SSB(2007)= 262.4; HC landings (2006) = 46.6; Discards (2006) = 20.5; Industrial bycatch (2006) = 0.3.

Rationale	HumanCons 2007	Basis	F 2007	Fmult (2007)	Catches 2007	Disc 2007	Industrial bycatch 2007	SSB 2008
Zero catch	0.0	F=0	0.00	0.00	0.0	0.0	0.0	364.4
Status quo	58.8	$\mathbf{F}_{sq}$	0.32	1.00	93.3	34.5	0.0	286.7
High long-term yield	38.3	F(long-term yield)	0.20	0.63	60.7	22.4	0.0	313.6
Agreed management plan	55.4	F(management plan)	0.30	0.94	88.0	32.5	0.0	291.1
Precautionary limits	14.1	F(prec limits) * 0.1	0.07	0.22	22.3	8.2	0.0	345.7
	33.9	F(prec limits) * 0.25	0.18	0.55	53.7	19.8	0.0	319.5
	63.6	F(prec limits) * 0.5	0.35	1.10	100.8	37.3	0.0	280.5
	89.6	F(prec limits) * 0.75	0.53	1.64	142.3	52.7	0.0	246.6
	103.7	F(prec limits) * 0.90	0.63	1.97	164.8	61.1	0.0	228.5
	112.6	F(prec limits)	0.70	2.19	178.9	66.4	0.0	217.2
	121.0	F(prec limits) * 1.1	0.77	2.41	192.4	71.4	0.0	206.4
	132.8	F(prec limits) * 1.25	0.88	2.74	211.3	78.6	0.0	191.5

Weights in ‘000 t.
Shaded scenarios are considered inconsistent with the Precautionary Approach.

Management considerations

Information on fishing effort indicates significant reductions in the fleet sectors which take the largest proportion of haddock. Also, in recent years, the minimum mesh size has been increased and gear selectivity measures have been introduced that allow for the release of small fish. The reduction in effort and the technical measures may have lead to the significant reduction in fishing mortality as indicated by the assessment. However, discarding still occurs and is substantial.

The stock and fishery are presently dominated by the strong 1999 year class, followed by a sequence of poor recruitment through 2004. Nevertheless, it is expected that the spawning stock will remain stable in 2007 and 2008 because of the current reduced fishing mortality levels.
The advice on landings assumes that the industrial fishery bycatch will be zero in 2007 and that the fraction of the catch-at-age that is discarded remains stable. For 2007, that would imply discards of 32 500 t.

Reducing discards would improve landing opportunities in the longer term.

Management plan evaluations

ICES has carried out a preliminary evaluation of the management plan. So far this shows that several of the HCRs tested are likely to lead to a low risk (not more than 10%) of exceeding management reference points. These are fixed TACs between 20 000 tonnes and 40 000 tonnes; target Fs between 0.3 and 0.4; and a target F in conjunction with a TAC constraint of ±15% or ±20%. Further investigations are needed to improve the recruitment modelling, taking account of occasional high recruitment.

ICES recommends that such evaluations of management plans are done in collaboration with managers and stakeholders in order to avoid the problems caused by ambiguous interpretation of the management plan.

Factors affecting the fisheries and the stock

Haddock are generally caught in mixed fisheries along with cod, *Nephrops*, and whiting.

The effects of regulations

EU technical regulations in force are contained in Council Regulation (EC) 850/98 and its amendments. The regulation prescribes the minimum target species composition for different mesh size ranges. In 2001, haddock in the whole of NEAFC region 2 were a legitimate target species for towed gears with a minimum codend mesh size of 100 mm. As part of the cod recovery measures, the EU and Norway introduced additional technical measures from 1 January 2002 (EC 2056/2001). The basic minimum mesh size for towed gears for cod from 2002 was 120 mm, although in a transitional arrangement running until 31 December 2002 vessels were allowed to exploit cod with 110-mm codends provided that the trawl was fitted with a 90-mm square mesh panel and the catch composition of cod retained on board was not greater than 30% by weight of the total catch. From 1 January 2003, the basic minimum mesh size for towed gears for cod was 120 mm. The minimum mesh size for vessels targeting haddock in Norwegian waters is also 120 mm.

Effort restrictions in the EC were introduced in 2003 (EC 2341/2002, Annex XVII, amended in EC 671/2003). Effort restriction measures were revised for 2005 (EC 27/2005, Annex IV). Preliminary analysis of fishing effort trends in the major fleets exploiting North Sea cod indicates that fishing effort in those fleets has been decreasing since the mid-1990s due to a combination of decommissioning and days-at-sea regulations. The decrease in effort is most pronounced in the years 2002 and beyond.

Changes in fishing technology and fishing patterns

The change in mesh size might be expected to shift exploitation patterns to older ages and increase the weight-at-age for retained fish from younger age classes. Improvements in the exploitation pattern have not been observed. It was not possible to examine if this is due to confounding effects from other fleet segments. Information presented to ICES noted that the UK large mesh demersal trawl fleet category (>100 mm, 4A) has been reduced by decommissioning and days-at-sea regulations to 40% of the levels recorded in the EU reference year of 2001. There was a movement into the 70-90 mm sector to increase days at sea in 2002 and 2003, but the level of effort stabilised in 2004. From the EU reference year of 2001 the effort of the combined trawl gears has shown a continued decrease of 36% overall.

Scientific basis

Data and methods

The age-based assessment model (XSA) is calibrated with three survey indices. Discards and industrial bycatch were included in the assessment for the North Sea only. Discards were estimated from the Scottish discards sampling programme, raised to the total international fleet.

The 1999–2000 year classes are slow-growing. This has been taken account of in the forecast.

Information from the fishing industry

The fishers' survey was evaluated and is broadly in agreement with the perception from the assessment.

Uncertainties in assessment and forecast

Stock dynamics estimated using several different sources of information were consistent. The assessment and forecast are largely influenced by the strong 1999 year class.

An assumption has been made in the forecast that industrial bycatch will be zero in 2007 following the advice given for Norway pout.

Comparison with previous assessment and advice

In this assessment the 1999 year class continues to be estimated as strong, and further indications are that the 2005 year class is of moderate strength. Since conclusions regarding stock status remain similar to the previous assessment, the advice also remains similar.

Source of information

Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, 5–14 September 2006 (ICES CM 2006/ACFM: 35).

Subarea IV

Year	ICES Advice	Single-stock Exploitation Boundaries	Predicted lndgs corresp. to advice[1]	Predicted lndgs corresp. To Single-stock Exploitation Boundaries[2]	Agreed TAC	Off. lndgs.	ACFM catches Hum. Cons.	ACFM catches Disc Slip.	ACFM catches Indust. bycatch	Total
1987	80% of F(85)		105		140	109	108	59	4	172
1988	77% of F(86); TAC		185		185	105	105	62	4	171
1989	Reduce decline in SSB; TAC; protect juveniles		68		68	64	76	26	2	104
1990	80% of F(88); TAC		50		50	43	51	33	3	87
1991	70% of effort (89)				50	45	45	40	5	90
1992	70% of effort (89)				60	51	70	48	11	129
1993	70% of effort (89)				133	80	80	80	11	170
1994	Significant reduction in effort; mixed fishery				160	87	81	65	4	150
1995	Significant reduction in effort; mixed fishery				120	75	75	57	8	140
1996	Mixed fishery to be taken into account				120	75	76	73	5	154
1997	Mixed fishery to be taken into account				114	73	79	52	7	138
1998	No increase in F		100.3		115	72	77	45	5	128
1999	Reduction of 10% F(95–97)		72		88.6	64	64	43	4	111
2000	F less than $\mathbf{F}_{pa}$		<51.7		73.0	47	45	47	8	100
2001	F less than $\mathbf{F}_{pa}$		<58.0		61	40	39	118	8	165
2002	F less than $\mathbf{F}_{pa}$		<94.0		104.0	54	53	45	4	101
2003	No cod catches		-		52	42	42	23	1	76
2004	Mixed fisheries consideration	F should be below $\mathbf{F}_{pa}$	*	No forecast	85	47	47	17	1	65
2005	Mixed fisheries consideration	F should be below $\mathbf{F}_{pa}$	*	92	66	47	48	10	0	57
2006	Mixed fisheries consideration	F should be below 0.3	*	39	51.9					
2007	Mixed fisheries consideration	F should be below 0.3	*	55.4						

[1]Only pertaining to the North Sea. [2] For the whole stock (IIIa and IV). * Single-stock boundary and the exploitation of this stock should be conducted in the context of mixed fisheries protecting stocks outside safe biological limits. Weights in '000 t.

Division IIIa

Year	ICES Advice	Single-stock Exploitation Boundaries	Predicted lndgs corresp. to advice	Predicted lndgs corresp tol single-stock exploitation boundaries	Agreed TAC	ACFM landings Hum. Cons.	ACFM landings Indust. bycatch	ACFM landings Total
1987	Precautionary TAC		-		11.5	3.8	1.4	5.3
1988	Precautionary TAC		-		10.0	2.9	1.5	4.3
1989	Precautionary TAC		-		10.0	4.1	0.4	4.5
1990	Precautionary TAC		-		10.0	4.1	2.0	6.1
1991	Precautionary TAC		4.6		4.6	4.1	2.6	6.7
1992	TAC		4.6		4.6	4.4	4.6	9.0
1993	Precautionary TAC		-		4.6	2.0	2.4	4.4
1994	Precautionary TAC		-		10.0	1.8	2.2	4.0
1995	If required, precautionary TAC; link to North Sea		-		10.0	2.2	2.2	4.4
1996	If required, precautionary TAC; link to North Sea		-		10.0	3.1	2.9	6.1
1997	Combined advice with North Sea		-		7.0	3.4	0.6	4.0
1998	Combined advice with North Sea		4.7		7.0	3.8	0.3	4.0
1999	Combined advice with North Sea		3.4		5.4	1.4	0.3	1.7
2000	Combined advice with North Sea		<1.8		4.5	1.5	0.6	2.1
2001	Combined advice with North Sea		<2.0		4.0	1.9	0.2	2.1
2002	Combined advice with North Sea		<3.0		6.3	4.1	0.06	4.1
2003	Combined advice with North Sea		-		3.2	1.8	n/a	1.8
2004	Combined advice with North Sea	F should be below $\mathbf{F}_{pa}$		No forecast	4.9	1.4	n/a	1.4
2005	Combined advice with North Sea	F should be below $\mathbf{F}_{pa}$		-	4.0	0.8	0	0.8
2006	Combined advice with North Sea	F should be below 0.3		-	3.2			
2007	Combined advice with North Sea	F should be below 0.3		-				

Weights in ‘000 t. n/a = not available.

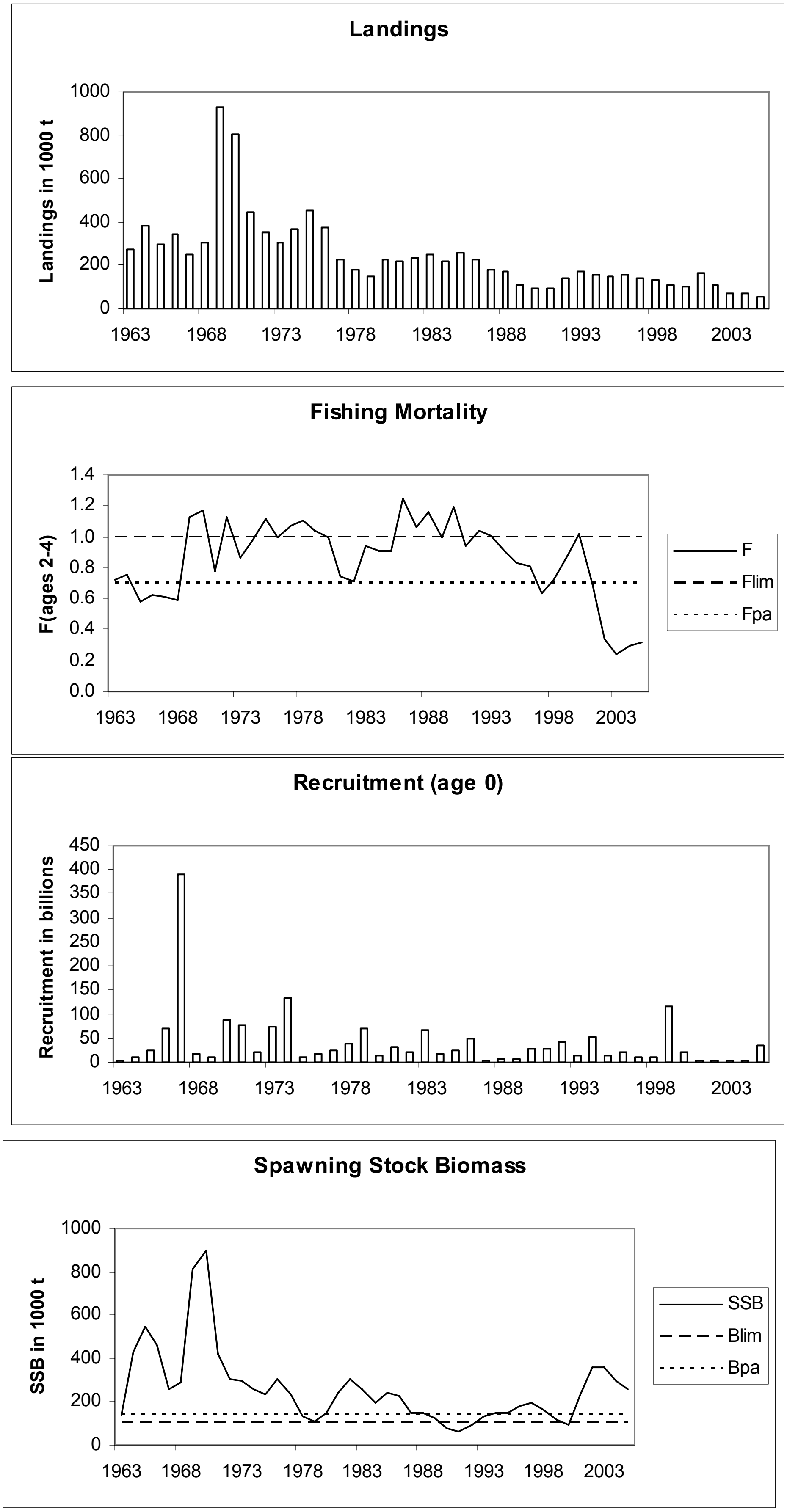
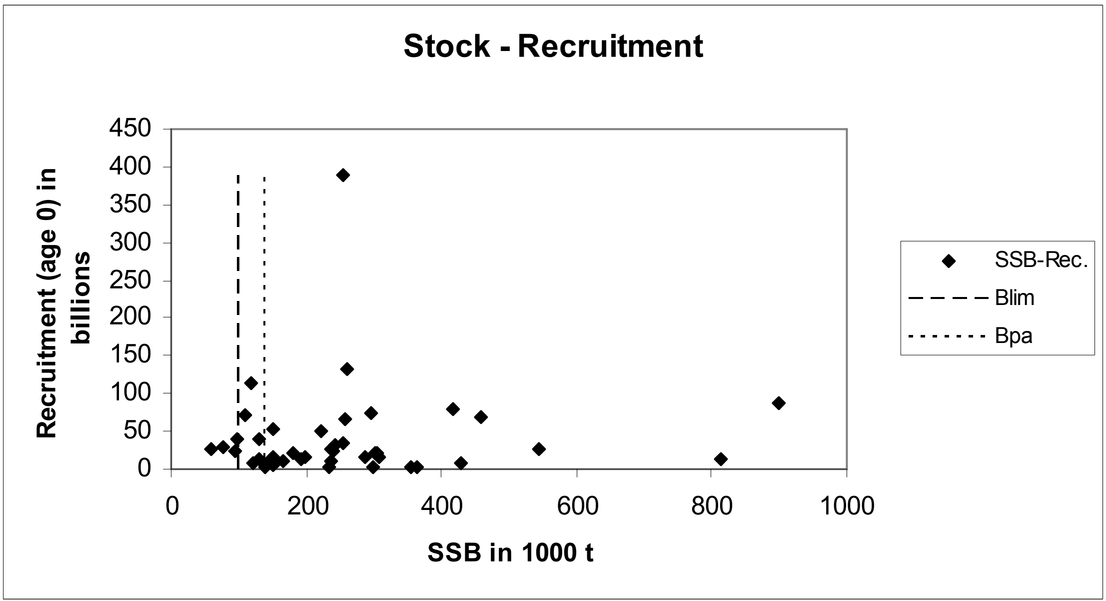
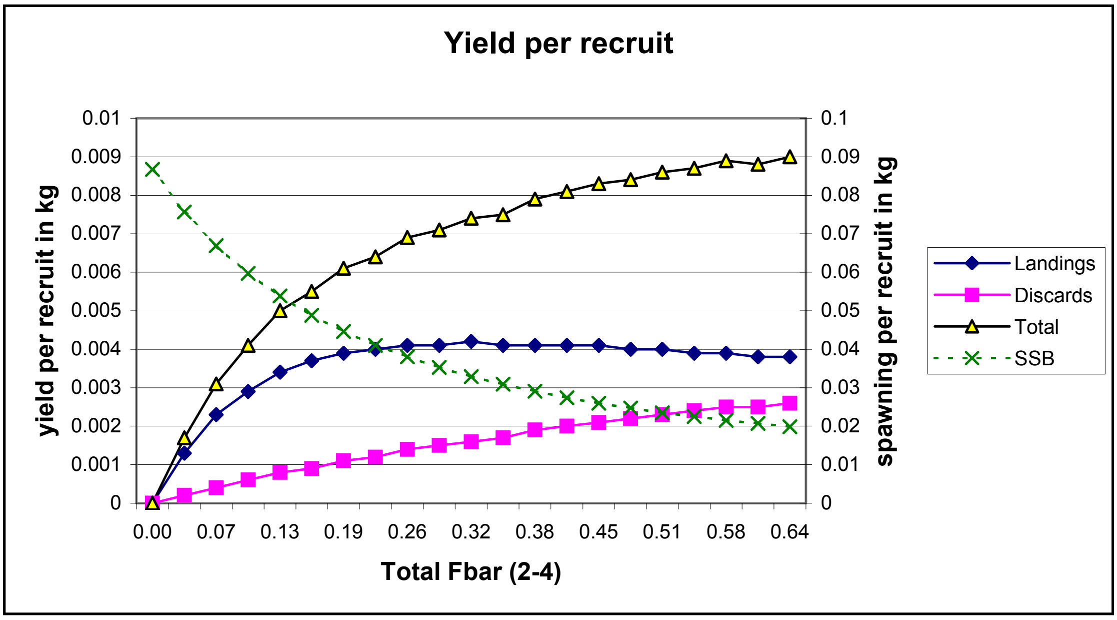


Figure 6.4.3.1 Haddock in Subarea IV (North Sea) and Division IIIa. Landings, fishing mortality, recruitment and SSB.





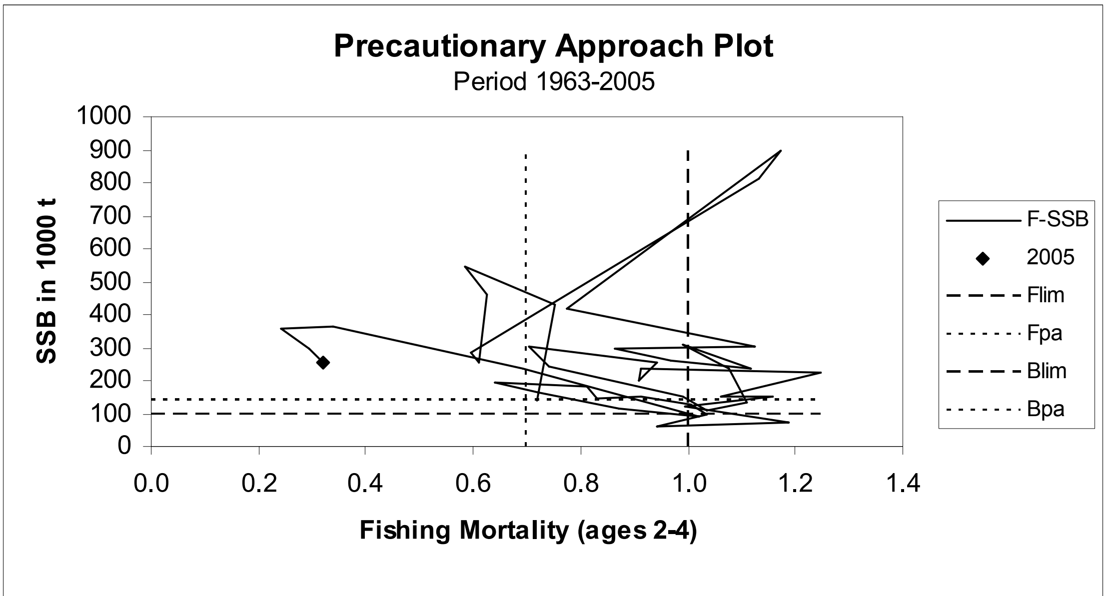


Figure 6.4.3.2 Haddock in Subarea IV (North Sea) and Division IIIa. Stock and recruitment; Yield and SSB per recruit.

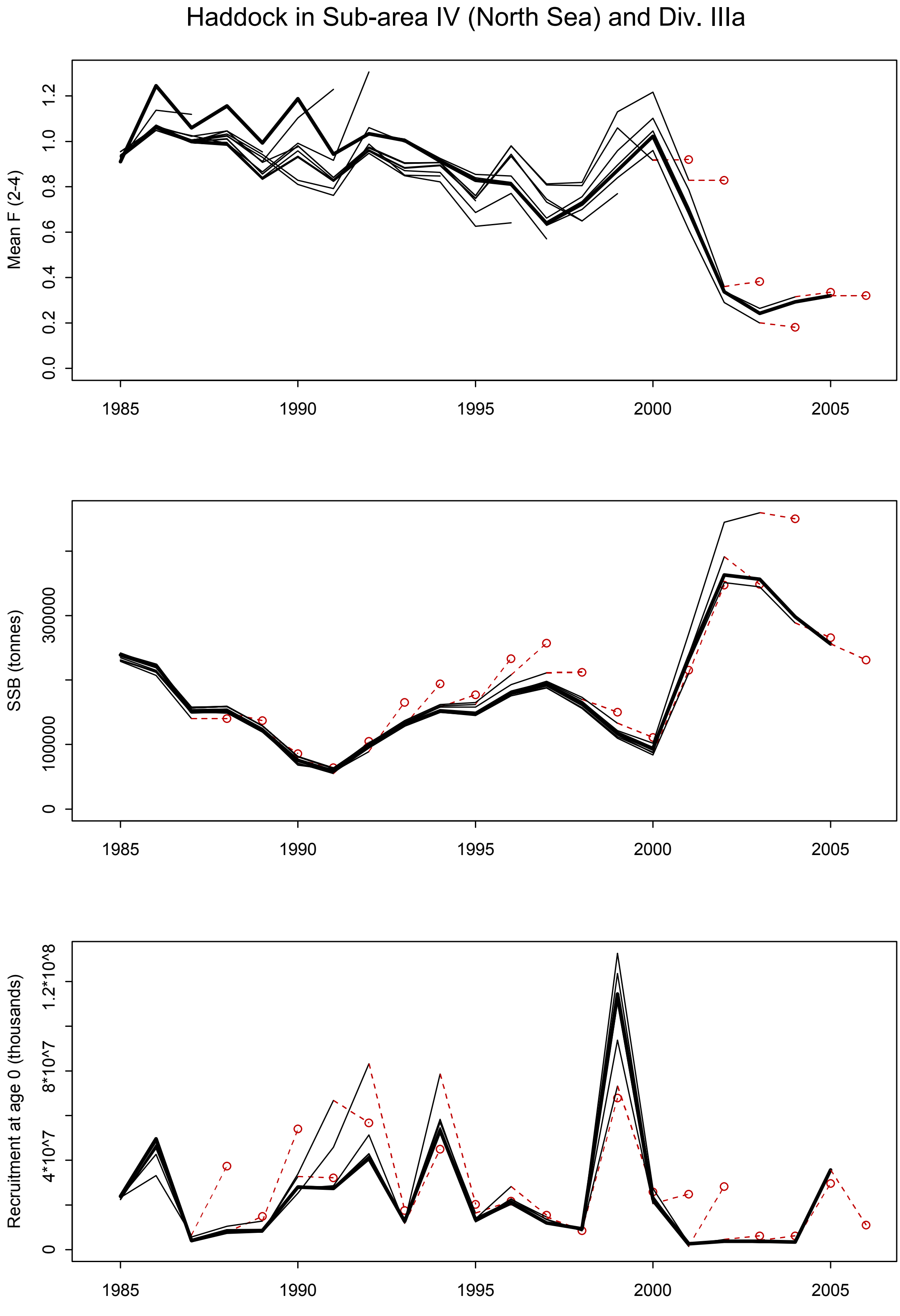


Figure 6.4.3.3 Haddock in Subarea IV and Division IIIa. Historical performance of the assessment.

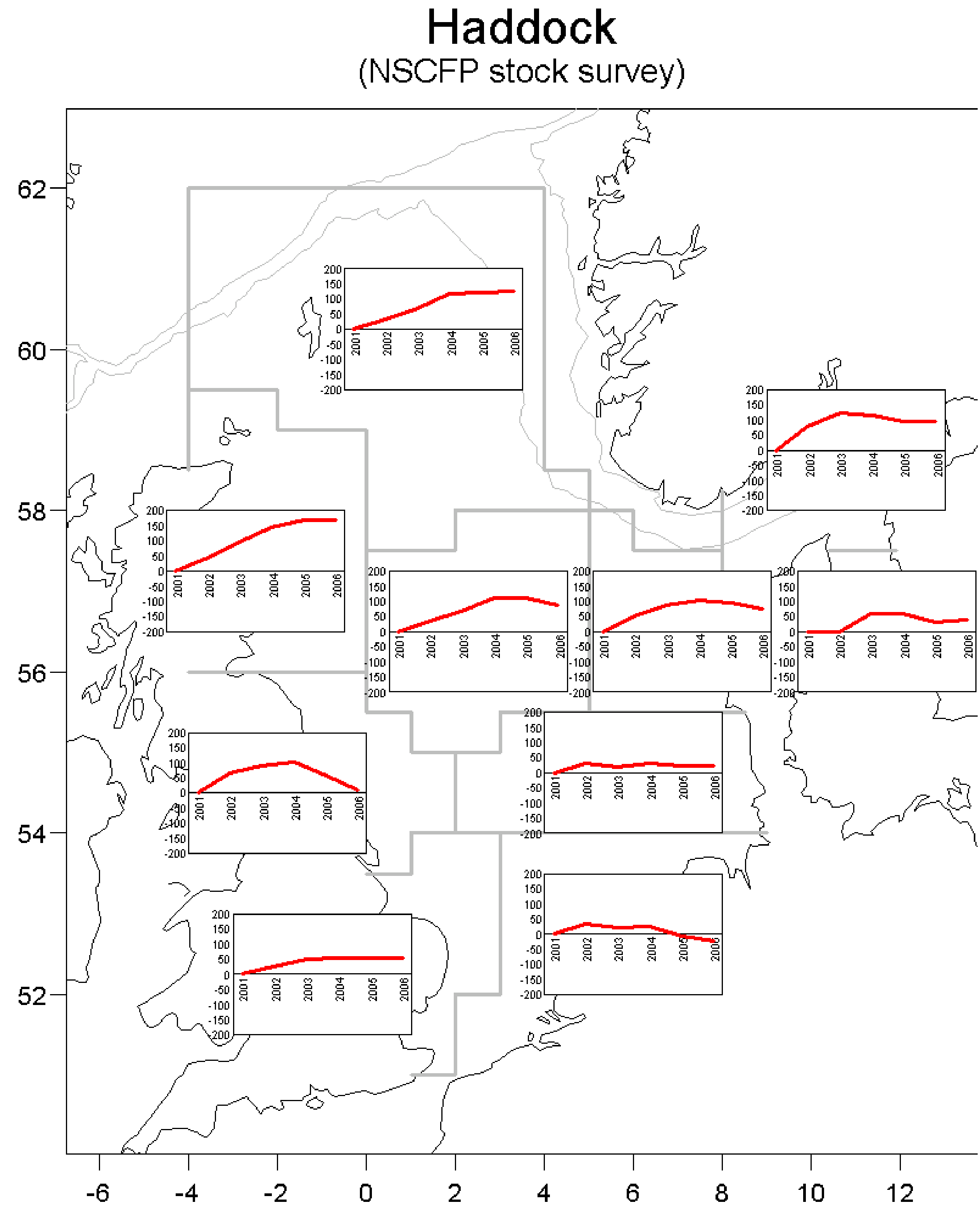


Figure 6.4.3.4 Haddock in Subarea IV and Division IIIa. Results of the North Sea fishers' survey.

Table 6.4.3.1 Haddock in Subarea IV and Division IIIa. Nominal catch ('000 t) 1999–2005, as officially reported to ICES and estimated by ACFM.

Division IIIa

Country	1999	2000	2001	2002	2003	2004	2005	2006
Denmark	1012	1033	1590	3791	1741	1116	615	
Germany	3	1	128	239	113	69	69	
Netherlands	0	0	0	0	6	1	0	
Norway	168	126	149	149	211	154	93	
Sweden	206	367	283	393	165	158	175	
UK – Scotland	0	0	7	0	0	0	0	
Total reported	1389	1527	2157	4572	2236	1498	952	
Unallocated	-29	-42	-254	-435	-428	-55	-188	
WG estimate of H.cons. landings	1360	1485	1903	4137	1808	1443	764	
WG estimate of industrial by-catch	334	617	218	0	0	0	0	
WG estimate of total catch	**1694**	**2102**	**2121**	**4137**	**1808**	**1443**	**764**	
TAC	*5400*	*4450*	*4000*	*6300*	*3150*	*4940*	*4018*	*3189* *

* Includes areas III bcd (EC waters)

Sub-area IV

Country	1999	2000	2001	2002	2003	2004	2005	
Belgium	462	399	606	559	374	373	190	
Denmark	2104	1670	2407	5123	3035	2075	1274	
Faeroe Islands	55	0	1	25	12	22	11	
France	0	724	485	914	1108	552	419	
Germany	565	342	681	852	1562	1241	733	
Greenland	0	0	0	0	149	10	0	
Ireland	0	0	0	0	1	0	0	
Netherlands	110	119	274	359	187	104	64	
Norway	3830	3150	1902	2404	2196	2258	2069	
Poland	17	13	12	17	16	0	0	
Sweden	686	596	804	572	477	188	132	
UK - Eng+Wales+N.Irl.	2398	1876	3334	3647	1561	1159	843	
UK – Scotland	53628	37772	29263	39624	31527	39339	41584	
Total reported	63855	46661	39769	54096	42205	47321	47319	
Unallocated	354	-577	-811	75	74	-68	297	
WG estimate of H.cons. landings	64209	46084	38958	54171	42279	47253	47616	
WG estimate of discards	42562	48841	118320	45892	23499	17226	9508	
WG estimate of industrial by-catch	3834	8134	7879	3717	1149	554	168	
WG estimate of total catch	**110605**	**103059**	**165157**	**103780**	**66927**	**65033**	**57292**	
TAC	*88550*	*73000*	*61000*	*104000*	*51735*	*77000*	*66000*	*51850* *

* Includes area II a (EC waters)

Division IIIa and Sub-area IV

	1999	2000	2001	2002	2003	2004	2005	
WG estimate of total catch	112299	105161	167278	107917	68735	66476	58056	
TAC	*93950*	*77450*	*65000*	*110300*	*54885*	*81940*	*70018*	*55039* *

* Includes areas II a and III bcd (EC waters)

Table 6.4.3.2 Haddock in Subarea IV and Division IIIa. XSA final assessment: Stock summary table.

	Recruitment Age 0 ('000 millions)	Total Biomass ('000t)	SSB ('000t)	Total Catch ('000t)	Human Cumsomption ('000t)	Discards (North Sea only) ('000t)	Industrial By-catch ('000t)	Yield/SSB	F (2-4)	F HC (2-4)	F Disc (2-4)	F IBC (2-4)
1963	2.406	3473	140	272	69	189	14	1.94	0.72	0.49	0.20	0.03
1964	9.201	1314	430	380	131	160	89	0.88	0.75	0.47	0.12	0.16
1965	26.316	1101	544	299	162	62	75	0.55	0.59	0.34	0.10	0.14
1966	68.833	1497	458	347	226	74	47	0.76	0.63	0.36	0.17	0.10
1967	388.514	5514	254	247	148	78	21	0.97	0.61	0.35	0.23	0.03
1968	17.097	6851	288	302	106	162	34	1.05	0.59	0.38	0.15	0.07
1969	12.153	2476	813	931	331	260	339	1.15	1.13	0.69	0.15	0.29
1970	87.711	2545	899	807	525	101	180	0.90	1.17	0.70	0.20	0.27
1971	78.186	2521	419	447	237	177	32	1.07	0.78	0.54	0.18	0.06
1972	21.501	2183	301	354	195	128	30	1.17	1.12	0.84	0.24	0.04
1973	73.093	4118	296	308	182	115	11	1.04	0.86	0.65	0.21	0.00
1974	133.187	4759	259	369	153	167	49	1.42	0.97	0.60	0.23	0.13
1975	11.514	2373	237	455	151	260	43	1.92	1.12	0.68	0.34	0.10
1976	16.513	1098	307	377	173	154	50	1.23	0.99	0.62	0.25	0.11
1977	26.005	1058	237	226	145	44	37	0.95	1.08	0.68	0.21	0.18
1978	39.58	1098	131	180	92	77	12	1.37	1.11	0.79	0.28	0.04
1979	72.062	1325	110	146	87	42	17	1.33	1.04	0.85	0.14	0.04
1980	15.788	1421	152	224	105	95	24	1.47	0.99	0.75	0.13	0.11
1981	32.425	970	244	217	139	60	18	0.89	0.74	0.57	0.14	0.03
1982	20.453	1071	305	238	177	41	21	0.78	0.71	0.54	0.11	0.05
1983	66.632	2227	257	254	167	66	20	0.99	0.94	0.69	0.21	0.04
1984	17.118	1658	199	223	135	75	13	1.12	0.91	0.73	0.15	0.03
1985	23.939	1165	239	258	166	85	7	1.08	0.91	0.76	0.13	0.02
1986	49.657	1955	223	226	169	52	4	1.01	1.25	0.94	0.30	0.01
1987	4.16	1023	151	177	112	59	6	1.17	1.06	0.81	0.24	0.01
1988	8.417	602	152	176	108	62	5	1.16	1.16	0.86	0.25	0.05
1989	8.577	603	122	109	80	26	3	0.89	0.99	0.74	0.22	0.03
1990	28.075	1508	76	93	56	33	5	1.23	1.19	0.78	0.36	0.04
1991	27.409	1528	59	97	49	40	8	1.65	0.94	0.81	0.11	0.03
1992	40.861	1322	97	138	75	48	15	1.43	1.03	0.85	0.17	0.02
1993	12.708	971	130	174	82	80	13	1.34	1.00	0.74	0.24	0.03
1994	53.469	1408	152	154	83	65	6	1.01	0.91	0.63	0.27	0.01
1995	13.494	1099	148	145	78	57	10	0.98	0.83	0.58	0.24	0.01
1996	20.947	970	179	160	79	73	8	0.89	0.81	0.53	0.26	0.02
1997	12.059	848	193	142	82	52	7	0.73	0.64	0.42	0.20	0.03
1998	9.376	715	165	132	81	45	5	0.80	0.72	0.46	0.22	0.04
1999	114.402	2898	118	112	66	43	4	0.95	0.87	0.50	0.34	0.03
2000	22.645	3160	94	105	48	49	9	1.12	1.02	0.68	0.26	0.09
2001	2.623	996	235	167	41	118	8	0.71	0.69	0.38	0.20	0.11
2002	3.813	670	363	108	58	46	4	0.30	0.34	0.22	0.10	0.02
2003	3.826	593	356	69	44	23	1	0.19	0.24	0.07	0.15	0.02
2004	3.387	606	298	66	49	17	1	0.22	0.29	0.14	0.15	0.00
2005	35.722	2410	256	58	48	10	0	0.23	0.32	0.21	0.11	0.00
2006	11.028*		231									
* RCT3 estimate												
mean	40.369	1853	258	243	128	85	30	1.05	0.87	0.60	0.20	0.06

6.4.4 Whiting in IIIa (Skagerrak – Kattegat)

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	
Unknown	Unknown	Unknown	

The available information is inadequate to evaluate spawning stock or fishing mortality. It is likely that this stock is linked to the North Sea stock.

Management objectives

There are no explicit management objectives for this stock.

Reference points

There is no reference points defined for the stock.

Single-stock exploitation boundaries

Exploitation boundaries in relation to precautionary limits

The landings in 2007 should be less than 1500 t as a precautionary value to restrict the potential for re-expansion of the fishery and misreporting from other regions.

Management considerations

The major part of the catch is taken as a bycatch in small-mesh fisheries. The landings value advised for 2007 is consistent with ICES advice provided in 2006, and is based on the average of the catch during 1996–1998.

Source of information

Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, 5–14 September 2006 (ICES CM 2006/ACFM:35).

Year	ICES Advice	Single-Stock Exploitation Boundaries	Predicted catch corresp. to advice	Predicted catch corresp. to Single-Stock Exploitation Boundaries	Agreed TAC	ACFM Catch[1]
1987	Precautionary TAC		-		17.0	16.7
1988	Precautionary TAC		-		17.0	11.8
1989	Precautionary TAC		-		17.0	13.3
1990	Precautionary TAC		-		17.0	19.4
1991	TAC		-		17.0	14.0
1992	No advice		-		17.0	12.3
1993	Precautionary TAC		-		17.0	4.6
1994	If required, precautionary TAC		-		17.0	6.0
1995	If required, precautionary TAC		-		15.2	9.6
1996	If required, precautionary TAC		-		15.2	2.9
1997	If required, TAC equal to recent catches		-		15.2	0.7
1998	No advice				15.2	1.0
1999	TAC, average period 1993–1996		6.0		8.0	1.3
2000	TAC, average period 1996–1998		1.5		4.0	0.6
2001	TAC, average period 1996–1998		1.5		2.5	0.2
2002	TAC, average period 1996–1998		1.5		2.0	0.3
2003	TAC, average period 1996–1998		1.5		1.5	0.2
2004	TAC, average period 1996–1998		1.5		1.5	0.2
2005	[2)]	TAC, average period 1996–1998	1.5		1.5	0.1
2006	[2)]	TAC, average period 1996–1998	1.5		1.5	
2007	[2)]	TAC, average period 1996–1998	1.5			

Weights in '000 t.
[1]Includes bycatch in small-mesh industrial fishery except for 2001–2003.
[2)] Single-stock boundary, and the exploitation of this stock should be conducted in the context of mixed fisheries protecting stocks outside safe biological limits.

Table 6.4.4.1 Nominal landings (t) of Whiting from Division IIIa as supplied by the Study Group on Division IIIa Demersal Stocks (ICES, 1992b) and updated by the Working Group.

Year	Denmark			Norway	Sweden	Others	Total
1975	19,018			57	611	4	19,690
1976	17,870			48	1,002	48	18,968
1977	18,116			46	975	41	19,178
1978	48,102			58	899	32	49,091
1979	16,971			63	1,033	16	18,083
1980	21,070			65	1,516	3	22,654
	Total consumption	Total industrial	Total				
1981	1,027	23,915	24,942	70	1,054	7	26,073
1982	1,183	39,758	40,941	40	670	13	41,664
1983	1,311	23,505	24,816	48	1,061	8	25,933
1984	1,036	12,102	13,138	51	1,168	60	14,417
1985	557	11,967	12,524	45	654	2	13,225
1986	484	11,979	12,463	64	477	1	13,005
1987	443	15,880	16,323	29	262	43	16,657
1988	391	10,872	11,263	42	435	24	11,764
1989	917	11,662	12,579	29	675	-	13,283
1990	1,016	17,829	18,845	49	456	73	19,423
1991	871	12,463	13,334	56	527	97	14,041
1992	555	10,675	11,230	66	959	1	12,256
1993	261	3,581	3,842	42	756	1	4,641
1994	174	5,391	5,565	21	440	1	6,027
1995	85	9,029	9,114	24	431	1	9,570
1996	55	2,668	2,723	21	182	-	2,926
1997	38	568	606	18	94	-	718
1998	35	847	882	16	81	-	979
1999	37	1,199	1,236	15	111	-	1,362
2000	59	386	445	17	138	1	622
2001	61	n/a	n/a	27	126	+	214
2002	101	n/a	n/a	23	127	1	252
2003	93	n/a	n/a	20	71	2	186
2004	93	n/a	n/a	17	74	1	185
2005	49	n/a	n/a	13	73	0	135

6.4.5 Whiting in Subarea IV (North Sea) and Division VIId (Eastern Channel)

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
Unknown	Unknown	Unknown	

The available information is inadequate to evaluate the spawning stock in relation to precautionary approach reference points. The assessment is indicative of trends only. The stock is estimated at or near the lowest observed level. Landings and fishing mortality remain at a low level.

Management objectives

There are no explicit management objectives for this stock.

Reference points

ICES considers that:	ICES proposes that:
$\mathbf{B}_{lim}$ is 225 000 t, the lowest observed biomass.	$\mathbf{B}_{pa}$ be set at 315 000 t. This affords a high probability of maintaining SSB above $\mathbf{B}_{lim}$, taking into account the uncertainty of assessments. Below this value the probability of below-average recruitment increases.
$\mathbf{F}_{lim}$ is 0.90, the fishing mortality estimated to lead to potential stock collapse.	$\mathbf{F}_{pa}$ be set at 0.65. This F is considered to provide approximately 95% probability of avoiding $\mathbf{F}_{lim}$, taking into account the uncertainty of the assessment.

Yield and spawning biomass per Recruit
F-reference points:(from ACFM 2005)

	Fish Mort Ages 2–6	Yield/R	SSB/R
$\mathbf{F}_{max}$	N/A		
$\mathbf{F}_{0.1}$	0.268	0.022	0.158
$\mathbf{F}_{med}$	0.373	0.023	0.132

Technical basis:

$\mathbf{B}_{lim} = \mathbf{B}_{loss}$ = 225 000 t.	$\mathbf{B}_{pa} = 1.4*\mathbf{B}_{lim}$, apparent impaired recruitment below this value: 315 000 t.
$\mathbf{F}_{lim} = \mathbf{F}_{loss}$ = 0.9.	$\mathbf{F}_{pa} \sim 0.7\ \mathbf{F}_{lim}$=0.65.

Single-stock exploitation boundaries

Exploitation boundaries in relation to precautionary considerations

The stock status cannot be assessed with reference to precautionary reference points. However, in the light of the low estimate of stock size in combination with the low recent landings with indication of current low exploitation rates, ICES recommends that total human consumption landings in 2007 should not be allowed to increase above the recent (2003–2005) average of 15 100 t for Subarea IV and Division VIId.

Management considerations

The advice on landings assumes that the fraction of the catch-at-age that is discarded and that is caught as bycatch by the industrial fishery remain stable. For 2007, this would imply discards of 16 300 t in the North Sea.

Reducing discards would improve landings opportunities in the longer term.

The assessment is only regarded as indicative of trends for the most recent 10–15 years. Without a reliable assessment for the whole time period, no revised reference points can be proposed. The present indicative assessment cannot be compared to the previous defined reference points.

Research vessel surveys indicate a stable or declining stock since 2001 in the northern and southern areas. However, fisher surveys indicate a decline in the northern component from 2001 to 2005, and a stable or increasing southern component. Landings in the Eastern Channel area (where a smaller mesh is used) have remained stable.

Whiting is taken in mixed fisheries together with other roundfish and *Nephrops* as well as bycatch in the industrial fishery for Norway pout.

Factors affecting the fisheries and the stock

The effects of regulations

The minimum mesh size increased to 120 mm in the northern area in 2002 and this may have contributed to the substantial decrease in reported landings.

The total number of fish discarded appears to have been significantly reduced since 2003 to around 60%, while in 2002 this ratio was one of the highest of the series (~80%). However, the contribution of the discards to the total catch-at-age in the commercial fisheries does not show any major change in the recent period, and the effect of the increase in mesh size for part of the fishery is not apparent. Given the uncertainties in the fishing mortality estimates it is not possible to determine regulatory effects on the stock.

Scientific basis

Data and methods

Commercial catch-at-age data were disaggregated into human consumption, discards, and industrial bycatch components. This could not be done on an area basis. Discards were estimated based on the Scottish discards sampling programme and raised to the total international fleet in the North Sea.

Three survey CPUE series are available: English groundfish survey (EngGFS), Scottish groundfish survey (ScoGFS), and IBTS Q1. The English and Scottish groundfish surveys were each split into two independent surveys because of gear and vessel changes. Due to poor estimation of fishing effort (in terms of hours fished), commercial CPUE series were not considered reliable and were not included in the exploratory analyses.

Two assessment approaches, an age-based catch model (XSA) and an age-based survey model (SURBA) were used.

Information from the fishing industry

Spatial information on landings (based on 70% of the total in 2002) suggests three distinct areas of major catch: a northern zone, an area off the eastern English coast, and a southern area extending into the Channel (with the largest catches, and prosecuted predominantly by French vessels). The southern whiting fishery uses 80-mm nets, whereas the other fisheries are prosecuted by vessels using larger mesh nets. Northern catches have declined whilst southern landings have been maintained. In the northern zone the reduction in landings may have taken place because of changes in mesh (increases, square mesh panels, etc.).

The fishers' North Sea Stock Survey indicated different stock trends among different roundfish areas of the North Sea. The fishers' survey suggests a stable stock in the north, but increasing further south.

Uncertainties in assessment and forecast

There are considerable discrepancies in stock trends prior to 1990 between the survey time-series and the assessment based on commercial catch data.
Discard estimates are based on the Scottish sampling program, which is mainly in the northern area. Extrapolation of this to the entire area is a source of uncertainty because the fishery in the southern area is mostly carried out with different gears and smaller mesh sizes. No discards were included in the Area VIId assessment.

The issue of stock structure remains to be resolved.

Comparison with previous assessment and advice

No analytical assessment of whiting has been provided in the recent years due to the discrepancies between survey information and the catch data. The assessment that is the basis for the current advice covers a short time-series of catch data and survey information where this discrepancy does not occur, and is essentially the same procedure as last year. The assessment is only considered indicative of trends and does not form the basis for a short-term forecast.

Compared to the situation last year, both the assessment based on the commercial catch and the research vessel data indicate a low stock size this year. Therefore, the catch advice this time is lower than last year.

Source of information

Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, 5–14 September 2006 (ICES CM 2006/ACFM:35).

North Sea (Subarea IV)

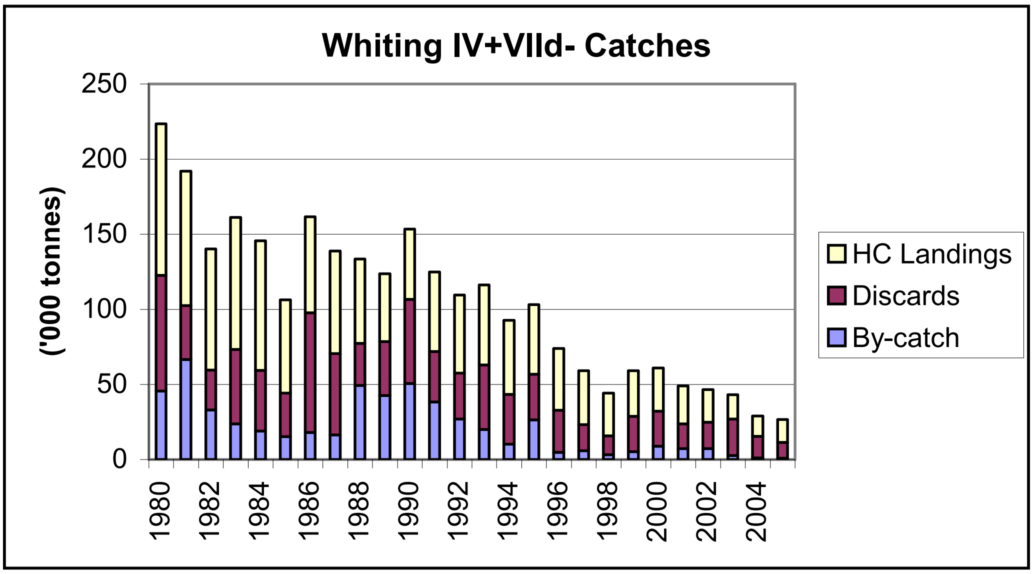
Year	ICES Advice	Single-Stock Exploitation Boundaries	Predicted Landings Corresp. To advice	Predicted Landings Corresp. To single-stock exploitation boundaries	Agreed TAC	Off. Lndgs.	ACFM figures			
							Hum. Cons.	Indust. bycatch	Disc. slip.	Total catch
1988	No increase in F; TAC		134		120	66	52	49	28	129
1989	Protect juveniles		-		115	40	41	43	36	120
1990	80% of F(88); TAC		130		125	41	43	51	56	150
1991	70% of effort (89)		-		141	47	47	38	34	119
1992	70% of effort (89)		-		135	47	46	27	31	104
1993	70% of effort (89)		-		120	47	48	20	43	111
1994	Significant reduction in effort; mixed fishery		-		100	42	43	10	33	86
1995	Significant reduction in effort; mixed fishery		-		81	41	41	27	30	98
1996	Mixed fishery; take into account cod advice		-		67	35	36	5	28	69
1997	Mixed fishery; take into account cod advice		-		74	32	31	6	17	54
1998	No increase from 1996 level		54		60	24	24	3	13	40
1999	at least 20% reduction of F(95–97)		40.4		44	25	26	5	24	55
2000	lowest possible catch		0		30	24	24	9	22	55
2001	60% reduction of F(97–99)		19.4		30	19	19	7	16	43
2002	F not larger than 0.37		≤33		32	16	16	7	17	40
2003	No cod catches		-		16	11	11	3	24	38
2004	No cod catches*)	Fishing mortality in 2004 should be less than F_{pa}	*)	catch should not increase in 2004 compared to recent years.	16	9	9	1	14	25
2005	No cod catches*)	Less than recent average	*)	52**)	28.5	10	11	1	11	22
2006	No cod catches*)	Less than recent average	*)	< 17.3**)	23.8					
2007	No cod catches*)	Less than recent average		<15.1**)						

Weights in '000 t.
*) Single-stock boundary, and the exploitation of this stock should be conducted in the context of mixed fisheries protecting stocks outside safe biological limits. **) including VIId.

Eastern Channel (Division VIId)

Year	ICES Advice	Single-Stock Exploitation Boundaries	Predicted catch corresp. to advice	Predicted Landings Corresp. To single-stock exploitation boundaries	Agreed TAC[1]	Official landings	ACFM Catch
1988	Precautionary TAC		-		-	7.8	4.4
1989	Precautionary TAC		-		-	n/a	4.2
1990	No increase in F; TAC		8.0[2]		-	n/a	3.5
1991	$\mathbf{F}_{sq}$; TAC		5.1		-	n/a	5.7
1992	If required, precautionary TAC		6.0[2]		-	5.9	5.7
1993	No basis for advice		-		-	5.4	5.2
1994	No long-term gains in increasing F		-		-	7.1	6.6
1995	Significant reduction in effort; link to North Sea		-		-	5.6	5.4
1996	Reference made to North Sea advice		-		-	5.1	5.0
1997	Reference made to North Sea advice		-		-	4.8	4.6
1998	Reference made to North Sea advice		5.8		-	4.8	4.6
1999	Reference made to North Sea advice		3.9		-	n/a	4.4
2000	Lowest possible catch		0		-	6.1	4.3
2001	60% reduction of $\mathbf{F}_{sq}$		2.5		-	6.6	5.8
2002	F not larger than 0.37		<=4		-	5.4	5.8
2003	No cod catches		-		-	6.8	5.7
2004	No cod catches *)	Fishing mortality in 2004 should be less than $\mathbf{F}_{pa}$		Catch should not increase in 2004 compared to recent years.	-	0.3	4.4
2005	No cod catches *)	-		-	-	4.1	4.8
2006	No cod catches*)	Less than recent average		< 17.3**)			
2007	No cod catches*)	Less than recent average		<15.1**)			

Weights in '000 t.
[1] Included in TAC for Subarea VII (except Division VIIa). [2]Including VIIe. *) Single stock boundary, and the exploitation of this stock should be conducted in the context of mixed fisheries protecting stocks outside safe biological limits. **) Includes both areas (IV and V). n/a = Not available.



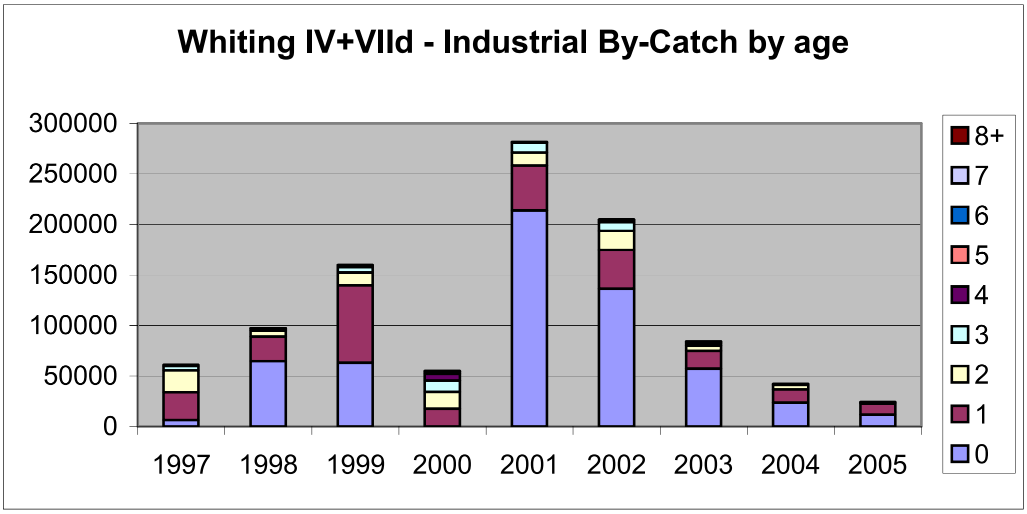
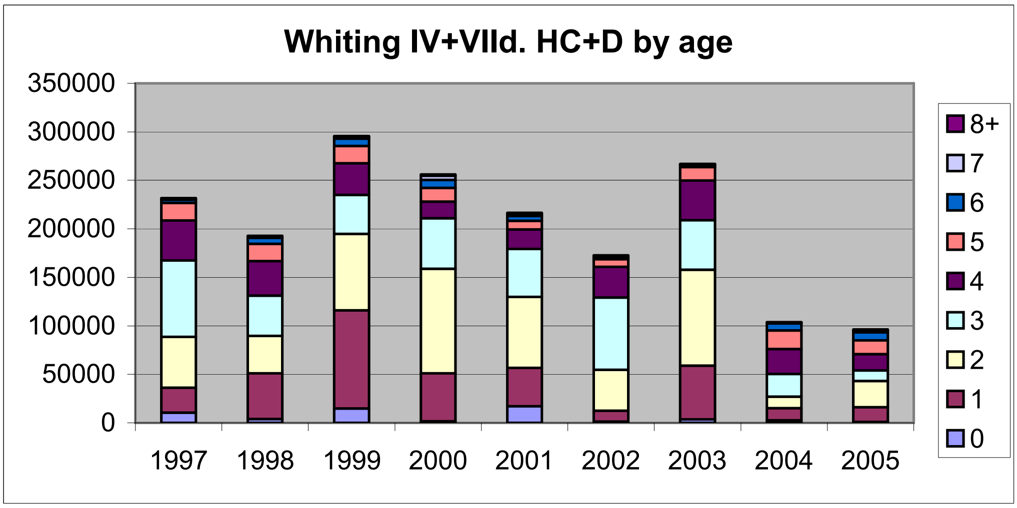
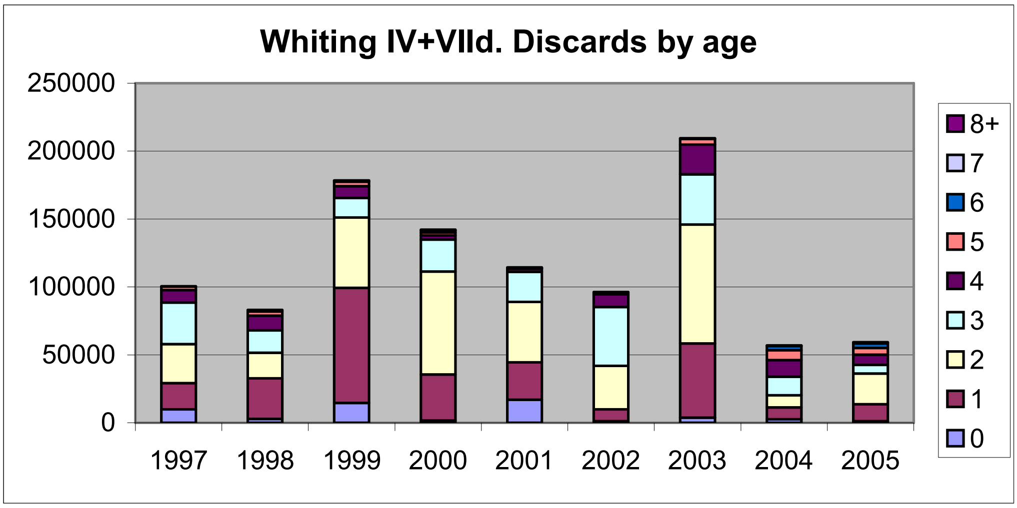


Figure 6.4.5.1 Whiting in Subarea IV (North Sea) & Division VIId (Eastern Channel)





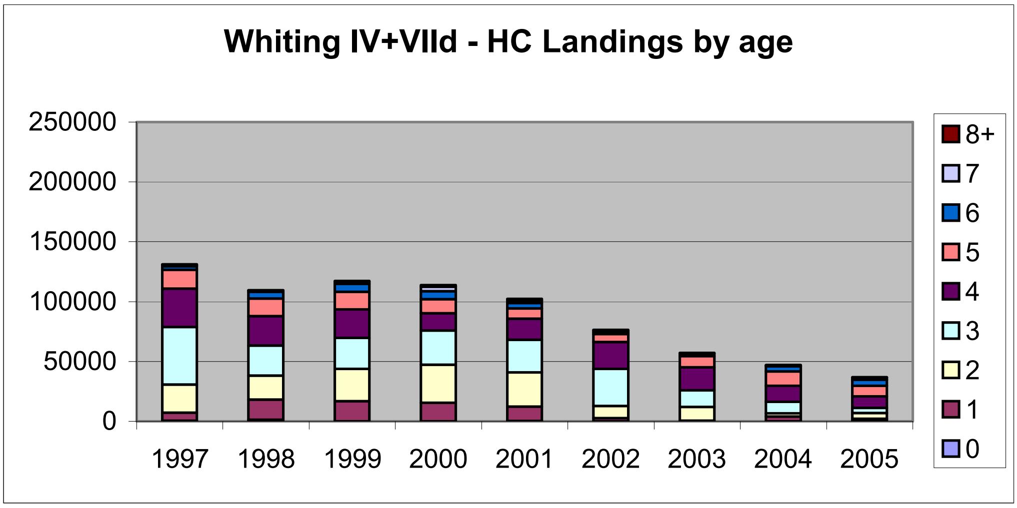
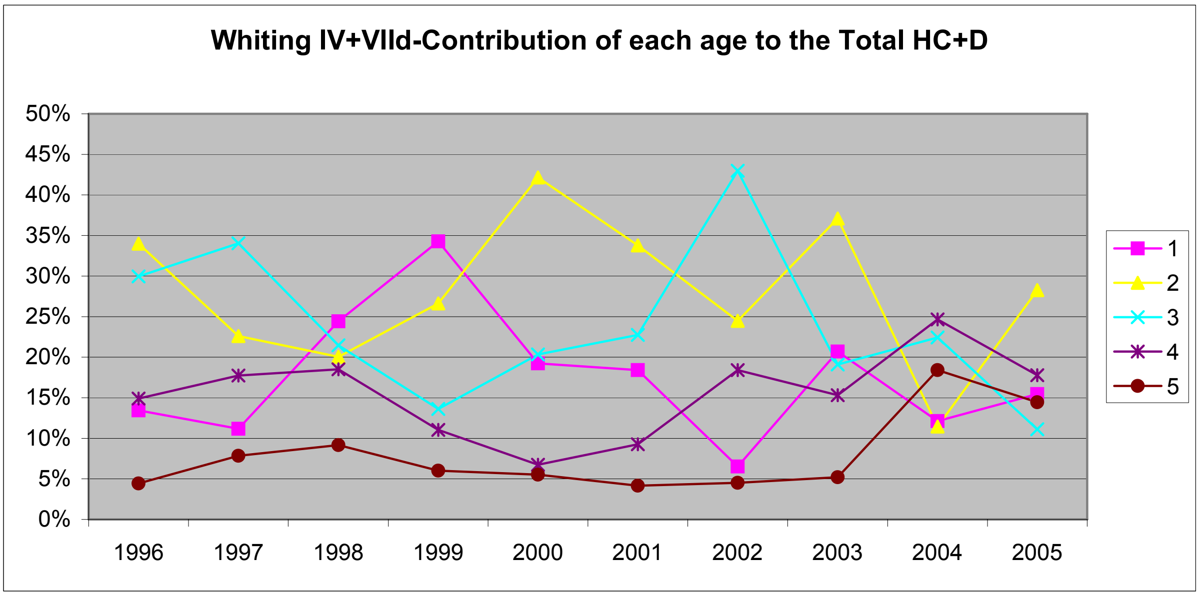


Figure 6.4.5.2 Whiting in Subarea IV (North Sea) & Division VIId (Eastern Channel)



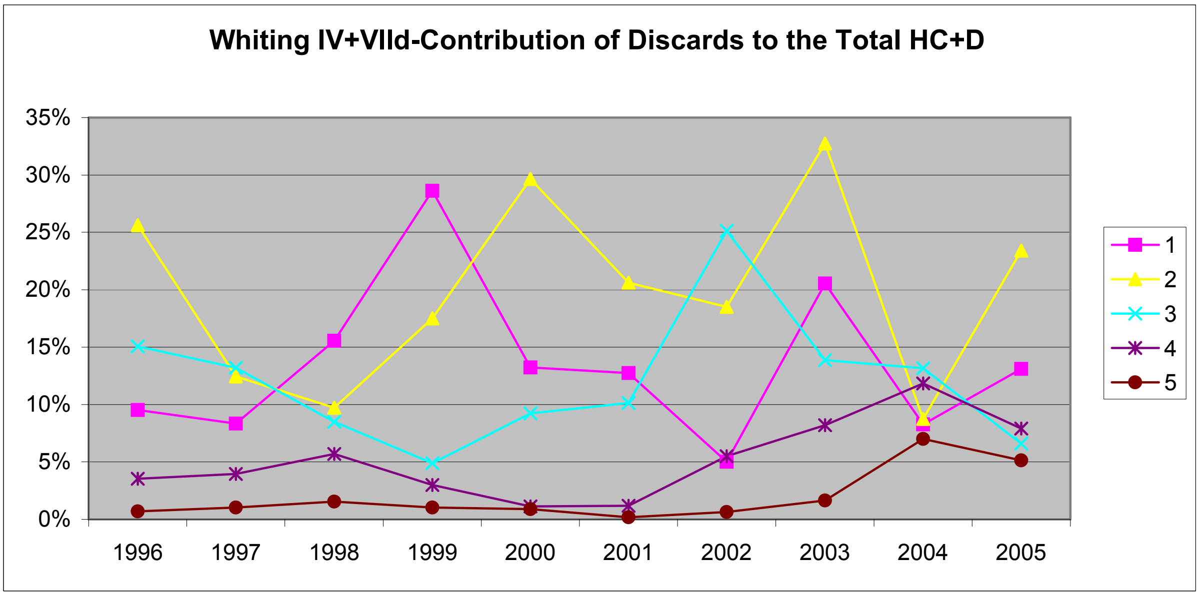


Figure 6.4.5.3 Whiting in Subarea IV (North Sea) & Division VIId (Eastern Channel)

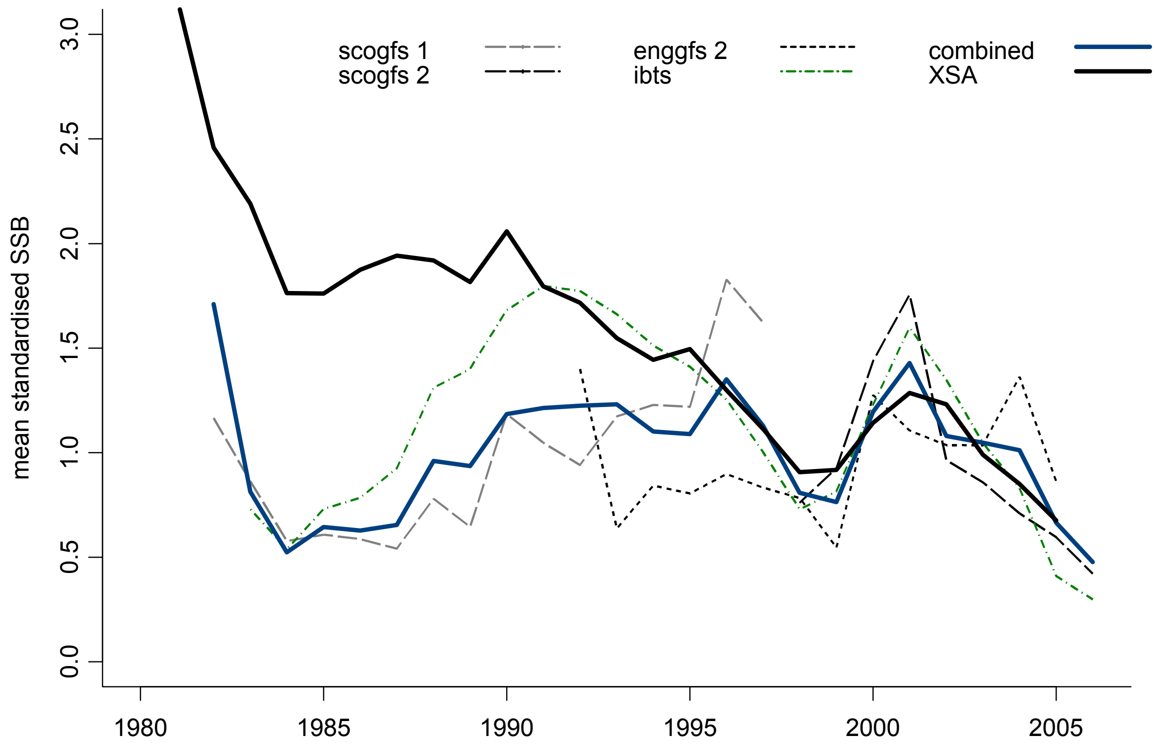


Figure 6.4.5.4 Whiting in IV and VIId. Comparison of SSB trends from SURBA runs and a multi-fleet XSA run using last years setting (with shrinkage reduced to 2.0).

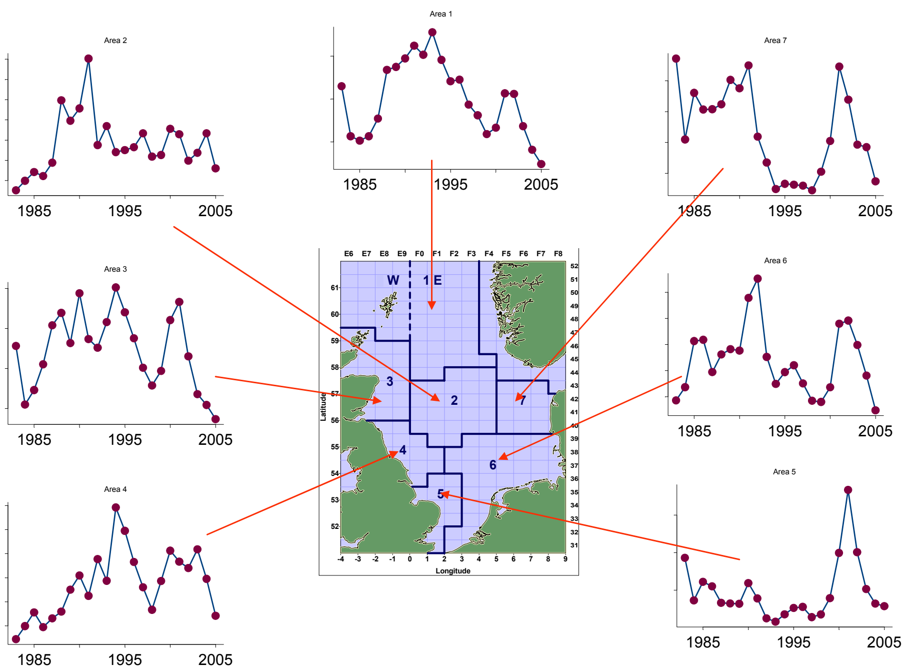


Figure 6.4.5.5 Whiting in IV and VIId. Surba-estimated SSB by IBTS roundfish area.

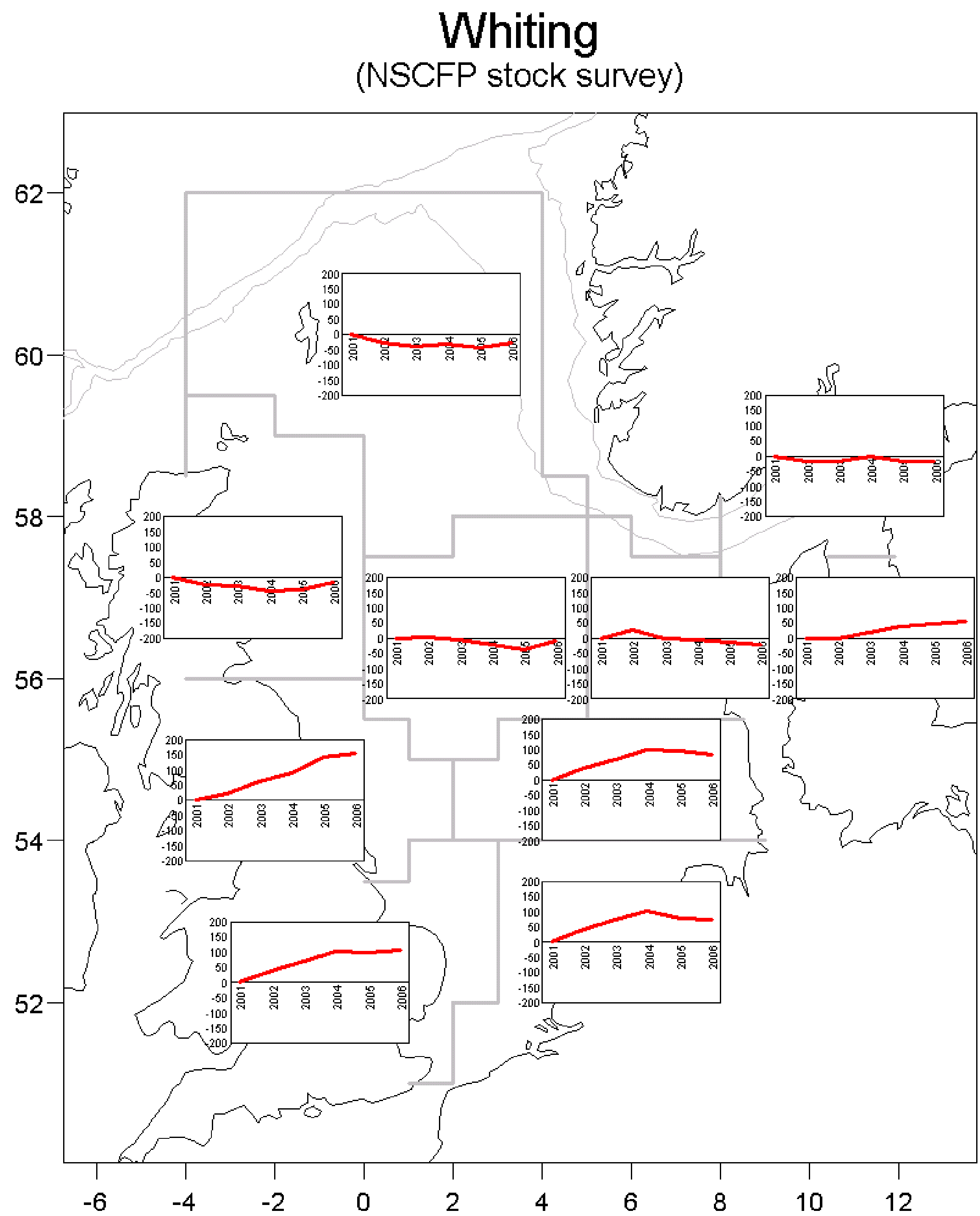


Figure 6.4.5.6 Whiting in IV and VIId. North Sea Commision Fisheries Partnership Stock Survey.

Table 6.4.5.1 Whiting in Subarea IV and Division VIId. Nominal landings (in tonnes) as officially reported to ICES.

Subarea IV

Country	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Belgium	944	1042	880	843	391	268	529	536	454	270	248	144	105
Denmark	1418	549	368	189	103	46	58	105	105	96	89	62	57
Faroe Islands	7	2	21	0	6	1	1	0	0	17	5	0	0
France	5502	4735	5963	4704	3526	1908	0	2527	3455	3314	2675	1721	1059
Germany	441	239	124	187	196	103	176	424	402	354	334	296	149
Netherlands	4799	3864	3640	3388	2539	1941	1795	1884	2478	2425	1442	977	802
Norway	130	79	115	66	75	65	68	33	44	47	38	23	16
Poland	0	0	0	0	0	1	0	0	0	0	0	0	0
Sweden	18	10	1	1	1	0	9	4	6	7	10	2	1
UK (E.&W)[3]	2774	2722	2477	2329	2638	2909	2268	1782	1301	1322	680	1209	2653
UK (Scotland)	31268	28974	27811	23409	22098	16696	17206	17158	10589	7756	5734	5057	5361
Total	**47301**	**42216**	**41400**	**35116**	**31573**	**23938**	**22110**	**24453**	**18834**	**15608**	**11256**	**9491**	**10202**
Unallocated landings	695	423	-549	812	-273	-50	3884	29	552	308	-597	-258	315
WG estimate of H.Cons. landings	47996	42639	40851	35928	31300	23888	25994	24482	19386	15916	10659	9233.4	10517
WG estimate of discards	42953	33050	30315	28156	17194	12721	23525	23214	16488	17509	24093	12561	10448
WG estimate of Ind. By-catch	20140	10360	26544	4691	5974	3161	5160	8885	7357	7327	2743	1218	882
WG estimate of total catch	**116284**	**92683**	**103095**	**73731**	**59087**	**44370**	**59108**	**60857**	**49011**	**46271**	**43208**	**27362**	**21847**

Division VIId

Country	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Belgium	74	61	68	84	98	53	48	65	75	58	66	45	45
France	5032	6734	5202	4771	4532	4495	-	5875	6338	5172	6478	-	3819
Netherlands	-	-	-	1	1	32	6	14	67	19	175	132	125
UK (E.&W)	321	293	280	199	147	185	135	118	134	112	109	80	86
UK (Scotland)	2	-	1	1	1	+	-	-	-	-	-	-	-
United Kingdom													-
Total	**5429**	**7088**	**5551**	**5056**	**4779**	**4765**	**189**	**6072**	**6614**	**5361**	**6828**	**274**	**4074**
Unallocated	-214	-463	-161	-104	-156	-167	4,242	-1775	-810	439	-1117	4076	713
W.G. estimate	5194	6633	5385	4956	4619	4599	4428	4275	5780	5519	5712	4350	4787

Subarea IV and Division VIId

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
W.G. estimate	116284	92683	103095	73731	59087	44370	59108	60857	49011	46271	43208	27362	26633

Annual TAC for Subarea IV and Division IIa

	2000	2001	2002	2003	2004	2005	2006
TAC	29700	32358	16000	16000	16000	28500	23800

6.4.6 Plaice in Division IIIa (Skagerrak – Kattegat)

State of the stock

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

The assessment is indicative of trends only. All survey indices indicate that abundance and recruitment of plaice in Skagerrak and Kattegat has been substantially higher in the last 6–7 years, compared with measurements in the 1990s.

Management objectives

There are no explicit management objectives for this stock.

Reference points

	ICES considers that:	ICES proposed that:
Precautionary Approach reference points	$\mathbf{B}_{lim}$ cannot be accurately defined.	$\mathbf{B}_{pa}$ = 24 000 t.
	$\mathbf{F}_{lim}$ cannot be accurately defined.	$\mathbf{F}_{pa}$ = 0.73.
Target reference points		$\mathbf{F}_{y}$ undefined.

Technical basis

	$\mathbf{B}_{pa}$ = smoothed $\mathbf{B}_{loss}$ (no sign of impairment).
	$\mathbf{F}_{pa}$ = $\mathbf{F}_{med}$.

Single-stock exploitation boundaries

Exploitation boundaries in relation to precautionary limits

There is no analytical assessment, but indications from the surveys are that biomass has increased. The advice is to maintain the current TAC of 9600 t for 2007.

Short-term implications

The assessment is very uncertain and is characterized by large annual revisions in population estimates, hence no short-term forecasts were performed (see Uncertainties in assessment and forecast).

Management considerations

Plaice is taken both in a directed fishery and as an important bycatch in a mixed cod-*Nephrops*-plaice fishery. The stock area for North Sea cod includes the Skagerrak (Division IIIaN). Both North Sea cod and Kattegat (Division IIIa South) cod are well below $\mathbf{B}_{lim}$. Thus, monitoring of bycatches and discards of cod should be continued.

Ecosystem considerations

The large-scale circulation pattern in the northern Kattegat depends mainly on the interaction between Baltic runoffs and local variations due to wind stress. Nielsen *et al.* (1998) demonstrated that the abundance of settled 0-group plaice along the Danish coast of the Kattegat depends on transport from the Skagerrak. The 0-group abundance measured in July–August was significantly higher in years when wind conditions during the larval development period (March–April) were moderate to strong. This might imply that larval plaice are food-limited in years when calm conditions prevail during the larval drift period (Nielsen *et al.*, 1998).

A summary of biological inference on stock entity on plaice in these waters can be summarized as follows: Plaice in Skagerrak and Kattegat mix and Skagerrak plaice might be recruited partly from the North Sea. Kattegat plaice seems also to be connected to plaice in the Belt Sea and the western Baltic. It is likely that environmental conditions in the Belt Sea are not optimal for plaice spawning and it is therefore hypothesized that fish in this area are recruiting from the

Kattegat spawning. The current management area of IIIa is thus likely to have little affinity with the true biological entity or plaice in these waters.

Factors affecting the fisheries and the stock

The effects of regulations

The use of beam trawl is prohibited in the Kattegat, but allowed in the Skagerrak. Minimum mesh size is 90 mm for towed gears, and 100 mm for fixed gears. The minimum landing size is 27 cm. Danish fleets are prohibited to land female plaice from Division IIIa from January 15th to April 30th.

In February 2003 new regulations in IIIa were put in force in order to reduce bycatches of cod. If the mesh size was larger than or equal to 80 mm in the beam trawls and larger than or equal to 100 mm in the demersal trawls and seiners, fishing days were reduced from 25 to 9 per month (EU L 97/12). Logbook data shows a large decrease in effort by vessels with mesh size greater than 100 mm since 2003, but anecdotal information from the gear industry suggests that such a shift in mesh size has not occurred.

Scientific basis

Data and methods

The estimates of abundance of plaice in Management Area IIIa are based on annual survey estimates and an age-based survey model (SURBA), while the XSA shows severe retrospective bias and is thus not considered reliable.

Information from the fishing industry

The fishing industry has provided information which has been included in considerations of assessments. Such information has contributed to the understanding of the fisheries, also in cases where information has not been in a form which enables direct inclusion in quantitative assessments. Information from the fishery suggests that the previous concern on misreporting between Skagerrak and the North Sea is superfluous; the fishery actually takes place in the Skagerrak part of the rectangle and there is no incentive for mis-reporting either from Div. IV to IIIa or visa versa.

Uncertainties in assessment and forecast

The various surveys are reasonably consistent. Major uncertainties in the assessment relate to biological stock entity vs. the current management area. The age structure of the stock indicates few older fish; it is not known whether this is due to emigration or mortality.

Comparison with previous assessment and advice

The advice is the same as last year.

Sources of information

Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, 5–14 September 2006 (ICES CM 2006/ACFM:35).

Nielsen, E., Bagge, O., and MacKenzie, B. R. 1998. Wind-induced transport of plaice (*Pleuronectes platessa*) early life-history stages in the Skagerrak-Kattegat. J. Sea Res. 39, 11–28.

Year	ICES Advice	Single-stock Exploitation Boundaries	Predicted catch corresp. to advice		Predicted catch corresp. to Single-stock Exploitation Boundaries		Agreed TAC:		ACFM Landings
			Kattegat	Skagerrak	Kattegat	Skagerrak	Kattegat	Skagerrak	
1992	TAC		14.0				2.8	11.2	11.9
1993	Precautionary TAC		-				2.8	11.2	11.3
1994	If required, precautionary TAC		-				2.8	11.2	11.3
1995	If required, precautionary TAC		-				2.8	11.2	10.8
1996	If required, precautionary TAC		-				2.8	11.2	10.5
1997	No advice		-				2.8	11.2	10.1
1998	No increase in F from the present level		11.9				2.8	11.2	8.4
1999	No increase in F from the present level		11.0				2.8	11.2	8.5
2000	$F < \mathbf{F}_{pa}$		11.8				2.8	11.2	8.8
2001	$F < \mathbf{F}_{pa}$		9.4				2.35	9.4	11.7
2002	$F < \mathbf{F}_{pa}$		8.5[1]				1.6[2]	6.4[2]	8.7
2003	$F < \mathbf{F}_{pa}$		18.4				3.0	10.4	8.9
2004	[3]	$F < \mathbf{F}_{pa}$	[3]		n.a.		1.8	9.5	9.1
2005		$F < \mathbf{F}_{pa}$	< 9.5				1.9	7.6	6.9
2006		No increase in F	< 9.6				1.92	7.68	
2007		Maintain current TAC	<9.6						

Weights in '000 t.
1) In March 2002 ACFM revised its advice to 11.6 for both areas combined.
2) The TAC for the two areas combined was adjusted to 11 200 tonnes in mid-2002.
3) Single-stock boundary and the exploitation of this stock should be conducted in the context of mixed fisheries.

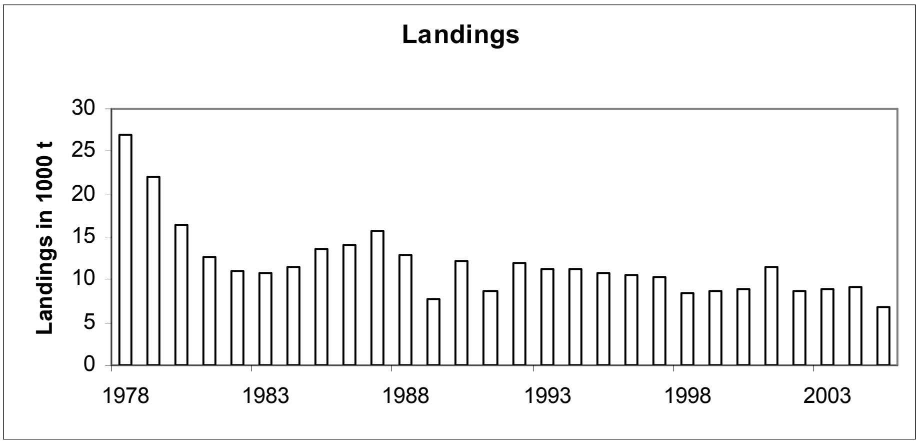


Figure 6.4.6.1 Plaice in Division IIIa (Skagerrak–Kattegat)

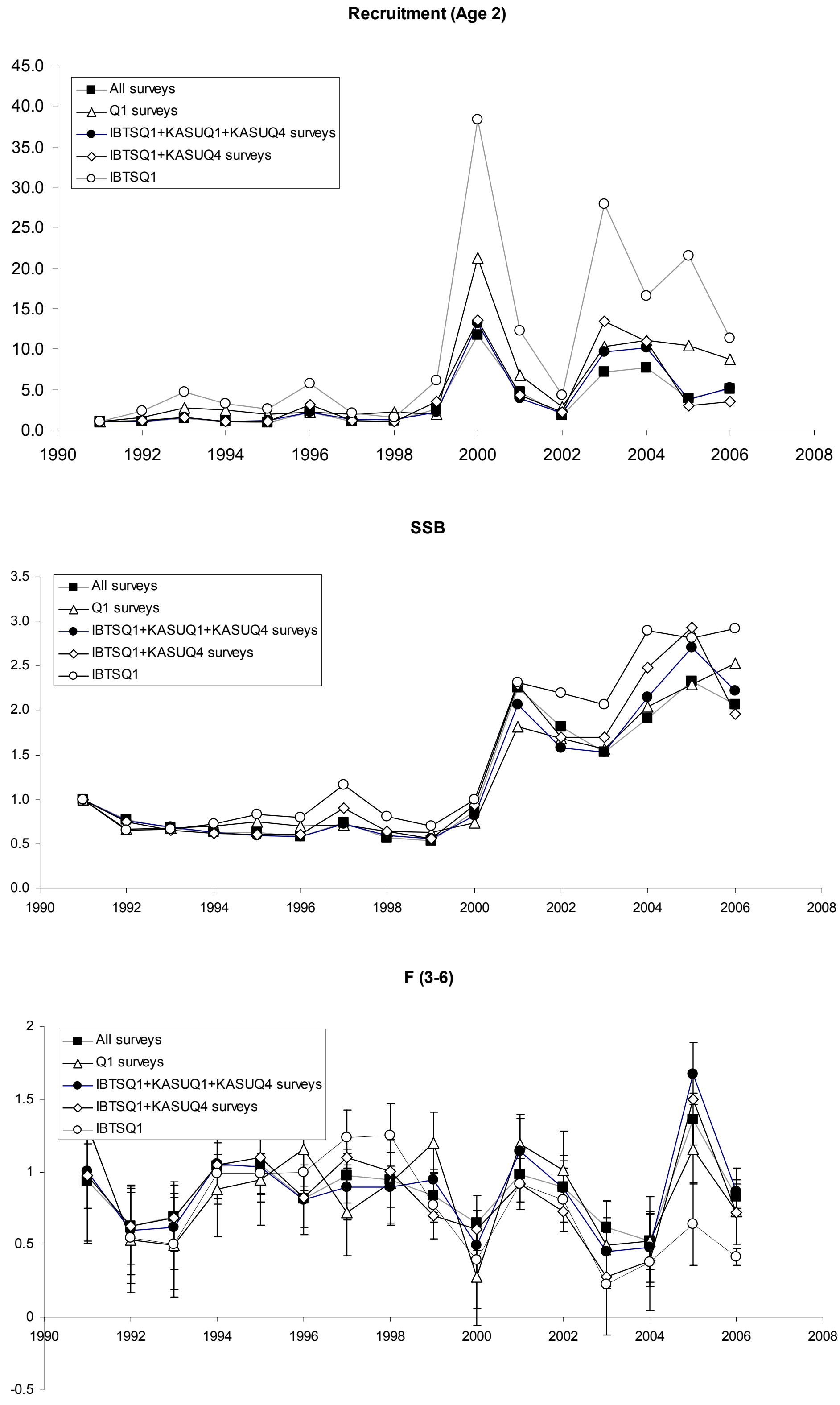


Figure 6.4.6.2 Plaice in IIIa. Summary plot of the survey-based assessment approach SURBA for combinations of surveys.

Table 6.4.6.1 Plaice in IIIa. Official landings in tonnes as reported to ICES and WG estimates, 1972-2005

Year	Denmark		Sweden		Germany		Belgium		Norway		Netherlands		Total			
	Official	WG est.	Official	WG est.	Official	WG est.	Official	WG est.	Official	WG est.	Official	WG est.	Official	Unalloc.	WG est.	TAC
1972		20,599		418		77				3					21,097	
1973		13,892		311		48				6					14,257	
1974		14,830		325		52				5					15,212	
1975		15,046		373		39				6					15,464	
1976		18,738		228		32		717		6					19,721	
1977		24,466		442		32		846		6					25,792	
1978		26,068		405		100		371		9					26,953	
1979		20,766		400		38		763		9					21,976	
1980		15,096		384		40		914		11					16,445	
1981		11,918		366		42		263		13					12,602	
1982		10,506		384		19		127		11					11,047	
1983		10,108		489		36		133		14					10,780	
1984		10,812		699		31		27		22					11,591	
1985		12,625		699		4		136		18					13,482	
1986		13,115		404		2		505		26					14,052	
1987		14,173		548		3		907		27					15,658	19,250
1988		11,602		491		0		716		41					12,850	19,750
1989		7,023		455		0		230		33					7,741	19,000
1990		10,559		981		2		471		69					12,082	13,000
1991		7,546		737		34		315		68					8,700	11,300
1992		10,582		589		117		537		106					11,931	14,000
1993		10,419		462		37		326		79					11,323	14,000
1994		10,330		542		37		325		91					11,325	14,000
1995	9,722	9,722	470	470	48	48	302	302	224	224			10,766	0	10,766	14,000
1996	9,593	9,641	465	465	31	11			428	428			10,517	28	10,545	14,000
1997	9,505	9,504	499	499	39	39			249	249			10,292	-1	10,291	14,000
1998	7,918	7,918	393	393	22	21			181	181			8,514	-1	8,513	14,000
1999	7,983	7,983	373	394	27	27			336	336			8,719	21	8,740	14,000
2000	8,324	8,324	401	414	15	15			163	163			8,789	127	8,916	14,000
2001	11,114	11,114	385	385	1	0			61	61			11,561	-1	11,560	11,750
2002	8,275	8,276	322	338	29	29			58	58			8,684	17	8,701	12,800
2003	6,884	6884	377	396	14	14			341	341	1494	1584	9,110	109	9,219	16,600
2004	7,135	7,135	317	244	77	77			106	106	1455	1511	9,090	-17	9,073	11,173
2005	5,605	5,619	244	244	21	47			80	80	808	915	6,758	147	6,905	9,500
2006																

6.4.7 Plaice in Subarea IV (North Sea)

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
At risk of reduced reproductive capacity	Harvested sustainably	Overexploited		

Based on the most recent estimate of SSB and fishing mortality, ICES classifies the stock as being at risk of reduced reproductive capacity and as being harvested sustainably. SSB in 2005 is estimated at around 193 kt and is estimated at a similar level (194 kt) in 2006. SSB is below the $\mathbf{B}_{pa}$ of 230 kt. Fishing mortality in 2005 is estimated as below $\mathbf{F}_{pa}$. Recruitment since 2003 has been below the time-series average.

Management objectives

The management agreement, previous agreed between the EU and Norway was not renewed for 2005 and is no longer in force. A new management plan for North Sea plaice is under development.

Reference points (as changed in 2004)

	ICES considers that:	ICES proposed that:
Precautionary Approach reference points	$\mathbf{B_{lim}}$ is 160 000 t.	$\mathbf{B_{pa}}$ be set at 230 000 t.
	$\mathbf{F_{lim}}$ is 0.74.	$\mathbf{F_{pa}}$ be set at 0.60.
Target reference points		

Yield and spawning biomass per Recruit
F-reference points:

	Total Fish Mort Ages 2–6	Yield/R	SSB/R
Average last 3 years	0.620	0.129	0.196
$\mathbf{F}_{max}$	0.252	0.156	1.006
$\mathbf{F}_{0.1}$	0.165	0.148	1.711
$\mathbf{F}_{med}$	0.481	0.140	0.327

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 $\mathbf{F_{0.1}}$–$\mathbf{F_{max}}$.

Technical basis

$\mathbf{B_{lim}} = \mathbf{B_{loss}}$ = 160 000 t, the lowest observed biomass in 1997 as assessed in 2004.	$\mathbf{B_{pa}}$ = Approximately 1.4 $\mathbf{B_{lim}}$.
$\mathbf{F_{lim}} = \mathbf{F_{loss}}$ = 0.74 (ages 2–6).	$\mathbf{F_{pa}}$ = 5th percentile of $\mathbf{F}_{loss}$ (0.6) and implies that $\mathbf{B}_{eq}>\mathbf{B}_{pa}$[1)] and a 50% probability that $\mathbf{SSB}_{MT} \sim \mathbf{B}_{pa}$.[2)]

[1)] see Figure 4.4.4.b.2 in ICES 2004. [2)] see Figure 4.4.4.b.3 in ICES 2004.

Single-stock exploitation boundaries

Exploitation boundaries in relation to existing management plans

The management agreement has not been renewed for 2005. Therefore, advice is only presented in the context of precautionary boundaries.

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

The current total fishing mortality (including discards) is estimated at 0.52, which is well above the rate expected to lead to high long-term yields ($\mathbf{F}_{0.1}$ = 0.17).

Exploitation boundaries in relation to precautionary limits

The exploitation boundaries in relation to precautionary limits imply human consumption landings of less than 32 000 t in 2007, which is expected to rebuild SSB to the $\mathbf{B}_{pa}$ (=230 000 t) in 2008.

Short-term implications

Outlook for 2007

Basis: $\mathbf{F}_{sq}$ = mean F(2003–2005) scaled = 0.52; R2006 = RCT3 = 704.2; R2007–08 = GM1957–2003 = 911.7; Landings(2006) = 52.6; Discards(2006) = 40.6; SSB(2007) = 189.0.

Rationale	Landings 2007	Basis	F total ages(2-6) (2007)	F H Cons Ages(2-6) (2007)	F disc Ages(2-3) (2007)	Disc (2007)	Catch (2007)	SSB (2008)	%SSB change	%TAC change
Zero catch	0.0	F=0	0.0	0.0	0.0	0.0	0.0	294	56	-100
High long-term yield	19	F(long-term yield)	0.17	0.09	0.15	18	37	256	35	-67
Status quo	6	$\mathbf{F}_{sq}$*0.1	0.05	0.03	0.05	6	12	282	49	-89
	25	$\mathbf{F}_{sq}$ *0.45	0.23	0.13	0.21	24	50	243	29	-56
	28	$\mathbf{F}_{sq}$ *0.5	0.26	0.14	0.23	27	54	238	26	-52
	32	$\mathbf{F}_{sq}$ *0.58	0.30	0.16	0.27	30	62	230	22	-45
	40	$\mathbf{F}_{sq}$ *0.75	0.39	0.21	0.34	37	77	215	14	-30
	46	$\mathbf{F}_{sq}$ *0.9	0.47	0.25	0.41	43	89	203	5	-19
	50	$\mathbf{F}_{sq}$ *1.0	0.52	0.28	0.46	47	97	194	3	-13
	54	$\mathbf{F}_{sq}$ *1.1	0.57	0.31	0.51	50	105	187	-1	-6
	57	TACsq= $\mathbf{F}_{sq}$ *1.19	0.62	0.33	0.55	53	111	180	-5	0
	60	$\mathbf{F}_{sq}$ *1.25	0.65	0.35	0.57	55	115	176	-7	4
Precautionary limits	7	$\mathbf{F}_{pa}$*0.1	0.06	0.03	0.06	7	14	280	48	-87
	17	$\mathbf{F}_{pa}$ *0.25	0.15	0.08	0.13	16	33	260	38	-71
	32	$\mathbf{F}_{pa}$ *0.5	0.30	0.16	0.27	30	62	230	22	-45
	40	$\mathbf{F}_{pa}$ *0.65	0.39	0.21	0.34	37	77	215	14	-31
	52	$\mathbf{F}_{pa}$ *0.9	0.54	0.29	0.48	48	100	191	1	-10
	56	$\mathbf{F}_{pa}$ = $\mathbf{F}_{sq}$*1.15	0.60	0.32	0.53	52	108	183	-3	-3
	60	$\mathbf{F}_{pa}$ *1.1	0.66	0.35	0.58	56	116	175	-7	5
	66	$\mathbf{F}_{pa}$ *1.25	0.75	0.40	0.66	61	127	164	-13	15
	75	$\mathbf{F}_{pa}$ *1.5	0.90	0.48	0.79	69	144	147	-22	31
	83	$\mathbf{F}_{pa}$ *1.75	1.05	0.56	0.93	75	158	132	-30	44
	90	$\mathbf{F}_{pa}$ *2.0	1.20	0.64	1.06	81	171	119	-37	57
	96	$\mathbf{F}_{pa}$ *2.25	1.35	0.73	1.19	86	183	108	-43	67

Weights in '000t.
Shaded scenarios are not considered consistent with the precautionary approach.
%SSB change: 2008 relative to 2007.
%TAC change: 2007 relative to 2006.

Management considerations

Due to a range of factors such as TAC constraints on plaice, effort limitations and increases in fuel prices, the fishing effort of the major fleets has concentrated in the southern part of the North Sea. This is the area where many juvenile fish are found. In addition, juvenile plaice has shown a more off-shore distribution in recent years. The combination of a change in fishing pattern and the spatial distribution of juvenile plaice has lead to an apparent increase in discarding of plaice.

Technical measures applicable to the mixed flatfish fishery will affect both sole and plaice. The minimum mesh size of 80 mm in the beam trawl fishery selects sole at the minimum landing size. However, this mesh size generates catches of plaice from 17 cm, while the minimum landing size is 27 cm, leading to a high discard rate. Mesh enlargement would reduce the catch of undersized plaice, but would also result in short-term loss of marketable sole. An increase in the minimum landing size of sole could provide an incentive to fish with larger mesh sizes and therefore mean a reduction in the discarding of plaice.

The advice on landings assumes that the fraction of the catch-at-age that is discarded remains stable. For 2007, that would imply discards of 30 000 t.

Reducing discards would improve landings opportunities in the longer term.

Factors affecting the fisheries and the stock

The effects of regulations

The Dutch beam trawl fleet has reduced the number of vessels and shifted towards two categories of vessels: 2000 HP (the maximum engine power allowed) and 300 HP (the maximum engine power for vessels that are allowed to fish within the 12-nautical mile coastal zone and in the plaice box). A substantial number of the Dutch vessels have been replaced by vessels in other countries (England, Scotland, Germany, Belgium). Overall capacity and effort of North Sea beam trawl vessels appears to have decreased since 1995.

The minimum landing size of North Sea plaice is 27 cm. This minimum landing size results in high discarding levels in the mixed flatfish fishery with beam and bottom trawls using 80-mm mesh size.

The Plaice Box is a closed area along the continental coast that has been introduced in 1989. The area was closed in all quarters since 1995. The closed area applies to vessels using towed gears, but vessels smaller than 300 HP are exempted from the regulation. An evaluation of the plaice box (Grift *et al.*, 2004) has indicated that: "From trends observed it was inferred that the Plaice Box has likely had a positive effect on the recruitment of plaice, but that its overall effect has decreased since it was established. There are two reasons to assume that the Plaice Box has a positive effect on the recruitment of plaice: 1) at present, the Plaice Box still protects the majority of undersized plaice. Approximately 70% of the undersized plaice are found in the Plaice Box and in the Wadden Sea, and despite the changed distribution, densities of juvenile plaice inside the box are still higher than outside; 2) In the 80-mm fishery, discard percentages in the box are higher than outside. Because more than 90% of the plaice caught in the 80-mm fishery in the box are discarded, any reduction in this fishery would reduce discard mortality. There is, however, no proof of a direct relationship between total discard mortality and recruitment."

Changes in fishing technology and fishing patterns

The Dutch beam trawl fleet, one of the major operators in the mixed flatfish fishery in the North Sea, has shifted towards more inshore fishing grounds and a reduction in fishing effort in the more northern areas. This shift may be caused by a number of factors, such as the implementation of fishing effort restrictions, the recent increase in fuel prices, and different changes in the TACs for the two main target species plaice and sole. However, the contribution of each of these factors is yet unknown. This concentration of fishing effort in more inshore fishing grounds could result in increased discarding of juvenile plaice that are mainly distributed in those areas.

Ecosystem

Adult North Sea plaice have an annual migration cycle between spawning and feeding grounds. The spawning grounds are located in the central and Southern North Sea, overlapping with the distribution area of sole. The feeding grounds are located more northerly than the sole distribution areas.

Juvenile stages are concentrated in shallow inshore waters and move gradually offshore as they become larger. The nursery areas on the eastern side of the North Sea contribute most of the total recruitment. Sub-populations have strong homing behavior to specified spawning grounds and rather low mixing rate with other sub-populations during the feeding season. Genetically, North Sea plaice are slightly distinguishable from neighboring stocks using mitochondrial DNA (Hoarau *et al.*, 2002). Available tagging information suggests that nursery grounds in the North Sea contribute around 40% to the recruits in VIId. Movements of adult plaice are also reported. Some similarities between trends in F, SSB and R between VIId and North Sea Plaice stocks suggest that the mixing between Eastern Channel and North Sea stock may be important for this species.

Juvenile plaice have been distributed more offshore in recent years. Surveys in the Wadden Sea have shown that 1-group plaice is almost absent from the area where it was very abundant in earlier years. This could be linked to environmental changes in the productivity or changes in the temperature of the southern North Sea, but these links have not been shown conclusively.

Scientific basis

Data and methods

The stock assessment is based on an age-based model (XSA) using landings and discards, calibrated with three survey indices. Commercial CPUE series are not included in the assessment model, but they are used as general indicators of stock development.

Since 1999, discards estimates are based on Dutch and UK samples raised to the total fishery by effort ratio. For the years prior to 1999, discards were reconstructed based on a model-based analysis of growth, selectivity of the 80-mm beam trawl gear, and the availability of undersized plaice on the fishing grounds.

Information from the fishing industry

The results from the North Sea Fishers' Survey indicate that perceptions of the plaice abundance vary considerably across the North Sea, and only agree with the assessment in the north and northwest of the North Sea.

Uncertainties in assessment and forecast

The assessment is considered to be uncertain.

Estimates of discards are based on a few observations of two dominant fleets since 1999, and by using a reconstruction model for the years prior to 1999. The most recent information shows that nearly 80% of the catch by number is discarded. The inclusion of discard estimates appears to contribute to a reduction in the retrospective bias that was previously observed in this assessment. However, the apparent reduction in bias has probably been accompanied by decreased precision. The estimate of discard mortality in 1999 is much lower compared with adjacent years. This cannot be explained from changes in the fishery and may be more reflecting the noise in the discard data.

Different trends are observed in different areas of the North Sea. Commercial CPUE series and a survey in the central part of the North Sea appear to indicate an increase in the plaice stock, whereas a survey in the southern North Sea indicates that the stock has remained at a low level, and a survey in the coastal region indicates a decrease in the plaice stock. This discrepancy adds to noise in the assessment.

Comparison with previous assessment and advice

This year's assessment is consistent with the two previous assessments which included discards.

The advice for this year is given on the same basis as for last year. The advice for 2007 is 32 000 tonnes compared to 48 000 tonnes last year. This is mainly caused by the fact that all year classes recruiting in the fishery since 2003 are weak.

Sources of information

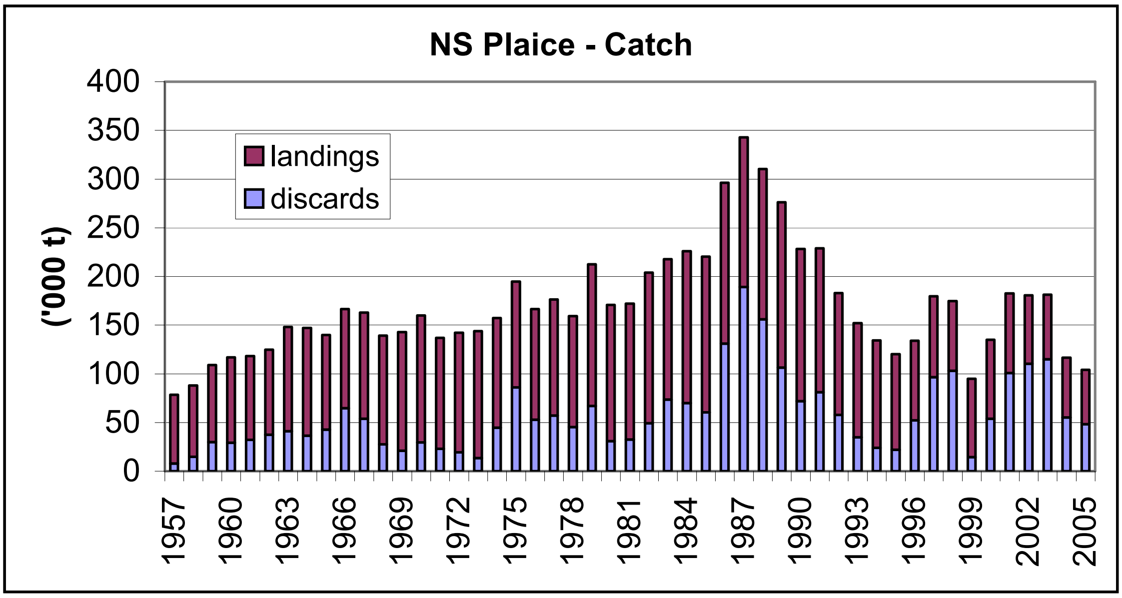
Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, 5–14 September 2006 (ICES CM 2006/ACFM:35).

Grift, R,E., Tulp, I., Clarke, L., Damm, U., McLay, A., Reeves, S., Vigneau, J., Weber, W. 2004. Assessment of the ecological effects of the Plaice Box. Report of the European Commission Expert Working Group to evaluate the Shetland and Plaice boxes. Brussels. 121 p.

Hoarau, G., Rijnsdorp, A. D., Van der Veer, H. W., Stam, W. T., and Olsen, J. L. 2002. Population structure of plaice (*Pleuronectes platessa* L.) in northern Europe: microsatellites revealed large-scale spatial and temporal homogeneity. Molecular Ecology 11: 1165–1176.

Year	ICES Advice	Single-stock exploitation boundaries	Predicted catch corresponding to advice	Predicted catch corresponding to single-stock boundaries	Agreed TAC	Official landings	ACFM landings
1987	F<F(84); TAC		120		150	131	154
1988	70% of F(85); TAC		150		175	138	154
1989	Reduce F; Buffer SSB		<175		185	152	170
1990	*status quo* F; TAC		171		180	156	156
1991	No increase in F; TAC		169		175	144	148
1992	No long-term gains in increasing F		-[1]		175	123	125
1993	No long-term gains in increasing F		170[1]		175	115	117
1994	No long-term gains in increasing F		-[1]		165	110	110
1995	Significant reduction in F		87[2]		115	96	98
1996	Reduction in F of 40%		61		81	80	82
1997	Reduction in F of 20%		80		91[3]	82	83
1998	Fish at F=0.3		82		87	70	72
1999	Fish at F=0.3		106		102	79	81
2000	Fish at F=0.3		95		97	84	81
2001	Fish at F=0.26		78		78	80	82
2002	F<$\mathbf{F_{pa}}$		<77		77	70	70
2003	Fish at F=0.23		60		73	66	67
2004		Recovery plan		-	61	61	61
2005	Rebuild the SSB above $\mathbf{B}_{pa}$ in 2006		35	35	59	55	56
2006	Rebuild the SSB above $\mathbf{B}_{pa}$ in 2007		48		57		
2007	Rebuild the SSB above $\mathbf{B}_{pa}$ in 2008		<32				

Weights in '000t.
[1] Catch at *status quo* F.
[2] Catch at 20% reduction in F.
[3] After revision from 77 000 t.



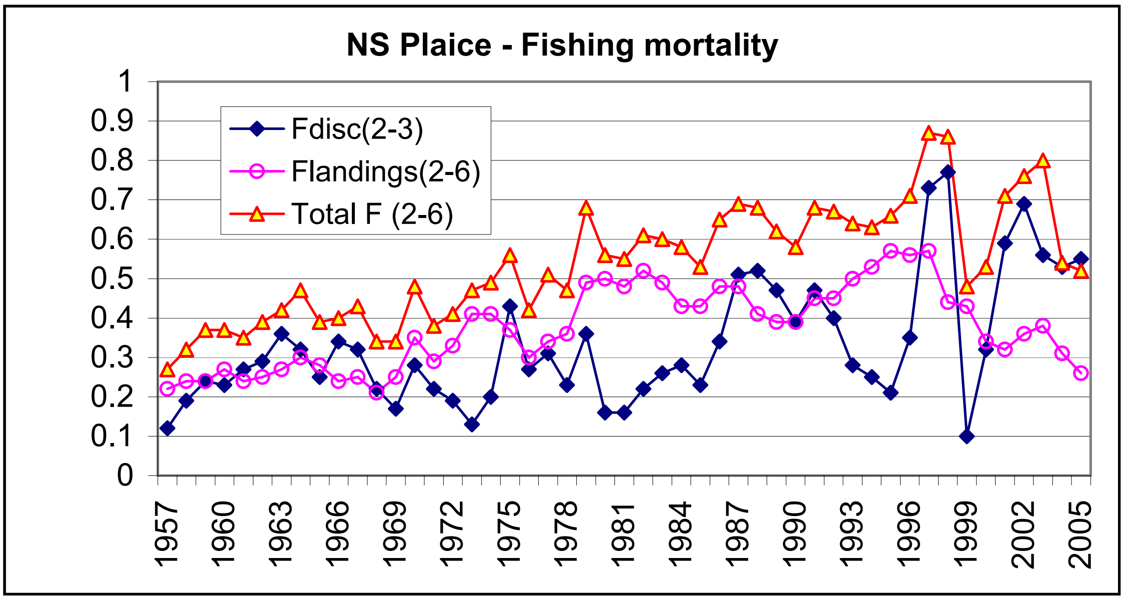
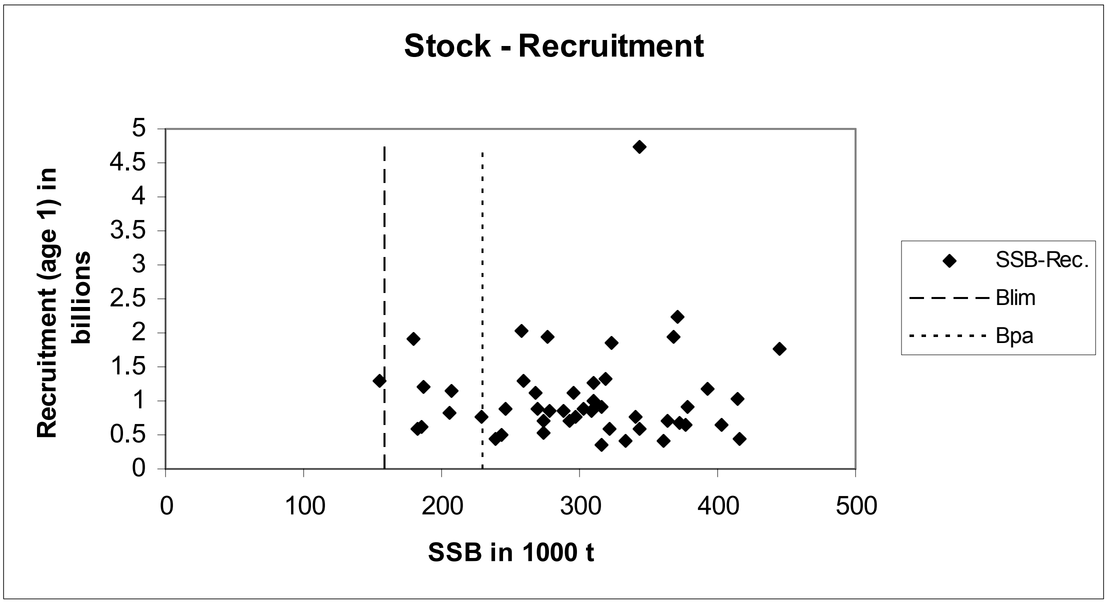
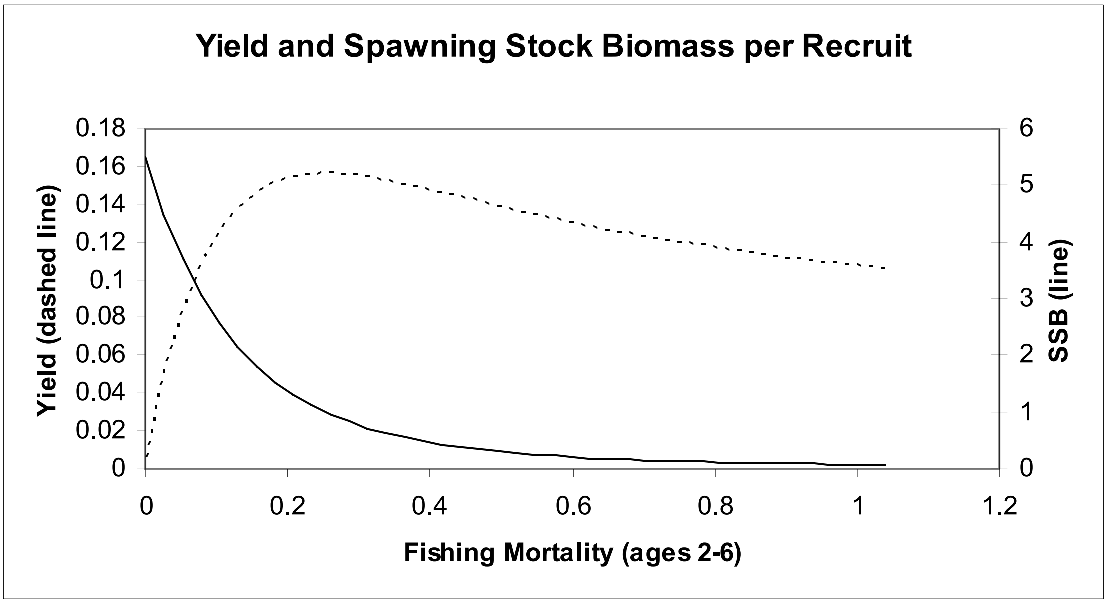


Figure 6.4.7.1 North Sea plaice. Landings and discards (top) and fishing mortality by catch component (bottom)





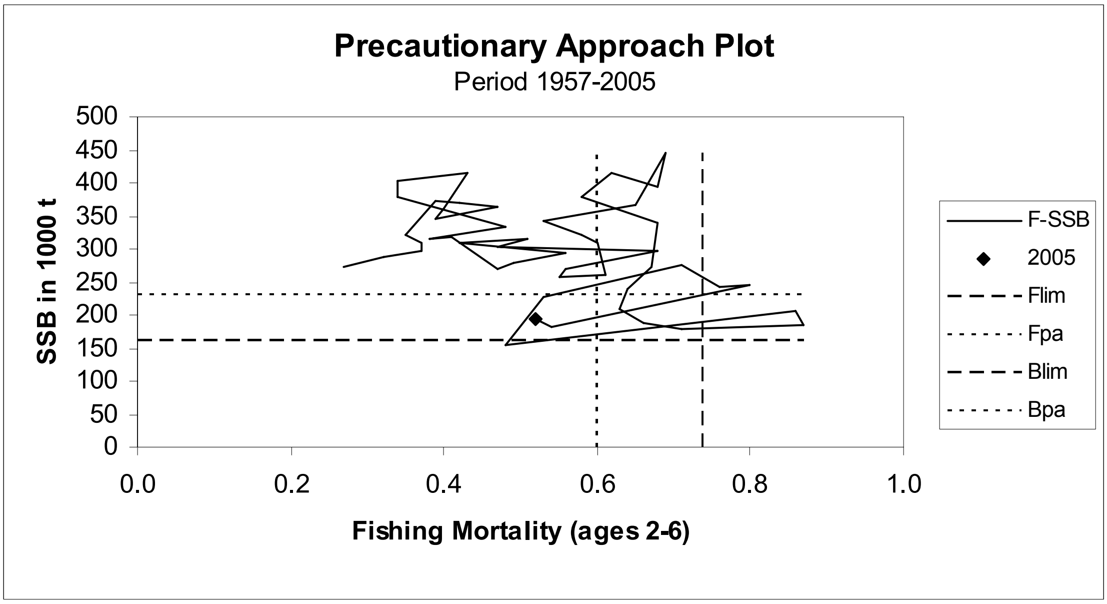


Figure 6.4.7.2 North Sea Plaice. Landings, fishing mortality, recruitment and SSB.

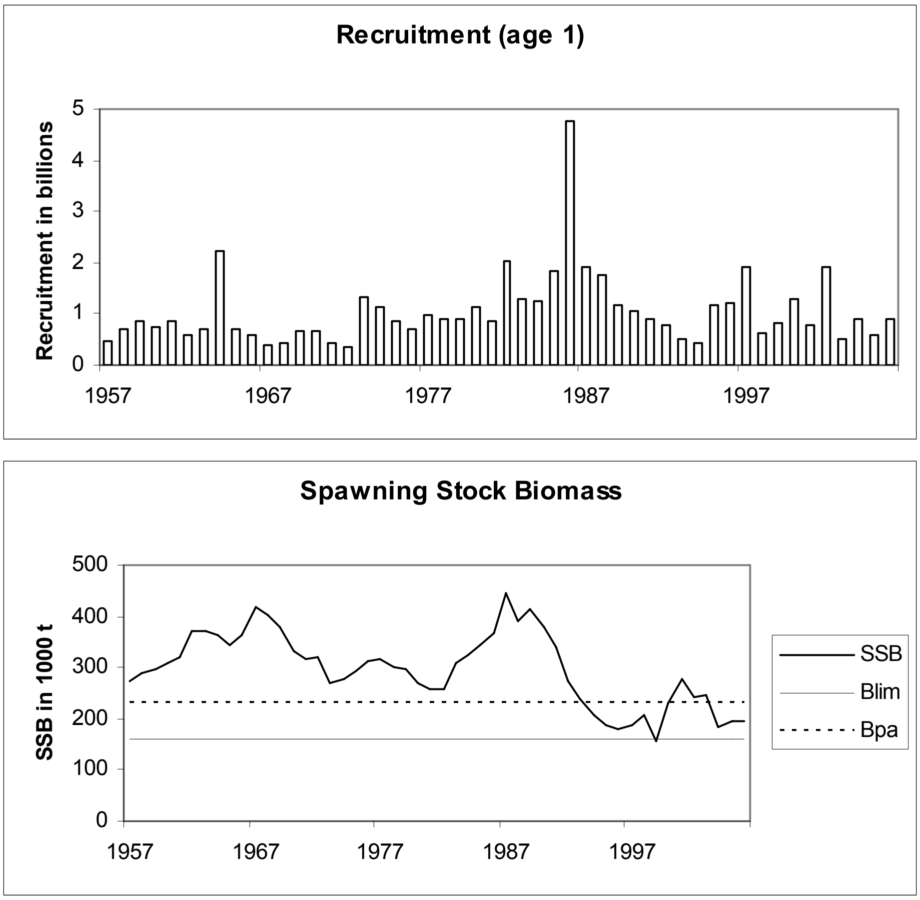


Figure 6.4.7.3 North Sea Plaice. Recruitment and SSB per recruit

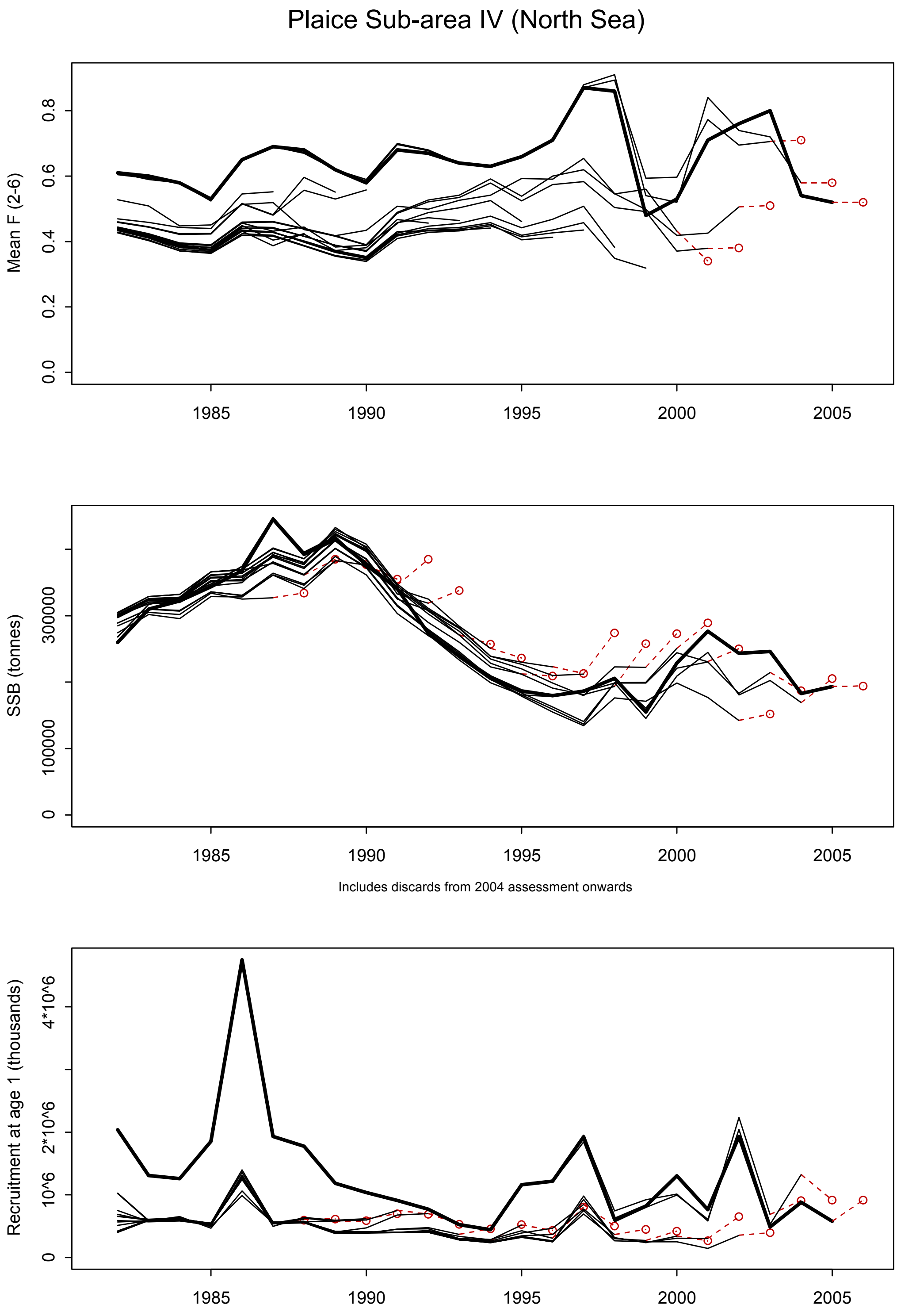


Figure 6.4.7.4 North Sea plaice. Historical performance of the assessment. Circles indicate forecasts.

Figure 6.4.7.5 North Sea plaice. Summary of the North Sea Fishers' Stock Survey results.

Table 6.4.7.1 **North Sea plaice. Nominal landings (tonnes) in Sub-Area IV as officially reported to ICES and WG estimates.**

YEAR	Belgium	Denmark	France	Germany	Nether-lands	Norway	Sweden	UK E/W/NI	UK Scotland	Others	Total	Unallocated	WG estimate	TAC
1980	7005	27057	711	4319	39782	15	7	18687	4345		101928	38023	139951	
1981	6346	22026	586	3449	40049	18	3	17129	4390		93996	45701	139697	105000
1982	6755	24532	1046	3626	41208	17	6	16385	4355		97930	56616	154546	140000
1983	9716	18749	1185	2397	51328	15	22	13241	4159		100812	43218	144030	164000
1984	11393	22154	604	2485	61478	16	13	12681	4172		114996	41153	156149	182000
1985	9965	28236	1010	2197	90950	23	18	11335	4577		148311	11527	159838	200000
1986	7232	26332	751	1809	74447	21	16	12428	4866		127902	37445	165347	180000
1987	8554	21597	1580	1794	76612	12	7	14891	5747		130794	22876	153670	150000
1988	11527	20259	1773	2566	77724	21	2	17613	6884	43	138412	16063	154475	175000
1989	10939	23481	2037	5341	84173	321	12	20413	5691		152408	17410	169818	185000
1990	13940	26474	1339	8747	78204	1756	169	18810	6822		156261	-21	156240	180000
1991	14328	24356	508	7926	67945	560	103	18267	9572		143565	4438	148003	175000
1992	12006	20891	537	6818	51064	836	53	21049	10228		123482	1708	125190	175000
1993	10814	16452	603	6895	48552	827	7	20586	10542		115278	1835	117113	175000
1994	7951	17056	407	5697	50289	524	6	17806	9943		109679	713	110392	165000
1995	7093	13358	442	6329	44263	527	3	15801	8594		96410	1946	98356	115000
1996	5765	11776	379	4780	35419	917	5	13541	7451		80033	1640	81673	81000
1997	5223	13940	254	4159	34143	1620	10	13789	8345		81483	1565	83048	91000
1998	5592	10087	489	2773	30541	965	2	11473	8442	1	70365	1169	71534	87000
1999	6160	13468	624	3144	37513	643	4	9743	7318		78617	2045	80662	102000
2000	7260	13408	547	4310	35030	883	3	13131	7579		82151	-1001	81150	97000
2001	6369	13797	429	4739	33290	1926	3	11025	8122		79700	2147	81847	78000
2002	4859	12552	548	3927	29081	1996	2	8504	8236		69705	512	70217	77000
2003	4570	13742	343	3800	27353	1967	2	7135	6757		65669	820	66489	73250
2004	4314	12123	231*	3649	23662	1744	1	7542	7742		61008	428	61436	61000
2005	3396	11385	112	3379	22271	1660	0	7683	5022		54908	792	55700	59000

*WG estimate

Table 6.4.7.2 Plaice in Subarea IV (North Sea).

	recruitment age 1	ssb	catch	landings	discards	Ftot (2-6)	Fdisc (2-3)	Fland (2-6)	Y/ssb
1957	457973	274205	78410	70563	7847	0.27	0.12	0.22	0.26
1958	698110	288540	88133	73354	14779	0.32	0.19	0.24	0.25
1959	863385	296824	109031	79300	29731	0.37	0.24	0.24	0.27
1960	757297	308163	116918	87541	29377	0.37	0.23	0.27	0.28
1961	860573	321353	118234	85984	32250	0.35	0.27	0.24	0.27
1962	589152	372862	124958	87472	37486	0.39	0.29	0.25	0.23
1963	688361	370371	148014	107118	40896	0.42	0.36	0.27	0.29
1964	2231479	363074	147059	110540	36519	0.47	0.32	0.30	0.30
1965	694564	344009	139747	97143	42604	0.39	0.25	0.28	0.28
1966	586765	361543	166589	101834	64755	0.40	0.34	0.24	0.28
1967	401281	416553	162737	108819	53918	0.43	0.32	0.25	0.26
1968	434257	402506	139259	111534	27725	0.34	0.22	0.21	0.28
1969	648830	377412	142708	121651	21057	0.34	0.17	0.25	0.32
1970	650536	333907	159877	130342	29535	0.48	0.28	0.35	0.39
1971	410215	316303	136807	113944	22863	0.38	0.22	0.29	0.36
1972	366523	319002	142308	122843	19465	0.41	0.19	0.33	0.39
1973	1311561	268640	143826	130429	13397	0.47	0.13	0.41	0.49
1974	1132162	278523	157277	112540	44737	0.49	0.20	0.41	0.40
1975	864263	292919	194672	108536	86136	0.56	0.43	0.37	0.37
1976	692030	310580	166515	113670	52845	0.42	0.27	0.30	0.37
1977	985840	316356	176300	119188	57112	0.51	0.31	0.34	0.38
1978	908601	302477	159285	113984	45301	0.47	0.23	0.36	0.38
1979	890114	295506	212501	145347	67154	0.68	0.36	0.49	0.49
1980	1127636	269737	170782	139951	30831	0.56	0.16	0.50	0.52
1981	871004	258216	172144	139747	32397	0.55	0.16	0.48	0.54
1982	2035523	259703	203863	154547	49316	0.61	0.22	0.52	0.60
1983	1305294	309919	217660	144038	73622	0.60	0.26	0.49	0.46
1984	1257091	322526	226102	156147	69955	0.58	0.28	0.43	0.48
1985	1850544	343791	220424	159838	60586	0.53	0.23	0.43	0.46
1986	4747578	368065	296260	165347	130913	0.65	0.34	0.48	0.45
1987	1929110	445526	342796	153670	189126	0.69	0.51	0.48	0.34
1988	1774162	392444	310444	154475	155969	0.68	0.52	0.41	0.39
1989	1184971	414796	276128	169818	106310	0.62	0.47	0.39	0.41
1990	1035975	378509	228218	156240	71978	0.58	0.39	0.39	0.41
1991	910226	340757	229063	148004	81059	0.68	0.47	0.45	0.43
1992	772165	273487	182887	125190	57697	0.67	0.40	0.45	0.46
1993	524548	238907	151999	117113	34886	0.64	0.28	0.50	0.49
1994	442017	207874	134218	110392	23826	0.63	0.25	0.53	0.53
1995	1158562	186469	120215	98356	21859	0.66	0.21	0.57	0.53
1996	1215952	179635	133861	81673	52188	0.71	0.35	0.56	0.45
1997	1926329	186132	179759	83048	96711	0.87	0.73	0.57	0.45
1998	607418	205668	174711	71534	103177	0.86	0.77	0.44	0.35
1999	819387	155093	94978	80662	14316	0.48	0.10	0.43	0.52
2000	1301974	228710	135002	81148	53854	0.53	0.32	0.34	0.35
2001	763592	276865	182750	81963	100787	0.71	0.59	0.32	0.30
2002	1929171	243394	180652	70217	110435	0.76	0.69	0.36	0.29
2003	488754	246132	181302	66502	114800	0.80	0.56	0.38	0.27
2004	880836	182637	116551	61436	55115	0.54	0.53	0.31	0.34
2005	579514	193408	104080	55700	48380	0.52	0.55	0.26	0.29
2006	704238*	194051							

*RCT3 estimate

6.4.8 Plaice in Division VIId (Eastern Channel)

State of the stock

Spawning biomass in relation to precautionary limits	Fishing mortality in relation to precautionary limits	Fishing mortality in relation to agreed management targets	Fishing mortality in relation to highest yield	Comment
Unknown	Unknown	Unknown	Unknown	Divergent perception between catch-at-age based and survey-based analyses

The assessment is indicative of trends only. In the absence of a reliable assessment, the state of the stock cannot be evaluated in relation to the Precautionary Approach. Analysis of survey indices show that SSB has remained stable since 1998.

Management objectives

There are no explicit management objectives for this stock.

Reference points

ICES considers that:	ICES proposes that:
$\mathbf{B_{lim}}$ = 5600 t.	$\mathbf{B_{pa}}$ = 8000 t.
$\mathbf{F_{lim}}$ = 0.54.	$\mathbf{F_{pa}}$ = 0.45.

Technical basis

$\mathbf{B_{lim}}$~ $\mathbf{B_{loss}}$ (= 5584 t).	$\mathbf{B_{pa}}$ = 1.4 $\mathbf{B_{lim}}$.
$\mathbf{F_{lim}}$ = $\mathbf{F_{loss}}$.	$\mathbf{F_{pa}}$ = 5th percentile of $\mathbf{F_{loss}}$; long-term SSB >$\mathbf{B_{pa}}$ and P(SSB_{MT}<$\mathbf{B_{pa}}$) < 10%.

Single-stock exploitation boundaries

Exploitation boundaries in relation to precautionary limits

In the absence of short-term forecasts, ICES recommends to maintain landings in 2007 at 4000 t which is the average of landings from the last three years (2003–2005).

Management considerations

The plaice stock in VIId is mostly harvested in a mixed fishery with sole. Even if there exists a directed fishery on plaice that occurs in a limited period at the beginning of the year on the spawning grounds, plaice is mainly taken as bycatch by the demersal fisheries, especially the fisheries targeting sole.

Due to the minimum mesh size (80 mm) in the mixed beam trawl fishery, a large number of undersized plaice are discarded. The 80-mm mesh size is not matched to the minimum landing size of plaice (27 cm). Measures taken specifically directed at sole fisheries will also impact the plaice fisheries.

Factors affecting the fisheries and the stock

The effects of regulations

The minimum landing size for plaice is 27 cm. Demersal gears permitted to catch plaice are 80 mm for beam trawling and otter trawling. Fixed nets are required to use 100-mm mesh since 2002, although an exemption to permit 90 mm has been in force since that time.

The impact of effort limitations enforced since 2004 as part of the cod recovery measures have not been formally evaluated by ICES for plaice in Subarea VIId.

Scientific basis

Data and methods

The assessment is based on reported landings data, three commercial CPUE indices, and three survey indices. Time-series of discard data are not available, but French observations from 2003 indicate that discards are high.

Uncertainties in assessment and forecast

The updated formulation as used in the 2005 assessment exhibited patterns in the residuals, trends in the index-specific catchabilities, and a retrospective problem. These may be associated with a lack of discarding information, the use of commercial catch rate indices, and stock identification problems.

Routine discard sampling has recently begun following the introduction of the EU Data Collection Regulations and indicates percentages of discards up to 50% in number, depending on the trip and on fishing practices. However, the time-series of discards is not yet long enough to be used in an analytical assessment.

There is some uncertainty about the stock structure. Historical tagging information shows that around 40% of the juvenile plaice in VIId come from nursery grounds in the North Sea, while the Eastern Channel supplies very few recruits to the North Sea. Similarly, around 20% of the recruits in VIIe come from VIId, while VIId does not receive significant numbers of juvenile from VIIe. There is also an adult migration between the North Sea and the Channel – 20–30% of the plaice caught in the winter in VIId were from migratory North Sea fish. The available information also suggests that plaice may migrate from the VIIe into the VIId and the North Sea after spawning.

Comparison with previous assessment and advice

The assessment was considered unreliable due to the conflicting signals of data. Last year's advice was no increase in effort. Given the apparent stability of the stock, this year's advice recommends no increase in landings.

Source of information

Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, 5–14 September 2006 (ICES CM 2006/ACFM:35).

Year	ICES Advice	Single-stock Exploitation Boundaries	Predicted catch corresp. to advice	Predicted catch corresp. to single-stock exploitation	Agreed TAC[1]	Official landings	ACFM landings
1987	Precautionary TAC[1]		6.8[1]		8.3	7.9	8.4
1988	Precautionary TAC[1]		6.9[1]		9.96	9.1	10.4
1989	No increase in effort[1]		11.7[1]		11.7	6.7[2]	8.8
1990	No increase in F; TAC		10.7[1]		10.7	7.8[2]	9.0
1991	TAC		8.8[1]		10.7	7.4[2]	7.8
1992	*Status quo* F gives mean SSB		7.6[3]		9.6	6.2	6.3
1993	Within safe biological limits		6.4[3]		8.5	4.8	5.3
1994	No long-term gains in increased F		-		9.1	5.6	6.1
1995	No increase in F		5.6		8.0	4.6	5.1
1996	No long-term gains in increasing F		6.5		7.53	4.6	5.4
1997	No advice		-		7.09	5.3	6.3
1998	Reduce F in 98 by 30% from 96 value		4.3		5.7	4.8	5.8
1999	Fishing at $\mathbf{F}_{pa}$		6.3		7.4	5.4	6.3
2000	Fishing at $\mathbf{F}_{pa}$		4.9		6.5	5.2	6.0
2001	Fishing at $<\mathbf{F}_{pa}$		<4.4		6.0	5.0	5.3
2002	Fishing at $<\mathbf{F}_{pa}$		<5.8		6.7	5.5	5.8
2003	Fishing at $<\mathbf{F}_{pa}$		<5.3		6.0	4.5	4.5
2004	*)	Fishing at $<\mathbf{F}_{pa}$	*)	<5.4	6.06	4.0	4.0
2005	*)	Fishing at $<\mathbf{F}_{\mathbf{pa}}$		<4.4	5.15	3.0	3.4
2006	*)	No effort increase			5.15		
2007	*)	Average landings		<4.0			

Weights in '000 t.
[1]TACs for Divisions VIId,e.
[2]For France Division VIId landings are estimated by ICES from combined VIId,e landings.
[3] Catch at *status quo* F.
*) Single-stock boundary and the exploitation of this stock should be conducted in the context of mixed fisheries.

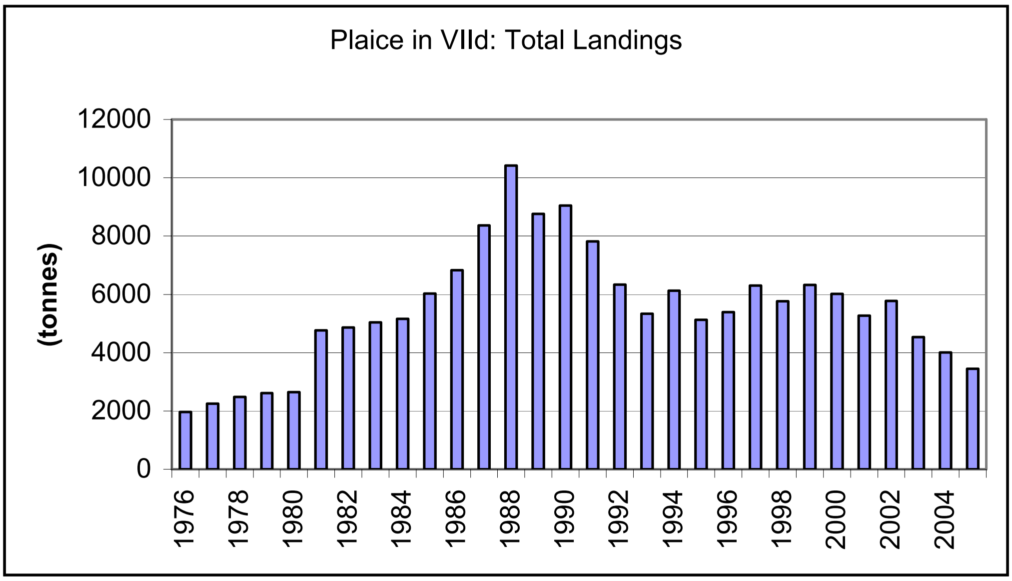


Figure 6.4.8.1 Plaice in Division VIId (Eastern Channel).

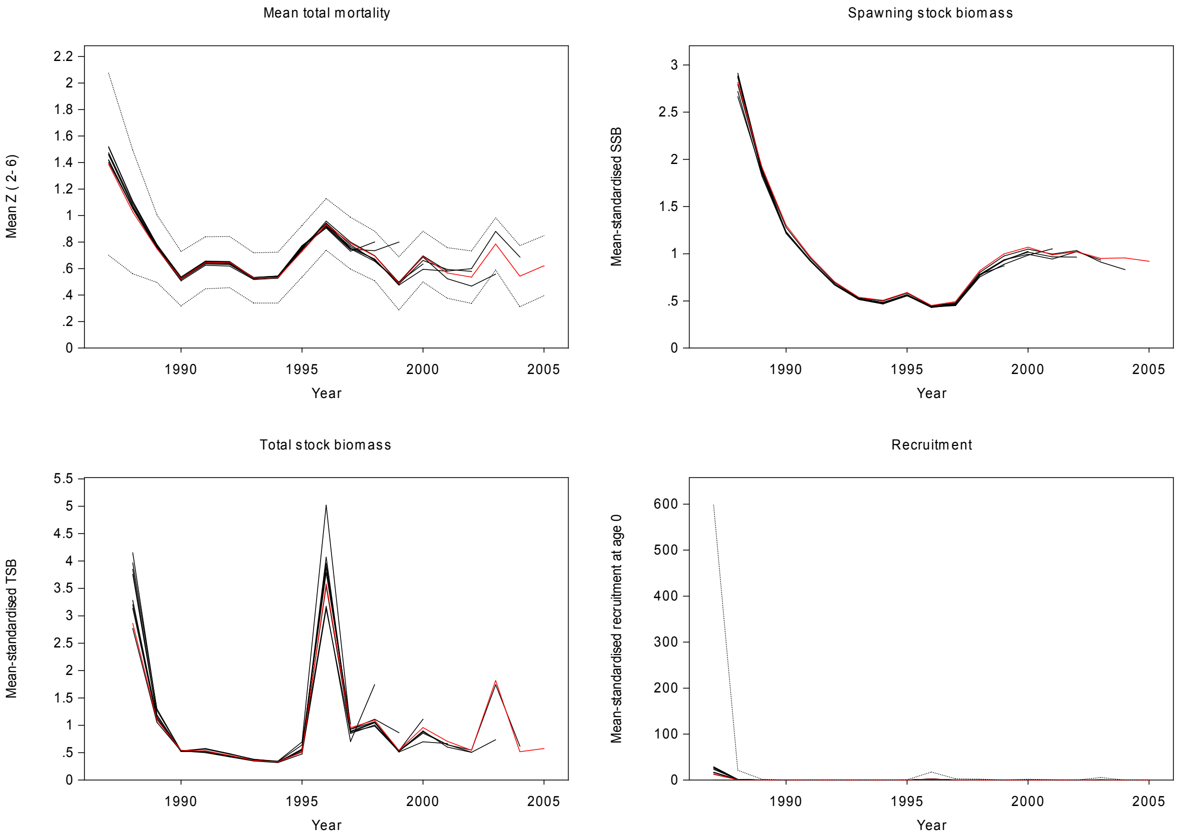


Figure 6.4.8.2 - Plaice VIId. Summary plots of the retrospective analysis from SURBA.

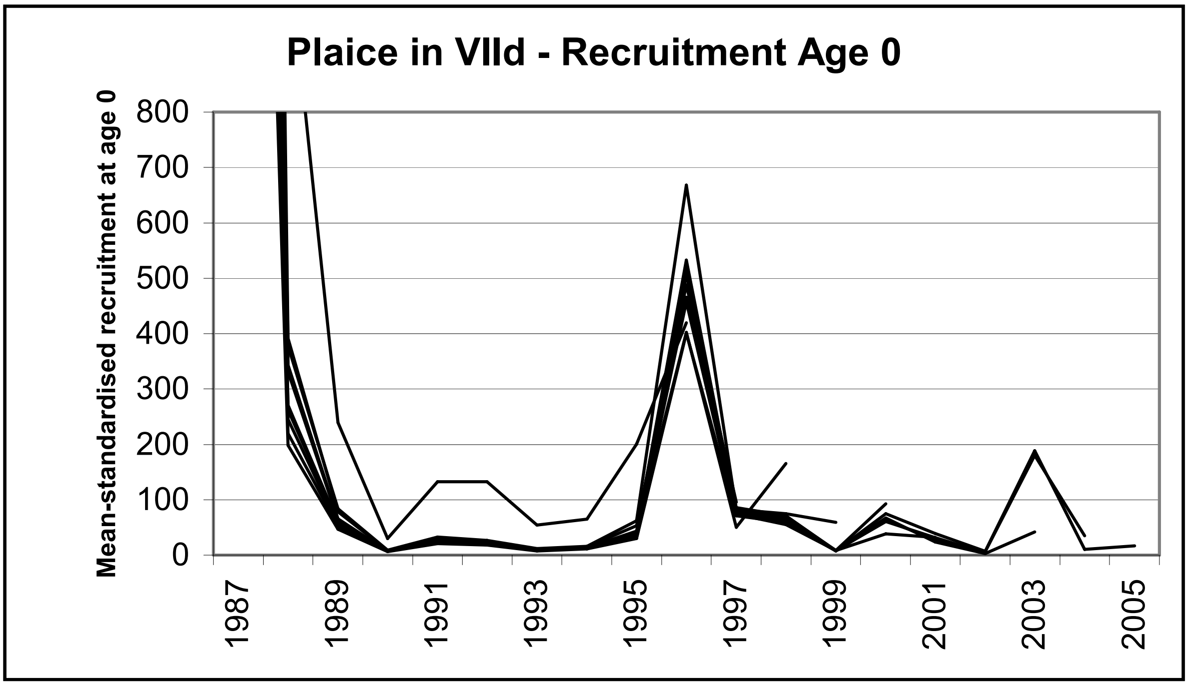


Figure 6.4.8.3 Plaice in Division VIId. Recruitment at age 1.

Table 6.4.8.1 Plaice in VIId. Nominal landings (tonnes) as officially reported to ICES, 1976–2005.

Year	Belgium	Denmark	France	UK(E+W)	Others	Total reported	Un-allocated	Total as used by WG	Agreed TAC (5)
1976	147	1(1)	1439	376	-	1963	-	1963	
1977	149	81(2)	1714	302	-	2246	-	2246	
1978	161	156(2)	1810	349	-	2476	-	2476	
1979	217	28(2)	2094	278	-	2617	-	2617	
1980	435	112(2)	2905	304	-	3756	-1106	2650	
1981	815	-	3431	489	-	4735	34	4769	
1982	738	-	3504	541	22	4805	60	4865	
1983	1013	-	3119	548	-	4680	363	5043	
1984	947	-	2844	640	-	4431	730	5161	
1985	1148	-	3943	866	-	5957	65	6022	
1986	1158	-	3288	828	488 (2)	5762	1072	6834	
1987	1807	-	4768	1292	-	7867	499	8366	8.30
1988	2165	-	5688 (2)	1250	-	9103	1317	10420	9.96
1989	2019	+	3265 (1)	1383	-	6667	2091	8758	11.70
1990	2149	-	4170 (1)	1479	-	7798	1249	9047	10.70
1991	2265	-	3606 (1)	1566	-	7437	376	7813	10.70
1992	1560	1	3099	1553	19	6232	105	6337	9.60
1993	877	+(2)	2792	1075	27	4771	560	5331	8.50
1994	1418	+	3199	993	23	5633	488	6121	9.10
1995	1157	-	2598 (2)	796	18	4569	561	5130	8.00
1996	1112	-	2630 (2)	856	+	4598	795	5393	7.53
1997	1161	-	3077	1078	+	5316	991	6307	7.09
1998	854	-	3276 (23)	700	+	4830	932	5762	5.70
1999	1306	-	3388 (23)	743	+	5437	889	6326	7.40
2000	1298	-	3183	752	+	5233	781	6014	6.50
2001	1346	-	2962	655	+	4963	303	5266	6.00
2002	1204		3454	841		5499	278	5777	6.70
2003	995	-	2783 (3)	756		4536	-	4536	6.00
2004	987		2439 (4)	580		4007	-	4007	6.06
2005	830		1756	411	20	3018	428	3446	5.15

1 Estimated by the working group from combined Division VIId+e
2 Includes Division VIIe
3 Provisional
4 Data provided to the WG but not officially provided to ICES
5 TAC«s for Divisions VII d, e.

6.4.9 Sole in Division IIIa (Skagerrak and Kattegat)

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
Full reproductive capacity	Unknown	Unknown	

Based on the most recent estimates of SSB, ICES classifies the stock as having full reproductive capacity. The assessment is uncertain due to substantial discarding and non-reporting in the most recent years. The SSB estimate is relatively robust to the uncertainty in the catch data, but the fishing mortality trend in recent years is uncertain.

Management objectives

There are no management objectives for this stock.

Reference points

The reference points were established in 1999.

	ICES considers that:	ICES proposed that:
Limit reference points	$\mathbf{B}_{lim}$ is 770 t.	$\mathbf{B}_{pa}$ be set at 1060 t.
	$\mathbf{F}_{lim}$ is 0.47.	$\mathbf{F}_{pa}$ be set at 0.30.
Target reference points		**N/A**

Technical basis:

$\mathbf{B}_{lim}$: : $\mathbf{B}_{pa}$*exp(-1.645*0.2).	$\mathbf{B}_{pa}$: MBAL.
$\mathbf{F}_{lim}$: : $\mathbf{F}_{med}$ 98 excluding the abnormal years around 1990.	$\mathbf{F}_{pa}$: consistent with $\mathbf{F}_{lim}$.

Single-stock exploitation boundaries

There is no management plan or any considerations available in relation to fishing for high yields, etc.

Exploitation boundaries in relation to precautionary limits

The SSB is high and fishing mortality is stable or decreasing. In the absence of a reliable assessment, ICES recommends keeping catches below those recently observed, i.e. 740 t (average of 2002–2005).

Management considerations

During the period 2002–2004 there was considerable misreporting and discarding of fish above minimum landing size. However, during 2005, the increase in TAC and improved control is believed to result in less misreporting and discarding.

The sensitivity of the assessment to assumptions regarding non-reporting and discarding has been evaluated last year for a range of likely scenarios. SSB estimates are relatively stable against such assumptions, but estimates of recent fishing mortalities and, thus, the projected catches in future years are not. The sensitivity analysis was repeated this year and indicates that the trend in fishing mortality in recent years is uncertain due to uncertain catch data in 2002–2004.

Sole is taken in a directed trawl fishery with bycatch of *Nephrops* and cod. Also, sole is taken as bycatch in the *Nephrops* trawl fishery. There is a directed gillnet fishery for sole. TAC for sole in 2007 should be set taking into account the status of the Kattegat cod stock, for which ICES advises no fishery in 2007.

The European Commission is developing an effort management system for implementation in 2007.

Management plan evaluations

No management plan is in place.

Regulations and their effects

The Danish fishery is regulated by half-monthly rations that depend on vessel length and which vary over the year. The rations have been reduced in the period 2002 to 2004, reflecting the decline in the agreed TAC and the Danish sole fishery was completely closed late in the years 2002 to 2004.

For the period 1991–1993, the official catch statistics are disputable with a significant amount of misreporting. For Kattegat where most of the sole catches in 1994–2000 were taken under an effort control regime, the official statistics are assumed to be fairly accurate. Considerable misreporting by areas in 2000 and 2001 was corrected.

Analyses of private logbooks, survey data, and observer data indicate that, in 2002–2004, there was considerable economic incentive to landing without reporting as the entire two-week ration in many cases could be taken in just a few hauls. However, it is not known to what extent the catches are discarded or landed as black landings (i.e. without providing both catch and effort data to the official statistics), or distributed to and landed by vessels that have not caught their rations. Based on information from the industry estimates of non-reporting and discarding at 50% in 2002 and 100% in both 2003 and 2004 was included in the current assessment. In 2005, in view of the less restrictive TAC, no adjustments to the reported catches were necessary.

The management area includes Division IIIa plus the Western Baltic (Subdivisions 22–24). Danish vessel rations cover the management area and there is therefore no incentive to misreport sole taken in Division IIIa into the Western Baltic.

Factors affecting the fisheries and the stock

Changes in fishing technology and fishing patterns

There are no major changes in the sole directed fishery in recent years. Changes in the regulations for the *Nephrops* fishery may have resulted in changes in the bycatch and selectivity on sole.

The environment

The stock is probably influenced by both temperature and salinity because it is located near the species' physiological limits for both of these factors. Variations in either factor will therefore influence stock productivity.

Scientific basis

Data and methods

The exploratory assessment includes cpue data from 4 commercial tuning series and one survey series. Different assumptions about misreporting/discarding have been explored.

The available data from discard sampling is insufficient to be used directly in the assessment.

Information from the fishing industry

Collaboration between the Danish Fishers' Organisation and DIFRES was initiated in 2004 to establish a database with data from private logbooks. Data from 6 trawlers and 3 gillnetters covering the time period 1987 to 2005 were available for the assessment.

Uncertainties in assessment and forecast

The main uncertainty is due to uncertainty in the catch data and divergent signals in the cpue data.

Sensitivity analysis indicated that combining some of the commercial tuning series used in last year's assessment did not have a major affect on the assessment output this year. Two of the commercial tuning series were based on data from private logbooks and two were based on data from official logbooks. The latter were from fisheries outside the main sole season when rations were not restrictive.

There is still a need for a fishery-independent survey series to be established as the current survey does not target sole. A sole-directed research survey was initiated in 2004, but this time-series is currently too short to be included in the assessment.

Comparison with previous assessment and advice:

The present assessment is consistent with the 2005 mid-year revision of the assessment and supports the perception of an increasing trend in SSB in recent years. Last year the advice was based on a status quo fishing mortality argument. In the absence of an analytical assessment, the advice this year is based on status quo landings (mean from 2002-2005).

Source of information

Report of the Baltic Fisheries Assessment Working Group. Rostock, 18–27 April 2006 (ICES CM 2006/ACFM:24).

Year	ICES Advice	Single-stock exploitation boundaries	Predicted catch corresp. to advice	Predicted catch corresp. to single-stock exploitation boundaries	Agreed TAC	ACFM Catch
1987	-		-		0.85	0.72
1988	-		-		0.95	0.71
1989	TAC		<0.8		0.80	0.82
1990	Precautionary TAC		0.6		0.50	1.05
1991	TAC		1.0		1.00	-[1]
1992	TAC		1.0		1.40	-[1]
1993	TAC at recent catch levels		1.0		1.60	-[1]
1994	No advice due to uncertain catches		-		2.10	1.20
1995	No advice		-		2.25	1.30
1996	No advice		-		2.25	1.10
1997	No advice		-		2.25	0.81
1998	No advice		-		1.80	0.61
1999	No increase in F		0.8		1.35	0.64
2000	No increase in F		0.65		0.95	0.63
2001	No increase in F		0.7		0.70	0.46
2002	F below $\mathbf{F}_{pa}$		0.5		0.50	0.84
2003	F below $\mathbf{F}_{pa}$		0.3		0.35	0.60
2004	F below $\mathbf{F}_{pa}$		0.5		0.52	0.78
2005	No increase in F		0.85		0.90	0.73
2006	F below $\mathbf{F}_{pa}$		0.82		0.90	
2007	Limit catches to 2002–2005 average		0.74			

[1] Uncertain. Weights in '000 t.

Sole in Division IIIa

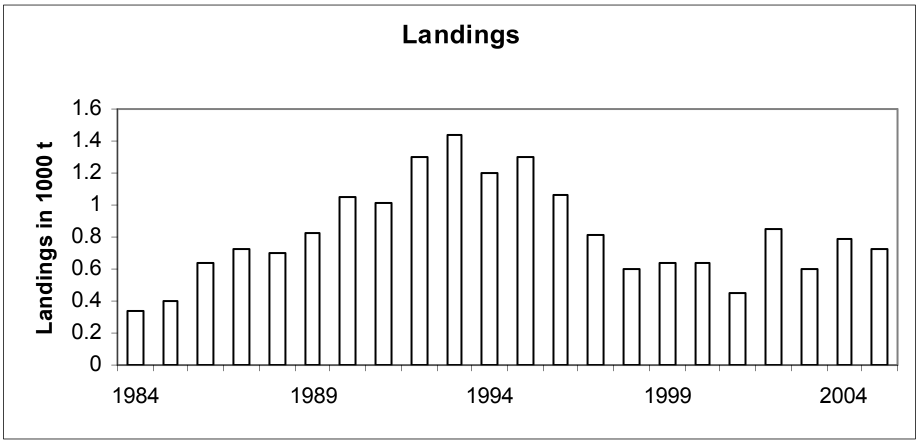


Figure 6.4.9.1 Sole in Division IIIa. Landings as estimated by ICES.

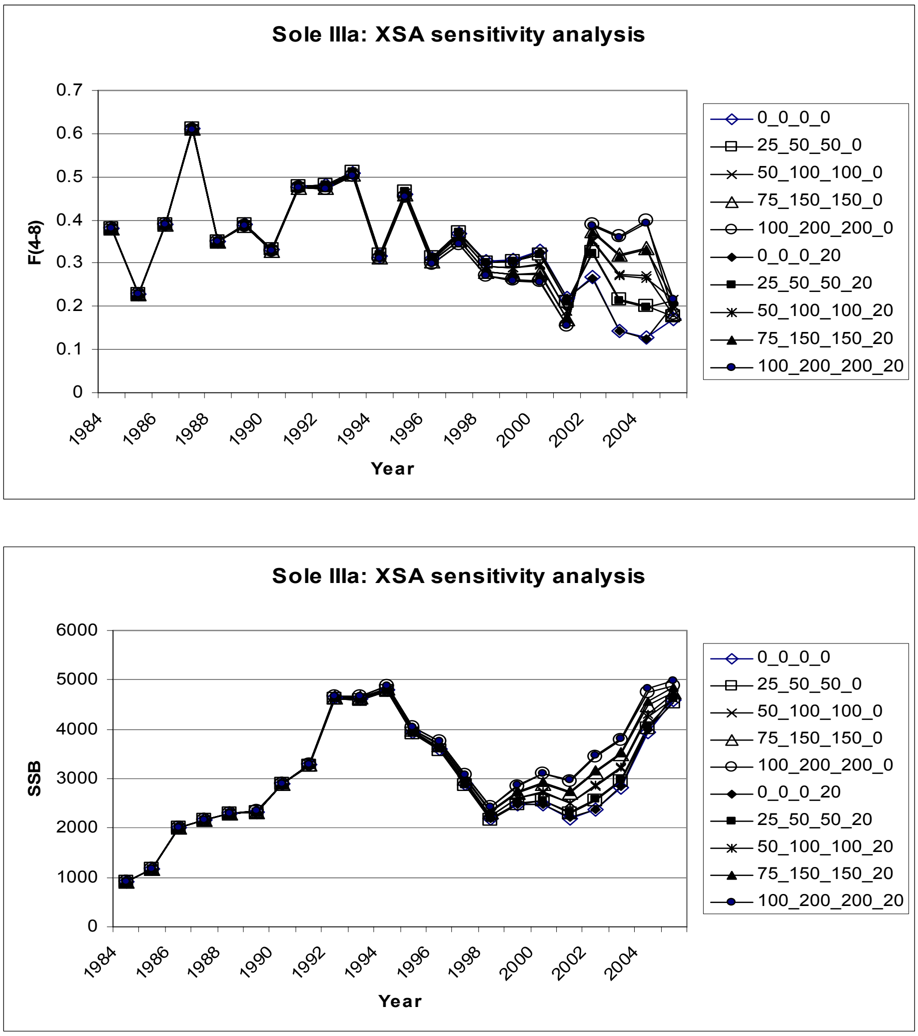


Figure 6.4.9.2 Trajectory of fishing mortalities and Stock Spawning Biomass (SSB) for sole in Division IIIa with varying degrees of misreporting during the period 2002–2005. Misreporting varied between 0%-100% in 2002, 0%-200% in 2003 and 2004, and 0%-20% in 2005.

Table 6.4.9.1 **Sole in Division IIIa**. Catches (tonnes) in the Kattegat and Skagerrak 1952–2005. Official statistics and Working Group corrections. For Sweden there is no information 1962–1974.

Year	Denmark		Sweden	Germany	Belgium	Netherlands	Working Group	Total
	Kattegat	Skagerrak	Skag+Kat	Kat+Skag	Skagerrak	Skagerrak	Corrections	
1952	156		51	59				266
1953	159		48	42				249
1954	177		43	34				254
1955	152		36	35				223
1956	168		30	57				255
1957	265		29	53				347
1958	226		35	56				317
1959	222		30	44				296
1960	294		24	83				401
1961	339		30	61				430
1962	356			58				414
1963	338			27				365
1964	376			45				421
1965	324			50				374
1966	312			20				332
1967	429			26				455
1968	290			16				306
1969	261			7				268
1970	158	25						183
1971	242	32		9				283
1972	327	31		12				370
1973	260	52		13				325
1974	388	39		9				436
1975	381	55	16	16		9	-9	468
1976	367	34	11	21	2	155	-155	435
1977	400	91	13	8	1	276	-276	513
1978	336	141	9	9		141	-141	495
1979	301	57	8	6	1	84	-84	373
1980	228	73	9	12	2	5	-5	324
1981	199	59	7	16	1			282
1982	147	52	4	8	1	1	-1	212
1983	180	70	11	15		31	-31	276
1984	235	76	13	13		54	-54	337
1985	275	102	19	1	+	132	-132	397
1986	456	158	26	1	2	109	-109	643
1987	564	137	19		2	70	-70	722
1988	540	138	24		4			706
1989	578	217	21	7	1			824
1990	464	128	29	-	2		+427	1050
1991	746	216	38	+			+11	1011[1]
1992	856	372	54				+12	1294[1]
1993	1016	355	68	9			-9	1439[1]
1994	890	296	12	4			-4	1198
1995	850	382	65	6			-6	1297
1996	784	203	57	612			-597	1059
1997	560	200	52	2				814
1998	367	145	90	3				605
1999	431	158	45	3				637
2000	399	320	34	11			-132[2]	633[2]
2001[1]	249	286	25				-103[2]	455[2]
2002	360	177	15	11			+281[3]	844
2003	195	77	11	17			+301[3]	602
2004	249	109	16	18			+392[3]	784
2005	531	132	30	34				727

[1]Considerable non-reporting assumed for the period 1991–1993. [2]Catches from Skagerrak were reduced by these amounts because of misreporting from the North Sea. The subtracted amount has been added to the North Sea sole catches. Total landings for these years in IIIA has been reduced by the amount of misreporting. [3]Assuming misreporting rates at 50, 100, and 100% in 2002, 2003, and 2004, respectively.

6.4.10 Sole in Subarea IV (North Sea)

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
Risk of reduced reproductive capacity	Risk of being harvested unsustainably	Overexploited	

Based on the most recent estimate of SSB and fishing mortality, ICES classifies the stock as being at risk of reduced reproductive capacity and as being at risk of being harvested unsustainably. SSB in 2006 was estimated at 30 000 t which is below $\mathbf{B}_{pa}$ (35 000 t), and F in 2005 (0.45) was above $\mathbf{F}_{pa}$. The year classes 2003 and 2004 are weak and surveys indicate that the year class 2005 is above average.

Management objectives

There are no explicit management objectives for this stock.

Reference points

	ICES considers that:	ICES proposed that:
Precautionary Approach reference points	$\mathbf{B}_{lim}$ = 25 000 t.	$\mathbf{B}_{pa}$ = 35 000 t.
	$\mathbf{F}_{lim}$ is undefined.	$\mathbf{F}_{pa}$ = 0.4.

Technical basis

$\mathbf{B}_{lim}$=$\mathbf{B}_{loss}$=25 000 t.	$\mathbf{B}_{pa}$ = 1.4 *$\mathbf{B}_{lim}$.
$\mathbf{F}_{lim}$: undefined.	$\mathbf{F}_{pa}$ = 0.4 implies $\mathbf{B}_{eq} > \mathbf{B}_{pa}$ and P($\mathbf{SSB}_{MT} < \mathbf{B}_{pa}$) < 10%.

Yield and spawning biomass per Recruit
F-reference points:

	Fish Mort Ages 2–6	Yield/R	SSB/R
Average last 3 years	0.46	0.18	0.37
$\mathbf{F}_{max}$	0.33	0.18	0.53
$\mathbf{F}_{0.1}$	0.14	0.16	1.22
$\mathbf{F}_{med}$	0.38	0.18	0.46

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 about $\mathbf{F}_{0.1}$.

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 fishing mortality ($\mathbf{F}_{sq}$) is estimated at 0.45, which is above the rate that would lead to high long-term yields. $\mathbf{F}_{max}$ is not well defined and $\mathbf{F}_{0.1}$ is 0.14.

Exploitation boundaries in relation to precautionary limits

The exploitation boundaries in relation to precautionary limits imply landings of less than 10 800 t in 2007, which is expected to lead to an SSB above $\mathbf{B}_{pa}$ (=35 000 t) in 2008.

Short-term implications

Outlook for 2007

Basis: $\mathbf{F}_{sq}$ =mean F(02–04) scaled = 0.45; R06 = RCT3 = 134 millions; R07–08 = GM57–03 = 97 millions; landings (2006) = 13.5; SSB(2007) = 24.4.

Rationale	Landings (2007)	Basis	F total (2007)	SSB (2008)	%SSB change 1)	%TAC change 2)
Zero catch	0.0	F=0	0.0	45.8	88	-100
High long-term yield	4.5	F(long-term yield)	0.13	41.3	69	-75
Status quo	1.6	$\mathbf{F}_{sq}$ *0.1	0.05	44.2	81	-91
	3.9	$\mathbf{F}_{sq}$ *0.25	0.11	41.9	72	-78
	7.4	$\mathbf{F}_{sq}$ *0.5	0.23	38.4	57	-58
	10.8	$\mathbf{F}_{sq}$ *0.77	0.35	35.0	43	-39
	11.1	$\mathbf{F}_{sq}$ *0.8	0.36	34.6	42	-37
	12.3	$\mathbf{F}_{sq}$ *0.9	0.41	33.5	37	-30
	13.4	$\mathbf{F}_{sq}$ *1	0.45	32.4	33	-24
	16.0	$\mathbf{F}_{sq}$ *1.25	0.56	29.8	22	-9
Precautionary limits	1.4	F(prec limits) *0.1	0.04	44.3	82	-92
	3.4	F(prec limits) *0.25	0.10	42.3	73	-81
	6.6	F(prec limits) *0.5	0.20	39.2	61	-63
	9.4	F(prec limits) *0.75	0.30	36.3	49	-47
	10.8	$\mathbf{F}_{sq}$ *0.77	0.35	35.0	43	-39
	12.1	$\mathbf{F}_{pa} = \mathbf{F}_{sq}$ *0.88	0.40	33.7	38	-32
	14.6	F(prec limits) *1.25	0.50	31.2	28	-17
	16.8	F(prec limits) *1.5	0.60	29.0	19	-5
	18.8	F(prec limits) *1.75	0.70	27.0	11	6
	20.7	F(prec limits) *2	0.80	25.2	3	17

All weights in thousand tonnes.
1) SSB(2008) relative to SSB(2007).
2) Calculated landings (2007) relative to TAC 2006.
Shaded scenarios are not considered consistent with the precautionary approach.

Management considerations

Sole are mainly caught in a mixed beam trawl fishery with plaice and other flatfish using 80-mm mesh in the southern North Sea. The minimum mesh size in the mixed beam trawl fishery in the southern North Sea means that large numbers of undersized plaice and cod are discarded. Measures to reduce discarding in the mixed beam trawl fishery would greatly benefit these stocks. An increase in the minimum landing size of sole could provide an incentive to fish with larger mesh sizes and would therefore mean a reduction in the discarding of plaice. The minimum landing size of North Sea sole is 24 cm. An increased mesh size in the fishery would reduce the catch of undersized plaice and cod, but would also result in short-term loss of marketable sole.

The peaks in the historical time-series of SSB of North Sea sole correspond with the occasional occurrence of strong year classes. Due to a high fishing mortality the SSB has declined during the nineties. The fishery opportunities and SSB are now dependent on incoming year classes and can therefore fluctuate considerably between years. The SSB and landings in recent years have been dominated by the 1996 and 2001 year classes.

The present advice framework implies large interannual changes in TAC advice when stocks are just above or just below $\mathbf{B}_{pa}$. Such variations could be avoided with the development of a long-term management plan with a lower fishing mortality than that observed at present. This will make the stock size and catch opportunities less dependent on incoming year classes.

The TAC for 2006 has been set with an implied F much higher than $\mathbf{F}_{pa}$ and $\mathbf{F}_{sq}$ and with an implied SSB in 2007 of below $\mathbf{B}_{pa}$. The present forecast assumes F *status quo* in 2006, which indicates that it is unlikely that the 2006 TAC will be taken.

Factors affecting the fisheries and the stock

The effects of regulations

Due to a range of factors such as TAC constraints on plaice, effort limitations, and increases in fuel prices, the fishing effort of the major fleets targeting sole has concentrated in the southern part of the North Sea. This is the area where a large part of the juvenile plaice in the North Sea is found. The combination of a change in fishing pattern and the spatial distribution of juvenile plaice has lead to an apparent increase in discarding of plaice.

The plaice box was established in 1989, and the area has been closed in all quarters since 1995. The closed area applies to vessels using towed gears, but vessels smaller than 300 HP are exempted from the regulation. The effectiveness of the plaice box has been evaluated by an expert group which concluded that the proportion of undersized sole inside the plaice box did not change after closure and remained stable at 60–70% (Grift *et al.,* 2004).

Changes in fishing technology and fishing patterns

The fishing effort of the major fleets exploiting North Sea sole has decreased since the mid-1990s. Recently the combination of days-at-sea regulations, high fuel prices, and decreasing TAC for plaice and relatively stable TAC for sole, appear to have induced a more coastal fishing pattern in the southern North Sea. This concentration of fishing effort could result in increased discarding of juvenile plaice that are mainly distributed in those areas.

The technical efficiency has increased in the sole fishery since the early 1990s, which could have counteracted the overall decrease in effort. This is not taken into account in the assessment.

Data and methods

The stock assessment is based on an XSA assessment, calibrated with two survey indices and one commercial CPUE index.

Information from the fishing industry

The results from the North Sea Fishers' Survey (Figure 6.4.10.4) indicate that perceptions of the sole abundance vary considerably across the North Sea, and only agree with the assessment in east and southeast.

Uncertainties in assessment and forecast

There are indications of retrospective underestimation of fishing mortality and some overestimation of abundance.

Comparison with previous assessment and advice

The assessment is generally consistent with previous assessments. The low F for 2004 of 0.35 estimated last year was confirmed by the current assessment at 0.36. The 2005 SSB estimate in 2004 was 42 000 t and was also confirmed in the current assessment being 40 000 t. The low advice for 2007 is a result of the weak 2003 and 2004 year classes and the need to rebuild SSB to above $\mathbf{B}_{pa}$.

Sources of information

Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, 5–14 September 2006 (ICES CM 2006/ACFM:35).

Grift, R,E., Tulp, I., Clarke, L., Damm, U., McLay, A., Reeves, S., Vigneau, J., Weber, W. 2004. Assessment of the ecological effects of the Plaice Box. Report of the European Commission Expert Working Group to evaluate the Shetland and Plaice boxes. Brussels. 121 p.

Year	ICES Advice	Single-stock exploitation boundaries	Predicted catch corresponding to advice	Predicted catch corresponding to single-stock	Agreed TAC	Official landings	ACFM landings
1987	Rebuild SSB to 40 000 t; TAC		11.0		14.0	13.8	17.4
1988	Increase SSB towards 50 000 t; TAC		11.0		14.0	13.4	21.6
1989	Increase SSB towards 50 000 t; TAC		14.0		14.0	14.5	21.8
1990	80% of F(88); TAC		25.0		25.0	26.5	35.1
1991	SSB>50 000 t; TAC		27.0		27.0	27.6	33.5
1992	TAC		21.0		25.0	26	29.3
1993	no long-term gains in increased F		29.0[1]		32.0	29.8	31.5
1994	no long-term gains in increased F		31.0[1]		32.0	31.3	33
1995	no long-term gains in increased F		28.0[1]		28.0	28.8	30.5
1996	Mixed fishery, link plaice advice		23.0[1]		23.0	20.4	22.7
1997	<80% of F(95)		14.6		18.0	13.7	15
1998	75% of F(96)		18.1		19.1	19.7	20.9
1999	$F<\mathbf{F}_{pa}$ (80% of F(97))		20.3		22.0	22	23.5
2000	$F<\mathbf{F}_{pa}$		<19.8		22.0	20.7	22.5
2001	$F<\mathbf{F}_{pa}$		<17.7		19.0	16.4	19.9
2002	F<0.37		<14.3		16.0	16	16.9
2003	$F<\mathbf{F}_{pa}$		<14.6		15.85	17.1	17.9
2004	[2]	$F<\mathbf{F}_{pa}$	[2]	<17.9	17.0	17.8	17.1
2005		$F<\mathbf{F}_{pa}$		<17.3	18.6	15.6	16.4
2006	Keep SSB above $\mathbf{B}_{pa}$			<11.9	17.67		
2007	SSB above $\mathbf{B}_{pa}$			<10.8			

Weights in '000 t.
[1] Catch *status quo* F.
[2] Single-stock boundary and the exploitation of this stock should be conducted in the context of mixed fisheries protecting stocks outside safe biological limits.

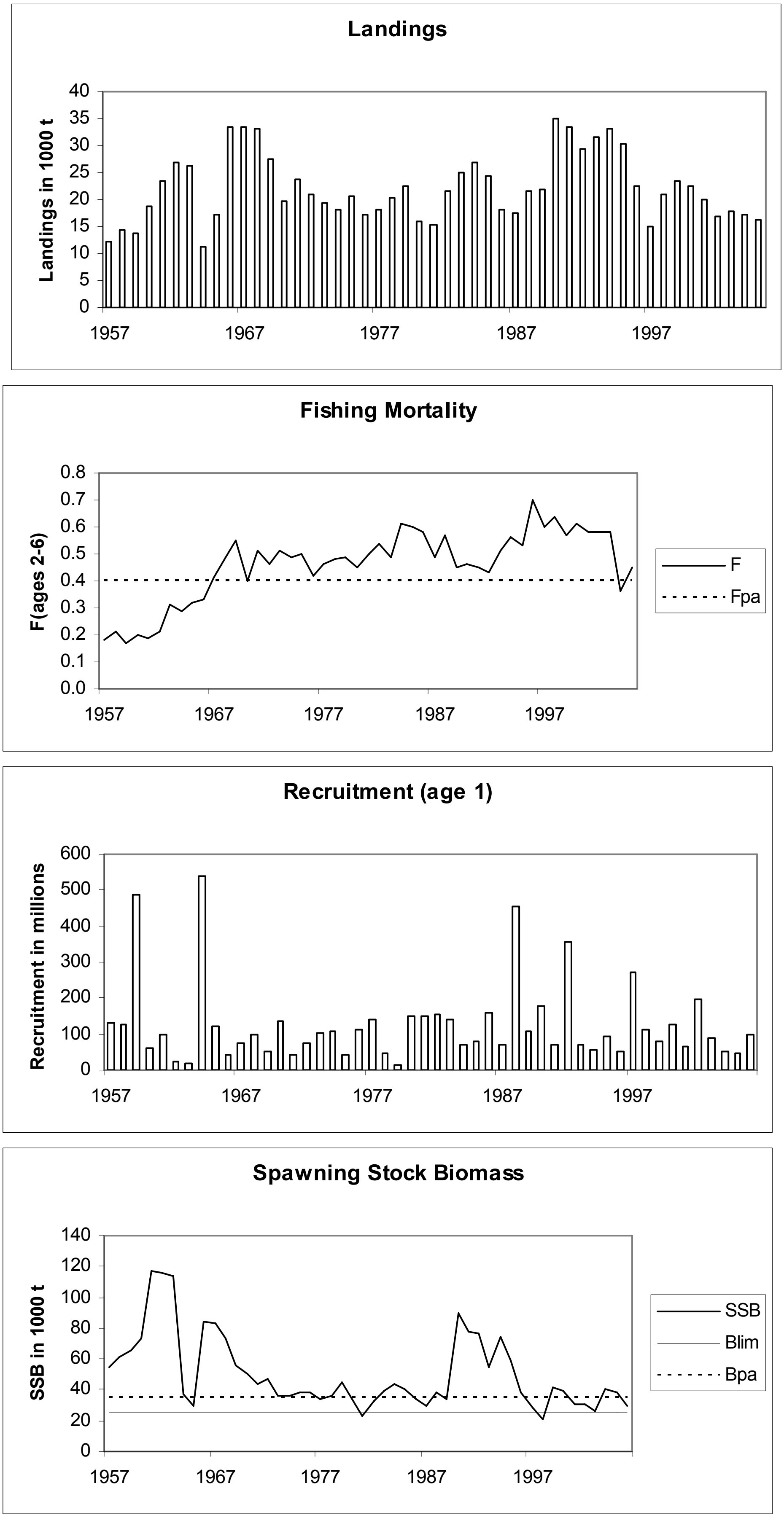
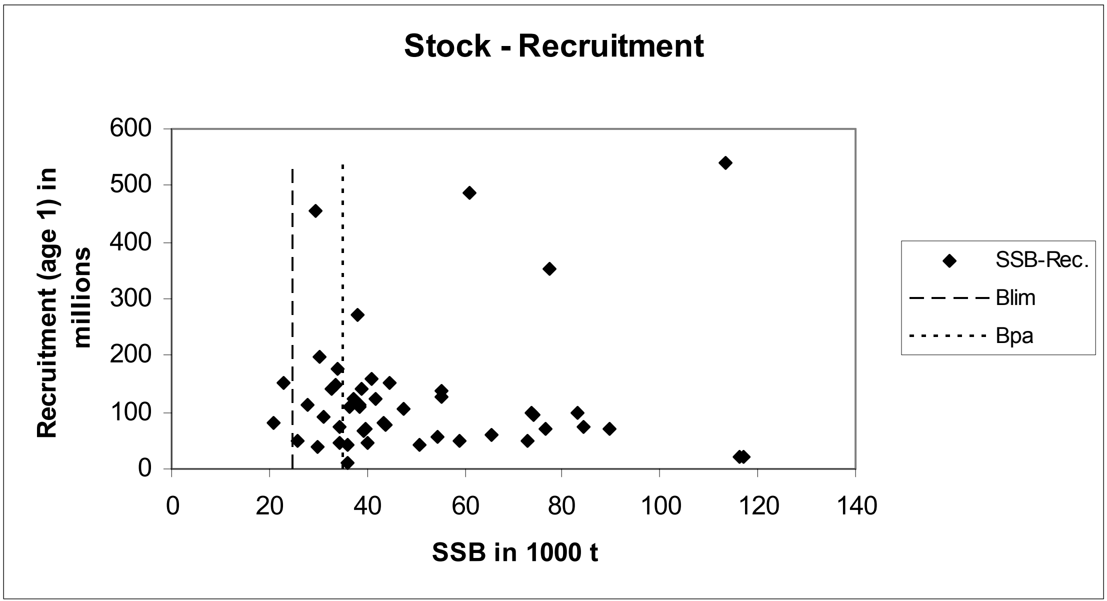
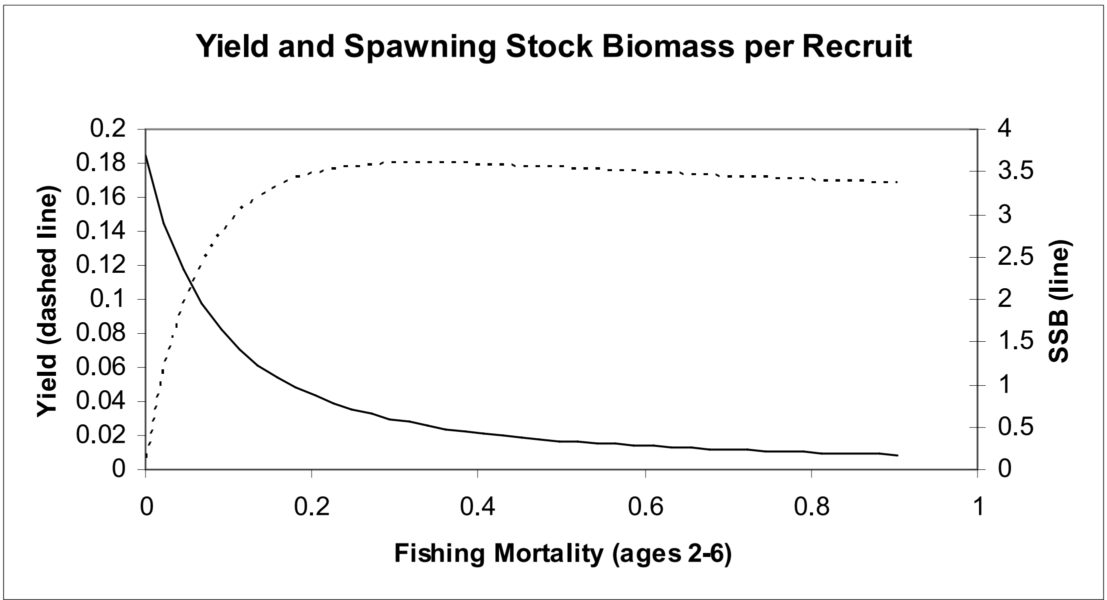


Figure 6.4.10.1 Sole in Subarea IV (North Sea). Landings, fishing mortality, recruitment and SSB.





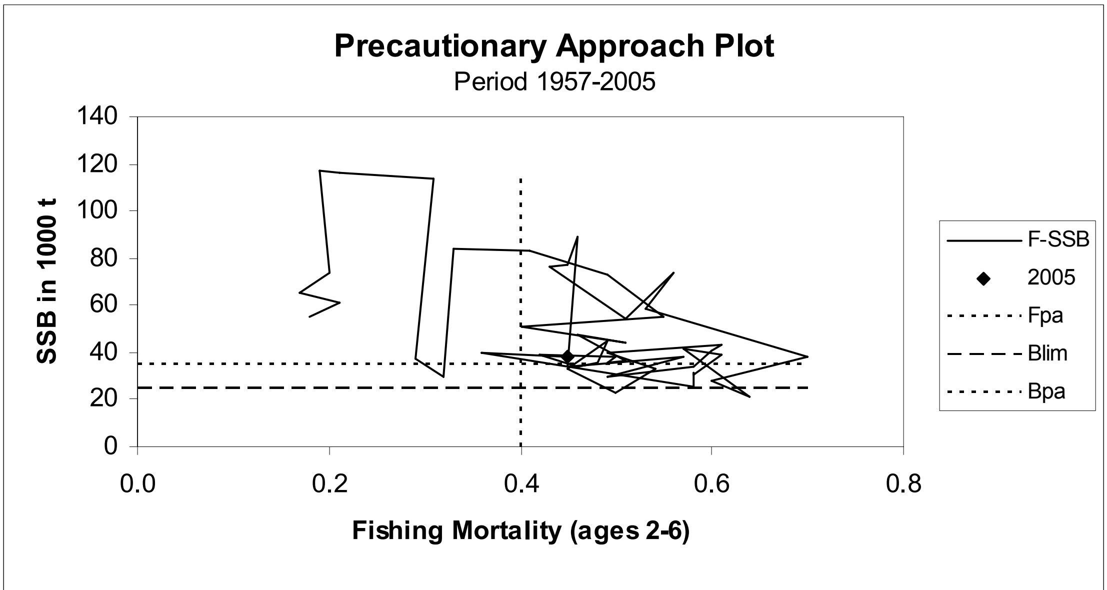


Figure 6.4.10.2 Sole in Subarea IV (North Sea). Stock and recruitment; Yield and SSB per recruit.

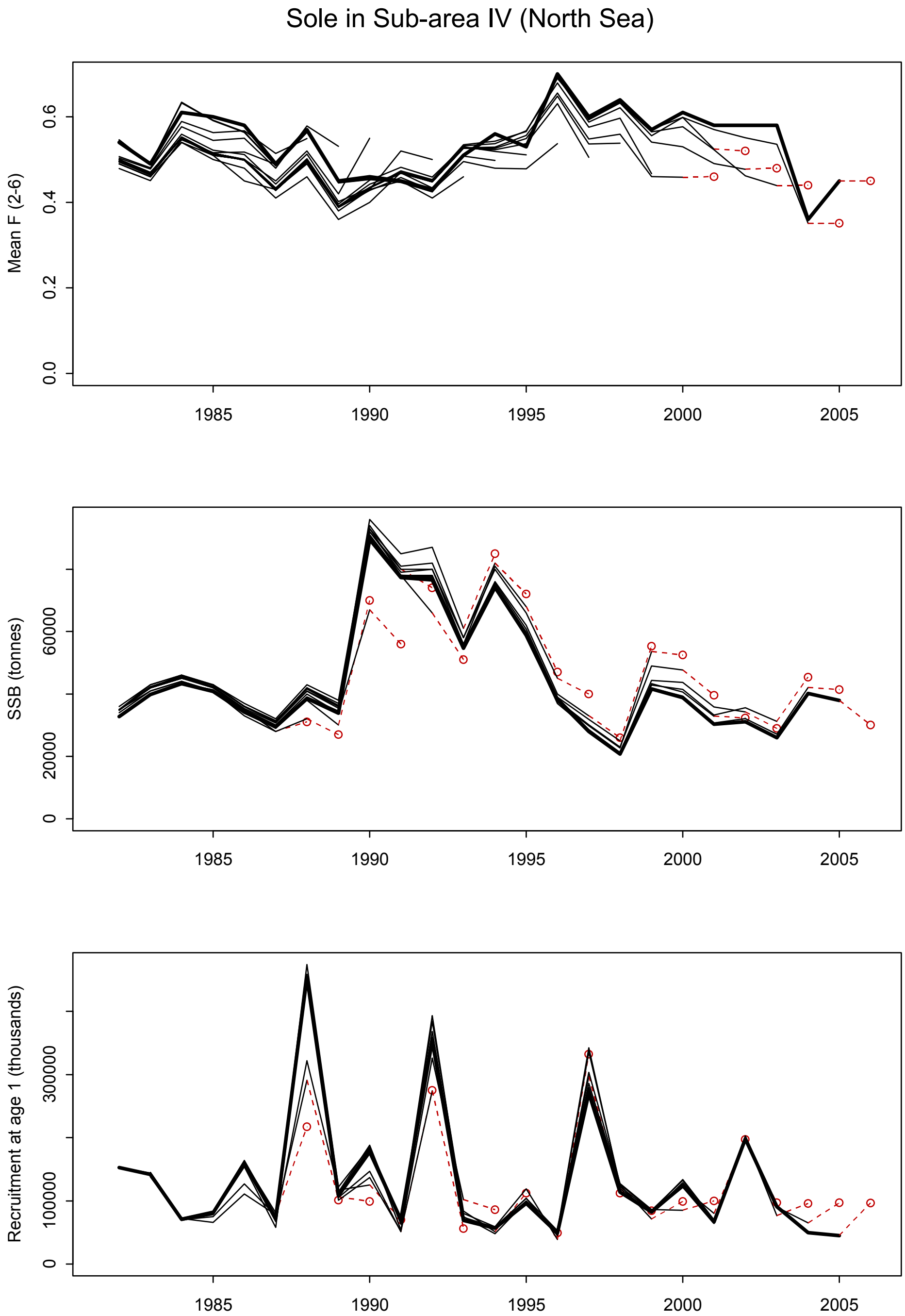


Figure 6.4.10.3 Sole in Subarea IV. Historical performance of the assessment.

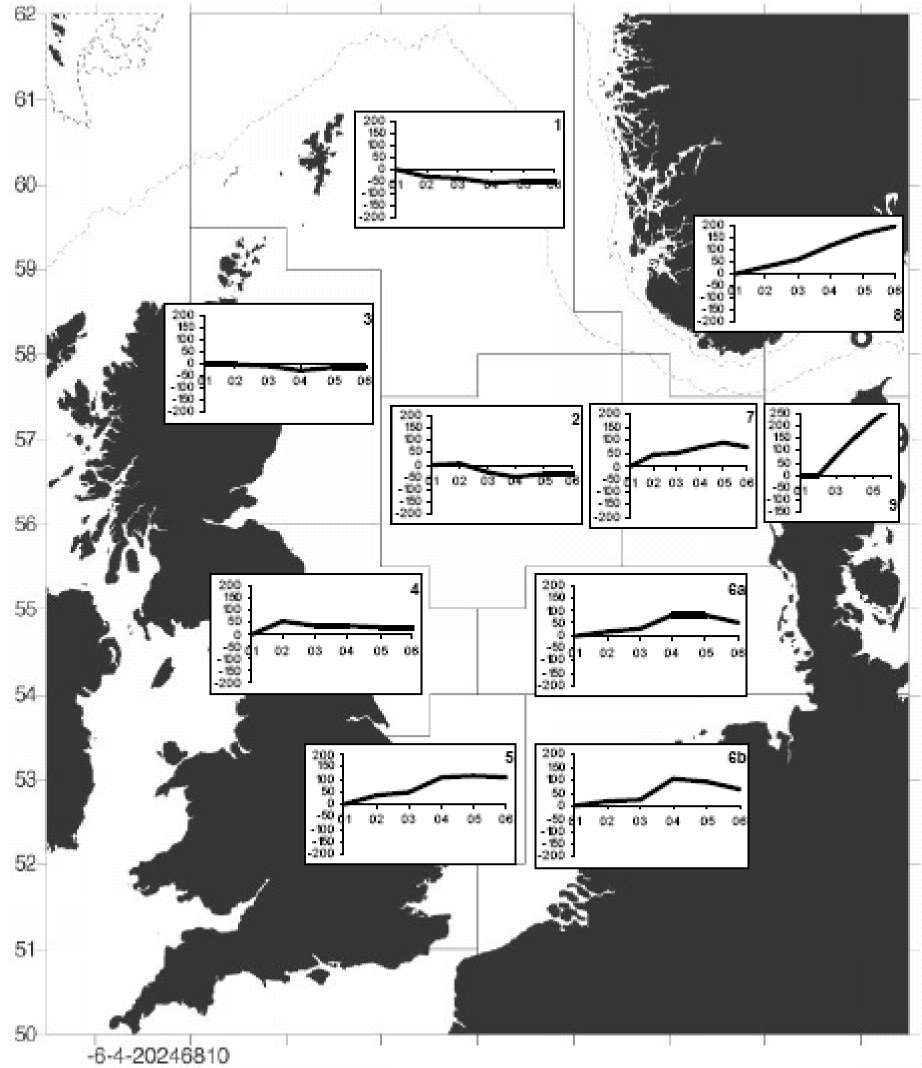


Figure 6.4.10.4 Sole in Subarea IV. Fisher's survey 2006.

Table 6.4.10.1 Sole in Subarea IV: Nominal landings and landings as estimated by the Working Group (tonnes).

Year	Belgium	Denmark	France	Germany	Netherlands	UK (E/W/NI)	Other countries	Total reported	Unallocated landings	WG Total
1982	1900	524	686	266	17686	403	2	21467	112	21579
1983	1740	730	332	619	16101	435		19957	4970	24927
1984	1771	818	400	1034	14330	586	1	18940	7899	26839
1985	2390	692	875	303	14897	774	3	19934	4314	24248
1986	1833	443	296	155	9558	647	2	12934	5266	18200
1987	1644	342	318	210	10635	676	4	13829	3539	17368
1988	1199	616	487	452	9841	740	28	13363	8227	21590
1989	1596	1020	312	864	9620	1033	50	14495	7311	21806
1990	2389	1427	352	2296	18202	1614	263	26543	8577	35120
1991	2977	1307	465	2107	18758	1723	271	27608	5905	33513
1992	2058	1359	548	1880	18601	1281	277	26004	3337	29341
1993	2783	1661	490	1379	22015	1149	298	29775	1716	31491
1994	2935	1804	499	1744	22874	1137	298	31291	1711	33002
1995	2624	1673	640	1564	20927	1040	312	28780	1687	30467
1996	2555	1018	535	670	15344	848	229	21199	1452	22651
1997	1519	689	99	510	10241	479	204	13741	1160	14901
1998	1844	520	510	782	15198	549	339	19742	1126	20868
1999	1919	828		1458	16283	645	501	21634	1841	23475
2000	1806	1069	362	1280	15273	600	539	20929	1603	22532
2001	1874	772	411	958	13345	597	394	18351	1593	19944
2002	1437	644	266	759	12120	451	292	15969	976	16945
2003	1605	703	728	749	12469	521	363	17138	782	17920
2004	1477	808	655	949	12860	535	544	17828	-681	17147
2005	1374	831	676	756	10917	667	357	15579	776	16355

*

Table 6.4.10.2 Sole in Subarea IV (North Sea).

Year	Recruitment Age 1 thousands	SSB tonnes	Landings tonnes	Mean F Ages 2-6
1957	128907	55147	12067	0.18
1958	128641	60967	14287	0.21
1959	488743	65550	13832	0.17
1960	61712	73578	18620	0.20
1961	99479	117015	23566	0.19
1962	22894	116453	26877	0.21
1963	20418	113380	26164	0.31
1964	539002	37061	11342	0.29
1965	121935	30036	17043	0.32
1966	39890	84156	33340	0.33
1967	75147	82920	33439	0.41
1968	99250	72788	33179	0.49
1969	50652	55305	27559	0.55
1970	137683	50750	19685	0.40
1971	42079	43721	23652	0.51
1972	76484	47311	21086	0.46
1973	104789	36493	19309	0.51
1974	109891	36012	17989	0.49
1975	40817	38279	20773	0.50
1976	113279	38799	17326	0.42
1977	140256	34190	18003	0.46
1978	47166	36034	20280	0.48
1979	11723	44609	22598	0.49
1980	151590	33445	15807	0.45
1981	148986	22852	15403	0.50
1982	152693	32784	21579	0.54
1983	142098	39837	24927	0.49
1984	70749	43284	26839	0.61
1985	80790	40831	24248	0.60
1986	159600	34221	18201	0.58
1987	72513	29502	17368	0.49
1988	454313	38576	21590	0.57
1989	108279	33784	21805	0.45
1990	177673	89462	35120	0.46
1991	70463	77323	33513	0.45
1992	353986	76630	29341	0.43
1993	69255	54621	31491	0.51
1994	57050	74198	33002	0.56
1995	96090	58780	30467	0.53
1996	49257	38140	22651	0.70
1997	270668	27972	14901	0.60
1998	113509	20804	20868	0.64
1999	82031	41684	23475	0.57
2000	124495	39187	22641	0.61
2001	66740	30424	19944	0.58
2002	198090	31094	16945	0.58
2003	90852	25863	17920	0.58
2004	49375	40155	17147	0.36
2005	45173	38011	16355	0.45
2006	96733	30077		
Average	125078	50282	22154	0.46

6.4.11 Sole in Division VIId (Eastern Channel)

State of the stock

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

Based on the most recent estimate of SSB (12 000 t), ICES classifies the stock as having full reproductive capacity. The spawning stock biomass has been fluctuating around a mean of about 10 000 t since 1982, and is presently far above $\mathbf{B}_{pa}$.

Based on the most recent estimates of fishing mortality (0.38), ICES classifies the stock as being harvested sustainably. The fishing mortality has decreased since 1999 and has been around $\mathbf{F}_{pa}$ since 2001.

Recent recruitment has been strong, with the 2001 and 2004 year classes being the second-highest and highest, respectively, of the time-series (1982–2005).

Management objectives

No explicit management objectives are set for this stock.

Reference points

(unchanged since 1999)

ICES considers that:	ICES proposes that:
There is currently no biological basis for defining $\mathbf{B}_{lim}$.	$\mathbf{B}_{pa}$ be set at 8000 t. This is the lowest observed biomass at which there is no indication of impaired recruitment.
$\mathbf{F}_{lim}$ is 0.55. This is a fishing mortality at or above which the stock has shown continued decline.	$\mathbf{F}_{pa}$ be set at 0.4. This F is considered to provide approximately 95% probability of avoiding $\mathbf{F}_{lim}$.

Yield and spawning biomass per Recruit
F-reference points:

	Fish Mort Ages 3–8	Yield/R	SSB/R
Average last 3 years	0.383	0.170	0.429
$\mathbf{F}_{max}$	0.305	0.171	0.550
$\mathbf{F}_{0.1}$	0.127	0.153	1.254
$\mathbf{F}_{med}$	0.401	0.170	0.408

Technical basis:

$\mathbf{B}_{lim}$: Poor biological basis for definition.	$\mathbf{B}_{pa}$: Smoothed $\mathbf{B}_{loss}$ (no sign of impairment): 8000 t.
$\mathbf{F}_{lim}$ is set equal to $\mathbf{F}_{loss}$, but poorly defined; analogy to North Sea and setting of 1.4 $\mathbf{F}_{pa}$ = 0.55.	$\mathbf{F}_{pa}$: Between $\mathbf{F}_{med}$ and 5th percentile of $\mathbf{F}_{loss}$; SSB>$\mathbf{B}_{pa}$ and probability ($\mathbf{SSB}_{mt}$<$\mathbf{B}_{pa}$), 10%: 0.4.

Single-stock exploitation boundaries

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

Target reference points have not been agreed for this stock. The current fishing mortality ($\mathbf{F}_{sq}$) is estimated at 0.38, which is above the rate that would lead to high long-term yields and low risk of stock depletion ($\mathbf{F}_{0.1}$ = 0.13). $\mathbf{F}_{max}$ (= 0.30) is not well defined. Fishing at $\mathbf{F}_{0.1}$ is expected to lead to landings in 2007 of 2400 t and SSB in 2008 of around 19 000 t.

Exploitation boundaries in relation to precautionary limits

The exploitation within the precautionary limits would imply landings of less than 6440 t in 2007, which is expected to lead to a 13% decrease in SSB in 2008.

Short-term implications

Outlook for 2007

Basis: F(2006) = $\mathbf{F}_{sq}$ = mean F(03–05) = 0.38; R06–08 = GM R82–03 = 23 million; SSB(2007) = 16.83 kt; landings (2006) = 6.06 kt.

Rationale	TAC(2007) (1)	Basis	F(2007)	SSB(2008)	%SSB change	%TAC change
Zero catch	0.00	F=0	0.00	21.52	28%	-100%
Status quo	6.43	$\mathbf{F}_{sq}$	0.40	14.70	-13%	12%
High long-term yield	5.05	F(long-term yield)	0.30	16.15	-4%	-12%
Status quo	3.39	$\mathbf{F}_{sq}$ *0.5	0.19	17.91	6%	-41%
	4.00	$\mathbf{F}_{sq}$ *0.6	0.23	17.27	3%	-30%
	4.59	$\mathbf{F}_{sq}$ *0.7	0.27	16.65	-1%	-20%
	5.15	$\mathbf{F}_{sq}$ *0.8	0.30	16.05	-5%	-10%
	5.69	$\mathbf{F}_{sq}$ *0.9	0.34	15.48	-8%	0%
	6.22	$\mathbf{F}_{sq}$ *1	0.38	14.93	-11%	9%
	6.44	$\mathbf{F}_{sq}$ *1.05	0.40	14.69	-13%	13%
	6.72	$\mathbf{F}_{sq}$ *1.1	0.42	14.39	-15%	18%
Precautionary limits	0.76	TAC($\mathbf{F}_{pa}$) *0.1	0.04	20.71	23%	-87%
	1.85	TAC($\mathbf{F}_{pa}$) *0.25	0.10	19.55	16%	-68%
	3.53	TAC($\mathbf{F}_{pa}$) *0.5	0.20	17.77	6%	-38%
	5.05	TAC($\mathbf{F}_{pa}$) *0.75	0.30	16.15	-4%	-12%
	5.90	TAC($\mathbf{F}_{pa}$) *0.9	0.36	15.26	-9%	3%
	6.44	$\mathbf{F}_{pa}$ = $\mathbf{F}_{sq}$ *1.05	0.40	14.69	-13%	13%
	6.96	TAC($\mathbf{F}_{pa}$) *1.1	0.44	14.14	-16%	22%
	7.71	TAC($\mathbf{F}_{pa}$) *1.25	0.50	13.36	-21%	35%
	8.86	TAC($\mathbf{F}_{pa}$) *1.5	0.60	12.16	-28%	55%
	9.90	TAC($\mathbf{F}_{pa}$) *1.75	0.70	11.06	-34%	73%
	11.01	TAC($\mathbf{F}_{pa}$) *2	0.80	9.90	-41%	93%
	12.39	TAC($\mathbf{F}_{pa}$) *2.25	0.90	8.45	-50%	117%
Mixed Fisheries						

All weights in thousand tonnes.

(1) It is assumed that the TAC will be implemented and that the landings in 2007 therefore correspond to the TAC.

Shaded scenarios are not considered consistent with the precautionary approach.

Management considerations

Due to recent large recruitments, SSB is expected to remain well above $\mathbf{B}_{pa}$ in the short term, provided the fishing mortality does not exceed $\mathbf{F}_{pa}$.

Sole is mainly caught in beam trawl fisheries with plaice or in mixed demersal fisheries using otter trawls. There is also a directed fishery during parts of the year by inshore trawlers and netters on the English and French coasts.

Due to the minimum mesh size (80 mm) in the mixed beam trawl fishery, a large number of (undersized) plaice are discarded. The 80-mm mesh size is not matched to the minimum landing size of plaice. Measures to reduce discarding in the sole fishery would greatly benefit the plaice stock and future yields. Mesh enlargement would reduce the catch of undersized plaice, but would also result in short-term loss of marketable sole. An increase in the minimum landing size of sole could provide an incentive to fish with larger mesh sizes and therefore mean a reduction in the discarding of plaice.

Factors affecting the fisheries and the stock

There are 5 main commercial fleets fishing for sole in Division VIId. Belgian and English offshore beam trawlers (> 300 HP) fish mainly for sole, but can switch to scallops or move to adjacent areas. French offshore trawlers target roundfish and take sole as bycatch. Numerous inshore (vessels under 10 m) on the English and French coasts using mainly fixed nets target sole in the spring and autumn. The inshore vessels take half the reported landings and sole forms their main source of income. Effort from the beam trawl fleet can change considerably depending on whether the fleet moves to other areas or directs effort at other species such as scallops and cuttlefish.

The minimum landing size for sole is 24 cm. Demersal gears permitted to catch sole are 80 mm for beam trawling and 80 mm for otter trawlers. Fixed nets are required to use 100-mm mesh since 2002, although an exemption to permit 90 mm has been in force since that time.

The effects of regulations

The impact of effort limitations enforced since 2004 as part of the cod recovery measures have not been formally evaluated by ICES for sole in Subarea VIId.

Changes in fishing technology and fishing patterns

It is likely that the high oil prices have had some impact on the fishing behavior of the Belgian and UK beam trawl fleets. For the French and UK inshore fleets, however, this will probably not be the case since they are constrained to the inshore areas.

Scientific basis

Data and methods

The assessment is based on landings data, two commercial CPUE indices, and two research-vessel survey indices.

Uncertainties in assessment and forecast

Routine discard sampling has recently begun following the introduction of the EU Data Collection Regulations and indicates percentages of discards up to 30% in weight, depending on the trip and on fishing practices. However, the time-series of discards is not yet long enough to be used in the analytical assessment.

Under-reporting from the inshore fleets and misreporting by beam trawlers fishing in adjacent management areas is thought to be significant. The historical landings have been adjusted for misallocated landings between the Eastern and Western Channel over the period 1986–2005. XSA diagnostics and the retrospective analysis indicate a tendency to underestimate fishing mortality and overestimate SSB.

Comparison with previous assessment and advice

The current assessment is very consistent to last year's; it has revised the value of SSB in 2004 by less than 1%. Past recruitment estimates were subject to considerable annual revision. The downward revision of the 2003 year class was mainly due to a revision of the Young Fish Survey index for that year class.

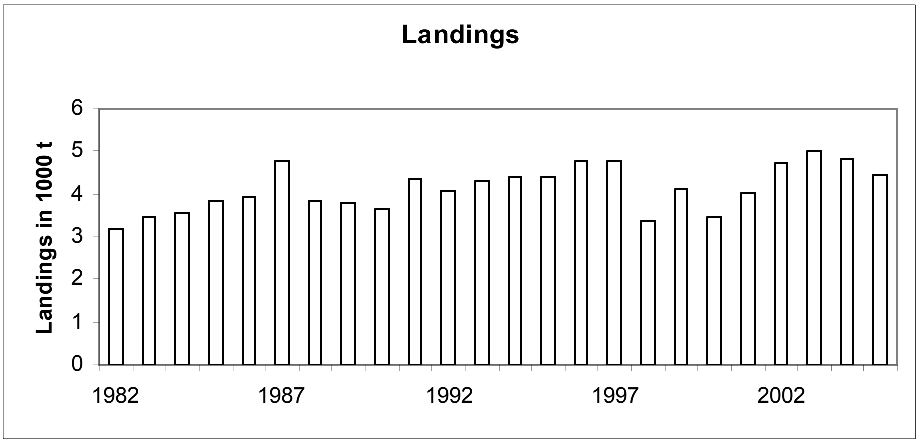
The advice remains also similar.

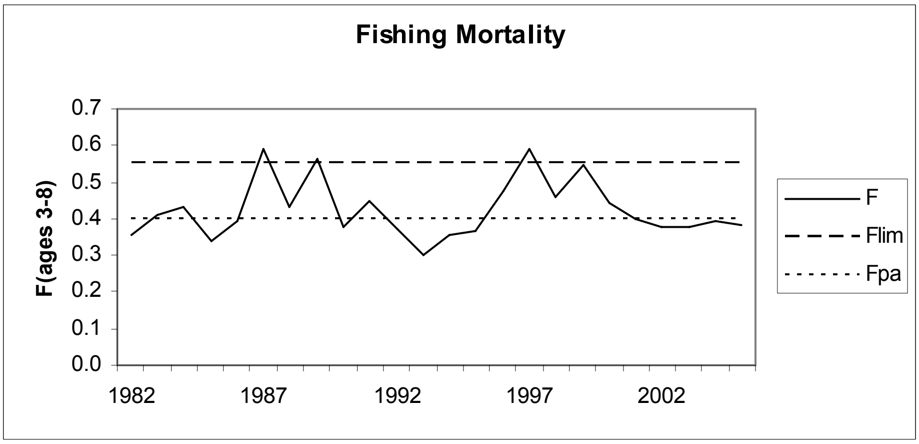
Source of information

Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, 5–14 September 2006 (ICES CM 2006/ACFM:35).

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
1987	Precautionary TAC		3.1		3.85	3.8	4.8
1988	*Status quo* (Shot) TAC		3.4		3.85	3.3	3.9
1989	*Status quo* (Shot) TAC		3.8		3.85	2.9	3.8
1990	No effort increase; TAC		3.7		3.85	3.0	3.6
1991	*Status quo* F; TAC		3.4		3.85	3.8	4.4
1992	TAC		≤2.7		3.5	3.8	4.1
1993	70% of F(91)~2 800 t		2.8		3.2	3.4	4.3
1994	Reduce F		<3.8		3.8	3.7	4.4
1995	No increase in F		3.8		3.8	3.7	4.4
1996	No long-term gain in increasing F		4.7		3.5	4.1	4.8
1997	No advice		-		5.23	3.9	4.8
1998	No increase in effort		4.5		5.23	3.0	3.4
1999	Reduce F to $\mathbf{F}_{pa}$		3.8		4.7	3.9	4.1
2000	$F < \mathbf{F}_{pa}$		<3.9		4.1	3.8	3.5
2001	$F < \mathbf{F}_{pa}$		<4.7		4.6	4.6	4.0
2002	$F < \mathbf{F}_{pa}$		<5.2		5.2	5.4	4.7
2003	$F < \mathbf{F}_{pa}$		<5.4		5.4	5.6	5.0
2004	[1)]	$F < \mathbf{F}_{pa}$	[1)]	<5.9	5.9	5.3	4.8
2005	[1)]	$F < \mathbf{F}_{pa}$	[1)]	<5.7	5.7	4.1	4.4
2006	[1)]	$F < \mathbf{F}_{pa}$	[1)]	<5.7	5.72		
2007	[1)]	$F < \mathbf{F}_{pa}$	[1)]	<6.44			

Weights in '000 t.
[1)] Single-stock boundary and the exploitation of this stock should be conducted in the context of mixed fisheries protecting stocks outside safe biological limits.





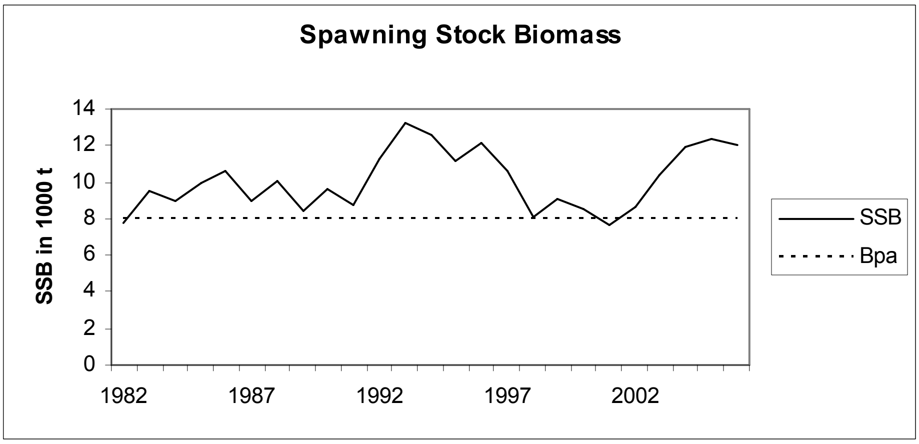


Table 6.4.11.1 Sole in Division VIId (Eastern Channel). Landings, fishing mortality, recruitment and SSB.

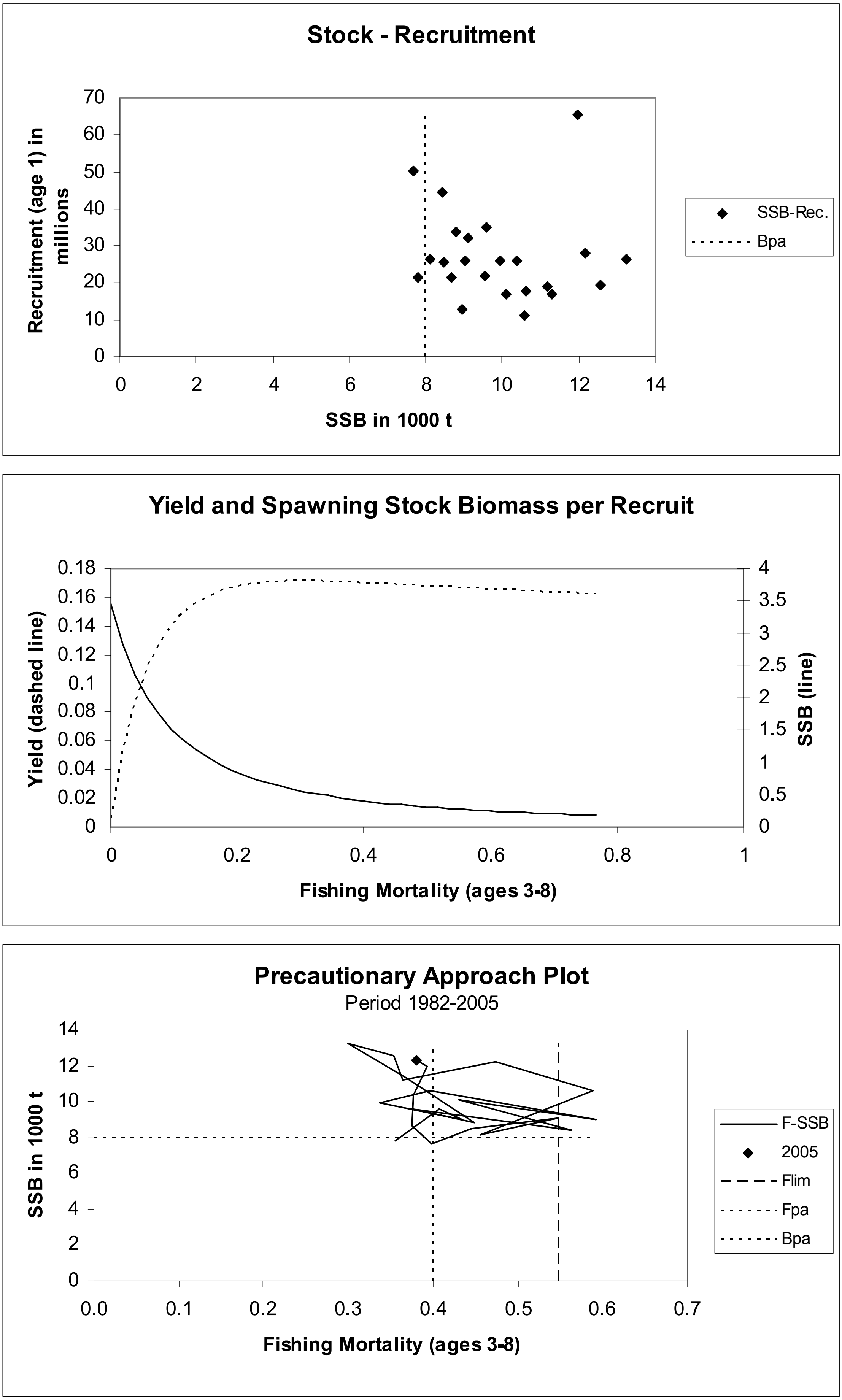


Figure 6.4.11.2 Sole in Division VIId (Eastern Channel). Stock and recruitment; Yield and SSB per recruit.

Sole in Div. VIId (Eastern Channel)

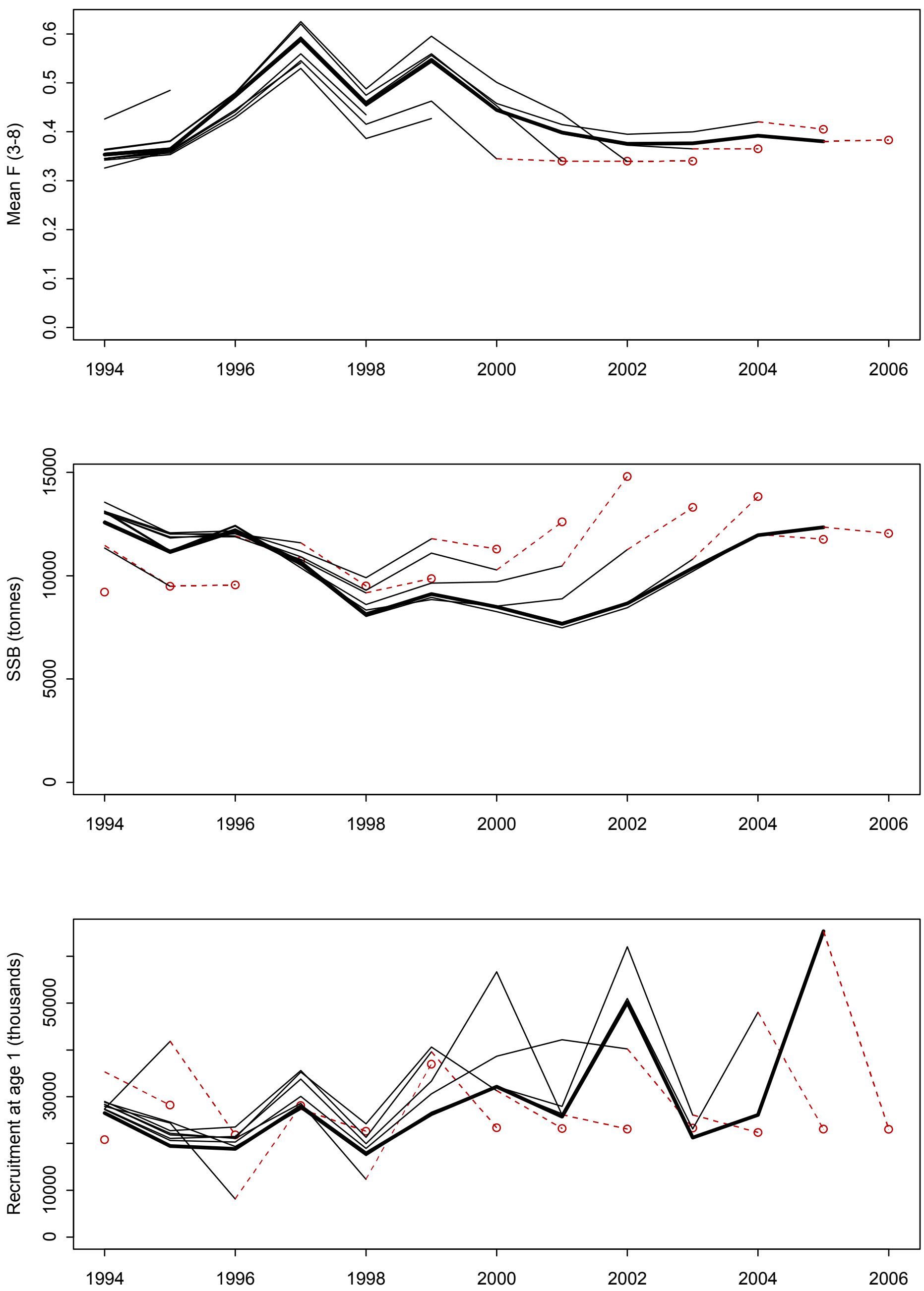


Figure 6.4.11.3

Table 6.4.11.1 Sole VIId. Nominal landings (tonnes) as officially reported to ICES and used by the Working Group

Year	Belgium	France		UK(E+W)	others	reported	Unallocated*	Total used by WG	TAC
1974	159	469		309	3	940	-56	884	
1975	132	464		244	1	841	41	882	
1976	203	599		404	.	1206	99	1305	
1977	225	737		315	.	1277	58	1335	
1978	241	782		366	.	1389	200	1589	
1979	311	1129		402	.	1842	373	2215	
1980	302	1075		159	.	1536	387	1923	
1981	464	1513		160	.	2137	340	2477	
1982	525	1828		317	4	2674	516	3190	
1983	502	1120		419	.	2041	1417	3458	
1984	592	1309		505	.	2406	1169	3575	
1985	568	2545		520	.	3633	204	3837	
1986	858	1528		551	.	2937	995	3932	
1987	1100	2086		655	.	3841	950	4791	3850
1988	667	2057		578	.	3302	551	3853	3850
1989	646	1610		689	.	2945	860	3805	3850
1990	996	1255		742	.	2993	654	3647	3850
1991	904	2054		825	.	3783	568	4351	3850
1992	891	2187		706	10	3794	278	4072	3500
1993	917	1907		610	13	3447	852	4299	3200
1994	940	2001		701	15	3657	726	4383	3800
1995	817	2248		669	9	3743	677	4420	3800
1996	899	2322		877	.	4098	699	4797	3500
1997	1306	1702		933	.	3941	823	4764	5230
1998	541	1703		803	.	3047	316	3363	5230
1999	880	2239		769	.	3888	247	4135	4700
2000	1021	2190		621	.	3832	-356	3476	4100
2001	1313	2482		822		4617	-592	4025	4600
2002	1643	2780		976		5399	-666	4733	5200
2003	1659	2898		1114	1	5672	-634	5038	5400
2004	1465	2734	***	1102		5300	-474	4826	5900
2005	1217	2365	**	558		4140	294	4434	5700

* Unallocated mainly due misreporting
** Preliminary
*** Data provided to the WG but not officially provided to ICES

Table 6.4.11.2 Sole in Division VIId (Eastern Channel).

Year	Recruitment Age 1 thousands	SSB tonnes	Landings tonnes	Mean F Ages 3-8
1982	12706	7806	3190	0.3560
1983	21385	9557	3458	0.4080
1984	21618	8957	3575	0.4345
1985	12897	9961	3837	0.3375
1986	25750	10584	3932	0.3963
1987	10976	9017	4791	0.5924
1988	25860	10095	3853	0.4312
1989	16768	8439	3805	0.5632
1990	44362	9597	3647	0.3754
1991	34799	8793	4351	0.4486
1992	33738	11282	4072	0.3704
1993	16788	13259	4299	0.3006
1994	26515	12579	4383	0.3536
1995	19428	11160	4420	0.3644
1996	18829	12184	4797	0.4732
1997	27894	10609	4764	0.5886
1998	17869	8117	3363	0.4567
1999	26293	9112	4135	0.5472
2000	32123	8483	3476	0.4444
2001	25690	7675	4025	0.3988
2002	50110	8653	4733	0.3756
2003	21271	10368	5038	0.3765
2004	26121	11965	4826	0.3922
2005	65340	12339	4434	0.3803
2006	23000*	12041		
Average	26464	10025	4134	0.4236

* Geometric mean 1982–2003.

6.4.12 Saithe in Subarea IV (North Sea), Division IIIa (Skagerrak), and Subarea VI (West of Scotland and Rockall)

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	Appropriate	

Based on the most recent estimates of SSB and fishing mortality, ICES classifies the stock as having full reproductive capacity and being harvested sustainably. Fishing mortality has declined since 1986, and has been below $\mathbf{F}_{pa}$ since 1997. SSB was below $\mathbf{B}_{pa}$ from 1984 to 1997 (and was below $\mathbf{B}_{lim}$ from 1990–1993), but increased in the late 1990s and is estimated to have been at or above $\mathbf{B}_{pa}$ since 1997.

Management objectives
In 2004 EU and Norway *"agreed to implement a long-term plan for the saithe stock in the Skagerrak, the North Sea and west of Scotland, which is consistent with a precautionary approach and designed to provide for sustainable fisheries and high yields. The plan shall consist of the following elements:*

1. *Every effort shall be made to maintain a minimum level of Spawning biomass (SSB) greater than 106 000 tonnes (B_{lim}).*
2. *Where the SSB is estimated to be above 200 000 tonnes the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of no more than 0.30 for appropriate age groups.*
3. *Where the SSB is estimated to be below 200 000 tonnes but above 106 000 tonnes the TAC shall not exceed a level which, on the basis of a scientific evaluation by ICES, will result in a fishing mortality rate equal to 0.30-0.20*(200 000-SSB)/94 000.*
4. *Where the SSB is estimated by the ICES to be below the minimum level of SSB of 106 000 tonnes the TAC shall be set at a level corresponding to a fishing mortality rate of no more than 0.1.*
5. *Where the rules in paragraphs 2 and 3 would lead to a TAC which deviates by more than 15% from the TAC the preceding year the Parties shall fix a TAC that is no more than 15% greater or 15% less than the TAC of the preceding year.*
6. *Notwithstanding paragraph 5 the Parties may where considered appropriate reduce the TAC by more than 15% compared to the TAC of the preceding year.*
7. *A review of this arrangement shall take place no later than 31 December 2007.*
8. *This arrangement enters into force on 1 January 2005."*

The saithe management plan has not been evaluated by ICES.

Reference points

	ICES considers that:	**ICES proposed that:**
Limit reference points	$\mathbf{B}_{lim}$ is 106 000 t.	$\mathbf{B}_{pa}$ be set at 200 000 t.
	$\mathbf{F}_{lim}$ is 0.6.	$\mathbf{F}_{pa}$ be set at 0.4.
Target reference points	Target F according to the management plan is 0.3.	

Yield and spawning biomass per Recruit
F-reference points:

	Fish Mort Ages 3–6	Yield/R	SSB/R
Average last 5 Years	0.245	0.772	1.829
$\mathbf{F}_{max}$	0.216	0.849	2.493
$\mathbf{F}_{0.1}$	0.105	0.776	4.568
$\mathbf{F}_{med}$	0.357	0.825	1.396

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 $\mathbf{F}_{0.1}$–$\mathbf{F}_{max}$.

Technical basis

$\mathbf{B}_{lim} = \mathbf{B}_{loss}$ = 106 000 t (estimated in 1998).	$\mathbf{B}_{pa}$ = 200 000 t affords a high probability of maintaining SSB above $\mathbf{B}_{lim}$.
$\mathbf{F}_{lim} = \mathbf{F}_{loss}$ = 0.6, the fishing mortality estimated to lead to stock falling below $\mathbf{B}_{lim}$ in the long term.	$\mathbf{F}_{pa}$ = 0.4 implies that $\mathbf{B}_{eq} > \mathbf{B}_{pa}$ and $P(SSB_{MT} < \mathbf{B}_{pa}) < 10\%$.

Single-stock exploitation boundaries

Exploitation boundaries in relation to existing management plans

At the present SSB level, F should be below 0.3 to be in accordance with the management plan. This corresponds to landings of 136 000 t in 2007.

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

The current fishing mortality is estimated at 0.25, which is above the rate expected to lead to high long-term yields ($\mathbf{F}_{0.1}$ = 0.11). Fishing at $\mathbf{F}_{0.1}$ is expected to lead to landings of 51 000 t in 2007.

Exploitation boundaries in relation to precautionary limits

The exploitation boundaries in relation to precautionary limits imply human consumption landings of about 170 000 t in 2007, where the SSB is expected to remain above $\mathbf{B}_{pa}$ (200 000 t) in 2008.

ICES conclusion on exploitation boundaries

Although ICES has not evaluated the agreed management plan, the target fishing mortality in the management plan is expected to give higher long-term gains in the present situation with a stock that is well above $\mathbf{B}_{pa}$ and ICES therefore recommends to limit landings in 2007 to 136 000 t.

Short-term implications

The short-term prognosis is made using the Fsq assumption for the intermediate year. An Fsq landings for 2006 corresponds to 109 000 t, which is below the agreed TACs (123 000 t for the North Sea plus IIIa, and 13 000 t for Division VIa)

Outlook for 2007

Basis: F(2006) = F03–05 = 0.23; R06 = RCT3 = 111.9; R07–08 = GM88–02 = 126.8; SSB(2007) = 290; landings (2006) = 109.

Rationale	**TAC (2007)**	**TAC IIIa & IV (2007)[3]**	**TAC VI (2007)[3]**	**Basis**	**F 2007**	**SSB 2008**	**%SSB change [1)]**	**% TAC change [2)]**
Zero catch	0			F=0	0	391	35	
Target reference point				Ftarget or Btarget				
Status quo	109	99.2	9.8	$\mathbf{F}_{sq}$	0.23	280	-3	-20
High long-term yield	51	46.4	4.6	F(long-term yield)	0.1	338	17	-63
Agreed management plan	16	14.6	1.4	TAC(man. plan) * 0.1	0.03	374	29	-88
	40	36.4	3.6	TAC(man. plan) * 0.25	0.075	350	21	-71
	75	68.3	6.7	TAC(man. plan) * 0.50	0.15	314	8	-45
	107	97.4	9.6	TAC(man. plan) * 0.75	0.225	282	-3	-21
	124	112.8	11.2	TAC(man. plan) * 0.90	0.27	265	-9	-9
	136	123.8	12.2	TAC(man. plan)	0.30	254	-12	0
	146	132.9	13.1	TAC(man. plan) * 1.1	0.33	243	-16	7
	162	147.4	14.6	TAC(man. plan) * 1.25	0.375	228	-21	19
Precautionary limits	21	19.1	1.9	TAC($\mathbf{F}_{pa}$)* 0.1	0.04	369	27	-85
	51	46.4	4.6	TAC($\mathbf{F}_{pa}$)* 0.25	0.10	338	17	-63
	97	88.3	8.7	TAC($\mathbf{F}_{pa}$)* 0.5	0.20	292	1	-29
	136	123.8	12.2	TAC($\mathbf{F}_{pa}$)* 0.75	0.30	254	-12	0
	157	142.9	14.1	TAC($\mathbf{F}_{pa}$)* 0.90	0.36	233	-20	15
	170	154.7	15.3	$\mathbf{F}_{pa}$ (= $\mathbf{F}_{sq}$ *1.74)	0.40	220	-24	25
	182	165.6	16.4	TAC($\mathbf{F}_{pa}$)* 1.1	0.44	209	-28	34
	199	181.1	17.9	TAC($\mathbf{F}_{pa}$)* 1.25	0.50	192	-34	46

Weights in '000 t.
[1)] SSB 2008 relative to SSB 2007.
[2)] TAC 2007 relative to TAC 2006.
[3)] Landings split according to the average in 1993–1998, i.e., 91% in IIIa&IV and 9% in VI.
Shaded scenarios are not considered consistent with the Precautionary Approach**.**

Management considerations

Before 1999, saithe in Subarea VI and saithe in Subarea IV and Division IIIa were assessed as two separate stocks. The ICES advice now applies to the combined Areas IIIa, IV, and VI.

Because of its life-history, saithe in the North Sea is partly geographically protected from heavy exploitation as juveniles.

The reported landings have been much lower than the TAC the last five years. Information from fishers indicates that very low prices on saithe combined with high fuel prices are causing these reductions in landings.

The saithe management plan has not been evaluated by ICES. A requirement for consistency with the Precautionary Approach is that the SSB decision parameters are used as lower bounds on SSB, and not as targets and that paragraph 6 will be invoked whenever there is high risk that the SSB may fall below $\mathbf{B}_{\mathrm{lim}}$ in the short term.

Factors affecting the fisheries and the stock

The effects of regulations

Management of saithe is by TAC and technical measures. In January 2002 the minimum mesh size (in bottom trawls for human consumption) was changed from 100 to 110 mm in EU-waters and from 100 to 120 mm in Norwegian waters (the minimum mesh size for Norwegian vessels was set to 120 mm both in Norwegian and EU waters). This regulation was not strictly enforced in the first half of 2002 to allow a transition period, i.e. the implementation of larger mesh sizes probably happened gradually during 2002. Minimum landing size is 35 cm in the EU zone, 32 cm in the Norwegian zone.

Changes in fishing technology and fishing patterns

Variations in EU and Norwegian mesh size regulations in the saithe fishery in 2001–2003 might have contributed to changes in the exploitation pattern (spatial and temporal changes in size-specific fishing mortality between years).

Scientific basis

Data and methods

The stock is assessed using an age-based model (XSA), calibrated by three commercial CPUE series and two survey indices.

There are no discard estimates for the majority of the fishery, and they were thus not included in the assessment.

Information from the fishing industry

The reported landings in the last years have been much lower than the TACs and the reported effort was also lower than in 2004. Information from fishers indicates that very low prices on saithe, coupled with high fuel prices, are causing these reductions in targeted fisheries.

The fishers' survey corresponds with the outcome of the assessment.

Uncertainties in assessment and forecast

The most serious problems with the assessment and stock forecasts for saithe are the lack of reliable information about year-class strength before age 3. An annual 0-group survey has been conducted by the Institute of Marine Research (IMR, Norway) since 1999 in the northern North Sea, but this will not be continued due to lack of relationship between the 0-group index and later XSA population estimates for the year classes 1999–2001 (the 0-group index for the 2000 year class is extremely high, while this year class is estimated to be around average for age 4 in this year's assessment). IMR has started a new survey along the west coast of Norway to measure the relative abundance of saithe between 2 and 4 years old (when the saithe is distributed along the coast).

A retrospective bias exists for fishing mortality and SSB which results in an overestimation of F and underestimation of SSB. The cause of this bias is not known.

Comparison with previous assessment and advice

The estimates of SSB in 2005 and F in 2004 were similar to the previous assessment. The basis of the advice is unchanged.

Source of information

Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, 5–14 September 2006 (ICES CM 2006/ACFM:35).

Saithe in IIIa and IV

Year	ICES Advice	Single-Stock Exploitation Boundaries	Predicted landings corresp. to advice	Predicted landings correp. to single-stock exploitation boundaries	Agreed TAC	Official landings	ACFM landings
1987	Reduce F		<198		173	154	149
1988	60% of F(86); TAC		156		165	113	107
1989	No increase in F; TAC		170		170	92	92
1990	No increase in F; TAC		120		120	85	88
1991	No increase in F; TAC		125		125	93	99
1992	No increase in F; TAC		102		110	92	92
1993	70% of F(91) ~ 93 000 t		93		93	99	105
1994	Reduce F by 30%		72		97	90	102
1995	No increase in F		107		107	97	113
1996	No increase in F		111		111	96	110
1997	No increase in F		113		115	86	103
1998	Reduce F by 20%		97		97	88	100
1999	Reduce F to $\mathbf{F}_{pa}$		104		110	108	107
2000	Reduce F by 30 %		75		85	85	87
2001	Reduce F by 20 %		87		87	88	90
2002	F < $\mathbf{F}_{pa}$		<135		135	113	117
2003	F < $\mathbf{F}_{pa}$		<176		165	105	102
2004	*	F < $\mathbf{F}_{pa}$	*	<211	190	87	100
2005	*	F according to man. plan	*	<137	145	111	112
2006	*	F according to man. plan (< $\mathbf{F}_{pa}$)	*	<123	123		
2007		F according to man. plan (< $\mathbf{F}_{pa}$)	*	<124			

Weights in '000 t.
* Single-stock boundary and the exploitation of this stock should be conducted in the context of mixed fisheries.

Saithe in VI

Year	ICES Advice	Single-stock exploitation boundaries	Predicted landings corresp. to advice	Predicted catch corresp to single-stock exploitation boundaries	Agreed TAC	Official landings	ACFM landings
1987	F reduced towards $\mathbf{F}_{max}$		19		27.8	32.5	31.4
1988	80% of F(86); TAC		35		35	32.8	34.2
1989	F < 0.3; TAC		20		30	22.4	25.6
1990	80% of F(88); TAC		24		29	18.0	19.9
1991	Stop SSB decline; TAC		21		22	17.9	17.0
1992	Avoid further reduction in SSB		<19		17	10.8	11.8
1993	F = 0.21		6.3		14	14.5	13.9
1994	Lowest possible F				14	13.0[2]	12.8
1995	Significant reduction in effort		-		16	10.6[2]	11.8
1996	No increase in F		10.2[1]		13	9.4[2]	9.4
1997	Significant reduction in F				12	8.6[2]	9.4
1998	60% Reduction in F		4.8		10.9	7.4[2]	8.4
1999	60% reduction in F		4.8		7.5	6.8	7.3
2000	Reduce F by 30 %		6.0		7	6.4	5.9
2001	Reduce F by 20 %		9.0		9	8.7	8.4
2002	F < $\mathbf{F}_{pa}$		<13		14	5.6	5.2
2003	F < $\mathbf{F}_{pa}$		<17		17.1	5.0	5.3
2004	F < $\mathbf{F}_{pa}$	F < $\mathbf{F}_{pa}$	<21	<21	20	1.6	4.4
2005	F < $\mathbf{F}_{pa}$	F according to man. plan	<14	<14	15	8.7	5.7
2006	*	F according to man. plan (< $\mathbf{F}_{pa}$)	*	<12	13		
2007		F according to man. plan (< $\mathbf{F}_{pa}$)	*	<12			

Weights in '000 t.
[1]*Status quo* catch.
[2] Incomplete data.
* Single-stock boundary and the exploitation of this stock should be conducted in the context of mixed fisheries.

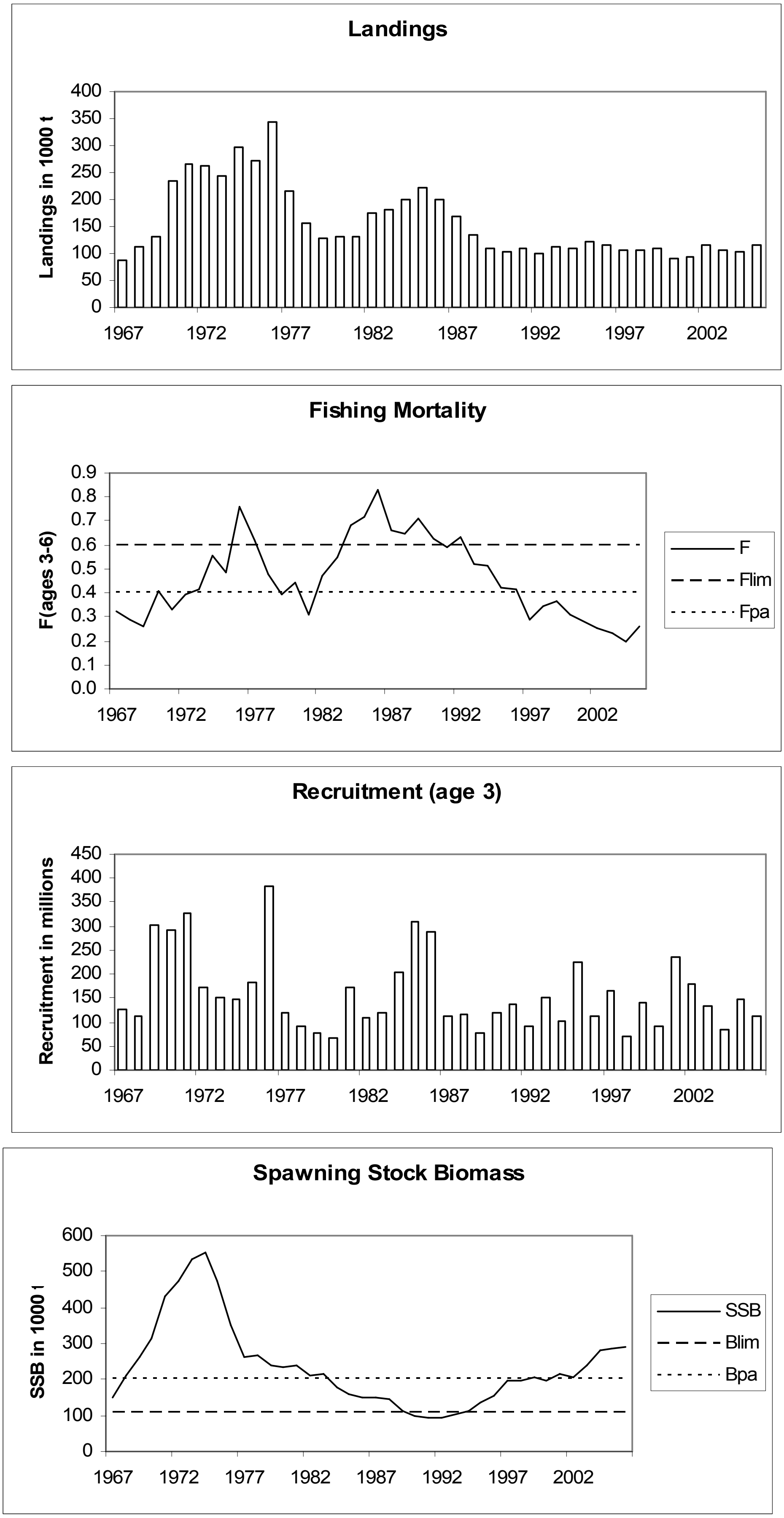


Figure 6.4.12.1 Saithe in Sub-area IV, Division IIIa (Skagerrak) & Sub-area VI. Landings, fishing mortality, recruitment and SSB

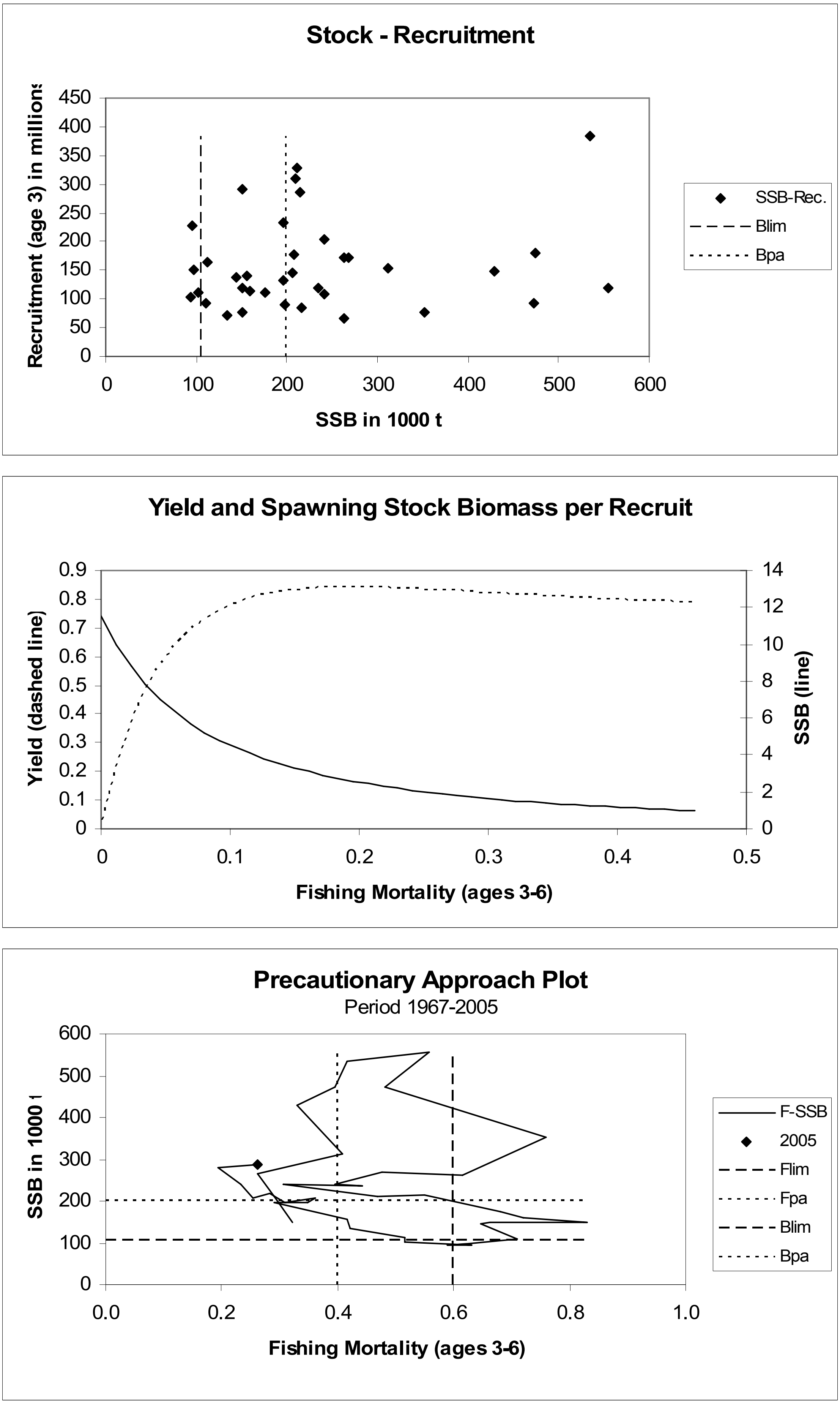


Figure 6.4.12.2 Saithe in Sub-area IV, Division IIIa (Skagerrak) & Sub-area VI. Stock and recruitment; Yield and SSB per recruit.

Table 6.4.12.1 Nominal landings (in tonnes) of Saithe in Subarea IV and Division IIIa and Subarea VI, 1998–2005, as officially reported to ICES.

SAITHE IV and IIIa

Country	1999	2000	2001	2002	2003	2004*	2005*
Belgium	200	122	24	107	45	22	28
Denmark	4494	3529	3575	5668	6954	7991	7498
Faroe Islands	1101		289	872	495	558	184
France	24305[1*]	19200	20472	25441	18001	13628	10768
Germany	10481	9273	9479	10999	8956	9589	12401
Greenland	-	601[2*]	1526[2*]	62	1616	403	
Ireland	-	1	-	-		1	
Netherlands	7	11	20	6	11*	3	40
Norway	56150	43665	44397	60013	61735	662783	67365
Poland	862	747	727	752	734*	0	1100
Russia	-	67	-	-	-		35
Sweden	1929	1468	1627	1863	1876	2249	2114
UK (E/W/NI)	2874	1227	1186	2521	1215	457	1190
UK (Scotland)	5420	5484	5219	6596	5829	5924	7703
Total reported	107823	85395	88541	114900	107467	103608	110575
Unallocated	-509	2281	1030	1291	-5809	-3646	968
W. G. Estimate	107314	87676	89571	116191	101658	99962	111543
TAC	110000	85000	87000	135000	165000	190000	145000

*Preliminary. [1]Reported by TAC area, IIa(EC), IIIa–d(EC), and IV. [2]Preliminary data reported in IVa.

SAITHE VI

Country	1999	2000	2001	2002	2003	2004*	2005*
Belgium	-	-	-	-	-		
Denmark	-	-	-	-	-		
Faroe Islands	2			2		34	21
France	3467[1*]	3310	5157	3062	3499	3053	3452
Germany	250	305	466	467	54	4	373
Ireland	320	410	399	91	170	95	168
Norway	126	58	31	12	28	16	20
Portugal	-	-	-	-	-		
Russia	3	25	1	1	6	6	25
Spain	23	3	15	4	6	2	3
UK (E/W/NI)	503	276	273	307	263	37	203
UK (Scotland)	2084	2463	2246	1567	1189	1563	4433
Total reported	6778	6850	8588	5513	5215	4810	8699
Unallocated	564	-960	-1770	-327	35	-296	-2960
W. G. Estimate	7342	5890	6818	5186	5250	4514	5739
TAC	7500	7000	9000	14000	17119	20000	15044

*Preliminary. [1]Reported by TAC area, IIa(EC), IIIa–d(EC), and IV.

SAITHE IV and IIIa + VI

	1999	2000	2001	2002	2003	2004	2005
WG estimate	114656	93566	96389	121377	106908	104476	117282

Table 6.4.12.2 Saithe in Subarea IV, Division IIIa (Skagerrak) & Subarea VI

Year	Recruitment Age 3 thousands	SSB tonnes	Landings tonnes	Mean F Ages 3-6
1967	127456	150838	88326	0.3219
1968	114114	211723	113751	0.2907
1969	300688	263959	130588	0.2624
1970	291834	312006	234962	0.4079
1971	327929	429567	265381	0.3286
1972	171371	474089	261877	0.3950
1973	152851	534480	242499	0.4164
1974	148738	554897	298351	0.5564
1975	181235	472054	271584	0.4817
1976	384100	351517	343967	0.7604
1977	118001	263103	216395	0.6153
1978	92439	268051	155141	0.4768
1979	77606	240997	128360	0.3960
1980	67077	235057	131908	0.4430
1981	172580	241021	132278	0.3063
1982	109696	210149	174351	0.4698
1983	117999	213726	180044	0.5500
1984	204920	175785	200834	0.6810
1985	310988	159562	220869	0.7193
1986	286563	150148	198596	0.8301
1987	112029	150451	167514	0.6619
1988	114431	144548	135172	0.6464
1989	77440	110511	108877	0.7091
1990	119870	97113	103800	0.6262
1991	138504	93264	108048	0.5900
1992	92858	95428	99742	0.6302
1993	151791	102985	111491	0.5169
1994	103255	112241	109622	0.5158
1995	226373	134592	121810	0.4213
1996	110797	155402	114997	0.4154
1997	164489	197292	107327	0.2904
1998	71724	196704	106123	0.3477
1999	140766	207222	110716	0.3622
2000	90889	195470	91322	0.3093
2001	234014	216400	95042	0.2826
2002	178215	206766	115395	0.2544
2003	132852	240858	105569	0.2342
2004	85786	281130	104237	0.1939
2005	146169	288144	116343	0.2610
2006	111900	290000		
Average	159058	235731	157005	0.4610

6.4.13 *Nephrops* in Division IIIa (Management Area E)

There are two Functional Units in this Management Area: Skagerrak (FU 3) and Kattegat (FU 4).

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	Unknown		

The available information is inadequate to evaluate spawning stock or fishing mortality relative to risk, so the state of the stock is unknown. Indices from the commercial fishery suggest that the stocks in this Management Area are exploited at sustainable levels. High rates of discards in particular years (1999–2000) may indicate strong recruitment.

Management objectives

No management objectives have been set for this fishery.

Single-stock exploitation boundaries

Exploitation boundaries in relation to precautionary limits

Given the apparent stability of the stocks, current levels of exploitation appear to be sustainable.

Due to uncertainty in the available data ICES is not able to reliably forecast catch. Therefore, ICES recommends that fishing effort for fleets targeting *Nephrops* should not be allowed to increase.

Management considerations

Since most of the trawl fisheries for *Nephrops* in Division IIIa are mixed fisheries, the effort in these fisheries may affect by-catch levels of other commercial species caught unless the species and size selectivity properties of the *Nephrops* trawls is improved (e.g. grids and square meshes). In view of the catch restrictions for cod and other demersal fish species in the North Sea and IIIa it should also be noted that if *Nephrops* fishing effort is allowed to increase, this may have implications for those stocks in mixed fisheries where *Nephrops* is targeted, unless species and size selectivity of the gears is improved (see above). Cod and sole are significant bycatch species in these fisheries in IIIa, and even though data on catch including discards of the bycatch gradually are becoming available, they have not yet been used in the management.

Discards of *Nephrops* are known to be very high and any improvement of the selectivity in the trawls would benefit the stock and medium-term yield.

Ecosystem considerations

Individual stocks inhabit distinct areas of suitable muddy sediment. No information is available on the extent to which larval mixing occurs between *Nephrops* stocks.

Severe depletion in oxygen content in the water can force the individuals out of their burrows, thus temporarily increasing the trawl catchability of this species during such environmental changes. An especially severe case was observed in the late 1980s in the southern part of IIIa in late summer, where unusually high catch rates of *Nephrops* were observed at first, but the increasing amount of dead specimens in the catches later lead to the conclusion of severe oxygen deficiency, especially in the southern part of IIIa (Kattegat) in late 1988.

Factors affecting the fisheries and the stock

The majority of landings are taken by Denmark and Sweden, with Norway contributing only small landings from the Skagerrak. During the last 10 years, total landings from the Skagerrak have varied between 1 900 and 3 250 t, while landings from the Kattegat have varied between 900 and 1 800 t (with the lowest landings recorded in 1992–1995).

The effects of regulations

The minimum landing size for *Nephrops* in Area IIIa is 40 mm carapace length.

Days-at-sea limits restrict *Nephrops* trawlers to 19 days per month when using 90-mm mesh with no square mesh panel, and 22 days with a square mesh panel. New gear regulations imply that it is mandatory to use a 35-mm species-selective grid and 8 metres of 70-mm full square mesh codend and extension piece when trawling for *Nephrops* in Swedish national waters. As Sweden has bilateral agreements with Denmark and Norway to fish inside the 12-nm limit, the regulations cover only waters exclusively fished by Swedish vessels (inside 3 nm in Kattegat and 4 nm in Skagerrak).

Traditionally, *Nephrops* have mainly been caught in trawls using 70- to 89-mm mesh sizes. In the last five years an increasing proportion of the total landings of *Nephrops* have been caught by vessels using gears with mesh sizes >89 mm (which have been used historically in the fishery for cod, plaice, and other demersal fish species). In Skagerrak and Kattegat mesh sizes between 70 and 89 mm have been prohibited since 2005, unless the codend and the extension piece is constructed of square meshed netting with a sorting grid (Council Regulation 27/2005). These changes in fishing patterns may be seen in the light of the declines in most important demersal fish stocks in the North Sea, Skagerrak, and Kattegat. Since 2006, days at sea is unlimited for trawls equipped with species-selective grids (Council Regulation 51/2006).

Changes in fishing technology and fishing patterns

Recent reports from industry and gear technologists suggest a more widespread use of “flip-up” gear in twin rig *Nephrops* trawls. This development will allow fleets to expand onto rougher grounds, potentially exploiting new *Nephrops* areas.

Scientific basis

Data and methods

LPUE and mean size data are available for both FUs. Length compositions are available from 1991 onwards.

Uncertainties in assessment and forecast

The assessment of the state of the *Nephrops* stocks in the Skagerrak and Kattegat area is based on the patterns in fluctuations of total combined LPUE by Denmark and Sweden during the period 1990–2005, and on the patterns in fluctuations of discards in the fisheries as estimated from the catch samples for the same period.

However, the quality of LPUE could be affected by changes in catchability (due to sudden changes in the environmental conditions), or changes in selectivity and/or in gear efficiency. Discards are also dependent on selectivity of the gear and on discarding practices.

Comparison with previous assessment and advice

Due to the age determination problems for *Nephrops* in general, ICES decided not to conduct age-based assessments of these stocks and no analytical assessments on these FUs were performed in 2006. The perception of the state of these stocks based on stock indicators such as LPUEs is similar to previous years.

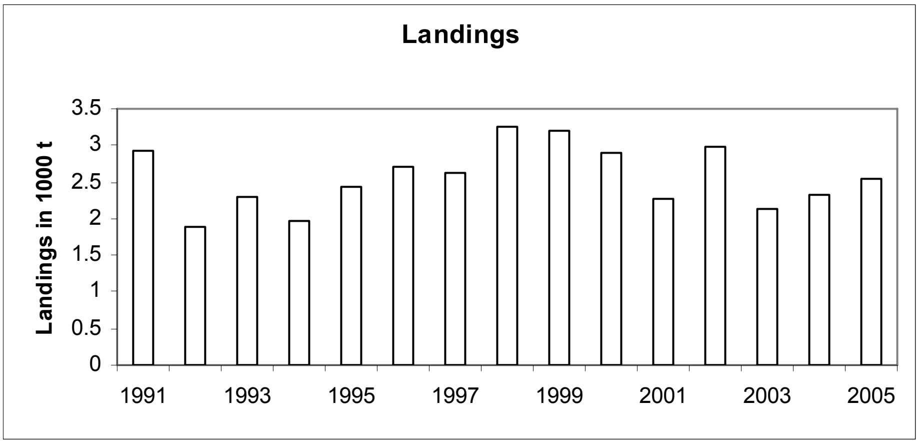
Source of information

Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, 5–14 September 2006 (ICES CM 2006/ACFM: 35).

Year	ICES advice	Recommended TAC	Agreed TAC	ACFM landings [1]
1987				4.0
1988				3.7
1989				3.9
1990				4.3
1991				4.2
1992		~4.0	3.5	2.9
1993		~4.3	3.5	3.2
1994		2.9	3.5	2.9
1995		2.9	4.8	3.4
1996	*Status quo* TAC	2.9	4.8	4.0
1997	*Status quo* TAC	2.9	4.8	4.2
1998		4.0	4.8	5.0
1999		4.0	4.8	4.9
2000		3.8	5.0	4.7
2001		3.8	4.5	4.1
2002	*Catches to be maintained at the 2000 level*	4.7	4.5	4.4
2003	*Catches to be maintained at the 2000 level*	4.7	4.5	3.8
2004	*Catches to be maintained at the 2000 level*	4.7	4.7	4.0
2005	*Catches to be maintained at the 2000 level*	4.7	5.2	4.0
2006	*No increase in effort*		5.2	
2007	*No increase in effort*			

Weights in '000 t.
[1)] Does not include discards.

Nephrops in Skagerrak



Nephrops in Kattegat.

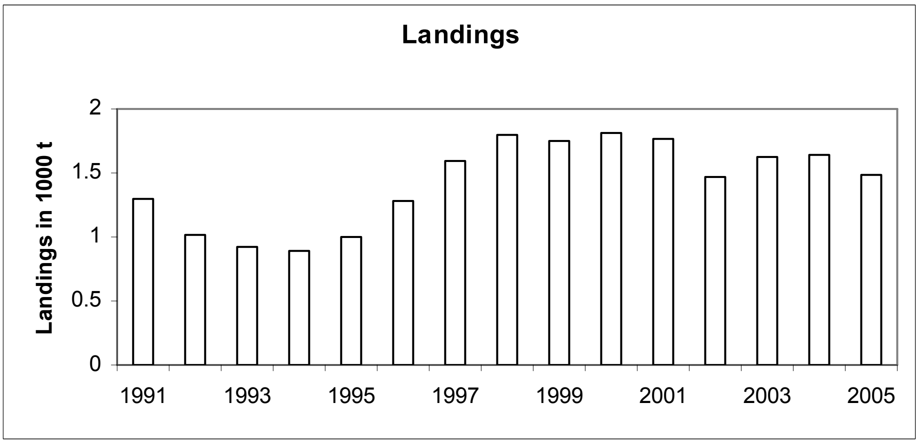


Figure 6.4.13.1

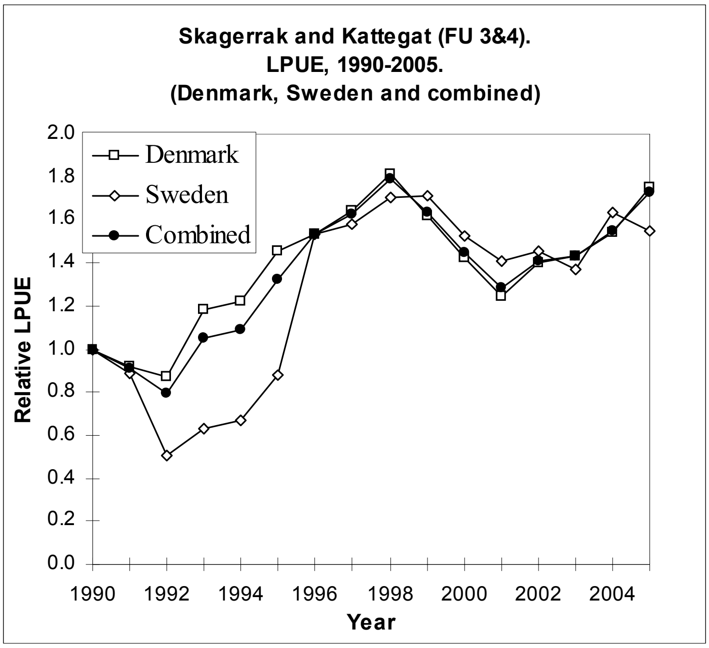


Figure 6.4.13.2 *Nephrops.* Trends in landings per unit effort from the Danish and Swedish fisheries.

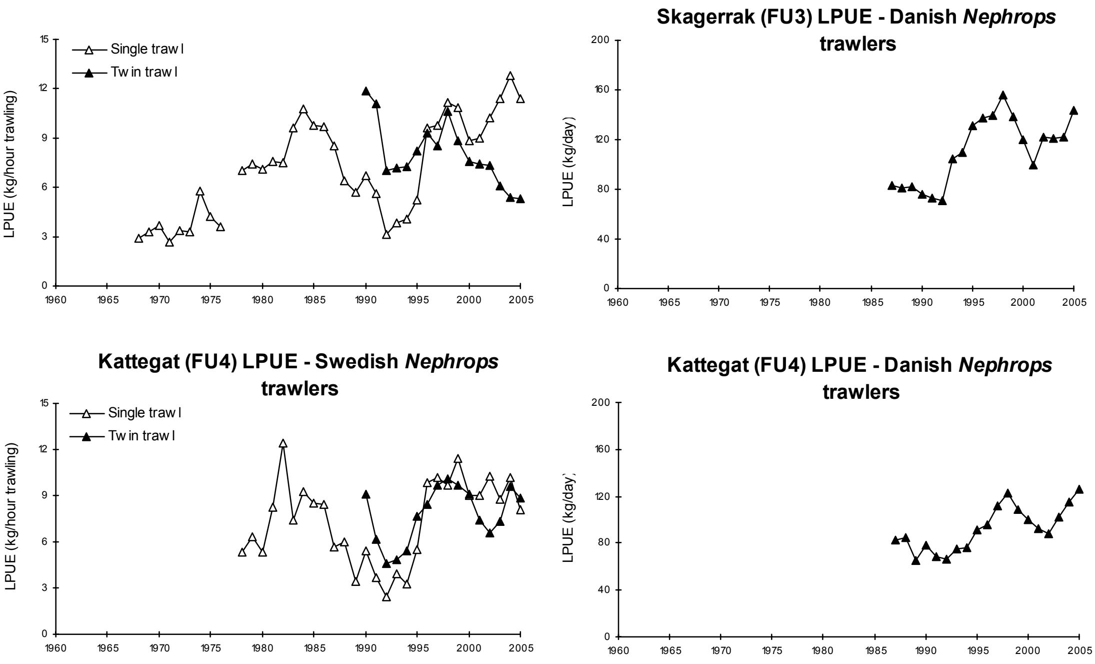


Figure 6.4.13.3 ***Nephrops*** Skagerrak (FU 3) and Kattegat (FU 4): Long-term trend in LPUE**.**

Table 6.4.13.1 ***Nephrops*** **Skagerrak.**

Year	Landings tonnes
1991	2934
1992	1900
1993	2285
1994	1981
1995	2429
1996	2694
1997	2612
1998	3248
1999	3194
2000	2894
2001	2282
2002	2977
2003	2126
2004	2312
2005	2546
Average	2561

Table 6.4.13.2 *Nephrops* Kattegat.

Year	Landings tonnes
1991	1304
1992	1012
1993	924
1994	893
1995	998
1996	1285
1997	1594
1998	1796
1999	1749
2000	1809
2001	1773
2002	1464
2003	1628
2004	1641
2005	1486
Average	1424

6.4.14 *Nephrops* in Division IVa, rectangles 44–48 E6-E7+44 E8 (Management Area F)

There are two Functional Units in this Management Area: a) Moray Firth (FU 9) and b) Noup (FU 10).

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	Unknown		

The available fishery information is inadequate to evaluate spawning stock or fishing mortality relative to precautionary reference points.

a) Moray Firth: The TV survey estimate of abundance for *Nephrops* in the Moray Firth suggests that the population increased by around 40% in 2002, probably due to good recruitment in that year. Based on the surveys the stock has been relatively stable since 2002, while length compositions in the catch have been relatively stable for 10 years.
b) Noup: The TV survey estimate of abundance for *Nephrops* in the Noup suggests that the population declined between the two surveys in 1994 and 1999, but unfortunately no recent data are available.
c) Small quantities of landings are made outside the statistical rectangles describing the Functional Unit, but within the Management Area.

Management objectives

No management objectives have been set for this fishery.

Reference points

No reference points have been determined for *Nephrops*.

Single-stock exploitation boundaries

Exploitation boundaries in relation to precautionary limits

The effort in this fishery should not be allowed to increase relative to the past three years. In addition to the ceiling on effort ICES advises that the harvest ratio in this stock should be no more than 15%, until such time that more reliable catch information becomes available. This corresponds to landings of less than 2400 tonnes for the Moray Firth stock. The fishery in Noup stock should be less than 240 t, the average of the last three years.

Short-term implications

Outlook for 2007

Harvest rate	Moray Firth landings in t
15%	2411
20%	3215
25%	4019

Noup: Average 03–05: 243 t.
“Other Squares”: Average 03–05: 77 t.

Management considerations

In the North Sea TAC (which comprises eight *Nephrops* stocks), the present aggregated management approach runs the risk of unbalanced effort distribution. Adoption of management initiatives to ensure that effort can be appropriately controlled in smaller areas within the overall TAC area is recommended.

In 2005, high abundance of 0 group cod was recorded in Scottish surveys in the Moray Firth area. High abundance of 0-group haddock was more widely reported. The abundance of these fish as 1-year-olds still appears to be relatively high. It is important that efforts are made to ensure that these and other fish are not taken as unwanted bycatch in smaller-mesh fisheries and technical measures that improve the exploitation pattern would be beneficial in the fisheries of these functional units.

Landings divided by survey biomass indices is a proxy of exploitation rate. Available information indicates that landings in recent years are most likely an underestimate of actual landing. The reported landings in the 1990s are considered more accurate. The lower bounds of the harvest ratio for the inshore stocks during that period was around 15%. The general increase in *Nephrops* abundance in recent years indicate that a 15% harvest ratio will probably not have detrimental effect on the stocks.

The STECF concluded that a 20% harvest rate, derived from an estimate of $\mathbf{F}_{0.1}$ from a length-based yield-per-recruit analysis, is appropriate. Deriving target rates from an analytical framework and applying it to survey indices are among other things very sensitive to the assumption of the length-based model and the assumption that survey indices are an absolute measure of biomass. These assumptions have not been evaluated.

Ecosystem considerations

Throughout its distribution, *Nephrops* is limited to a muddy habitat, and requires sediment with a silt and clay content of between 30–100% to excavate its burrows, and this means that the distribution of suitable sediment defines the species distribution. Adult *Nephrops* only undertake very small scale movements (a few hundred metres), but larval transfer may occur between separate mud patches in some areas. In the Moray Firth area the *Nephrops* stock inhabits a single continuous area of muddy sediment extending from north of Fraserburgh to Inverness.

Cod has been identified as a predator of *Nephrops* in some areas, and the generally low level of the cod stock is likely to have resulted in reduced predation.

Factors affecting the fisheries and the stock

Landings from this fishery are predominantly reported from Scotland, with very small contributions from England in the mid-1990s, but not recently.

About three quarters of the landings are made by single-rig trawlers, a high proportion of which use a 70-mm mesh. In 1999, twin-rig vessels predominantly used a 100-mm mesh, with 90% of the twin-rig landings made using this mesh size. Legislative changes in 2000 permitted the use of an 80-mm mesh.

The effects of regulations

The minimum landing size for *Nephrops* in the Moray Firth is 25 mm CL. Discarding of undersize and unwanted *Nephrops* occurs in this fishery. Discarding rates averaged over the period 2003 to 2005 for this stock were about 21% by number, or 11% by weight. This represents a marked reduction in discarding rate compared to the average for the period 2002 to 2004. This may arise from the increasing use of larger size meshes in the northern North Sea, although reduction in recruitment may also account for this change.

Changes in fishing technology and fishing patterns

A few small vessels attempted twin trawling, but have since reverted to single trawling. The Moray Firth vessels shifted seasonally into a squid fishery in 2004 and 2005 – this is less common in 2006. There is concern that a shift to the recent development of multiple rig gears (3 and 4 nets) will lead to a step change in effective effort which is counter to the advice.

Scientific basis

Data and methods

Underwater TV survey estimates are available for 1993–1994 and from 1996 onwards for the Moray Firth, and only in 1994 and 1999 for the Noup stock. Length compositions are available from 1980 for the Moray Firth stock and intermittently from 1996 for the Noup stock. Since recent landings and effort data are considered imprecise they are not used as a basis for assessing the status of the stock.

Information from the fishing industry

The NSCFP stock survey shows a continuous increase in *Nephrops* in the Northeast of Scotland (including Fladen Grounds) since 2001. The NSCFP survey also suggests increased abundance in recent years.

Uncertainties in assessment and forecast

There are concerns over the accuracy of landings and effort data and because of this the final assessment adopted is independent of official statistics.

Comparison with previous assessment and advice

The method and the basis of the advice is the same as last year.

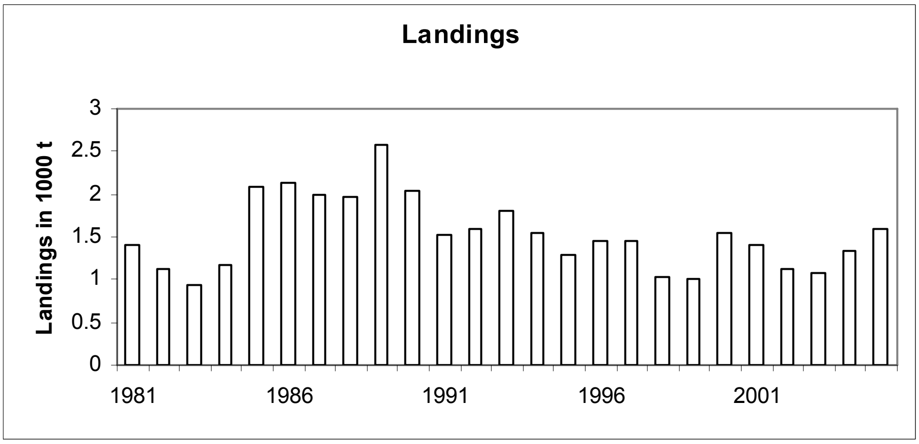
Sources of information:

Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, 5–14 September 2006 (ICES CM 2006/ACFM: 35).
Commission Staff Working Paper. 21st Report of the Scientific, Technical and Economic Committee for Fisheries (Second Plenary Meeting). Brussels, 7–11 November 2005.

Year	ICES advice	Recommended TAC	Agreed TAC[1]	ACFM landings [2]
1987				2.1
1988				2.1
1989				2.7
1990				2.3
1991				1.8
1992		~2.4	12.0	1.8
1993		2.4	12.0	2.3
1994		2.4	13.0	2.2
1995		2.4	15.2	1.7
1996	*Status quo* TAC	2.4	15.2	1.9
1997	*Status quo* TAC	2.4	15.2	1.9
1998		2.4	15.2	1.4
1999		2.4	15.2	1.4
2000		1.85	17.2	1.9
2001		1.85	15.48	1.7
2002	*Catches to be maintained at the 2000 level*	2.0	16.623	1.6
2003	*Catches to be maintained at the 2000 level*	2.0	16.623	1.5
2004	*Catches to be maintained at the 2000 level*	2.0	21.350	1.7
2005	*Catches to be maintained at the 2000 level*	2.0	21.350	1.8
2006	*No increase in effort*	-	28.147	
2007	*No increase in effort, and harvest rate below 15%*	2.64 [3)]		

Weights in ‘000 t.
[1)] EU zone of IIa and IV.
[2)] Does not include discards.
[3)] Based on a 15% harvest rate applied to TV survey abundance data.

Nephrops in Division IVa Rectangles 44–48 E6-E7+44 E8 (Management Area F): Moray Firth FU9.



Nephrops in Division IVa Rectangles 44–48 E6-E7+44 E8 (Management Area F): Noup FU 10.

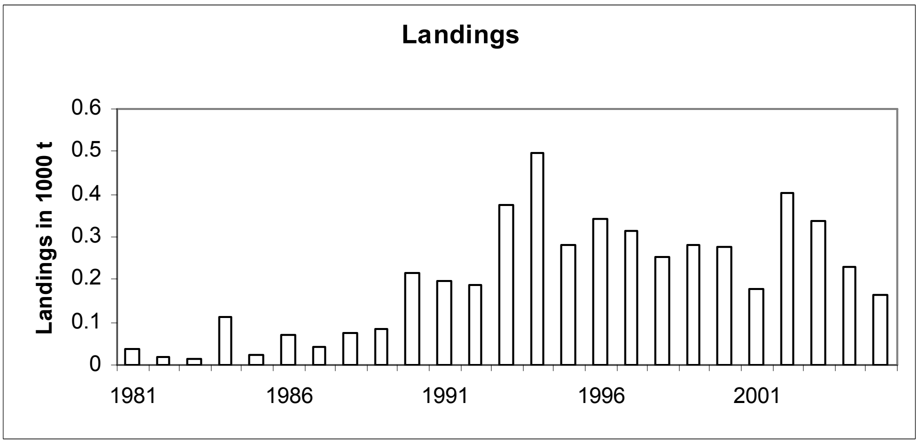


Figure 6.4.14.1

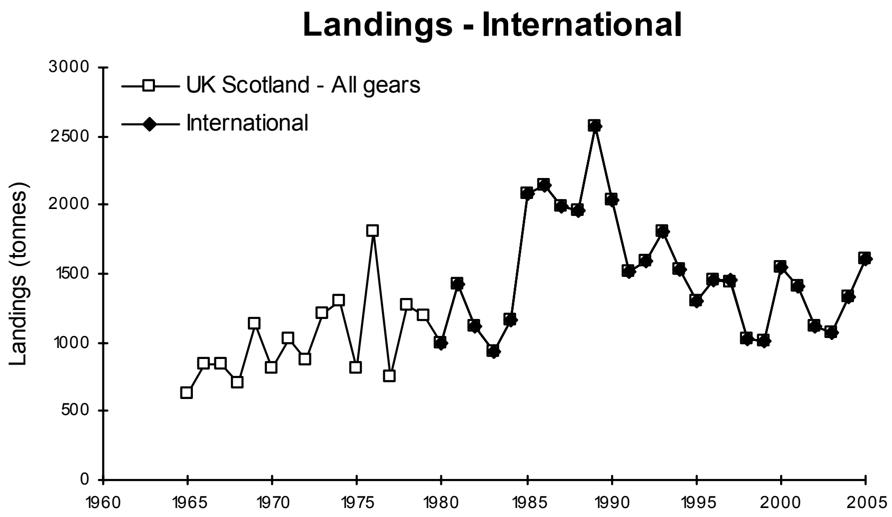


Figure 6.4.14.2. Moray Firth (FU 9). Long-term landings.

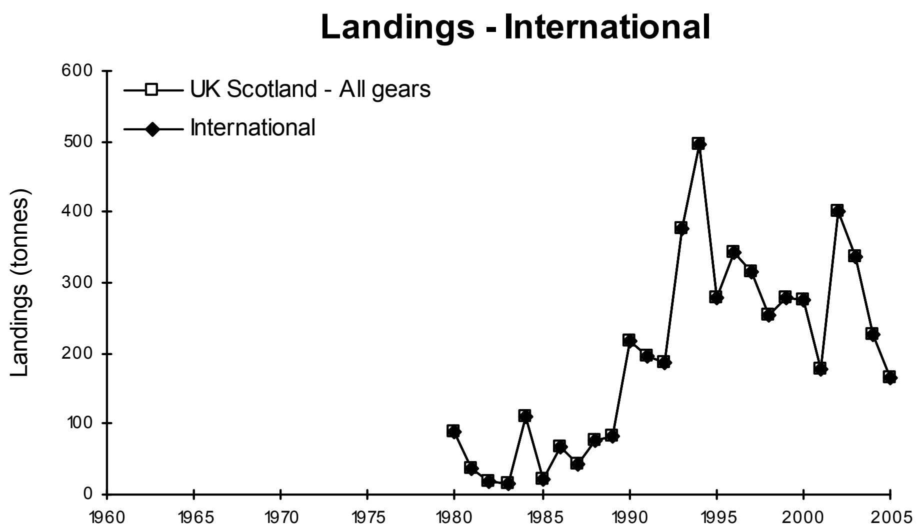


Figure 6.4.14.3 Noup (FU 10). Long-term landings.

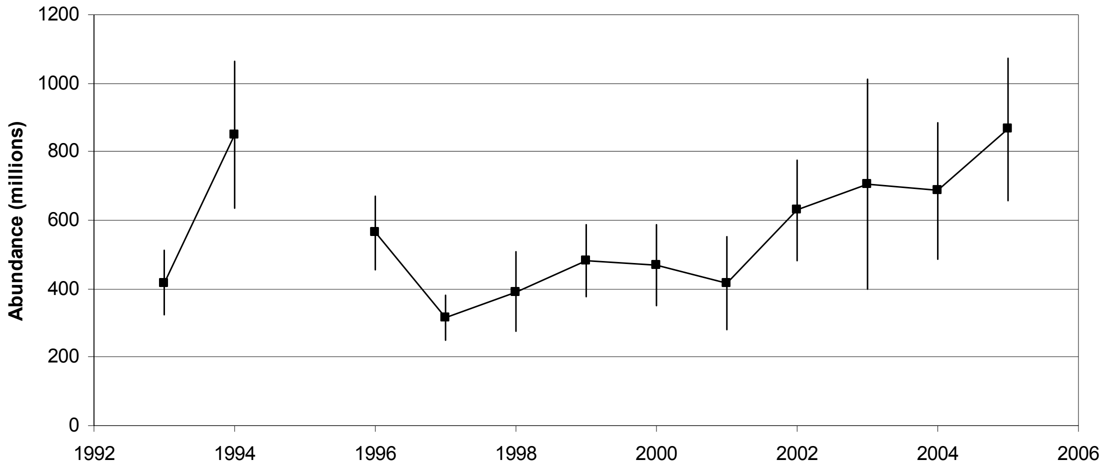


Figure 6.4.14.4 *Nephrops*, Moray Firth (FU 9). Time-series of TV survey abundance estimates, with 95% confidence intervals, 1993–2005.

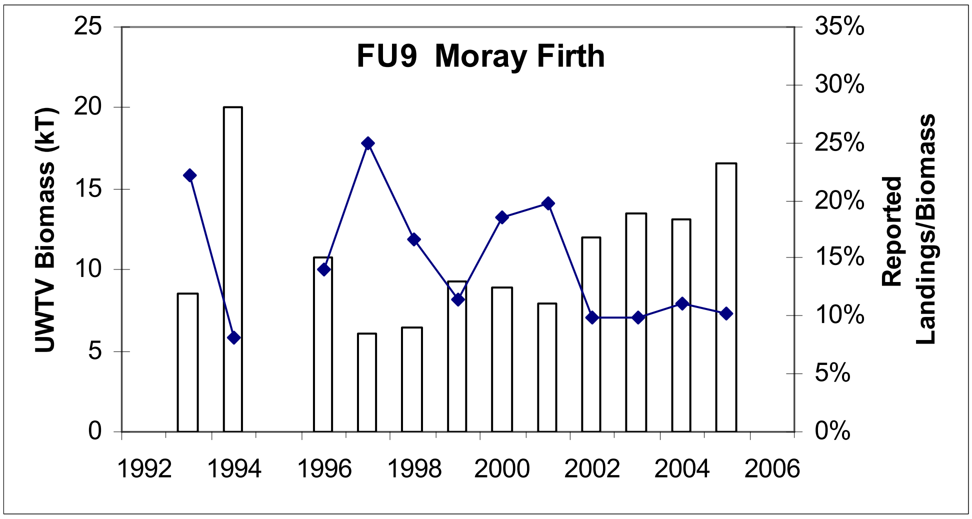


Figure 6.4.14.5 Moray Firth (FU 9). Time-series of TV survey abundance estimates and reported landing rate exploitation proxies.

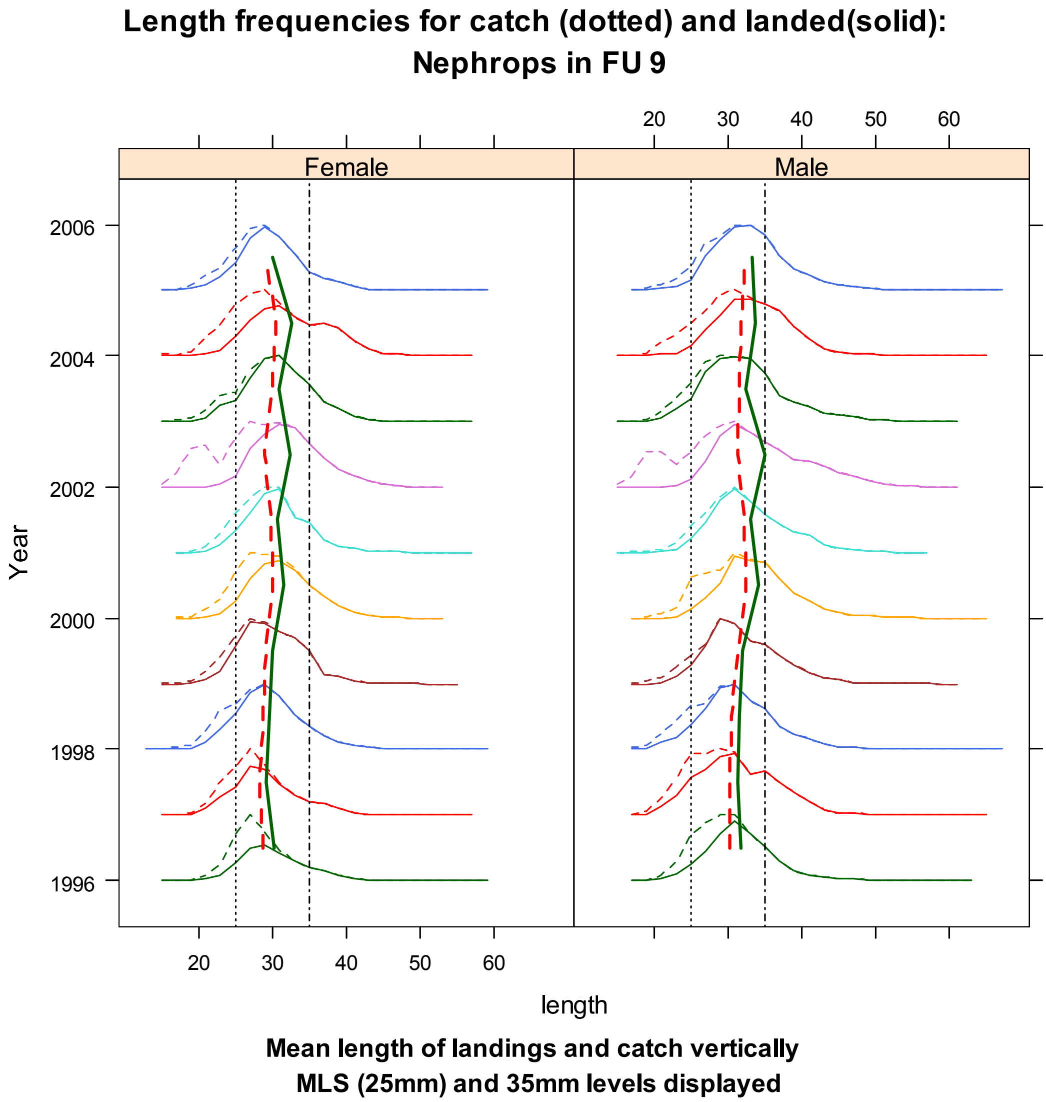


Figure 6.4.14.6 Length frequencies for catch (dotted) and landed (solid) *Nephrops* in FU 9.

Table 6.4.14.1 *Nephrops*, Management Area F: Total *Nephrops* landings (tonnes) by Functional Unit plus Other rectangles, 1981–2005.

Year	FU 9	FU 10	Other	Total
1981	1416	36	0	1452
1982	1120	19	1	1140
1983	940	15	1	956
1984	1170	111	3	1284
1985	2081	22	15	2118
1986	2143	68	44	2255
1987	1991	44	34	2069
1988	1959	76	45	2080
1989	2576	84	44	2704
1990	2038	217	68	2323
1991	1519	196	65	1780
1992	1591	188	43	1822
1993	1808	376	69	2253
1994	1538	495	138	2171
1995	1297	280	77	1654
1996	1451	344	101	1896
1997	1446	316	94	1856
1998	1032	254	74	1360
1999	1008	279	74	1361
2000	1541	275	64	1880
2001	1403	177	116	1696
2002	1118	401	69	1588
2003	1079	337	118	1534
2004	1335	228	80	1643
2005*	1605	165	32	1802

* provisional na = not available

6.4.15 *Nephrops* in Division IVa, West of 2°E, excluding Management Area F (Management Area G)

There is one Functional Unit in this Management Area: Fladen (FU 7).

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	Unknown		

The available fishery information makes it inadequate to use analytical methods to evaluate spawning stock or fishing mortality in relation to the precautionary approach. Results from TV surveys suggest that the stock is probably exploited at a sustainable level. The TV survey estimates of abundance for *Nephrops* on the Fladen Ground indicate that the stock has fluctuated around twofold since 1992. In the last four years it has declined by 40% and is currently of a size similar to that observed in the late 1990s.

Small quantities of landings are made outside the main Fladen Ground Functional Unit, but within the Management Area.

Management objectives

There are no management objectives set for this fishery.

Reference points

No reference points have been determined for *Nephrops*.

Single-stock exploitation boundaries

Exploitation boundaries in relation to precautionary limits

The effort in this fishery should not be allowed to increase relative to the past three years. In addition to the ceiling on effort ICES advises that the harvest ratio in this stock should be no more than 7.5%, until such time that more reliable catch information becomes available. This corresponds to landings of less than 10 882 tonnes for the Fladen stock. The fishery in adjacent squares should be limited to 105 t, the average of the last three years.

Short-term implications

Outlook for 2007

Harvest rate	Fladen Gound landings in t
5%	7279
7.5%	10882
10%	14392
15%	21587
20%	28783
25%	35979

‘Other Squares’ (Average 03–05): 105 t.

Management considerations

In the North Sea TAC (which comprises eight *Nephrops* stocks), the present aggregated management approach runs the risk of unbalanced effort distribution. Adoption of management initiatives to ensure that effort can be appropriately controlled in smaller areas within the overall TAC area is recommended.

Potential development of multiple rigs (triple and quadruple trawls) will potentially increase efficiency and effective effort. Any effort management measures should take these potential developments of multiple gears into account.

Scottish groundfish surveys indicate that the abundance of 1-year-old cod in 2006 is relatively higher than the record low indices observed in the last few years and that they are present on the Fladen Ground. The same observation applies to the emerging 2005 haddock year class which will start to enter into the fishery in 2007. According to forecasts, large haddock discard numbers are predicted under the present exploitation pattern. It is important that efforts are made to ensure that both of these species and others are not taken as unwanted bycatch in smaller-mesh fisheries, and technical measures that improve the exploitation pattern would be beneficial in the fisheries of this area.

Landings divided by survey biomass indices is a proxy of the exploitation rate. Available information indicates that landings in recent years are most likely an underestimate of actual landings. The reported landings in the 1990s are considered more accurate. The exploitation ratio for the Fladen stock during that period was around 7.5%.

The STCEF concluded that a 20% harvest rate was acceptable, derived from an estimate of $\mathbf{F}_{0.1}$ from a length-based yield-per-recruit analysis. Deriving target rates from an analytical framework and applying it to survey indices are among other things very sensitive to the assumption of the length-based model and the assumption that survey indices are an absolute measure of biomass. These assumptions have not been evaluated.

Ecosystem considerations

Throughout its distribution, *Nephrops* is limited to a muddy habitat, and requires sediment with a silt and clay content of between 30–100% to excavate its burrows, and this means that the distribution of suitable sediment defines the species distribution. Adult *Nephrops* only undertake very small-scale movements (a few hundred metres), but larval transfer may occur between separate mud patches in some areas. In the Fladen area the *Nephrops* stock inhabits a generally continuous area of muddy sediment extending from 57°30'N to 60°N, and from 1°W to 1°30'E, with other smaller patches to the north. The Fladen Ground is the largest known *Nephrops* ground, with around 28 200 km^2 of suitable mud substrate, and is the main offshore ground in Scottish waters. Hydrographic features in the area include a dome of cold bottom water present over the grounds. This may influence the biology of the animal, but has so far not been studied.

Cod has been identified as a predator of *Nephrops* in some areas, and the generally low level of the cod stock is likely to have resulted in reduced predation.

Factors affecting the fisheries and the stock

The fleet fishing the Fladen Ground for *Nephrops* comprises approximately 215 trawlers, which are predominantly Scottish (> 97%), based along the Scottish NE coast, with very few landings made in the UK by foreign vessels.

Approximately two-thirds of the landings are made by single-rig vessels and one-third by twin-rig vessels. In both units, two-thirds of the catches are taken with 100-mm meshes, the remainder with 70- to 80-mm meshes.

Nearly 40% of the *Nephrops* landings are reported as bycatch, where fish are the main target species. This may, however, be an artefact of the method of reporting to the Fishery Offices, since the mesh sizes used on the Fladen Ground tend to be larger (i.e. 100 mm) than in other areas. The consequence is that vessels using a 100-mm mesh are sometimes regarded as whitefish-directed, even if they have actually been targeting Nephrops.

The effects of regulations

The minimum landing size for *Nephrops* on the Fladen Ground is 25 mm CL. Discarding takes place at sea, but because of the larger mesh sizes used in the fishery proportionally fewer undersized animals need to be discarded than in other areas. Discarding rates averaged over the period 2003 to 2005 for this stock were 11% by number, or 7% by weight.

Changes in fishing technology and fishing patterns

Fishing effort was in the past primarily directed to a region that can be reached within 12-hours steaming from ports along the NE coast of Scotland. Recent information suggests that vessels are fishing more widely over the ground, including to the far eastern edges of the extensive mud area.

Scientific basis

Data and methods

Annual underwater TV survey estimates of the Fladen grounds are available for 1992–1995 and from 1997 onwards.

Information from the fishing industry

The NSCFP stock survey shows an increase in *Nephrops* between 2001 and 2002, a slight decrease to 2003, and a marked increase since this date. This supports the suggestion of an increase in abundance for this area shown by the LPUE data, but is not consistent with the TV data which shows a recent decline.

Uncertainties in assessment and forecast

The trends in abundance observed in the TV survey data have not been reflected in LPUE data or mean size data. This may be owing to the short time-series of discard data, or to spatial changes in the fishery.

Comparison with previous assessment and advice

The results of the most recent TV surveys were slightly lower than in 2004, but within the observed range of fluctuation. There is considerable doubt about the quality of fisheries data and assessments cannot be based on these data, i.e. catch and LPUE. The advice is for no increase in effort. Since reliable fisheries data are not available for predicting catch from landings, the fishery-independent TV underwater survey abundance estimates are used to derive future landings associated with various harvest rates.

Sources of information

Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, 5–14 September 2006 (ICES CM 2006/ACFM: 35).

Commission Staff Working Paper. 21st Report of the Scientific, Technical and Economic Committee for Fisheries (Second Plenary Meeting). Brussels, 7–11 November 2005.

Year	ICES advice	Recommended TAC	Agreed TAC[1]	ACFM Landings[2]
1989				2.3
1990				2.6
1991				4.3
1992		~2.7	12.0	3.4
1993		2.7	12.0	3.5
1994		5.0	13.0	4.7
1995		5.0	15.2	6.6
1996		5.0	15.2	5.4
1997		5.0	15.2	6.3
1998		7.0	15.2	5.2
1999		7.0	15.2	6.7
2000		9.0	17.2	5.6
2001		9.0	15.48	5.6
2002		9.0	16.623	7.4
2003		9.0	16.623	6.4
2004		12.8	21.350	8.8
2005		<12.8	21.350	10.8
2006	No increase of effort	-	28.147	
2007	No increase in effort and harvest rate below 7.5%	<10.9[3]		

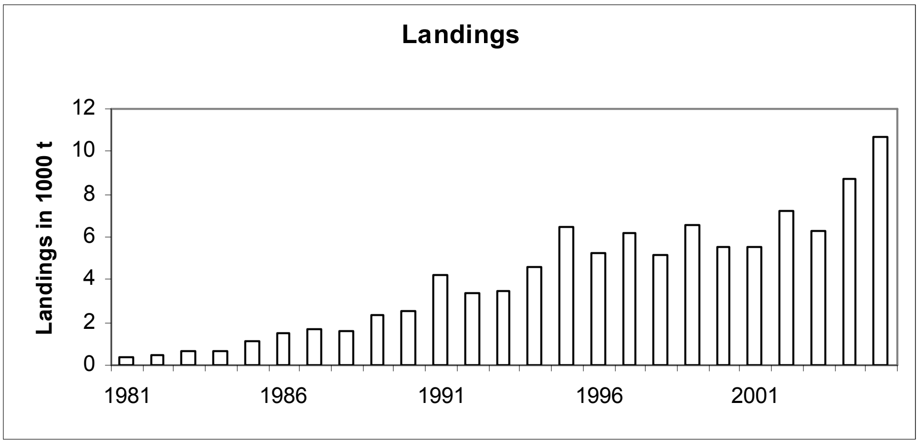
Weights in '000 t.

1) EU zone iIa and IV.

2) Does not include discards.

3) Based on a 7.5% harvest rate applied to TV abundance data.

Nephrops in Division IVa west of 2ºE, excluding Management Area F (Management Area G)



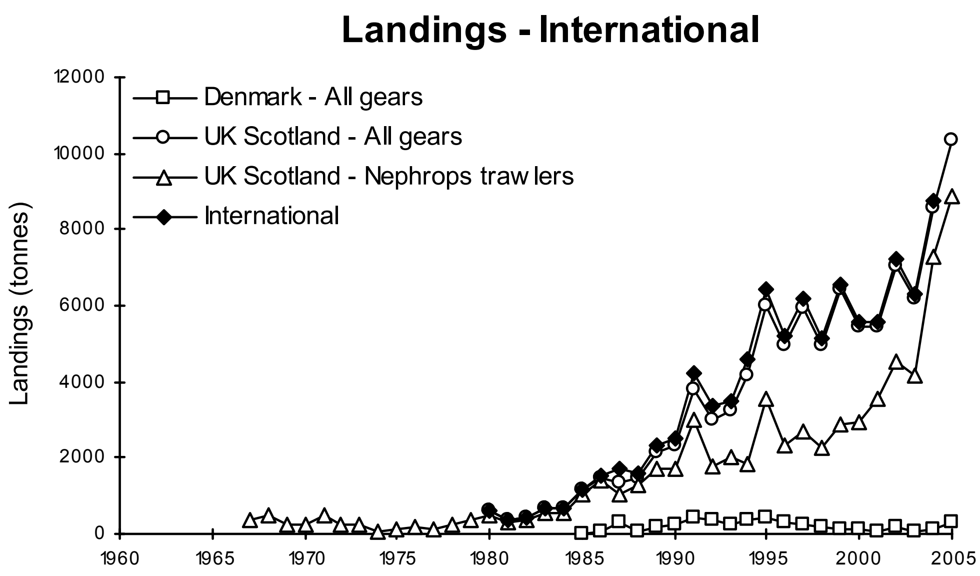


Figure 6.4.15.1 *Nephrops*, Fladen (FU 7). Long-term landings.

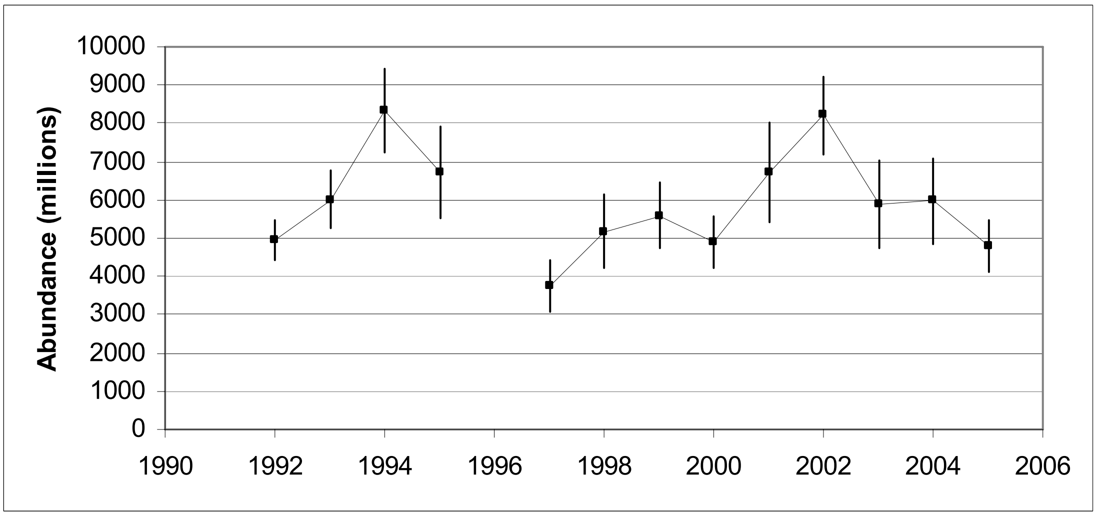


Figure 6.4.15.2 *Nephrops*, Fladen (FU 7). Time-series of TV survey abundance estimates, with 95% confidence intervals, 1992–2005.

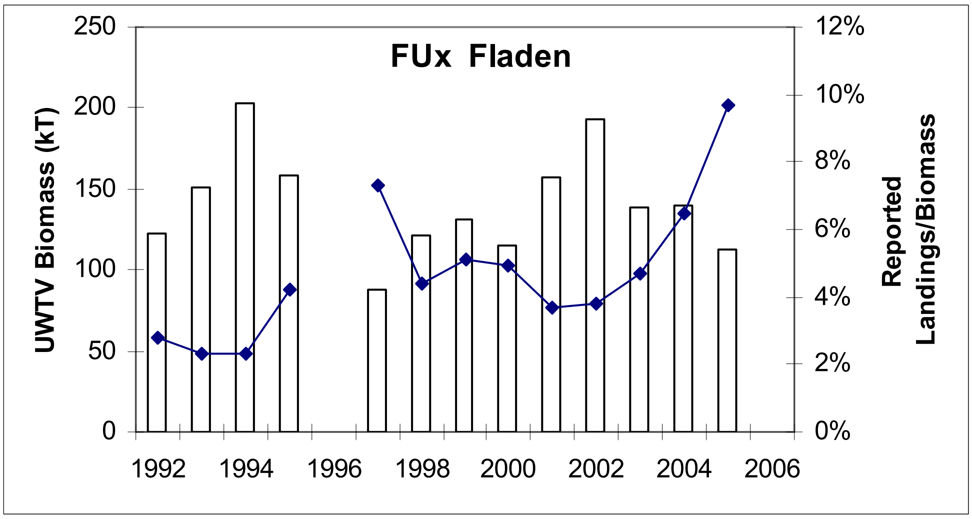


Figure 6.4.15.3 *Nephrops*, Fladen (FU 7)

Table 6.4.15.1 *Nephrops*, Management Area G: Total *Nephrops* landings (tonnes) by Functional Unit plus Other rectangles, 1981–2005.

Year	FU 7	Other	Total
1981	373	2	375
1982	422	0	422
1983	693	0	693
1984	646	7	653
1985	1148	18	1166
1986	1543	17	1560
1987	1696	14	1710
1988	1573	11	1584
1989	2299	31	2330
1990	2540	20	2560
1991	4221	52	4273
1992	3363	39	3402
1993	3493	39	3532
1994	4569	117	4686
1995	6440	184	6624
1996	5218	150	5368
1997	6171	95	6266
1998	5136	94	5230
1999	6521	175	6696
2000	5570	81	5650
2001	5541	103	5644
2002	7247	163	7410
2003	6294	108	6402
2004	8729	101	8830
2005*	10684	107	10791
* provisional na = not available			

6.4.16 *Nephrops* in Divisions IVb,c, East of 1°E, excluding rectangles 43 F5–F7 (Management Area H)

There are two Functional Units in this Management Area: a) Botney Gut (FU 5) and b) Off Horn Reef (FU 33).

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	Unknown		

The available information is inadequate to evaluate spawning stock or fishing mortality relative to risk.

d) Botney Gut: Indications from landing per unit effort do not indicate a decline in stock density. The mean sizes of males in the landings show evidence of an overall long term downward trend, while mean sizes of females seem to have stabilised, albeit at a level that is lower than in the early 1990s.

e) Off Horn Reef: The upward trend in LPUE is noted for the recent years. A precautionary interpretation of this increase suggests that the stock level remains relatively stable. However, the marked shift in the size distribution for 2005 compared to previous years could be a sign of a too high exploitation level in recent years. However, as LPUE was at a high level in 2005, the decrease in mean size in the catch could merely be a sign of large recruitment.

Management objectives

There are no management objectives for this fishery.

Reference points

No reference points have been determined for *Nephrops*.

Single-stock exploitation boundaries

Exploitation boundaries in relation to precautionary limits

Information on these stocks is considered inadequate to provide advice based on precautionary limits. Therefore, ICES recommends that the level of exploitation, i.e. effort on these stocks should not be increased.

Management considerations

ICES notes that by setting one single North Sea TAC (which comprises eight *Nephrops* stocks), this aggregated management approach runs the risk of unbalanced effort distribution. Adoption of management initiatives to ensure that effort can be appropriately controlled in smaller areas within the overall TAC area is recommended.

For FU 5 (Botney Gut) mean sizes of males in the landings show evidence of an overall long-term downward trend, while mean sizes of females seem to have stabilised, albeit at a level that is considerably lower than in the early 1990s. Although the observed shift apparently was of a temporary nature, it stresses the need to closely monitor this stock. As a matter of fact, shifts of this type may be indicative of increased fishing pressure on the oldest age classes in the population and/or of a change in discarding practices, a change towards retaining more of the smaller *Nephrops*.

For FU 33 (Horns Reef) the shift in the size composition in the catches in 2005 may be interpreted ambiguously, and would be a cause for concern unless it arises from increased recruitment. Measurements indicate that the discard rates in these fisheries are extremely high. There is an urgent need to reduce these and to improve the exploitation pattern.

The abundance of cod as 1-year-olds still appears to be relatively high. Similar comments can be made about the emerging 2005 haddock year class which will begin entering the fishery in 2007 and according to forecasts will result in large discard numbers under the present exploitation pattern. It is important that efforts are made to ensure that both of these species and others are not taken as unwanted bycatch. Technical measures that improve the exploitation pattern would be beneficial in the fisheries of these Management Areas.

Factors affecting the fisheries and the stock

2004 and 2005 saw a further decline in the Belgian *Nephrops* fishery in the Botney Gut–Silver Pit area. Up to 1995, the Belgian fleet would take over 75% of the international landings from this stock, but its share has dropped since then to less than 25%. The Netherlands is now the most important player in FU 5, with over 60% of the total international landings being taken by Dutch trawlers, for first sale in the Netherlands or in Belgium.

Long-term effort of the Belgian *Nephrops* fleet has shown an almost continuous decrease since the all-time high in the early 1990s.

As for FU 33 (Horn Reef), *Nephrops* landings from this area doubled from 2000 to 2004. Effort as well as landings decreased in 2005, but LPUE was the highest on record.

Scientific basis

Data and methods

The perception of the stocks (FUs 5 & 33) is based on LPUE only and length distribution in the catches.

Information from the fishing industry

The NSCFP stock survey trends show an increase between 2001 and 2002, a stable period to 2004, and an increase in 2005. There were no strong indications of changes in recruitment or discarding levels.

Uncertainties in assessment and forecast

For both FUs the LPUE values must be viewed cautiously as stock indicators. For FU 5 especially the LPUEs from Belgian specialist trawlers in 2004 and 2005 should be treated with caution since (a) they are based on a very small number of vessels only, (b) the *Nephrops* specialist trawlers remaining are the ones operating twin-rigs (which have higher catch rates than the single rigs that were in use in the 1980s and 1990s), and (c) there is a tendency—also amongst the specialist trawlers—to concentrate fishing effort in the season with the highest catch rates.

The lack of discards information for all the components of the Botney Gut (FU 5) fishery prevent any firm conclusion on the state of the stock based on a trend in the mean size of the catch. As mentioned above, for FU 33 the decrease in mean length in the catch may be interpreted as high recruitment causing increasing amounts of discards.

Comparison with previous assessment and advice

Previous assessments have considered this stock to be fully exploited. LPUE trends have been relatively stable up to the most recent years. Interpretation of recent changes is complicated by changes in the fleets providing the data.

Sources of information

Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, 5–14 September 2006 (ICES CM 2006/ACFM:35).

Commission Staff Working Paper. 21st Report of the Scientific, Technical and Economic Committee for Fisheries (Second Plenary Meeting). Brussels, 7–11 November 2005.

Year	ICES advice	Recommended TAC	Agreed TAC[1]	ACFM Landings[2]
1987				0.5
1988				0.7
1989				0.8
1990				0.9
1991				1.0
1992		0.87	12.0	0.7
1993		0.87	12.0	0.9
1994		0.87	13.0	0.7
1995		0.87	15.2	1.2
1996		0.87	15.2	0.9
1997		0.87	15.2	1.6
1998		1.0	15.2	1.6
1999		1.0	15.2	2.2
2000		1.6	17.2	2.0
2001		1.6	15.48	2.4
2002		2.1	16.623	2.4
2003		2.1	16.623	2.5
2004		2.38	21.350	2.6
2005		2.38	21.350	2.3
2006		2.38	28.147	
2007	No effort increase	-		

Weights in '000 t.
1) EU Zone of IIa and IV.
2) Does not include discards.

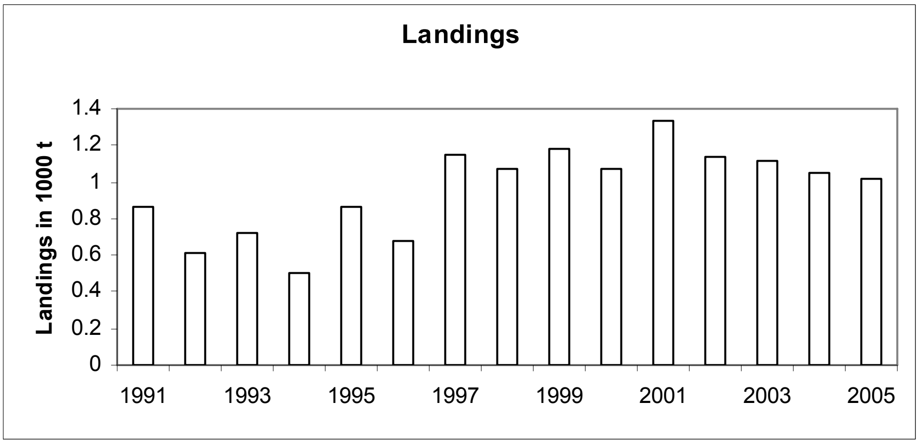


Figure 6.4.16.1 *Nephrops* in Division IVb,c, east of 1ºE, excluding Rectangles 43 F5–F7 (Management Area H), FU 5.

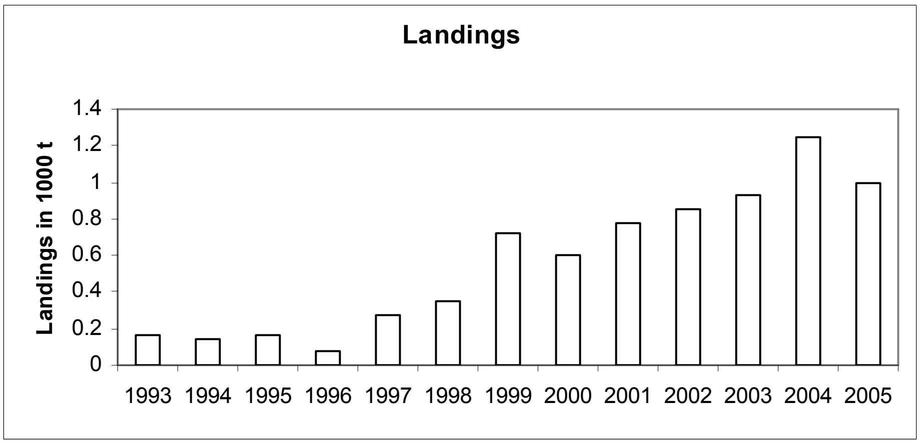


Figure 6.4.16.2 *Nephrops* in Division IVb,c, east of 1ºE, excluding Rectangles 43 F5–F7 (Management Area H), FU 33.

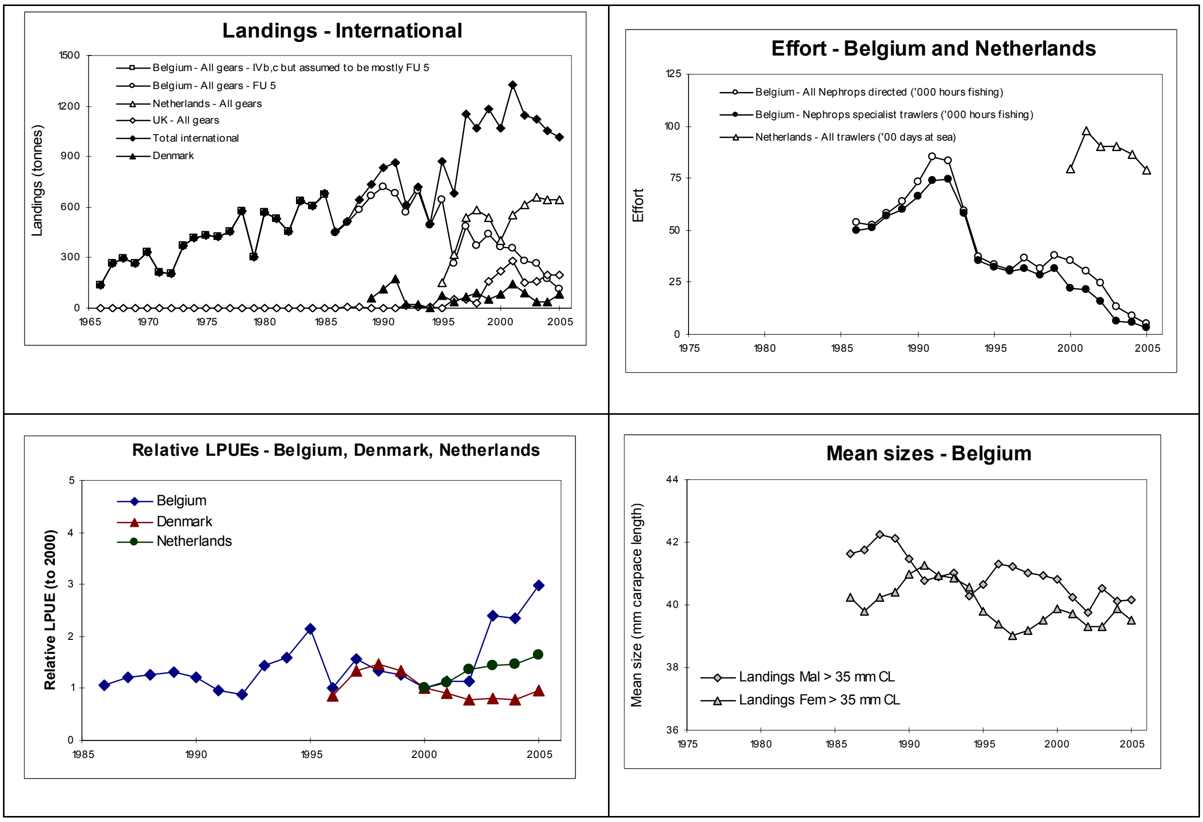


Figure 6.4.16.3. Botney Gut - Silver Pit (FU 5): Long-term trends in LPUE.

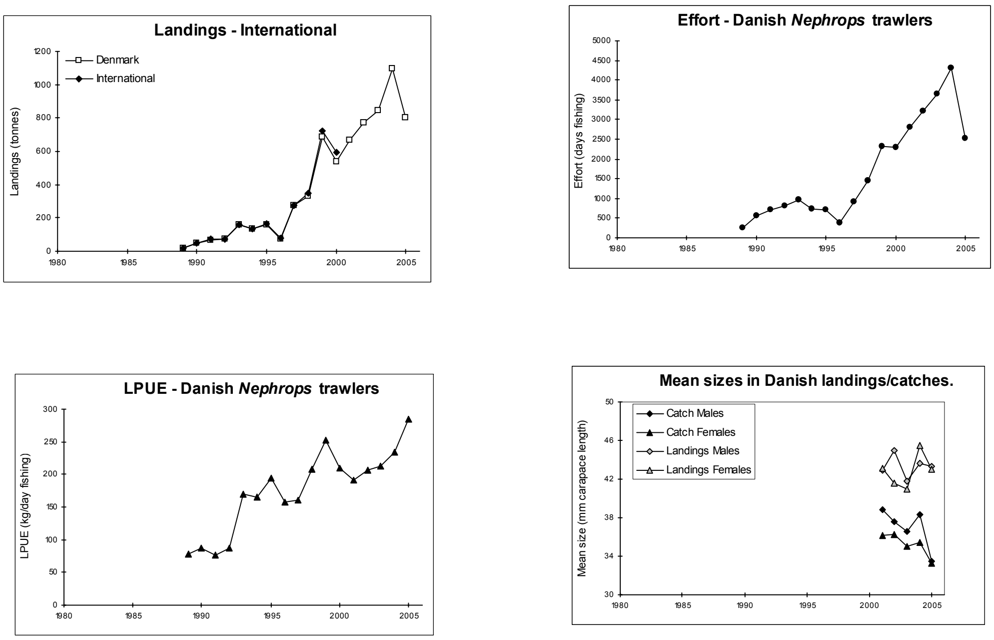


Figure 6.4.16.4 *Nephrops* Off Horn Reef (FU 33): Long-term trends in landings, effort, CPUEs and/or LPUEs, and mean sizes of *Nephrops*.

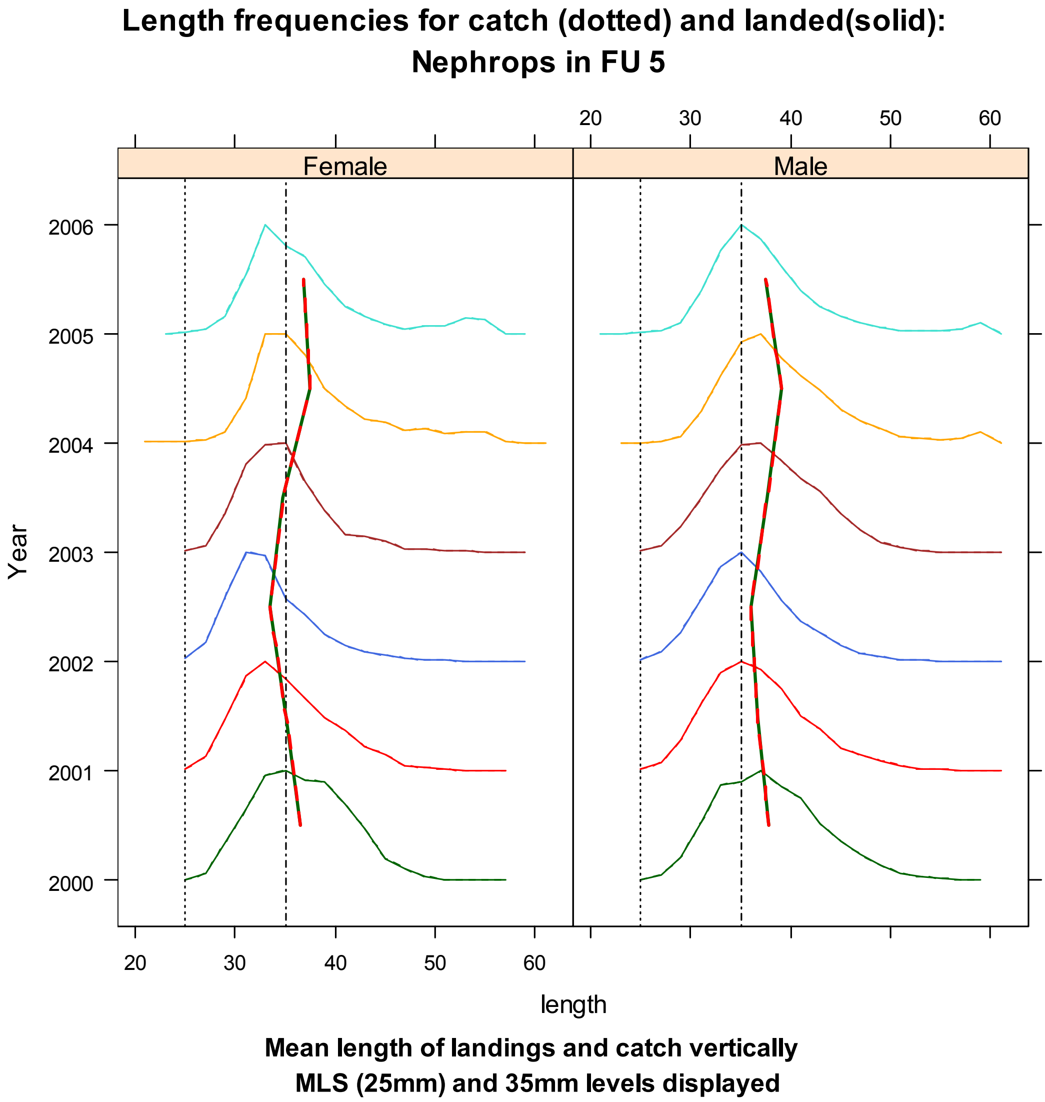


Figure 6.4.16.5 *Nephrops* Botney Gut–Silver Pit (FU 5). Length composition of catch (dotted) and landed (solid) of males (right) and females left from 2000 (bottom) to 2005 (top). Mean sizes of catch and landings (using same line types) is shown in relation to MLS.

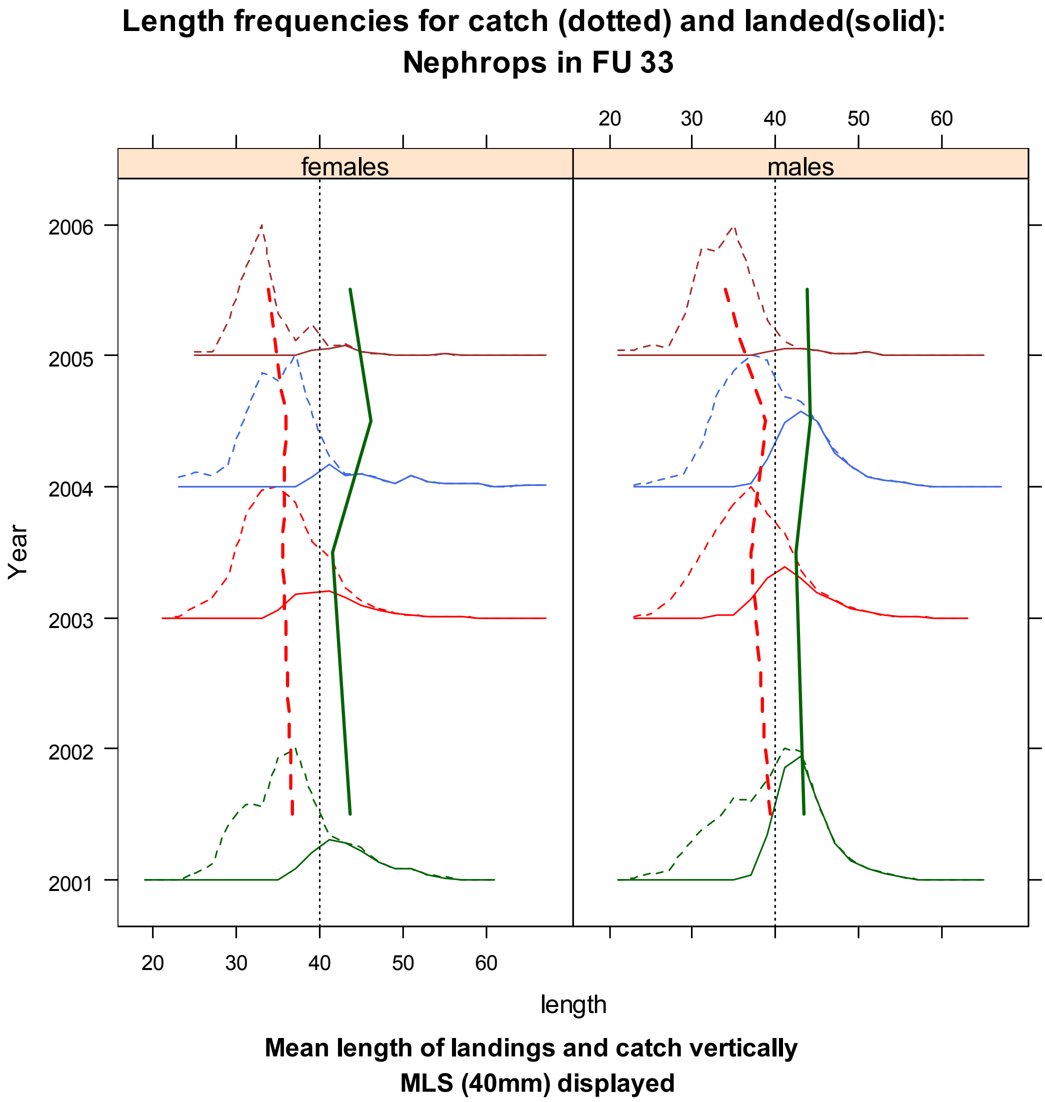


Figure 6.4.16.6 *Nephrops* Off Horn Reef (FU 33). Length composition of catch (dotted) and landed (solid) of males (right) and females left from 2000 (bottom) to 2005 (top). Mean sizes of catch and landings (using same line types) is shown in relation to MLS.

Table 6.4.16.1 *Nephrops* Management Area H (North Sea South East): Total *Nephrops* landings (tonnes) by Functional Unit plus Other rectangles, 1991–2005.

Year	FU 5	FU 33	Other	Total
1991	862	74	88	1023
1992	611	76	48	736
1993	721	160	64	945
1994	503	137	41	682
1995	869	165	200	1234
1996	679	77	165	921
1997	1150	277	128	1554
1998	1071	350	219	1640
1999	1185	725	294	2204
2000	1070	600	308	1978
2001	1329	759	340	2429
2002	1142	839	437	2418
2003	1120	911	426	2457
2004	1054	1227	340	2621
2005*	1015	994	304	2313
* provisional na = not available				

Table 6.4.16.2 *Nephrops* in Division IVb,c, east of 1ºE, excluding Rectangles 43 F5–F7 (Management Area H).

Year	Landings
	tonnes
1991	862
1992	611
1993	721
1994	503
1995	869
1996	679
1997	1150
1998	1071
1999	1185
2000	1070
2001	1329
2002	1142
2003	1120
2004	1054
2005	1015
Average	959

Table 6.4.16.3 *Nephrops* in Division IVb,c, east of 1ºE, excluding Rectangles 43 F5–F7 (Management Area H).

Year	Landings
	tonnes
1993	160
1994	137
1995	164
1996	77
1997	276
1998	350
1999	724
2000	597
2001	780
2002	848
2003	925
2004	1244
2005	994
Average	560

6.4.17 Herring in Subdivisions 22–24 and Division IIIa (spring spawners)

State of the stock

In the absence of defined reference points, the state of the stock cannot be fully evaluated. SSB and fishing mortality have been stable over a number of years.

Management objectives

There are no explicit management objectives for this stock.

Reference points

There are no precautionary approach reference points for this stock.

Yield and spawning biomass per Recruit
F-reference points:

	Fish Mort. Ages 3–6	Yield/R	SSB/R
Average last 3 years	0.398	0.025	0.049
$\mathbf{F}_{max}$	0.465	0.025	0.041
$\mathbf{F}_{0.1}$	0.216	0.023	0.091
$\mathbf{F}_{med}$	0.479	0.025	0.039

Single-stock exploitation boundaries

Exploitation boundaries in relation to existing management plans

There is no management plan for this stock.

Exploitation boundaries in relation to long-term yield

If target reference points are to be established, $\mathbf{F}_{0.1}$ would be associated with high long-term yields and low risk of reduced reproductive capacity. The current fishing mortality exceeds the fishing mortality associated with $\mathbf{F}_{0.1}$.

Exploitation boundaries in relation to precautionary limits

Current fishing mortality has led to stable SSB and, accordingly, the fishing mortality should not be allowed to increase. This corresponds to landings of 99 000 t in 2007.

Short-term implications

Outlook for 2007

Basis: F(2006) = $\mathbf{F}_{sq}$ = 0.408; SSB(2006) = 177; catch (2006) = 94.
Landings are for Division IIIa spring-spawning herring and western Baltic (Subdivisions 22–24) combined, see further in Section 6.4.8 on North Sea herring (autumn spawners).

Rationale	Catches (2007)	Basis	F(2007)	SSB(2008)
Zero catch	0	**F=0**	0	278
Proportion F	81	$\mathbf{F}_{sq}$ *0.8	0.326	204
Proportion F	90	$\mathbf{F}_{sq}$ *0.9	0.367	196
Status quo	99	$\mathbf{F}_{sq}$	0.408	189
Proportion F	107	$\mathbf{F}_{sq}$ *1.1	0.449	182
Proportion F	115	$\mathbf{F}_{sq}$ *1.2	0.490	175
Proportion F	123	$\mathbf{F}_{sq}$ *1.3	0.530	169
$\mathbf{F}_{0.1}$	56	$\mathbf{F}_{0.1}$	0.216	227

Weights in ‘000 t.

Catch options for mixed stocks in Division IIIa based on short-term predictions for Western Baltic Spring-Spawning herring (WBSS)

Catch options for the whole stock of Western Baltic Spring-Spawning herring (WBSS) can be partitioned into catches by area. Likewise, the catches of WBSS herring in Division IIIa also imply catches of North Sea Autumn-Spawning (NSAS) herring which constitute part of the total catch in that area. The basis for the split of the WBSS herring catch by area and of the catch in Division IIIa by stock was the ratios between the catches in 2005. The current relevant fleet definitions are:

North Sea

Fleet A: Directed herring fisheries with purse seiners and trawlers. Bycatches in industrial fisheries by Norway are included.
Fleet B: Herring taken as bycatch under EU regulations.

Division IIIa

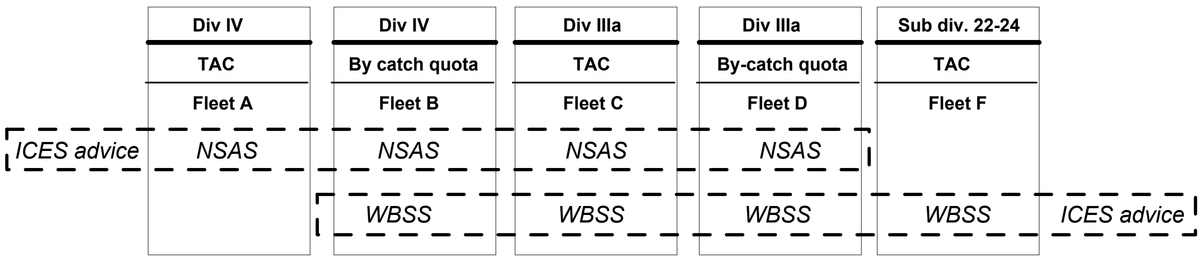
Fleet C: Directed herring fisheries with purse seiners and trawlers.
Fleet D: Bycatches of herring caught in the small-mesh fisheries.

Subdivisions 22–24

Fleet F: All herring fisheries in Subdivisions 22–24.

ICES catch predictions versus management TAC

ICES advises on catch options by fleet for the entire distribution of the two herring stocks separately, whereas herring is managed by areas cross sectioning the geographical distribution of the stocks (see the following text diagram).



The catch option for 2007 is based on the share by fleet and stock composition in catches given as a mean for 2004 and 2005. The ratio by fleet and stock composition is given in the following tables A and B, respectively:

Text table **A** showing the 2004 and 2005 average **share** of the total catch in t of WBSS by each fleet.

WBSS	FLEET C (IIIA)	FLEET D (IIIA)	FLEET F (SD22-24) *+ FLEET A (IV)**	TOTAL
mean(2004,2005) catch in t	24,650	8,150	49,800	82,600
mean(2004,2005) share in %	29.9 %	9.9 %	60.2 %	100%

***A constant catch of 7100 t of WBSS caught in Subarea IV are accounted for in the calculations**

Text table **B** showing the 2004 and 2005 average proportion of WBSS in catches by fleet

WBSS	FLEET C	FLEET D	FLEET F (SD22-24) *+ FLEET A (IV)*
mean(2004,2005) proportion	0.576	0.452	1

Predicted catches of WBSS and NSAS herring by fleet in Division IIIa are based on recent patterns of 1) ratio of WBSS catches taken by each fleet, and 2) proportion of the two stocks in catches of the different fleets.

Short-term predictions indicate a catch in 2007 of 99 000 t with *status quo* fishing mortality ($\mathbf{F}_{sq}$). The projected stock composition was assumed to equal the 2004 and 2005 average of the NSAS and WBSS in each of the C and D fleets (in Division IIIa) and a 2004 and 2005 average catch of 7100 t of WBSS taken in Subarea IV.

The table below gives the catch options for the Western Baltic spring spawners in Division IIIa, in SD 22–24, and in Subarea IV along with several other options between 80 000 and 105 000 t.

	WBSS herring				NSAS herring		Total catches of both stocks in Div. IIIa		Subdivisions 22–24
Total catches of WBSS herring*	Fleet A	Fleet C	Fleet D	Fleet F	Fleet C	Fleet D	Fleet C	Fleet D	Fleet F
80,000	7,100	23,900	7,900	41,100	17,600	9,600	41,500	17,500	41,100
90,000	7,100	26,900	8,900	47,100	19,800	10,800	46,700	19,700	47,100
99,000 (F_{sq})	**7,100**	**29,600**	**9,800**	**52,500**	**21,800**	**11,900**	**51,400**	**21,700**	**52,500**
105,000	7,100	31,400	10,400	56,100	23,100	12,600	54,500	23,000	56,100

For a quota of NSAS and total catch by the fleets in Division IIIa to be compatible with the advice for WBSS, the numbers derived as above, based on the largest advisable catch of WBSS, are upper bounds on the advisable catches of NSAS by the C- and D- fleets. Thus the resulting catch options were also used as constraints for short-term predictions for the NSAS herring.

Management considerations

North Sea Autumn-Spawning and the Western Baltic Spring-Spawning herring stocks are exploited and managed simultaneously in Division IIIa. Hence, the management of the herring fisheries in Division IIIa influences both stocks. The advisory emphasis on one or the other stock will vary between periods and depends on their relative status.

Factors affecting the fisheries and the stock

Regulations and their effects

Corrections for misreporting by area have been incorporated in the assessment. In recent years, ICES has calculated that a substantial part of the catch reported as having been taken in Division IIIa by fleet C was actually taken in Subarea IV. These catches have been allocated to the North Sea stock and accounted for under the A-fleet. Regulations allowing quota transfers from Division IIIa to the North Sea were introduced with the incentive to decrease misreporting for the Norwegian part of the fishery. Working group estimates may be underestimating the problem since not all countries supply this information to ICES.

The quota for the C-fleet and the bycatch quota for the D-fleet are set for the NSAS and the WBSS stocks together. The implication for the outtake of NSAS must be taken into account when setting fleet-wise quotas for these stocks.

Changes in fishing technology and fishing patterns

Since 2001, the fishery behavior has changed in the German fleet. In former years, the main catch of herring was taken in the passive gears, bottom-set gillnets and trapnets. Recently the landings by trawl have reached a level of more than 50% of the total landings (2003: 63%, 2004: 52%, and 2005: 57%). This change is due to requirements from a new fish factory on the Rügen Island.

The environment

Herring in Division IIIa and Subdivisions 22–24 are migratory. There are feeding migrations from the Western Baltic into more saline waters of Division IIIa and the eastern parts of Division IVa.

Scientific basis

Data and methods

The otolith microstructure method has been used to calculate the proportion of spring and autumn spawners caught in these areas for all catch and survey data in the period 1991–2005. An analytical assessment is based on catch data and acoustic and trawl survey results.

Development of stock identification methods using combinations of genetics and otolith analyses continues but, in order to improve the assessment, an acoustic survey covering the entire stock is still necessary.

Uncertainties in assessment and forecast

There is no firm basis for predicting the fraction of NSAS in the catches by the C- and D-fleets. The proportions of the two stocks as well as the distribution pattern of the fishery in the Eastern North Sea and in Division IIIa changes dynamically year by year. This is probably influenced by the year-class strength of the two stocks and their relative geographical distributions, as well as by fleet behaviour reacting to herring availability and management decisions.

The strength of a year class is not firmly estimated before the year class has been followed for 2–3 years.

Comparison with previous assessment and advice

The current procedure for assessing the stock has given consistent results with respect to fishing mortality and spawning biomass for several years. Compared to last year's assessment, the change in the estimate is +8% for the fishing mortality in 2004 and -6% for the SSB in 2004. The basis for the advice is the same as last year.

Information from the fishing industry

The fishing industries confirm that substantial area misreporting occurs from the North Sea to the Skagerrak and this has been taken into account in the assessment.

Source of information

Report of the Herring Assessment Working Group for the Area South of 62°N, 14–23 March 2006 (ICES CM 2006/ACFM:20).

Year	ICES Advice	Pred. catch corresp. to advice	Agreed TAC IIIa[2]	ACFM catch of Stock			
				22–24	IIIa	IV	Total
1987	Reduction in F	224	218	102	59	14	175
1988	No increase in F	196	218	99	129	23	251
1989	TAC	174	218	95	71	20	186
1990	TAC	131	185	78	118	8	204
1991	TAC	180	155	70	112	10	192
1992	TAC	180	174	85	101	9	195
1993	Increased yield from reduction in F; reduction in juvenile catches	188	210	81	95	10	186
1994	TAC	130–180	191	66	92	14	172
1995	If required, TAC not exceeding recent catches	168–192	183	74	80	10	164
1996	If required, TAC not exceeding recent catches	164–171	163	58	71	1	130
1997	IIIa: managed together with autumn spawners 22–24: if required, TAC not exceeding recent catches	66–85[1]	100	68	55	1	124
1998	Should be managed in accordance with North Sea autumn spawners	-	97	51	53	8	112
1999	IIIa: managed together with autumn spawners 22–24: if required, TAC not exceeding recent catches	-	99	50	43	5	98
2000	IIIa: managed together with autumn spawners 22–24: if required, TAC not exceeding recent catches	~60 for Subdivs. 22–24	101	54	57	7	118
2001	IIIa: managed together with autumn spawners 22–24: if required, TAC not exceeding recent catches	~50 for Subdivs. 22–24	101	64	42	6	112
2002	IIIa: managed together with autumn spawners 22–24: if required, TAC not exceeding recent catches	~50 for Subdivs. 22–24	101	53	47	7	107
2003	Reduce F	<80	101	40	36	2	78
2004	Separate management regime for this stock Reduce F	<92	91	42	24	7	77
2005	Separate management regime for this stock *Status quo* F	95	120	44	38	7	89
2006	Separate management regime for this stock *Status quo* F	95	102				
2007	Separate management regime for this stock *Status quo* F	99					

Weights in '000 t.

[1]Catch in Subdivisions 22–24. [2]Including mixed clupeoid TAC and bycatch ceiling in small-mesh fishery.

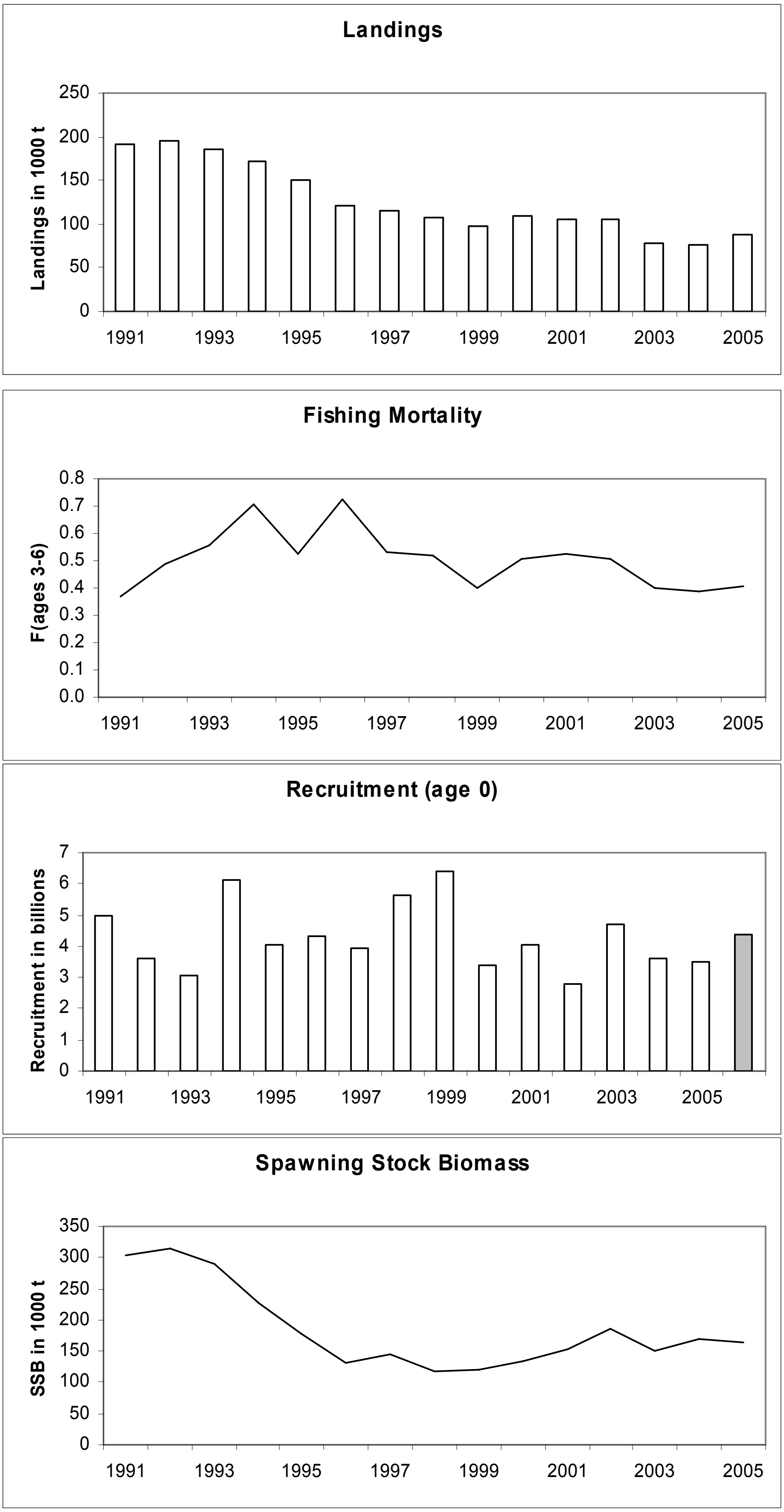


Figure 6.4.17.1 Herring in Subdivisions 22–24 and Division IIIa (spring spawners). Landings, fishing mortality, recruitment and SSB.

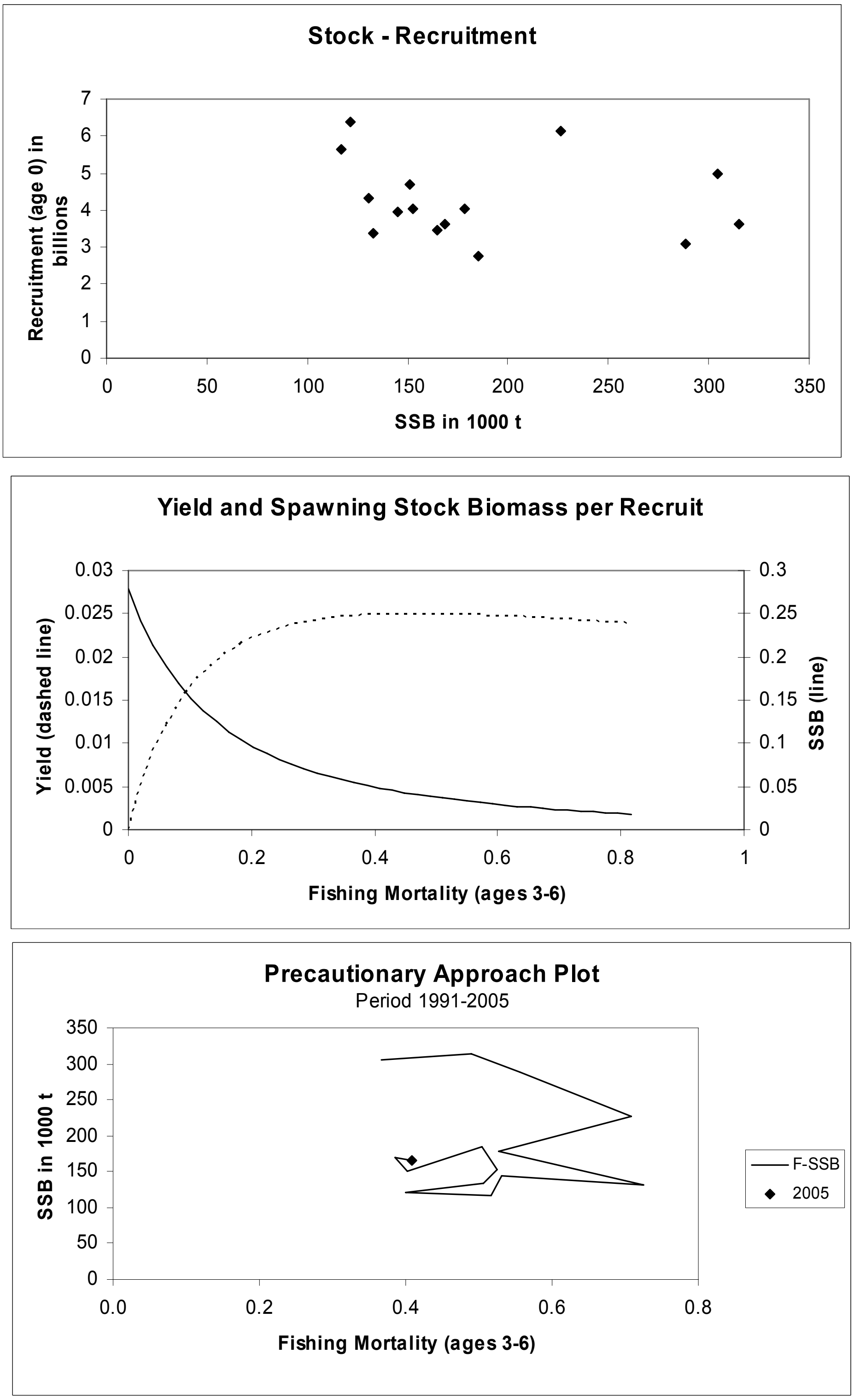


Figure 6.4.17.2 Herring in Subdivisions 22–24 and Division IIIa (spring spawners). Stock and recruitment; Yield and SSB per recruit.

Table 6.4.17.1

HERRING in Division IIIa and Sub. Division 22-24. 1986 - 2005
Landings in thousands of tonnes.
(Data provided by Working Group members 2006).

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Skagerrak										
Denmark	94.0	105.0	144.4	47.4	62.3	58.7	64.7	87.8	44.9	43.7
Faroe Islands	0.5									
Germany										
Norway	1.6	1.2	5.7	1.6	5.6	8.1	13.9	24.2	17.7	16.7
Sweden	43.0	51.2	57.2	47.9	56.5	54.7	88.0	56.4	66.4	48.5
Total	139.1	157.4	207.3	96.9	124.4	121.5	166.6	168.4	129.0	108.9
Kattegat										
Denmark	37.4	46.6	76.2	57.1	32.2	29.7	33.5	28.7	23.6	16.9
Sweden	35.9	29.8	49.7	37.9	45.2	36.7	26.4	16.7	15.4	30.8
Total	73.3	76.4	125.9	95.0	77.4	66.4	59.9	45.4	39.0	47.7
Sub. Div. 22+24										
Denmark	14.0	32.5	33.1	21.7	13.6	25.2	26.9	38.0	39.5	36.8
Germany	60.0	53.1	54.7	56.4	45.5	15.8	15.6	11.1	11.4	13.4
Poland	12.3	8.0	6.6	8.5	9.7	5.6	15.5	11.8	6.3	7.3
Sweden	5.9	7.8	4.6	6.3	8.1	19.3	22.3	16.2	7.4	15.8
Total	92.2	101.4	99.0	92.9	76.9	65.9	80.3	77.1	64.6	73.3
Sub. Div. 23										
Denmark	1.5	0.8	0.1	1.5	1.1	1.7	2.9	3.3	1.5	0.9
Sweden	1.4	0.2	0.1	0.1	0.1	2.3	1.7	0.7	0.3	0.2
Total	2.9	1.0	0.2	1.6	1.2	4.0	4.6	4.0	1.8	1.1
Grand Total	307.5	336.2	432.4	286.4	279.9	257.8	311.4	294.9	234.4	231.0

Year	1996	1997	1998 [2]	1999 [2]	2000	2001	2002	2003	2004	2005 [1]
Skagerrak										
Denmark	28.7	14.3	10.3	10.1	16.0	16.2	26.0	15.5	11.8	14.8
Faroe Islands										0.4
Germany								0.7	0.5	0.8
Norway	9.4	8.8	8.0	7.4	9.7					
Sweden	32.7	32.9	46.9	36.4	45.8	30.8	26.4	25.8	21.8	32.5
Total	70.8	56.0	65.2	53.9	71.5	47.0	52.3	42.0	34.1	48.5
Kattegat										
Denmark	17.2	8.8	23.7	17.9	18.9	18.8	18.6	16.0	7.6	11.1
Sweden	27.0	18.0	29.9	14.6	17.3	16.2	7.2	10.2	9.6	10.0
Total	44.2	26.8	53.6	32.5	36.2	35.0	25.9	26.2	17.2	21.1
Sub. Div. 22+24										
Denmark	34.4	30.5	30.1	32.5	32.6	28.3	13.1	6.1	7.3	5.3
Germany	7.3	12.8	9.0	9.8	9.3	**11.4**	22.4	18.8	18.5	21.0
Poland	6.0	6.9	6.5	5.3	6.6	9.3	-	4.4	5.5	6.1
Sweden	9.0	14.5	4.3	2.6	4.8	13.9	10.7	9.4	9.9	9.2
Total	56.7	64.7	49.9	50.2	53.3	62.9	46.2	38.7	41.2	41.5
Sub. Div. 23										
Denmark	0.7	2.2	0.4	0.5	0.9	0.6	4.6	2.3	0.1	1.8
Sweden	0.3	0.1	0.3	0.1	0.1	0.2	-	0.2	0.3	0.4
Total	1.0	2.3	0.7	0.6	1.0	0.8	4.6	2.6	0.4	2.2
Grand Total	172.7	149.8	169.4	137.2	162.0	145.7	128.9	109.5	92.8	113.3

[1] Preliminary data.
2 Revised data for 1998 and 1999
Bold= German revised data for 2001

Table 6.4.17.2 Herring in Subdivisions 22–24 and Division IIIa (spring spawners).

Year	Recruitment Age 0 thousands	SSB tonnes	Landings tonnes	Mean F Ages 3-6
1991	4982970	304411	191573	0.3665
1992	3635070	314917	194411	0.4891
1993	3088150	288746	185010	0.5567
1994	6148290	226086	172438	0.7091
1995	4023410	178238	150831	0.5271
1996	4305070	130676	121266	0.7252
1997	3944820	145258	115588	0.5320
1998	5629850	116790	107032	0.5161
1999	6376320	121128	97240	0.3996
2000	3364990	132694	109914	0.5062
2001	4030720	152643	105803	0.5250
2002	2777930	185578	106191	0.5032
2003	4686970	150752	78309	0.4013
2004	3611310	168700	76815	0.3857
2005	3473460	164639	88406	0.4079
2006	4390766*			
Average	4279381	185417	126722	0.5034

*Geometric mean for the years 1994–2003.

6.4.18 Herring in Subarea IV, Division VIId, and Division IIIa (autumn spawners)

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	At risk of being harvested unsustainably	Overexploited	Above target	

Based on the most recent estimates of SSB and fishing mortality, ICES classifies the stock as having full reproductive capacity but at risk of being harvested unsustainably. SSB in 2005 was estimated at 1.7 million t, and is expected to decrease to $\mathbf{B}_{pa}$ (1.3 million t) in 2006. Both the 1998 and the 2000 year classes were strong. However, all year classes since 2001 are estimated to be among the weakest since the late 1970s.

Due to the current circumstances of four poor recruiting year classes of North Sea herring, it is particularly important that the decline of future spawning stock biomass be addressed with sufficient caution to ensure the safety of the spawning stock in the next few years.

Management objectives

According to the EU-Norway agreement (November 2004): -

1. *Every effort shall be made to maintain a level of Spawning Stock Biomass (SSB) greater than the 800,000 tonnes (Blim).*
2. *Where the SSB is estimated to be above 1.3 million tonnes the Parties agree to set quotas for the directed fishery and for by-catches in other fisheries , reflecting a fishing mortality rate of no more than 0.25 for 2 ringers and older and no more than 0.12 for 0-1 ringers.*
3. *Where the SSB is estimated to be below 1.3 million tonnes but above 800,000 tonnes, the Parties agree to set quotas for the direct fishery and for by-catches in other fisheries, reflecting a fishing mortality rate equal to:*
   0.25 – (0.15(1,300,000-SSB)/500,000) for 2 ringers and older, and*
   0.12 – (0.08(1,300,000-SSB)/500,000) for 0-1 ringers.*
4. *Where the SSB is estimated to be below 800,000 tonnes the Parties agree to set quotas for the directed fishery and for by-catches in other fisheries, reflecting a fishing mortality rate of less than 0.1 for 2 ringers and older and less than 0.04 for 0-1 ringers.*

5. *Where the rules in paragraphs 2 and 3 would lead to a TAC which deviates by more than 15% from the TAC of the preceding year the Parties shall fix a TAC that is no more than 15% greater or 15% less than the TAC of the preceding year.*

6. *Not withstanding paragraph 5 the Parties may, where considered appropriate, reduce the TAC by more than 15% compared to the TAC of the preceding year.*

7. *By-catches of herring may only be landed in ports where adequate sampling schemes to effectively monitor the landings have been set up. All catches landed shall be deducted from the respective quotas set, and the fisheries shall be stopped immediately in the event that the quotas are exhausted.*

8. *The allocation of TAC for the directed fishery for herring shall be 29% to Norway and 71% to the Community. The by-catch quota for herring shall be allocated to the Community.*

9. *A review of this arrangement shall take place no later than 31 December 2007 .*

ICES has examined the performance of this revised harvest control rule. ICES considers that the strict application of the TAC change limit of 15% (rule number 5) is not consistent with the Precautionary Approach in a situation like the present when four consecutive weak year classes are recruiting to the population. The harvest control rule is in accordance with the Precautionary Approach if paragraph 6 is invoked sufficiently early to ensure that there is less than 5% chance of SSB falling below $\mathbf{B}_{lim}$ in 10 years, even in the case of several consecutive weak year classes. Assuming that paragraph 6 would be invoked when TAC constraints would lead to SSB falling below $\mathbf{B}_{pa}$, it is considered that the revised HCR is in accordance with the Precautionary Approach.

Reference points

	ICES considers that:	ICES proposed that:
Precautionary Approach reference points	$\mathbf{B}_{lim}$ is 800 000 t.	$\mathbf{B}_{pa}$ be set at 1.3 million t.
	$\mathbf{F}_{lim}$ is not defined.	$\mathbf{F}_{pa}$ be set at: $\mathbf{F}_{ages\ 0\text{-}1} = 0.12$ $\mathbf{F}_{ages\ 2\text{-}6} = 0.25$.

Yield and spawning biomass per Recruit
F-reference points:

	Mean $\mathbf{F}_{2\text{-}6}$	Yield/R	SSB/R
Average last 3 years	0.290		
$\mathbf{F}_{max}$	0.412	0.013	0.041
$\mathbf{F}_{0.1}$	0.126	0.011	0.100

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

$\mathbf{B}_{lim}$: below this value poor recruitment has been experienced.	$\mathbf{B}_{pa}$: part of a harvest control rule based on simulations.
$\mathbf{F}_{lim}$: Not defined.	$\mathbf{F}_{pa}$: part of a harvest control rule based on simulations.

Single-stock exploitation boundaries

Exploitation boundaries in relation to existing management plans

The revised management plan implies TACs and corresponding allocations among fleets as indicated in the catch options tables below.

Management of the autumn-spawning herring must be considered together with the western Baltic Herring.

The management plan is not specific as to when paragraph 6 should be invoked and how much the TAC would be reduced beyond the 15% limitation. Due to the current circumstances of a sequence of four poor recruiting year classes of North Sea herring, it is particularly important that the decline of future spawning stock biomass is addressed with sufficient caution to ensure the safety of the spawning stock in the next few years. If the 15% constraint is applied, the SSB in 2007 will fall well below $\mathbf{B}_{pa}$ in 2007 and continue to fall in 2008 (option 5 in the table below). Accordingly, ICES recommends that paragraph 6 be invoked.

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

Appropriate reference points would be in the range of $\mathbf{F}_{0.1}$ and $\mathbf{F}_{max}$. The management plan suggests fishing mortality rates in this range.

Exploitation boundaries in relation to precautionary limits

In order to comply with the Precautionary Approach, fishing mortality would have to be reduced on juveniles (to about 0.05) and on adults (to about 0.20) so as to bring SSB back to $\mathbf{B}_{pa}$ in 2008. Catches corresponding to such a reduction in fishing mortality would be of the order of 275 000 t from all fleets (see option 2 in table of fleet scenarios below), implying a TAC of approximately 240 000 t for fleet A, and a bycatch of 5000–9000 tonnes for fleet B (see below).

Conclusion on exploitation boundaries

As the revised harvest rule has not been tested under the current circumstances of four consecutive weak year classes, ICES advises that exploitation boundaries be set in relation to precautionary limits. Accordingly, ICES advises a total catch of 275 000 t for 2007, across all fleets, on herring autumn spawners in Subarea IV, Division VII d, and Division IIIa, corresponding to a reduction of fishing mortality on juveniles (to about 0.05) and on adults (to about 0.20). This would imply a TAC of approximately 240 000 t for fleet A and a bycatch of 5000–9000 tonnes for fleet B (see below).

Short-term implications

Catch forecasts are presented below for different options of sharing the catch amongst fleets, producing the total fishing mortality given in the table headings. The forecasts are based on an assumption of the fisheries in 2006, taking the TAC with an overshoot of 13% corresponding to the overshoot seen in the last three years.

The five options presented below are based on an interpretation of the harvest control rule or other options and are only illustrative:

1. to obtain SSB = $\mathbf{B}_{pa}$ = 1.3 Mt in 2007;
2. to reduce adult exploitation to 0.2 and maintain juvenile exploitation at the present low level, and to invoke paragraph 6 of the management plan;
3. to apply adult exploitation of 0.25 according to the HCR and maintain juvenile exploitation at the present low level, and to invoke paragraph 6 of the management plan;
4. to allow catches in 2007 arising from the F constraint in the management plan, and to invoke paragraph 6 of the management plan;
5. to comply with the 15% limit on TAC change.

Since the management plan only stipulates overall fishing mortalities for juveniles and adults, making fleet-wise predictions for 4 fleets that are more or less independent, provides an extensive range of options for 2007. The following tables include examples of the short-term forecast. In addition, an extensive range of catch options for fleets were investigated and are available from the ICES Secretariat.

Outlook assuming a TAC constraint for fleet A in 2006

Intermediate year (2006) – TAC constraint plus 13% overshoot:

Fleet A	Fleet B	Fleet C	Fleet D	F_{0-1}	F_{2-6}	Catch Fleet A	Catch Fleet B	Catch Fleet C	Catch Fleet D	SSB2006
0.346	*0.066*	*0.016*	*0.013*	0.098	0.371	*513.0*	*21.8*	*22.9*	*9.1*	1327.0

For each scenario, options are presented representing different distributions of fishing mortalities for juveniles and adults amongst fleets[1)].

F-values by fleet and total						Catches by fleet				SSB at spawning		% Change in catch	
F for fleet A	F for fleet B	F for fleet C	F for fleet D	F_{0-1}	F_{2-6}	Catch for fleet A	Catch for fleet B	Catch for fleet C	Catch for fleet D	2007	2008	TAC fleet A	Bycatch fleet B
1. Reduce F for A fleet to get SSB in 2007 at 1.3 mill. t													
0.13	0.04	0.01	0.011	0.063	0.147	177.5	13.4	*16*	*8.6*	1301	1508	-61	-69
2. Harvest control rule triggered on projection year (not assessment year): F on adults 0.20, F on juveniles 0.05 (invoking paragraph 6)													
0.183	0.027	0.01	0.011	*0.05*	*0.2*	242.2	9.1	*16*	*8.6*	1253	1390	-47	-79
0.174	0.016	0.016	0.017	*0.05*	*0.2*	231.1	5.3	*24*	*12.9*	1256	1393	-49	-88
3. Harvest control rule: F on adults 0.25, F on juveniles 0.05 (invoking paragraph 6 with reduced juvenile mortality)													
0.232	0.026	0.01	0.011	*0.05*	*0.25*	300.3	8.9	*16*	*8.6*	1209	1286	-34	-79
0.223	0.015	0.016	0.017	*0.05*	*0.25*	289.6	5.1	*24*	*12.9*	1212	1288	-36	-88
4. Harvest control rule : F on adults 0.25, F on juveniles 0.12 (invoking paragraph 6)													
0.232	0.096	0.011	0.012	*0.12*	*0.25*	300	31.5	*16*	*8.6*	1209	1271	-34	-27
0.223	0.085	0.016	0.017	*0.12*	*0.25*	289.1	27.8	*24*	*12.9*	1212	1274	-36	-35
5. Applying the 15% TAC constraint rule in 2007													
0.313	*0.04*	0.011	0.011	0.065	0.331	*387.8*	13.4	*16*	*8.6*	1141	1134	-15	-69
0.314	*0.1*	0.016	0.01	0.137	0.341	*387.9*	32.6	*24*	*12.9*	1135	1102	-15	-24

Grey areas denote options considered not precautionary, in that SSB will be below 1.3 million tonnes at spawning in 2008. All numbers apply to North Sea autumn-spawning herring only.

1) Fleet definitions:

Fleet A: Directed herring fisheries with purse seiners and trawlers (with 32-mm minimum mesh size) in the North Sea. Bycatches in industrial fisheries by Norway are included.

Fleet B: Herring taken as bycatch in the small-mesh fisheries in the North Sea (with mesh size less than 32 mm).

Fleet C: Directed herring fisheries in Skagerrak and Kattegat with purse seiners and trawlers (with 32-mm minimum mesh size).

Fleet D: Bycatches of herring caught in the small-mesh fisheries (with mesh size less than 32 mm) in Skagerrak and Kattegat.

Management considerations

There are now four recruiting year classes (2002, 2003, 2004, and 2005) that are all well below average. Managers should take this into account when implementing the HCR as there is an increased risk that the stock may fall below the 1.3 mill. tonnes in 2007 if the rule of 15% constraint on TAC variation is applied.

With the current low recruitment, medium-term simulations show that the SSB will fluctuate around SSB ~ 1.3 million tonnes if the realised fishing mortalities are at the level that is intended in the agreed management plan. To reduce the risk of finding SSB below 1.3 million tonnes to less than 5%, fishing mortality for adults will have to be reduced to about 0.17, provided that the fishing mortality on juveniles can be reduced to the level it had in the rebuilding phase prior to 2003 ($\mathbf{F}_{0\text{-}1} < 0.05$).

The agreed fishing mortality of 0.25 for adults should be sustainable (i.e. the low risk of reaching $\mathbf{B}_{\mathrm{lim}}$), provided the fishing mortality on juveniles is maintained at the present low level. However, failure to comply with the fishing mortality on the adult component is a matter of concern. The consequences of the present mortality for adults around 0.35 has not been examined in detail, but it is clear that it will lead to a substantial reduction in SSB in the near future. However, medium-term simulations indicate that the risk of the SSB falling below $\mathbf{B}_{\mathrm{lim}}$ is negligible if the management plan is implemented without the 15% constraint.

Management of the autumn-spawning herring must be considered together with the western Baltic herring. The options for TACs for the C and D fleets have been selected to be compatible with the exploitation of Western Baltic Spring Spawners (see Section 6.4.7).

The sub-TAC for Divisions IVc and VIId were established for the conservation of the spawning aggregation of Downs herring. The Downs herring has returned to its pre-collapsed state and is now again a major component of the stock, but it is currently dominated by one year class. Hence, the management of the fishery on the spawning aggregations of Downs herring should be more cautious than for the North Sea herring as a whole.

For the last three years, ICES proposed that a share of 11% on the total North Sea TAC (average share 1989–2002) would be appropriate for distributing the harvesting among Downs Herring and other stock components. In accordance with ICES advice the sub-TAC was reduced from 74.3 Kt in 2005 to 50 Kt in 2006. The IVc and VIId TAC is specific to the conservation of the spawning aggregation of Downs herring. Downs herring is caught in large numbers in other areas during the rest of the year. The basis for this exact 11% figure is weak; however, there are strong indications that the total mortality on the Downs component, of which fishing is the major component, has recently been significantly higher than for other North Sea components. This implies that exploitation of this group has been relatively high so any increased proportional allocations to Divisions IVc and VIId should be avoided. In the absence of data to the contrary ICES proposes that a share of 11% on the total North Sea TAC (average share 1989–2002) would still be appropriate for distributing the harvesting among Downs Herring and other stock components.

Management plan evaluations

The management plan has the objective of maintaining the SSB above 800 000 tonnes and the evaluations use the SSB as the key performance indicator. The Harvest Control Rule (HCR) built into the management plan has been tested, but the present situation with four poor year classes in succession is outside the range considered during the evaluation; the performance of the present harvest rule is not very good when tested with the present low recruitment.

The good performance of the HCR may easily break down if assessment and/or implementation, enforcement, and compliance are sufficiently biased. The TACs in the consumption fishery have been regularly overshot. For this situation, a HCR is required that is robust to errors in the assessment and implementation; the current HCR is not thought to be sufficiently robust to such errors.

Ecosystem considerations

Herring is considered to have a major impact on most other fish stocks as prey and predator and is itself prey for seabirds and sea mammals in that area. Herring spawning and nursery areas, being near the coasts, are particularly sensitive and vulnerable to anthropogenic influences. The most serious of these is the ever increasing anthropogenic pressure on the extraction of marine sand and gravel. This has the potential to seriously damage and destroy the spawning habitat, to disturb spawning shoals, and to destroy spawn if carried out during the spawning season. Similarly, trawling at or close to the bottom in known spawning areas can have the same detrimental effects. It is possible that the disappearance of spawning on the western edge of the Dogger Bank could well be attributable to such anthropogenic influences.

Despite the fact that the stock is considered to have full reproductive capacity, it has recently produced four poor year classes in a row. Larval surveys, which are considered to be a reliable indicator of the stock size, are carried out annually and show a large abundance of larvae in recent years. However, survival of these larvae seems to be very poor. The reasons for this are not known. It is also noted that other stocks, such as sandeel and Norway pout, have shown recruitment failure in recent years, which cannot be related to the state of the stock or the fisheries upon it. It is possible that changes in the environmental conditions in the North Sea are responsible or have contributed to the observed recruitment failures. Poor feeding conditions (particularly with respect to *Calanus*) for herring in the North Sea are a cause for concern and this is being investigated by ICES.

Factors affecting the fisheries and the stock

Regulations and their effects

Landings taken in the North Sea but reported from other areas such as Divisions IIa and IIIa, and from Division VIaN have increased by almost 80% in 2005 compared to 2004 (from 31 000 t to 56 000 t). The estimates of the total amount of misreported (including within-area misreporting) and unallocated catches have increased to about 79 000 t (roughly 13% of the total landings from the North Sea – 626 100 t). This is also an increase compared to 2004 (57 000 t, 11% of the total landings of 533 100 t).

Scientific basis

Data and methods

In 2005, the total weight of herring discarded in the North Sea was estimated at about 13 000 t, based on the raised figure for two sampled fleets. The estimates in 2003 and 2004 were 4000 t and 17 000 t respectively, based on the same two fleets. More complete information on discarding that could be raised by fleet to total catch is important and increased sampling of discards should be strongly encouraged. Information on discards is included in the assessment, when available.

Denmark and Norway provided information on bycatches of herring in the industrial fishery. These are the only countries conducting these fisheries.

The assessment is based on landings from Subarea IV and Divisions VIId and IIIa and on four surveys. Some national catch estimates were corrected for unallocated and misreported catch.

Uncertainties in assessment and forecast

The area of reallocation of the catches and the TAC overshoot lead to uncertainties in the assessment. ICES carried out a benchmark assessment this year, checking the appropriate use of the survey indices and catch. There are divergent signals in surveys. Nevertheless, the overall assessment gives a valid basis for advice.

Comparison with previous assessment and advice

In 2006, the SSB for 2004 was estimated at 1.80 mill. tonnes, while in 2005 it was estimated at 1.89 mill. tonnes. Fishing mortality ($\mathbf{F}_{2\text{-}6}$) in 2004 was estimated in last year's assessment at 0.25 and is this year estimated at 0.27. The basis for the advice is the same as last year.

Source of information

Report of the Herring Assessment Working Group for the Area South of 62°N, 14–23 March 2006 (ICES CM 2006/ACFM:20).

Herring in Subarea IV, Division VIId, and Division IIIa (autumn spawners): advice and catches

Year	ICES Advice	Predicted catch corresp. to advice	Agreed TAC[1]	Bycatch ceiling Fleet B	ACFM Lndgs.[4] IV, VIId	ACFM Catch[5] IV, VIId	ACFM Catch Autumn spawners IIIa, IV, VIId
1987	TAC	610	600		625	625	792
1988	TAC	515	530		710	710	888
1989	TAC	514	514		669	717	787
1990	TAC	403	415		523	578	646
1991	TAC	423	420		537	588	657
1992	TAC	406	430		518	572	716
1993	No increase in yield at F > 0.3	340[1]	430		495	540	671
1994	No increase in yield at F > 0.3	346[1]	440		463	498	571
1995	Long-term gains expected at lower F	429[1]	440		510	516	579
1996	50% reduction of agreed TAC[2]	156[1]	156[3]	44	207	233	275
1997	F = 0.2	159[1]	159	24	175	238	264
1998	F(adult) = 0.2, F(juv)< 0.1	254[1]	254	22	268	338	392
1999	F(adult) = 0.2, F(juv)< 0.1	265[1]	265	30	290	333	363
2000	F(adult) = 0.2, F(juv)< 0.1	265[1]	265	36	284	346	388
2001	F(adult) = 0.2, F(juv)< 0.1	See scenarios	265	36	296	323	363
2002	F(adult) = 0.2, F(juv)< 0.1	See scenarios	265	36	304	353	372
2003	F(adult) = 0.25, F(juv)=0.12	See scenarios	400	52	414	450	480
2004	F(adult) = 0.25, F(juv)=0.1	See scenarios	460	38	484	550	567
2005	F(adult) = 0.25, F(juv)=0.1	See scenarios	535	50	568	639	664
2006	F(adult) = 0.25, F(juv)=0.12	See scenarios	455	43			
2007	Bring SSB above B_{pa} by 2008	See scenarios					

Weights in '000 t.

[1]Catch in directed fishery in IV and VIId. [2]Revision of advice given in 1995. [3]Revised in June 1996, down from 263.

[4] Landings are provided by the working group and do not in all cases correspond to official statistics. [5]ACFM catch includes unallocated and misreported landings, discards, and slipping.

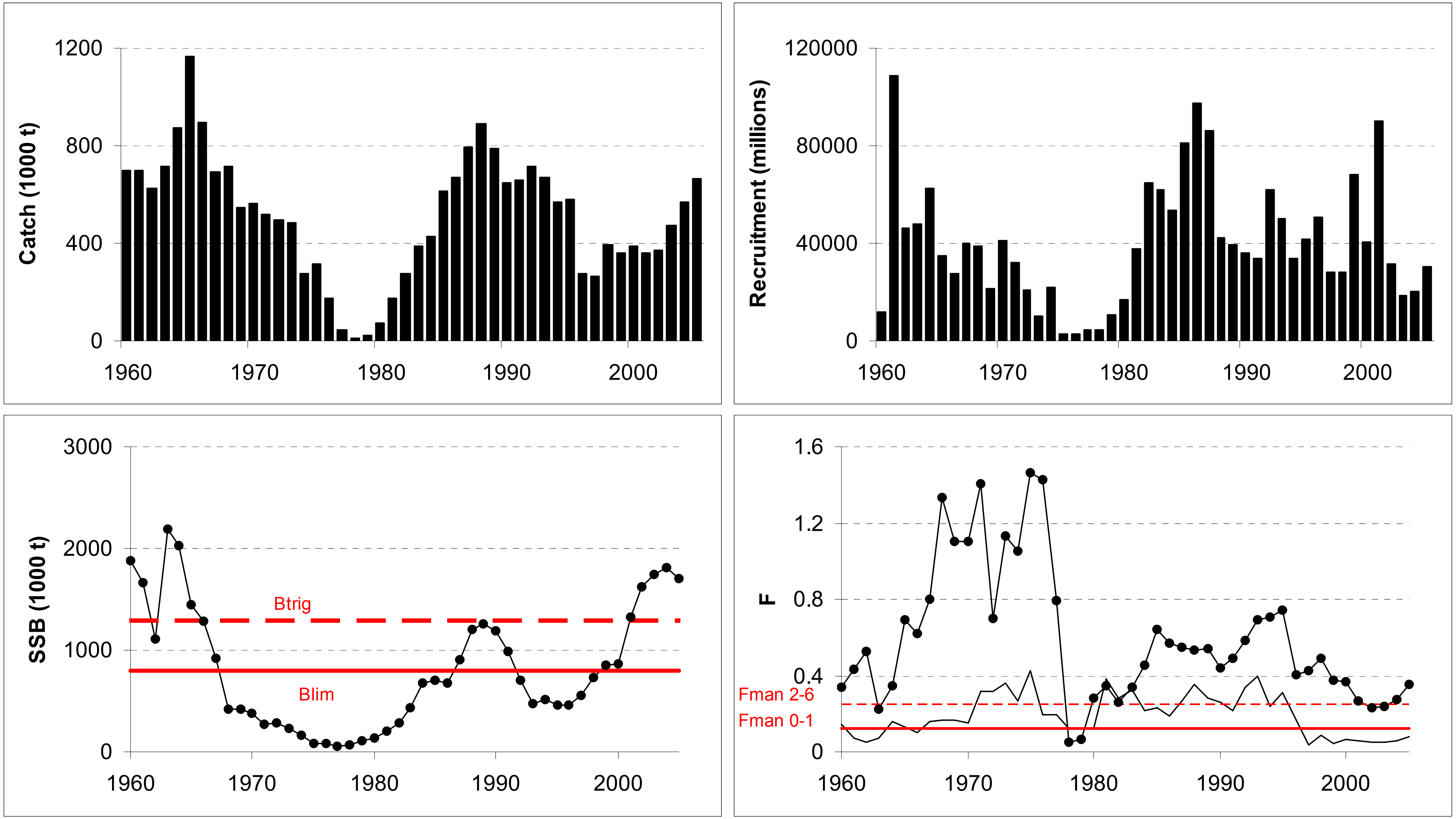


Figure 6.4.18.1 Herring in Subarea IV, Divisions VIId & IIIa (autumn spawners), stock summary. Fishing mortality is expressed as averages over ages 2–6 (dots) and 0–1 (line).

Table 6.4.18.1 Herring caught in the North Sea (Subarea IV and Division VIId). Catch in tonnes by country, 1996–2005. These figures do not in all cases correspond to the official statistics and cannot be used for legal purposes.

Country	**1996** [9]	**1997** [9]	**1998** [9]	**1999** [9]	**2000** [9]
Belgium	-	1	-	2	-
Denmark	66733	38324	58924	61268	64123
Faroe Islands	815	1156	1246	1977	915
France	12500	14525	20784	26962	20952
Germany, Fed.Rep	14215	13380	22259	26764	26687
Netherlands	42792	35985	49933	54467	54341
Norway [4]	43739	41606	70981	74071	72072
Sweden	2458	2253	3221	3241	3046
USSR/Russia	-	1619	452	-	-
UK (England)	6880	3470	7635	11434	11179
UK (Scotland)	17212	22582	31313	29911	30033
UK (N.Ireland)	-	-	1015	-	996
Unallocated landings	26069 [12]	63403 [6,12]	70329 [12]	43327 [12]	61673 [12]
Total landings	233413	238304	338092	333424	346017
Discards	-	-	-	-	-
Total catch	**233413**	**238304**	**338092**	**333424**	**346017**
Estimates of the parts of the catches which have been allocated to spring spawning stocks					
IIIa type (WBSS)	855	979	7833	4732	6649
Thames estuary [5]	168	202	88	88	76
Others [11]	-	-	-	-	378
Norw. Spring Spawners [13]	30274	54728	29220	32106	25678

Country	**2001** [9]	**2002**	**2003**	**2004** [1]	**2005** [1]
Belgium	-	23	5	8	6
Denmark [7]	67096	70825	78606	99037	128380
Faroe Islands	1082	1413	627	402	738
France	24880 [14]	25422	31544	34521	38829
Germany	29779	27213	43953	41858	46555
Netherlands	51293	55257	81108	96162	81531
Norway [4]	75886 [1]	74974 [1]	112481 [1]	137638	156802
Poland	-	-	-	-	458
Sweden	3695	3418	4781	5692	13465
Russia	-	-	-	-	99
UK (England)	14582	13757	18639	20855	25311
UK (Scotland)	26719	30926	40292	45331	73227
UK (N.Ireland)	1018	944	2010	2656	2912
Unallocated landings	27362 [12]	31552 [12]	31875 [12]	48898 [12]	59121
Total landings	323392 [14]	335724	445921	533058	627433
Discards	-	17093	4125	17059	11492
Total catch	**323392** [14]	**352817**	**450046**	**550117**	**638926**
Estimates of the parts of the catches which have been allocated to spring spawning stocks					
IIIa type (WBSS)	6449	6652	2821	7079	7039
Thames estuary [5]	107	60	84	62	74
Others [11]	1097	0	308	0	0
Norw. Spring Spawners [13]	7108	4069	979	452	417

[1] Preliminary
[4] Catches of Norwegian spring spawners removed (taken under a separate TAC)
[5] Landings from the Thames estuary area are included in the North Sea catch figure for the UK (England)
[7] Including any by-catches in the industrial fishery
[9] Figures verified and altered if needed in 2003 by SG Rednose (ICES 2003/ACFM:10)
[10] Figure altered in 2001
[11] Caught in the whole North Sea, partly included in the catch figure for The Netherlands
[12] may include misreported catch from IVaN and discards
[13] These catches (including some local fjord-type spring spawners) are taken by Norway under a separate quota south of 62°N and are not included in the Norwegian North Sea catch figure for this area
[14] Figure altered in 2004

Table 6.4.18.2 Herring. Catch in tonnes in Division IVa West. These figures do not in all cases correspond to the official statistics and cannot be used for legal purposes.

Country	**1996**[11]	**1997**[11]	**1998**[11]	**1999**[11]	**2000**[11]
Denmark	3183	2657	4634	15359	25530
Faroe Islands	815	1156	1246	1977	205
France	3177	362	4758	6369	3210
Germany	2167	4576	7753	11206	5811
Netherlands	7714	6072	10917	21552	15117
Norway	22187	16869	27290	31395	33164
Sweden	769	1617	315	859	1479
Russia	-	1619	452	-	-
UK (England)	2391	49	4306	7999	8859
UK (Scotland)	12763	17121	29462	28537	29055
UK (N. Ireland)	-	-	1015	-	996
Unallocated landings	12681[8]	40662[6,8]	56058[8]	25469[8]	44334[8]
Total Landings	67847	92760	148206	150722	167760
Discards					
Total catch	**67847**	**92760**	**148206**	**150722**	**167760**

Country	**2001**[11]	**2002**	**2003**	**2004**[1]	**2005**
Denmark[7]	17770	26422	48358	48128	80990
Faroe Islands	192	-	95	-	-
France	8164	10522	11237	10941	13474
Germany	17753	15189	25796	17559	22278
Netherlands	17503[10]	18289	25045	43876	36619
Norway	11653[1]	10836[1]	34443	36119	66232
Poland	-	-	-	-	458
Sweden	1418	2397	2647	2178	8261
Russia	-	-	-	-	99
UK (England)	12283	10142	12030	13480	15523
UK (Scotland)	25105	30014	39970	43490	71941
UK (N. Ireland)	1018	944	2010	2656	2912
Unallocated landings	24725[8]	14201[8]	14115[8]	28631[8]	40656[8]
Total Landings	137584	138956	215746	247058	359443
Discards		17093	4125	15794	9529
Total catch	**137584**	**156049**	**219871**	**262852**	**368972**

[1] Preliminary
[4] Including IVa East
[5] Negative unallocated catches due to misreporting from other areas
[6] Altered in 2000 on the basis of a Bayesian assessment on m isreporting into IVa (North)
[7] Including any by-catches in the industrial fishery
[8] May include misreported catch from VIaN and discards
[9] Figure altered in 2001
[10] Including 1057 t of local spring spawners
[11] Figures verified and altered if needed in 2003 by SG Rednose (ICES 2003/ACFM:10)

Table 6.4.18.3 Herring. Catch in tonnes in Division IVa East. These figures do not in all cases correspond to the official statistics and cannot be used for legal purposes.

Country	1996 [7]	1997 [7]	1998 [7]	1999 [7]	2000 [7]
Denmark [5]	19166	22862	25750	18259	11300
Faroe Islands	-	-	-	-	710
France	-	3	-	115	-
Germany	-	-	-	-	29
Netherlands	-	756	301	-	38
Norway [2]	18256	20975	43646	39977	38655
Sweden	1119	422	1189	772	1177
Unallocated landings	-	-756 [4]	-292 [4]	-	338
Total landings	38541	44262	70594	59123	52247
Discards	-	-	-	-	-
Total catch	**38541**	**44262**	**70594**	**59123**	**52247**
Norw. Spring Spawners [6]	30274	54728	29220	32106	25678

Country	2001 [7]	2002	2003 [1]	2004 [1]	2005 [1]
Denmark [5]	18466	17846	7401	16278	5761
Faroe Islands	890	1365	359	-	738
France	-	-	-	-	-
Germany	-	81	54	888	-
Netherlands	-	-	-	-	-
Norway [2]	56904 [1]	63482 [1]	62306	100443	89925
Sweden	517	568	1529	1720	3510
Unallocated landings	o	5961	11991	0	0
Total landings	76777	89303	83640	119329	99934
Discards	-	-	-	-	-
Total catch	**76777**	**89303**	**83640**	**119329**	**99934**
Norw. Spring Spawners [6]	7108	4069	979	452	417

[1] Preliminary
[2] Catches of Norwegian spring spawning herring removed (taken under a separate TAC)
[3] Included in IVa West
[4] Negative unallocated catches due to misreporting into other areas
[5] Including any by-catches in the industrial fishery
[6] These catches (including some fjord-type spring spawners) are taken by Norway under a separate quota south of 62°N and are not included in the Norwegian North Sea catch figure fir this area

Table 6.4.18.4 Herring. Catch in tonnes in Division IVb. These figures do not in all cases correspond to the official statistics and cannot be used for legal purposes.

Country	**1996** [6]	**1997** [6]	**1998** [6]	**1999** [6]	**2000** [6]
Belgium	-	-	-	1	-
Denmark [4]	43749	11558	26667	26211	26825
Faroe Islands	-	-	-	-	-
France	2373	6069	8945	7634	10863
Germany	11051	7455	13590	13529	18818
Netherlands	21053	14976	27468	22343	26839
Norway	3296	3762	45	2699	253
Sweden	570	214	1717	1610	390
UK (England)	2757	2033	1767	1641	669
UK (Scotland)	4449	5461	1851	1374	978
Unallocated landings	-17313 [5]	-3744 [5]	-12138 [5]	-3794 [5]	-9820 [5]
Total landings	71985	47784	69912	73248	75815
Discards [2]	-	-	-	-	-
Total catch	**71985**	**47784**	**69912**	**73248**	**75815**

Country	**2001** [6]	**2002**	**2003** [1]	**2004** [1]	**2005** [1]
Belgium	-	-	-	-	-
Denmark [4]	30277	26387	22574	33857	41423
Faroe Islands	-	48	173	402	-
France	7796 [14]	4214	7918	10592	10205
Germany	8340	7577	12116	13823	14381
Netherlands	24160	13154	19115	23649	10038
Norway	7329 [1]	656 [1]	15732	1076	645
Sweden	1760	453	605	1794	1694
UK (England)	814	317	2632	2864	3869
UK (Scotland)	1614	289	322	1841	1286
Unallocated landings	-22885 [5]	4052	-2401	8300	10233
Total landings	59205	57147	78786	98198	93774
Discards [2]	-	-	-	1265	1963
Total catch	**59205** [14]	**57147**	**78786**	**99463**	**95737**

[1] Preliminary
[2] Discards partly included in unallocated landings
[3] Negative unallocated catches due to misreporting from other areas
[4] Including any by-catches in the industrial fishery
[5] May include discards. Negative unallocated due to misreporting into other areas
[6] Figures verified and altered if needed in 2003 by SG Rednose (ICES 2003/ACFM:10)
[14] Figure altered in 2004

Table 6.4.18.5 Herring. Catch in tonnes in Division IVc and VIId. These figures do not in all cases correspond to the official statistics and cannot be used for legal purposes.

Country	1996 [9]	1997 [9]	1998 [9]	1999 [9]	2000 [9]
Belgium	-	1	-	1	1
Denmark	635	1247	1873	1439	468
France	6950	8091	7081	12844	6879
Germany	997	1349	916	2029	2029
Netherlands	14024	14181	11247	10572	12348
UK (England)	1733	1388	1562	1794	1651
UK (Scotland)	-	-	-	-	-
Unallocated landings	30702 [4]	27241 [4]	26701 [4]	21652 [4]	26822 [4]
Total landings	55041	53498	49380	50331	50198
Discards [3]	-	-	-	-	-
Total catch	**55041**	**53498**	**49380**	**50331**	**50198**
Coastal spring spawners included above [2]	168	143	88	88	76

Country	2001 [9]	2002	2003 [1]	2004 [1]	2005 [1]
Belgium	-	23	5	8	6
Denmark	583	170	273	774	206
France	8750	10686	12389	12988	15150
Germany	3686	4366	5987	9588	9896
Netherlands	9630	23814	36948	28637	34874
UK (England)	1485	3298	3977	4511	5919
UK (Scotland)	-	623	-	-	-
Unallocated landings	25522 [4]	7338	8170	11967	8231
Total landings	49656	50318	67749	68473	74282
Discards 3	-	-	-	-	-
Total catch	**49656**	**50318**	**67749**	**68473**	**74282**
Coastal spring spawners included above [2]	147 [11]	60	84	62	74

[1] Preliminary
[2] Landings from the Thames estuary area are included in the North Sea catch figure for UK (England)
[3] Discards partly included in unallocated landings
[4] May include misreported catch and discards
[9] Figures verified and altered if needed in 2003 by SG Rednose (ICES 2003/ACFM:10)
[10] Figure altered in 2002 (was 7851 t higher before)
[11] Thames/Blackwater herring landings: 107 t, others included in the catch figure for The Netherlands
[14] Figure altered in 2004

Table 6.4.18.6 ("The Wonderful Table"): HERRING in Sub-area IV, Division VIId and Division IIIa. Figures in thousand tonnes.

Year	1989	1990	1991	1992	1993	1994	1995 #	1996 #	1997 #	1998 #	1999 #	2000 #	2001 #	2002	2003	2004	2005	2006
Sub-Area IV and Division VIId: TAC (IV and VIId)																		
Recommended Divisions IVa, b [1]	484	373, 332	363 [6]	352	290 [7]	296 [7]	389 [11]	156	159	254	265	265	- [#]	- [#]	- [#]	- [#]	- [#]	-
Recommended Divisions IVc, VIId	30	30	50-60 [6]	54	50	50	50	- [14]	- [14]	- [14]	- [14]	- [14]	- [14]	- [14]	- [14]	- [14]	- [14]	-
Expected catch of spring spawners				10	8													
Agreed Divisions IVa,b [2]	484	385	370 [6]	380	380	390	390	263;131 [13]	134	229	240	240	240	223	340.5	393.9	460.7	404.7
Agreed Div. IVc, VIId	30	30	50 [6]	50	50	50	50	50; 25 [13]	25	25	25	25	25	42.7	59.5	66.1	74.3	50.0
Bycatch ceiling in the small mesh fishery									24	22	30	36	36	36	52.0	38.0	50.0	42.5
CATCH (IV and VIId)																		
National landings Divisions IVa,b [3]	639	499	495	481	463	421	465	183	149	245	261	261	272	261	354.5	427.7	502.3	
Unallocated landings Divisions IVa,b	-2	14	30	14	-1	6	-15	-5	36	44	22	35	2	24	23.7	36.9	49.6	
Discard/slipping Divisions IVa,b [4]	3	4	2	3	1	1	-	-	-	-	-	-	-	17	4.1	17.1	12.8	
Total catch Divisions IVa,b [5]	638	516	527	498	463	428	450	178	185	289	283	296	273	303	382.3	481.6	564.6	
National landings Divisions IVc, VIId [3]	30	24	42	37	32 [21]	42	45	24	26	23	29	23	24	43	59.5	56.5	66.1	
Unallocated landings Divisions IVc,VIId	48	32	16	35	43	30	22	31	27	27	22	27	26	7	8.2	12.0	8.2	
Discard/slipping Divisions IVc, VIId [4]	1	5	3	2	2	2	-	-	-	-	-	-	-	0	-	-	-	
Total catch Divisions IVc, VIId	79	61	61	74	77 [21]	74	67	55	53	49	50	50	50	50	67.7	68.5	74.3	
Total catch IV and VIId as used by ACFM [5]	**717**	**578**	**588**	**572**	**540** [21]	**498**	**516**	**233**	**238**	**338**	**333**	**346**	**323**	**353**	**450.0**	**550.1**	**638.9**	
CATCH BY FLEET/STOCK (IV and VIId) [10]																		
North Sea autumn spawners directed fisheries (Fleet A)	N.a.	N.a.	446	441	438	447	439	195	225	316	313	322	296	323	434.9	529.5	611.7	
North Sea autumn spawners industrial (Fleet B)	N.a.	N.a.	134	124	101	38	67	38	13	14	15	18	20	22	12.3	13.6	21.8	
North Sea autumn spawners in IV and VIId total	**696**	**569**	**580**	**564**	**539**	**485**	**506**	**233**	**237**	**330**	**329**	**339**	**317**	**346**	**447.2**	**543.0**	**631.9**	
Baltic-IIIa-type spring spawners in IV	20	8	8	8	9	13	10	1	1	8	5	7	6	7	2.8	7.1	7.0	
Coastal-type spring spawners	2.3	1.1	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	1.2	0.1	0.1	0.1	0.1	
Norw. Spring Spawners caught under a separate quota in	N.a.	4	5	5	9	6	10	30	55	29	32	26	7	4	1.0	0.5	0.4	
Division IIIa: TAC (IIIa)																		
Predicted catch of autumn spawners			96	153	102	77	98	48	35	58	43	53	- [#]	- [#]	- [#]	- [#]	- [#]	-
Recommended spring spawners	84	67	91	90	93–113	- [9]	- [12]	- [12]	- [15]	- [15]	- [15]	- [15]	- [15]	- [15]	- [15]	- [#]	- [#]	-
Recommended mixed clupeoids	80	60	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-
Agreed herring TAC	138	120	104.5	124	165	148	140	120	80	80	80	80	80	80	80.0	70.0	96.0	81.6
Agreed mixed clupeoid TAC	80	65	50	50	45	43	43	43										
Bycatch ceiling in the small mesh fishery									20	17	19	21	21	21	21.0	21.0	24.2	20.5
CATCH (IIIa)																		
National landings	192	202	188	227	214	168	157	115	83	120	86	108	90	79	76.0	61.1	90.8	
Catch as used by ACFM	162	195	191	227	214	168	140	105	74	108	79	99	82	73	68.1	52.7	69.6	
CATCH BY FLEET/STOCK (IIIa) [10]																		
Autumn spawners human consumption (Fleet C)	N.a.	N.a.	26	47	44	42	38	24	21	59	28 [17]	36	34	17	24.1	13.4	22.9	
Autumn spawners mixed clupeoid (Fleet D) [19]	N.a.	N.a.	13	23	25	12	6	9	4	6	8 [17]	13	12	9	8.4	10.8	9.0	
Autumn spawners other industrial landings (Fleet E)	N.a.	N.a.	38	82	63	32	29	8	2									
Autumn spawners in IIIa total	**91**	**77** [8]	**77**	**152**	**132**	**86**	**73**	**43**	**27**	**61**	**34** [17]	**49**	**46**	**26**	**32.5**	**24.2**	**31.9**	
Spring spawners human consumption (Fleet C)	N.a.	N.a.	68	53	68	59	44	58	43	40	40 [17]	45	33	38	31.6	16.8	32.5	
Spring spawners mixed clupeoid (Fleet D) [19]	N.a.	N.a.	5	2	1	1	2	4	3	3	3 [17]	5	3	9	4.0	11.2	5.1	
Spring spawners other industrial landings (Fleet E)	N.a.	N.a.	40	20	12	24	21	2	1									
Spring spawners in IIIa total	**71**	**118**	**113**	**75**	**81**	**84**	**67**	**64**	**47**	**43**	**43** [#]	**50**	**36**	**47**	**35.6**	**28.0**	**37.6**	
North Sea autumn spawners Total as used by ACFM	**787**	**646**	**657**	**716**	**671**	**571**	**579**	**275**	**264**	**392**	**363**	**388**	**363**	**372**	**479.7**	**567.2**	**663.8**	

[1] Includes catches in directed fishery and catches of 1-ringers in small mesh fishery up to 1992. [2] IVa,b and EC zone of IIa. [3] Provided by Working Group members. [4] Incomplete, only some countries providing discard information. Discards might also be included in un. [5] Includes spring spawners not included in assessment. [6] Revised during 1991. [7] Based on F=0.3 in directed fishery only; TAC advised for IVc, VIId subtracted. [8] Estimated. [9] 130-180 for spring spawners in all areas. [10] Based on sum-of-products (number x mean weight at age). [11] Status quo F catch for fleet A. [12] The catch should not exceed recent catch levels. [13] During the middle of 1996 revised to 50% of its original agreed TAC. [14] Included in IVa,b. [15] Managed in accordance with autumn spawners. [17] Figure altered in 2001 and again in 2004. [18] Data for 1995-2001 were verified and amended where necessary by SG REDNOSE in 2003. [19] Fleet D and E are merged from 1999 onwards. [20] These catches (including local fjord-type Spring Spawners) are taken by Norway under a separate quota south of 62°N and are not included in the Norwegian North Sea catch figure for this area. [21] figure altered in 2003 to account for earlier summarizing errors. 22 See catch option tables for different fleets.Shaded cells for the catch by fleet in Division IIIa indicate persisting inconsistencies which have to be resolved intersessionally.

Table 6.4.18.7 Herring in Subarea IV, Divisions IIIa and VIId (autumn spawners).

Year	Recruit thousands	SSB[1)] Tonnes	Catch tonnes	Mean F Ages 2-6	Mean F Ages 0-1
1960	12089090	1878943	696200	0.337	0.141
1961	108857940	1654851	696700	0.432	0.074
1962	46274080	1112088	627800	0.529	0.047
1963	47657600	2183934	716000	0.227	0.069
1964	62786690	2027794	871200	0.344	0.161
1965	34895610	1444957	1168800	0.694	0.127
1966	27859050	1278256	895500	0.62	0.103
1967	40256630	922295	695500	0.798	0.162
1968	38698600	412563	717800	1.336	0.168
1969	21582200	424184	546700	1.105	0.169
1970	41076490	374699	563100	1.105	0.152
1971	32311610	266156	520100	1.404	0.318
1972	20859910	288415	497500	0.696	0.318
1973	10110780	233539	484000	1.134	0.36
1974	21703360	162160	275100	1.052	0.263
1975	2838870	81920	312800	1.466	0.422
1976	2730140	78269	174800	1.43	0.197
1977	4339830	48108	46000	0.797	0.197
1978	4606470	65555	11000	0.053	0.123
1979	10610250	107880	25100	0.064	0.125
1980	16740200	131863	70764	0.282	0.119
1981	37886010	196653	174879	0.349	0.384
1982	64790370	279729	275079	0.263	0.28
1983	61831650	434419	387202	0.336	0.326
1984	53480290	681180	428631	0.453	0.216
1985	80962350	701654	613780	0.641	0.234
1986	97629230	681561	671488	0.569	0.189
1987	86218840	903069	792058	0.55	0.267
1988	42295410	1197041	887686	0.535	0.352
1989	39157000	1252346	787899	0.544	0.281
1990	35870540	1187869	645229	0.441	0.256
1991	33623240	982216	658008	0.489	0.213
1992	62131240	705619	716799	0.582	0.342
1993	50214890	474950	671397	0.691	0.399
1994	33944220	512037	568234	0.708	0.238
1995	41664490	461800	579371	0.741	0.311
1996	50536400	457038	275098	0.405	0.164
1997	28177000	550909	264313	0.426	0.035
1998	28262470	730446	391628	0.492	0.089
1999	68007550	855344	363163	0.377	0.042
2000	40293360	869867	388157	0.368	0.062
2001	90186270	1322733	363343	0.264	0.059
2002	31759100	1618810	370941	0.231	0.052
2003	18626860	1744290	472587	0.24	0.054
2004	21909350	1807780	567252	0.27	0.06
2005	21775360	1698377	663813	0.352	0.079
2006	26980000				
Average	39933548	815421	512837	0.592	0.191

[1]Projected (at spawning time autumn).

6.4.19 Sprat in Division IIIa

State of the stock

The state of the stock is unknown. Sprat in this area is short-lived with large annual natural fluctuations in stock biomass. Landings of sprat in Division IIIa averaged about 70 000 t in the 1970s, but since 1982 have typically been around 20 000 t, except in 1994, 1995, and 2005.

Management objectives

There are no explicit management objectives for this stock.

Reference points

Reference points for this stock have not been defined.

Single-stock exploitation boundaries

Exploitation boundaries in relation to precautionary limits

As sprat is mainly fished together with juvenile herring, the exploitation of sprat will be limited by the restrictions imposed on fisheries for juvenile herring.

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Short-term implications

Catch forecast for 2007

The available survey results are not reliable indicators of sprat abundance in Division IIIa. Therefore, fishing possibilities in 2006 or 2007 cannot be projected.

Factors affecting the fisheries and the stock

Sprat cannot be fished without bycatches of herring except in years with high sprat abundance or low herring recruitment. Management of this stock should consider management advice given for herring in Subarea IV, Division VIId, and Division IIIa. However, the decrease in recruitment for the North Sea Autumn-Spawning herring and probable high incoming sprat year class may potentially result in a fishery for sprat with less bycatches of herring.

Most sprat catches are taken in an industrial fishery where catches are limited by herring bycatch restrictions.

Regulations and their effects

With the current management regime, where there are bycatch ceilings of herring as well as bycatch percentage limits, the sprat fishery is controlled by these factors. Raising the percentage limit for bycatch of herring by continuing the increase in the catch of sprat causes some concern while there is a lack of juvenile herring.

The environment

Changes in environmental conditions, e.g., long-term changes in the temperature, may affect the ecology of this stock. The influence of inflow events is currently unknown.

Scientific basis

Data and methods

The data available are insufficient to carry out an assessment.

Information from the fishing industry

Sprat catches from the beginning of 2006 have been reported by the Danish industry to be good.

Source of information

Report of the Herring Assessment Working Group for the Area South of 62°N, 14–23 March 2006 (ICES CM 2006/ACFM:20).

Year	ICES Advice	Pred. cat. corr. to adv.	Agreed TAC[1]	Official lndgs.[2]	ACFM catch
1987	-	-	80	68	14
1988	TAC for "mixed clupeoid" fishery	80[1]	80	63	9
1989	Sprat catch lowest possible level; TAC for "mixed clupeoid" fishery	80[1]	80	62	10
1990	Sprat catch lowest possible level; TAC for "mixed clupeoid" fishery	60[1]	65	43	10
1991	Sprat catch lowest possible level; Zero TAC for "mixed clupeoid" fishery	-	50	44	14
1992	No advice for sprat; Zero TAC for "mixed clupeoid" fishery	-	50	40	11
1993	No advice for sprat	-	45	36	9
1994	Separate sprat TAC based on recent catches	10–14	43	67	96
1995	Separate sprat TAC based on recent catches	9–14	43	45	56
1996	No advice	-	43	28	18
1997	Reduce by-catch of herring	-	40	19	16
1998	Limited by restriction on juvenile herring catches	-	40	26	18
1999	Limited by restriction on juvenile herring catches	-	50	35	27
2000	Limited by restriction on juvenile herring catches	-	50	28	20
2001	Limited by restriction on juvenile herring catches	-	50	34	29
2002	Limited by restriction on juvenile herring catches	-	50	31	18
2003	Limited by restriction on juvenile herring catches	-	50		17
2004	Limited by restriction on juvenile herring catches	-	50		20
2005	Limited by restriction on juvenile herring catches	-	50		40
2006	Limited by restriction on juvenile herring catches	-	52		
2007	Limited by restriction on juvenile herring catches	-			

Weights in '000 t.
[1]TAC applies to all species in "mixed clupeoid" catch. [2]Includes other species in "mixed clupeoid" catches.

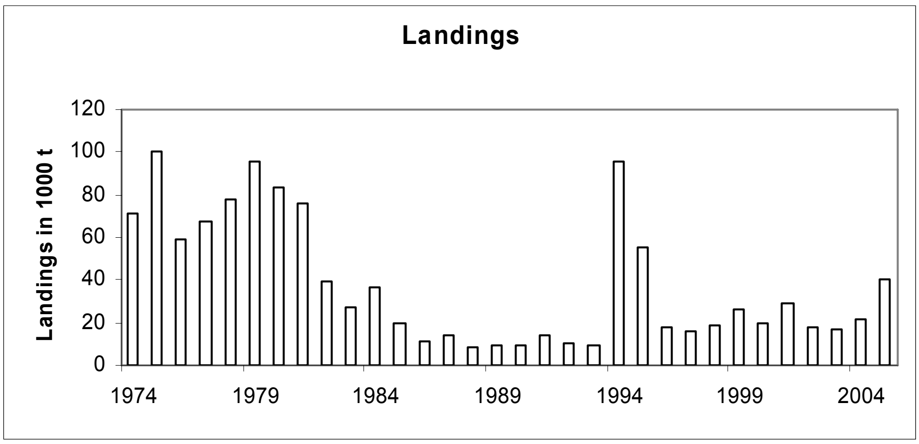


Table 6.4.19.1 Sprat in Division IIIa.

Year	Landings tonnes
1974	71300
1975	100600
1976	58800
1977	67400
1978	77900
1979	95600
1980	83900
1981	76300
1982	39700
1983	27400
1984	36100
1985	19700
1986	10800
1987	14400
1988	8700
1989	9800
1990	9700
1991	14000
1992	10500
1993	9100
1994	96000
1995	55600
1996	18000
1997	15800
1998	18400
1999	26700
2000	20100
2001	29107
2002	17716
2003	16479
2004	21996
2005	40296
Average	38059

6.4.20 Sprat in the North Sea (Subarea IV)

State of the stock

Precautionary reference points have not been defined for this stock and the available information is inadequate to estimate the absolute stock size. However, relative trends in biomass from an exploratory assessment indicate an increase over most of the time-series (Figure 6.4.20.5). The recent increase from 2004 to 2005 is due to the strong 2004 yearclass recruiting to the fishery. The 2005 year class is estimated to be very low in the IBTS survey carried out in 2006 (Figure 6.4.20.4).

Management objectives

There are no explicit management objectives for this stock.

Reference points

No reference points have been defined for this stock.

Single-stock exploitation boundaries

There are no precautionary reference points for this stock that can guide the single-stock exploitation boundaries. Two different approaches have been explored to evaluate potential harvest strategies for 2006:

1. The regression between survey index and catches suggests catches in 2006 in the order of 150 000 tonnes under the assumption of a similar exploitation rate (Figure 6.4.20.6).
2. An extrapolation of the exploratory assessment with a TAC in 2006 at the same level as in 2005 (257 000 tonnes) suggests that the stock is expected to decrease sharply (Figure 6.4.20.7).

There is no basis for a specific numeric advice for the TAC in 2006. The two methods are expressions of the uncertainty of the forecasting process and show the trade-off between different assumptions and choices.

Mixed fishery exploitation boundaries

Even though, the by-catch of juvenile herring in the sprat fishery is low as percentage of the overall catch in that fishery, the very poor recruitment of the herring in recent years could still be further jeopardized by this by-catch. Therefore ICES recommends that the TAC of sprat in 2006 should be set well below the level of 2005 and that the maximum allowed percentage herring by-catch per trip should be lowered. There is no basis for a specific numeric advice for the TAC in 2006.

Management considerations

Generally, the sprat fishery has generally not been limited by the TAC. Although an absolute stock estimate cannot be provided, there are indications that the stock is lightly exploited.

The North Sea sprat stock and catches are mostly driven by the recruiting year classes. Catches in the past have mainly consisted of 1-group sprat (mean 66%, min-max 16-96%, Figure 6.4.20.2). When strong year classes recruit to the fishery they are often also exploited at age 2. The very strong 2004 year class appears to have resulted in a substantial increase in the stock. The 2005 year class appears to be very low and this year class is expected to be the dominant part in the catches and stock in 2006.

Sprat has recently been fished with a 10% by-catch of juvenile herring (figure 1.4.20.3). The absolute by-catch of herring in 2005 was around 22 000 tonnes. The by-catch of juvenile herring was taken from a North Sea herring stock that is experiencing severe recruitment failures. Although the by-catch of juvenile herring was much lower than the allowed by-catch ceiling (50 000 t), the poor recruitment of herring warrants that the by-catch be constrained further.

For a short-lived species like sprat in the North Sea, a management approach that uses a mid-year revision of the TAC is appropriate.

Ecosystem considerations

Multispecies investigations have demonstrated that sprat is one of the important prey species in the North Sea ecosystem. Many of the plankton feeding fish have recruited poorly in recent years (e.g. herring, sandeel, Norway Pout). The implications for sprat are at present unknown.

The zooplankton community structure that is sustaining the sprat stocks appears to be changing, and there has been a long term decrease in total zooplankton abundance in the northern North Sea (Reid et al 2003, Beaugrand 2003, ICES 2006). However, sprat is mainly distributed in the southern North Sea where these trends have not been observed (ICES 2006).

Factors affecting the fisheries and the stock

Regulations and their effects

The regulation of by-catches of herring was changed in 2005 and allowed 40% by-catches of herring per trip compared to 20% previously.

The reduced availability of sandeel and Norway pout in the North Sea means that alternate fish species will be used by the industrial fisheries of the North Sea. This could put increased fishing pressure on the North Sea sprat stock.

Scientific basis

Data and methods

Assessment is based on indicators derived from a research survey and on a two-stage Catch-Survey Analysis (CSA). The CSA model assumes that the population consists of two stages: the recruits and the fully recruited ages.

Uncertainties in assessment and forecast

There are difficulties in age reading resulting in unreliable estimates of numbers-at-age from the surveys and the commercial catches. This has only partly been remedied by using a two-stage model as the key issue is the definition of the important age 1. Bootstrap analysis has suggested that the CSA estimates of stock size are very uncertain.

Comparison with previous assessment and advice:

The assessment methods are the same as used last year and the results are consistent with the perception from last year. The advice from last year was that a constant exploitation rate was expected to generate catches of 244 000 tonnes in 2005. This was based on the strong 2004 year class entering into the fisher. The current advice is to set the TAC in 2006 to well below the TAC of 2005, because of low 2005 year class.

Source of information

Report of the Herring Assessment Working Group for the Area South of 62°N 14 – 23 March 2006 (ICES CM 2006/ACFM:20).

Reid, P. C., M. Edwards, G. Beaugrand, M. Skogen and D. Stevens (2003). "Periodic changes in the zooplankton of the North Sea during the twentieth centure linked to oceanic inflow." Fisheries Oceanography 12: 260-269.

Beaugrand, G. (2003). "Long-term changes in copepod abundance and diversity in the north-east Atlantic in relation to fluctuations in the hydroclimatic environment." Fisheries Oceanography 12: 270-283.

ICES (2006) Report of the study group on recruitment variability in North Sea plantivorous fish (SGRECVAP). ICES CM 2006/LRC:03. 82pp

North Sea sprat. Summary of advice, TACS and catches.

Year	ICES Advice	Predicted catch corresp. to advice	Agreed TAC[1]	Official Catches	ACFM Catch
1987	Catch at lowest practical level	0	57	78	32
1988	TAC < recent catches, preferably zero	0	57	93	87
1989	No advice	-	59	50	63
1990	No advice	-	59	49	73
1991	No advice	-	55	92	112
1992	No advice	-	55	72	124
1993	No advice	-	114	127	200
1994	No advice for sprat; maintain by-catch regulations	-	114	184	320
1995	No advice	-	175	190	357
1996	No advice	-	200	141	136
1997	Enforce by-catch regulations	-	150	123	103
1998	Limited by restrictions on juvenile herring	-	150	175	163
1999	Limited by restrictions on juvenile herring	-	225	167	188
2000	Limited by restrictions on juvenile herring	-	225	208	196
2001	Catch prediction	225	225	180	170
2002	Catch prediction	160	232	167	144
2003	Catch prediction	175	257		177
2004	Catch prediction	171	257		194
2005	Catch prediction	244	257		206
2006	Catch predictions	<<250	283		
2007	---	---			

Weights in ‘000 t.
[1]EU zone.

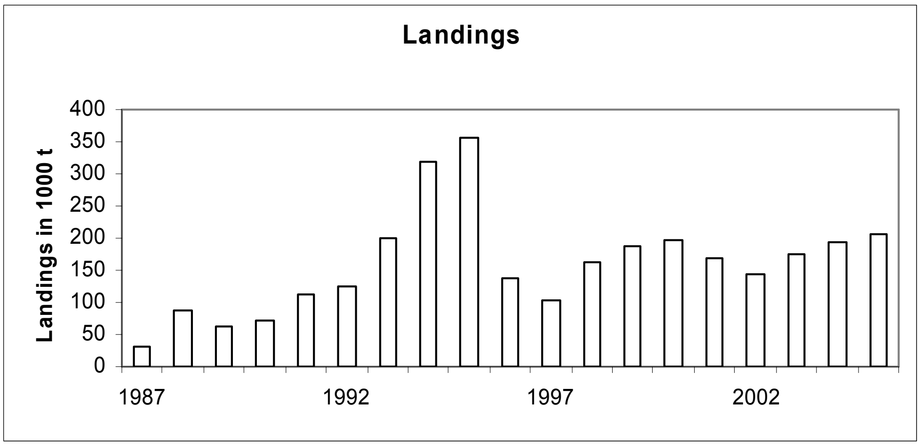


Figure 6.4.20.1 North Sea sprat. Catches in 1000 tonnes.

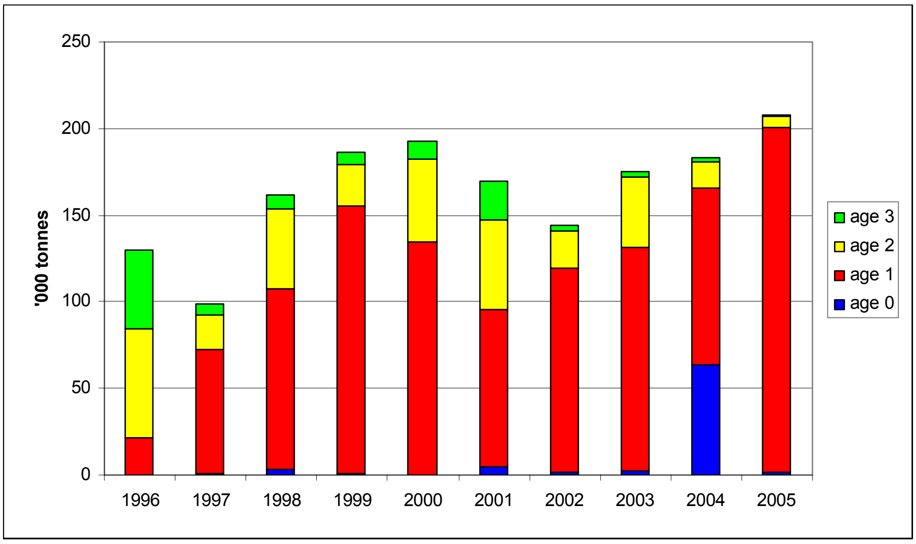


Figure 6.4.20.2 North Sea sprat. Catches by age-group in 1000 tonnes (1996-2005 only).

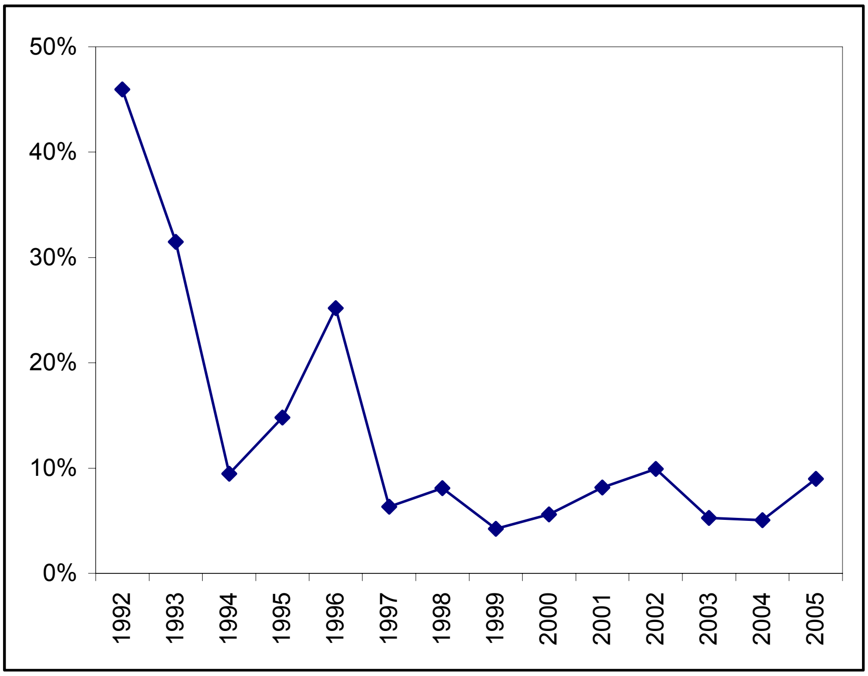


Figure 6.4.20.3 Percentage by-catch of juvenile North Sea herring in the Danish sprat fishery (source: DIFRES).

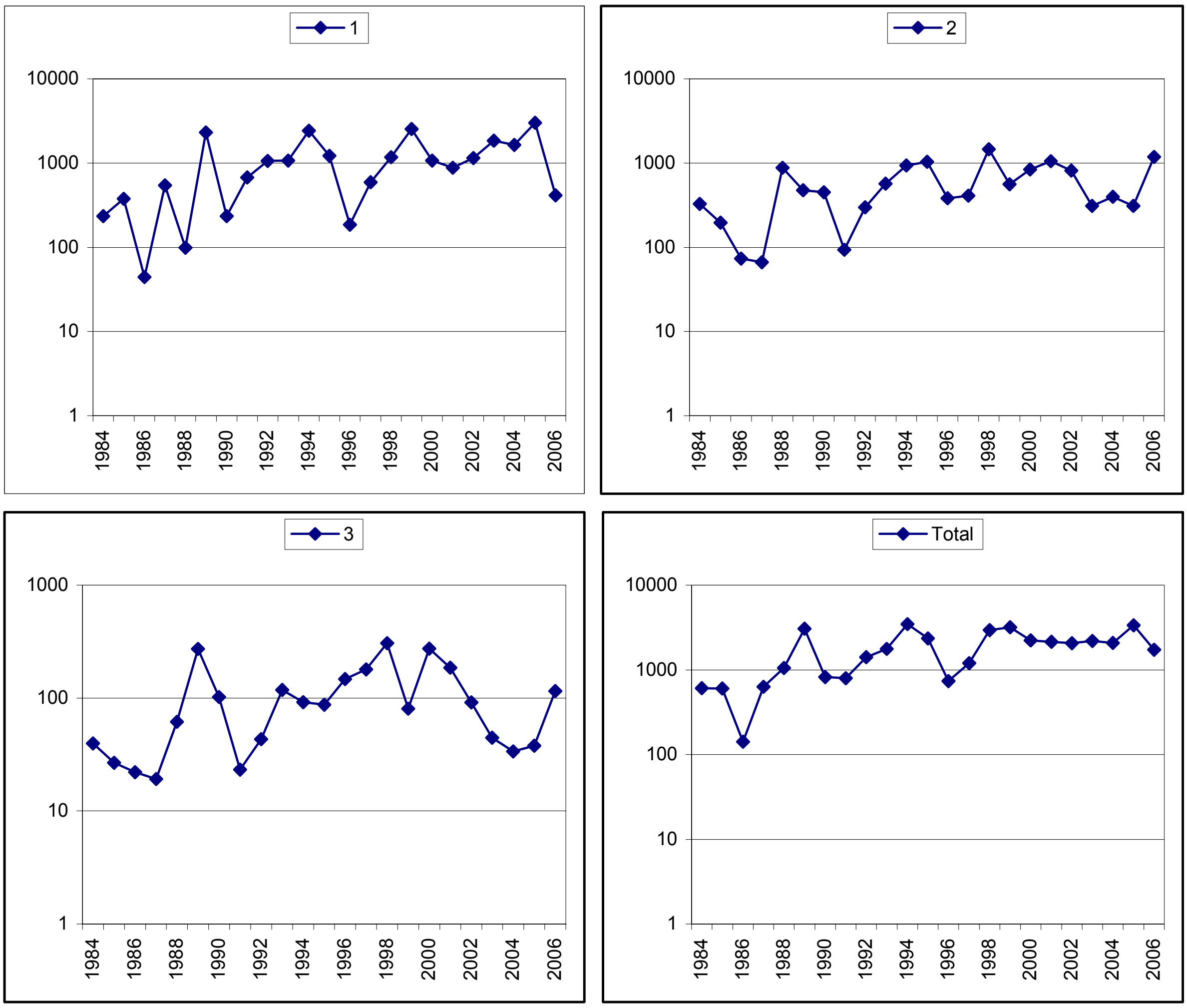


Figure 6.4.20.4 North Sea sprat. IBTS indices (N/hour) on a logarithmic scale for ages 1, 2, 3 and all (1-5+).

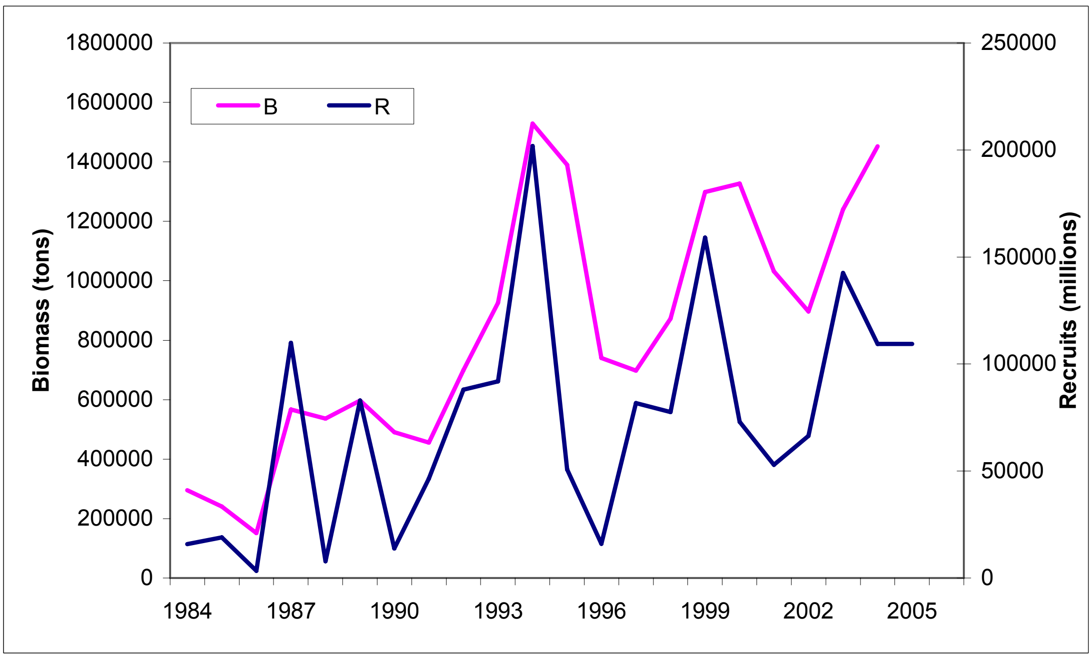


Figure 6.4.20.5 North Sea sprat. Estimated biomass and recruitment. Note that this should only be interpreted as relative indices of abundance.

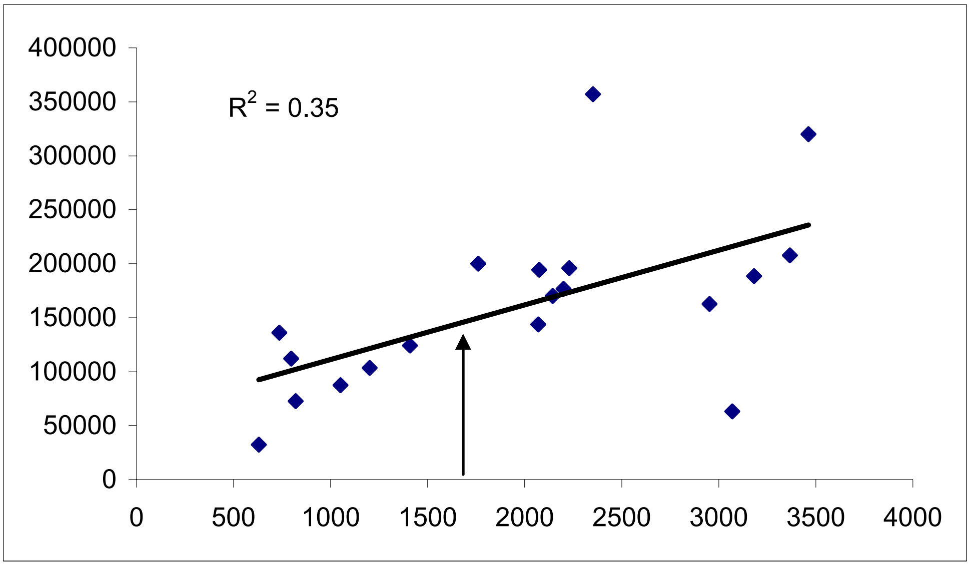


Figure 6.4.20.6. North Sea sprat. Relationship between IBTS survey index (all ages) and the total catch (in biomass). The arrow indicates the 2006 IBTS index.

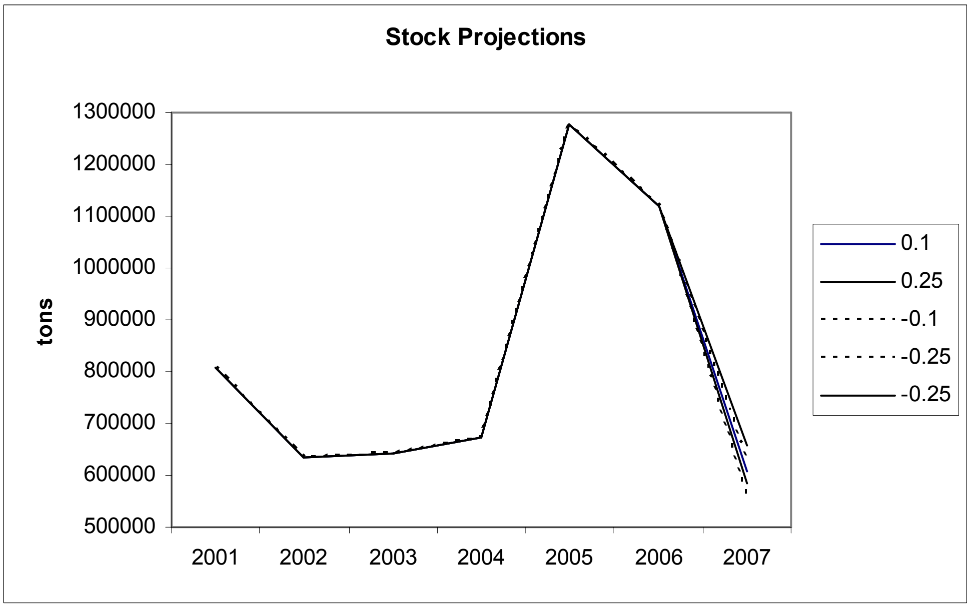


Figure 6.4.20.7 North Sea sprat. Stock trajectories under different assumptions about the 2006 catches (-25%, 10%, 0%, +10%, +25% relative to the TAC) based on the CSA stock analysis.

Table 6.4.20.1 North Sea sprat. Catches by country.

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Division IVa West (North Sea) stock																		
Denmark	0.1				0.3	0.6						0.7		0.1	1.1		0.0	
Netherlands																		
Norway				0.1														
Sweden														0.1				
UK(Scotland)							0.1											
Total	0.1			0.1	0.3	0.6	0.1					0.7		0.2	1.1		0.0	
Division IVa East (North Sea) stock																		
Denmark									0.3									
Norway					0.5	2.5		0.1										
Sweden				2.5														
Total				2.5	0.5	2.5		0.1	0.3									
Division IVb West																		
Denmark	1.4	2.0	10.0	9.4	19.9	13.0	19.0	26.0	1.8	82.2	21.1	13.2	18.8	11.1	16.3	22.0	53.8	53.3
Norway	3.5	0.1	1.2	4.4	18.4	16.8	12.6	21.0	1.9	2.3				0.9	0.0			
UK(Engl.&Wales)					0.5	0.5												
UK(Scotland)						0.5						0.8						
Total	4.9	2.1	11.2	13.8	38.8	30.8	31.6	47.0	3.7	84.5	21.1	14.0	18.8	12.0	16.3	22.0	53.8	53.3
Division IVb East																		
Denmark	80.7	59.2	59.2	67.0	66.6	136.2	251.7	283.2	74.7	10.9	98.2	147.1	144.1	132.9	109.8	130.9	122.2	150.7
Germany																		
Norway	0.6		0.6	25.1	9.5	24.1	19.1	14.7	50.9	0.8	15.3	13.1	0.9	5.0			0.1	
Sweden			+	+				0.2	0.5		1.7	2.1		1.4				0.0
UK(Scotland)												0.6						
Total	81.3	59.2	59.8	92.1	76.1	160.3	270.8	298.1	126.1	11.7	115.2	162.9	145.0	139.3	109.8	131.0	122.2	150.7
Division IVc																		
Denmark	0.1	0.5	1.5	1.7	2.5	3.5	10.1	11.4	3.9	5.7	11.8	3.3	28.2	13.1	14.8	22.3	16.8	2.0
France								+										
Netherlands	0.4	0.4										0.2						
Norway						0.4	4.6	0.4		0.1	16.0	5.7	1.8	3.6				
UK(Engl.&Wales)	0.6	0.9	0.2	1.8	6.1	2.0	2.9	0.2	2.6	1.4	0.2	1.6	2.0	2.0	1.6	1.3	1.5	1.6
Total	1.1	1.8	1.7	3.5	8.6	5.9	17.6	12.0	6.5	7.2	28.0	10.8	32.0	18.7	16.4	23.6	18.3	3.6
Total North Sea																		
Denmark	82.3	61.7	70.7	78.1	89.2	153.3	280.8	320.6	80.7	98.8	131.1	164.3	191.1	157.2	142.0	175.2	192.7	206.0
France								+										
Germany																		
Netherlands	0.4	0.4										0.2						
Norway	4.1	0.1	1.8	29.6	28.4	43.8	36.3	36.2	52.8	3.2	31.3	18.8	2.7	9.5	0.0		0.1	
Sweden				2.5								2.7		1.4				
UK(Engl.&Wales)	0.6	0.9	0.2	1.8	6.6	2.5	2.9	0.2	2.6	1.4	0.2	1.6	2.0	2.0	1.6	1.3	1.5	1.6
UK(Scotland)						0.5	0.1					0.8						
Total	87.4	63.1	72.7	112.0	124.3	200.1	320.1	357.0	136.1	103.4	162.6	188.4	195.9	170.1	143.6	176.5	194.3	207.7

6.4.21 North Sea horse mackerel (*Trachurus trachurus*) (Division IIIa (Eastern part), Divisions IVb,c VIId)

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
Unknown	Unknown	Unknown	No assessment available, due to limited data.

The available information is inadequate to evaluate spawning stock or fishing mortality relative to risk, so the state of the stock is unknown. Catches increased rapidly in the late 1990s and have remained high since then.

Management objectives

No explicit management objectives have been established for this stock.

Reference points

Not available.

Single-stock exploitation boundaries

Exploitation boundaries in relation to precautionary considerations

ICES reiterates the recommendation made in 2004 to limit the catches to below the 1982–1997 average of 18 000 t, in order to constrain the fishery until there is more information about the structure of horse mackerel stocks, and sufficient information to show that higher exploitation rates are sustainable.

Short-term implications

No forecast can be made for this stock.

Management considerations

ICES advised in 1999 to constrain an expansion of the fishery until there was a scientific basis for advice, because high catch rates can be maintained in pelagic fisheries even when the stock is in decline.

North Sea horse mackerel migrate to areas where they mix with the western horse mackerel stock. The present agreed TAC is for the North Sea and Division IIa, and these areas do not correspond to the distribution area of the stock. The TAC should apply only to those areas where the North Sea horse mackerel are fished, i.e. Divisions IIIa, IVb,c, and VIId.

The allocation of catches to the different horse mackerel stocks is based on the temporal and spatial distribution of the fishery. It is therefore important that catches be reported by ICES rectangle and by quarter.

The points listed below should be taken into account when considering management options for the North Sea horse mackerel:

1) The stock units are incompatible with the management units.
2) Catches have increased during the last decade. The major part of the increased catches is taken in Division VIId in quarters 1 and 4, which is adjacent to the boundary of the western stock. It is also adjacent to an area where juveniles of the western horse mackerel stock are found.
3) Recent catches are above the advised catch of 18 000 t. The average annual catch in the period 1995–2005 was 31 000 t.
4) There is a bycatch of mackerel in the horse mackerel fishery.

Factors affecting the fisheries and the stock

Changes in fishing technology and fishing patterns

In earlier years, the majority of the catch was taken as bycatch in the small-mesh industrial fishery. In recent years, most of the catch has come from a directed fishery for human consumption, mainly in Division VIId. This has led to a change in the age composition of the landings with a higher proportion of younger age groups.

Scientific basis

Data and methods

The stock cannot be assessed because there are no consistent signals in the catch-at-age data, sampling is insufficient, and fishery-independent indices of abundance are lacking.

Eggs surveys for horse mackerel were carried out during the period 1988–1991. The mackerel egg surveys in the North Sea do not cover the spawning area of horse mackerel.

Comparison with previous assessment and advice

There is no assessment on which to base the status of this stock. The current advice reiterates last year's advice based on average catches observed between 1982 and 1997.

Source of information

Report of the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy, Galway, Ireland, 5–14 September 2006 (ICES CM 2006/ACFM:36).

Year	ICES Advice	Predicted catch corresp. To advice	Agreed TAC[1]	ACFM landings[2]
1987	Not assessed	-	30	12
1988	No advice	-	50	24
1989	No advice	-	45	33
1990	No advice	-	40	19
1991	No advice	-	45	12
1992	No advice	-	55	15
1993	No advice	-	60	14
1994	No advice	-	60	6
1995	No advice	-	60	17
1996	No advice	-	60	19
1997	No advice	-	60	20
1998	Develop and implement management plan	-	60	31
1999	Develop and implement management plan	-	60	37
2000	Develop and implement management plan	-	51	48
2001	No increase in catch	-	51	46
2002	No increase in catch from 1982–1997 average	<18	58	23
2003	No increase in catch from 1982–1997 average	<18	50	32
2004	No increase in catch from 1982–1997	<18	42	35
2005	No increase in catch from 1982–1997	<18	43	29
2006	No increase in catch from 1982–1997	<18	43	
2007	No increase in catch from 1982–1997	<18		

Weights in '000 t.
[1]Division IIa and Subarea IV (EU waters only).
[2]Catch of North Sea stock (Divisions IIIaE, IVb,c & VIId).

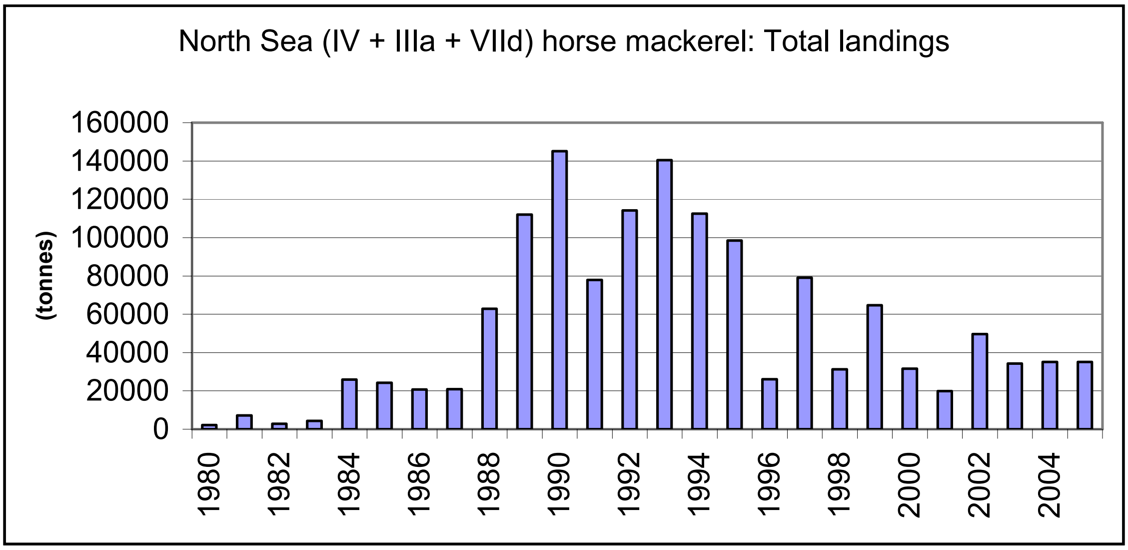


Figure 6.4.21.1

Table 6.4.21.1 HORSE MACKEREL general. Landings and discards (t) by year and Division, for the North Sea, Western, and Southern horse mackerel stocks. (Data submitted by Working Group members.)

Year	IIIa	IVa	IVb,c	Discards	VIId	**North Sea Stock**	IIa	IIIa	IVa	VIa,b	VIIa-c,e-k	VIIIa,b,d,e	VIIIc	Disc	**Western Stock**	**Southern Stock** (IXa)	All stocks
1982	2,788[1]		-		1,247	4,035	-		-	6,283	32,231	3,073	19,610	-	61,197	39,726	104,958
1983	4,420[1]		-		3,600	8,020	412		-	24,881	36,926	2,643	25,580	-	90,442	48,733	147,195
1984	25,893[1]		-		3,585	29,478	23		94	31,716	38,782	2,510	23,119	500	96,744	23,178	149,400
1985	-		22,897		2,715	26,750	79		203	33,025	35,296	4,448	23,292	7,500	103,843	20,237	150,830
1986	-		19,496		4,756	24,648	214		776	20,343	72,761	3,071	40,334	8,500	145,999	31,159	201,806
1987	1,138		9,477		1,721	11,634	3,311		11,185	35,197	99,942	7,605	30,098	-	187,338	24,540	223,512
1988	396		18,290		3,120	23,671	6,818		42,174	45,842	81,978	7,548	26,629	3,740	214,729	29,763	268,163
1989	436		25,830		6,522	33,265	4,809		85,304[2]	34,870	131,218	11,516	27,170	1,150	296,037	29,231	358,533
1990	2,261		17,437		1,325	18,762	11,414	14,878	112,753[2]	20,794	182,580	21,120	25,182	9,930	398,645	24,023	441,430
1991	913		11,400		600	12,000	4,487	2,725	63,869[2]	34,415	196,926	25,693	23,733	5,440	357,288	21,778	391,066
1992			13,955	400	688	15,043	13,457	2,374	101,752	40,881	180,937	29,329	24,243	1,820	394,793	26,713	436,548
1993			3,895	930	8,792	13,617	3,168	850	134,908	53,782	204,318	27,519	25,483	8,600	458,628	31,945	504,190
1994			2,496	630	2,503	5,689	759	2,492	106,911	69,546	194,188	11,044	24,147	3,935	413,022	28,442	447,153
1995	112		7,948	30	8,666	16,756	13,133	128	90,527	83,486	320,102	1,175	27,534	2,046	538,131	25,147	580,034
1996	1,657		7,558	212	9,416	18,843	3,366		18,356	81,259	252,823	23,978	24,290	16,870	420,942	20,400	460,185
1997			14,078	10	5,452	19,540	2,617	2,037	65,073[3]	40,145	318,101	11,677	29,129	2,921	471,700	27,642	518,882
1998	3,693		10,530	83	16,194	30,500	2,540[4]		17,011	35,043	232,451	15,662	22,906	830	326,443	41,574	398,523
1999			9,335		27,889	37,224	2,557[5]	2,095	47,316	40,381	158,715	22,824	24,188		298,076	27,733	363,033
2000			25,954		22,471	48,425	1,169[6]	1,105	4,524	20,657	115,245	32,227	21,984		196,911	27,160	272,496
2001	85	69	8,157		38,114	46,356	60	72	11,456	24,636	100,676	54,293	20,828		212,090	24,911	283,357
2002			12,636	20	10,723	23,379	1,324	179	36,855	14,190	86,878	32,450	22,110	305	194,292	23,665	241,336
2003	48	623	10,309		21,098	32,078	24	1,974	21,272	23,254	101,948	21,732	19,979		190,183	19,570	241,831
2004	351		18,348		16,455	35,154	47		11,841	21,929	98,984	8,353	15,772	701	157,627	23,581	216,361
2005	357		13,892	62	15,460	29,711	176		26,315	22,054	91,431	26,483	14,775	760	181,994	23,111	234,876

[1]Divisions IIIa and IVb,c combined.
[2]Norwegian catches in IVb included in Western horse mackerel.
[3] Includes Norwegian catches in IVb (1426 t).
[4]Includes 1,937 t from Vb.
[5]Includes 132 t from Vb.
[6]Includes 250 t from Vb.

Table 6.4.21.2 Landings (t) of HORSE MACKEREL in Subarea IV and Divisions IIIa and VIId by country. (Data submitted by Working Group members).

Country	1980	1981	1982	1983	1984	1985	1986	1987	1988
Belgium	8	34	7	55	20	13	13	9	10
Denmark	199	3,576	1,612	1,590	23,730	22,495	18,652	7,290	20,323
Faroe Islands	260	-	-	-	-	-	-	-	-
France	292	421	567	366	827	298	231[2]	189[2]	784[2]
Germany, Fed.Rep.	+	139	30	52	+	+	-	3	153
Ireland	1,161	412	-	-	-	-	-	-	-
Netherlands	101	355	559	2,029[3]	824	160[3]	600[3]	850[4]	1,060[3]
Norway[2]	119	2,292	7	322	[3]	203	776	11,728[4]	34,425[4]
Poland	-	-	-	2	94	-	-	-	-
Sweden	-	-	-	-	-	-	2	-	-
UK (Engl. + Wales)	11	15	6	4	-	71	3	339	373
UK (Scotland)	-	-	-	-	3	998	531	487	5,749
USSR	-	-	-	-	489	-	-	-	-
Total	2,151	7,253	2,788	4,420	25,987	24,238	20,808	20,895	62,877

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997
Belgium	10	13	-	+	74	57	51	28	-
Denmark	23,329	20,605	6,982	7,755	6,120	3,921	2,432	1,433	648
Estonia	-	-	-	293	-		17	-	-
Faroe Islands	-	942	340	-	360	275	-	-	296
France	248	220	174	162	302		-	-	-
Germany, Fed.Rep.	506	2,469[5]	5,995	2,801	1,570	1,014	1,600	7	7,603
Ireland	-	687	2,657	2,600	4,086	415	220	1,100	8,152
Netherlands	14,172	1,970	3,852	3,000	2,470	1,329	5,285	6,205	37,778
Norway	84,161	117,903	50,000	96,000	126,800	94,000	84,747	14,639	45,314
Poland	-	-	-	-	-	-	-	-	-
Sweden	-	102	953	800	697	2,087	-	95	232
UK (Engl. + Wales)	10	10	132	4	115	389	478	40	242
UK (N. Ireland)	-	-	350	-	-		-	-	-
UK (Scotland)	2,093	458	7,309	996	1,059	7,582	3,650	2,442	10,511
USSR / Russia (1992 -)	-	-	-						
Unallocated + discards	12,482[4]	-317[4]	-750[4]	-278[6]	-3,270	1,511	-28	136	-31,615
Total	112,047	145,062	77,904	114,133	140,383	112,580	98,452	26,125	79,161

Country	1998	1999	2000	2001	2002	2003[1]	2004	2005
Belgium	19	21	19	19	1,004	5	4	
Denmark	2,048	8,006	4,409	2,288	1,393	3,774	8,738	
Estonia	22	-	-					
Faroe Islands	28	908	24	-	699	809		
France	379	60	49	48	-	392	2,532	
Germany	4,620	4,071	3,115	230	2,671	3,048	4,912	
Ireland	-	404	103	375	72	93	1	
Netherlands	3,811	3,610	3,382	4,685	6,612	17,354	26,301	
Norway	13,129	44,344	1,246	7,948	35,368	20,493		
Russia	-	-	2	-	-			
Sweden	3,411	1,957	1,141	119	575	1,074	97	
UK (Engl. + Wales)	2	11	15	317	1,191	1,192	5,634	
UK (Scotland)	3,041	1,658	3,465	3,161	255	1	2	
Unallocated + discards	737	-325	14,613	649	-149	-14,009	-13,068	
Total	31,247	64,725	31,583	19,839	49,691	34,226	35,154	29,231

[1]Preliminary. [2] Includes Division IIa. [3] Estimated from biological sampling. [4] Assumed to be misreported. [5] Includes 13 t from the German Democratic Republic. [6] Includes a negative unallocated catch of -4,000 t.

6.4.22 Norway pout in ICES Subarea IV (North Sea) and Division IIIa (Skagerrak – Kattegat)

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	Reference points not defined	Reference points not defined	

Based on the most recent estimate of SSB, ICES classifies the stock as suffering from reduced reproductive capacity. SSB at the beginning of 2006 was near B_{lim}. Fishing mortality in 2005 and the first half of 2006 was close to zero due to a closure of the fishery. Recruitment was below average in the period 2000–2004, with a record low in 2003–2004. The recruitment in 2005 has been estimated to be at the long-term average, while survey estimates of recruitment for 2006 indicates recruitment below the long-term average.

Management objectives

There are no explicit and specific management objectives set for this stock.

Reference points

	ICES considers that:	**ICES proposed that:**
Limit reference points	$\mathbf{B}_{lim}$ is 90 000 t	$\mathbf{B}_{pa}$ be established at 150 000 t.
		Below this value the probability of below-average recruitment increases.
Target reference points		$\mathbf{F}_y$ not defined.

Technical basis

$\mathbf{B}_{lim}$: lowest observed biomass in the 1980s $\mathbf{B}_{lim}$ = $\mathbf{B}_{loss}$ = 90 000 t.	$\mathbf{B}_{pa}$: Below-average recruitment when SSB is less than 150 000 t.
$\mathbf{F}_{lim}$ None advised.	$\mathbf{F}_{pa}$ None advised.

Single-stock exploitation boundaries

Exploitation boundaries in relation to precautionary limits

The fishery should be closed until information, which assures that the stock will be above B_{pa} at the beginning of 2008 is available. Current information indicates that SSB in 2008 will be below B_{pa} even with zero catch in 2007.

Short-term implications

Outlook for 2007

Scenarios showing the outlook for 2007 for various assumptions on catch in 2006.

Assumed catch 2006	F (2006)	SSB (2007)	Catch 2007	SSB (2008)
0	0	183	0	142
25	0.15	167	0	135
50	0.31	149	0	129
95	0.65	120	0	117
120	0.87	105	0	110

The outlook for 2007 depends critically on the realized catch in 2006 and the 2006 year-class strength. First indications are that the 2006 year class is weak. More information about the 2006 year class will be obtained from the first quarter 2007 IBTS survey and the stock size is uncertain until then.

The fishery was opened on 24 August 2006 with an EC quota of 95 000 t and unrestricted Norwegian fishery in the Norwegian zone for the rest of the year. Information from the fishery indicates that this EC quota will not be fully utilized (1200 t landed early October) and Norwegian landings by early October are 7000 t. It is unknown how large the total catch in 2006 will be. The scenarios above indicate that SSB is below $\mathbf{B}_{pa}$ in 2008, even with zero catch both in 2006 and in 2007.

In this prediction the 2007 year class has been assumed to be average. This year class has a moderate impact on the SSB in 2008, and the first survey index for this year class will be obtained in the third quarter of 2007.

Management considerations

In 2005 ICES considered the spawning stock to be below $\mathbf{B}_{lim}$ with reduced reproductive capacity. Based on this consideration EU and Norway agreed to close the fishery in 2005 and in the first half of 2006.

At the start of 2006 the spawning stock was estimated at $\mathbf{B}_{lim}$, but was expected to increase to $\mathbf{B}_{pa}$ in 2007, while allowing some fishery in the second half of 2006. The expected increase in the spawning stock was due to a revised estimate of the 2005 year class which became available in 2006. ICES advised in spring 2006 that the fishery could be re-opened with a TAC for the North Sea of approximately 95 000 t for 2006, and this was implemented for the second half of 2006 with a TAC of 95 000 t in EU waters. Norway also opened the fishery in the Norwegian zone with no TAC limit.

EU and Norway have requested ICES to advise on harvest rules for Norway pout, primarily as a two-stage rule with an initial precautionary TAC and a mid-year revision. The ICES response to this request will be communicated in a separate document.

The present advice relies on a single survey information of the incoming year class. In a two-stage management, this would be the basis for a preliminary TAC. The 1st and the 3rd quarter IBTS survey and the 4th quarter commercial fishery (when it exists) indices of the previous year, provide relatively good indicators of the year-class strengths and the size of the stock, and can form a basis for an in-year final TAC decision. For 2007, the current estimate of the stock and recruitment is such that no fishery can be advised within the framework of the precautionary approach, unless the additional information later in the year changes this perception.

The fishery is targeting Norway pout and blue whiting. In managing this fishery, bycatches of cod, haddock, whiting, saithe, and herring should be taken into account, and existing technical measures to protect these bycatch species should be maintained.

Commercial, exploratory fishery and provision of recent bycatch information has shown bycatch ratios to be significant, and recent scientific research based on at-sea experiments in the commercial fishery has shown that the use of gear technological bycatch devices can reduce bycatches of juvenile gadoids significantly. Such gear technological bycatch reduction devices (or modified forms of those) should be brought into use in the fishery. The introduction of bycatch reduction devices (e.g. sorting grids) should be accompanied by adequate control measures to assure effective implementation of the existing bycatch measures.

Ecosystem considerations

The population dynamics of Norway pout in the North Sea and Skagerrak are very dependent on recruitment variation and variation in predation mortality (or other natural mortality causes). Recruitment variability influences SSB and TSB rapidly, due to the short life span of the species. With present fishing mortality levels the status of the stock is more determined by natural processes and less by the fishery.

Norway pout is an important prey species for a variety of fish species (e.g. saithe, haddock, and mackerel). However, growth and mean weight-at-age for these predators seems independent of the stock size of Norway pout.

Factors affecting the fisheries and the stock

Historically, the fishery includes bycatches especially of haddock, saithe, and herring.

Scientific basis

Data and methods

The assessment (SXSA) is based on time-series of catch-at-age, one commercial cpue series, and two bottom trawl research survey series. The assessment is considered appropriate to indicate trends in the stock. It provides stock status of all age groups (0–4) up to the second quarter of the assessment year (2006).

Uncertainties in assessment and forecast

Natural mortality levels have been explored for the stock, and inconsistent information of this from different sources exists. Consequently, it has been chosen to use the constant mortality levels as used previously in the assessment. These levels are consistent with average levels calculated from the multi-species model (MSVPA).

Comparison with previous assessment and advice

The estimates of the SSB, and the average fishing mortality of ages 1 and 2, are consistent with the estimates of previous year's assessment. The current estimate of the 2005 year class is 15% below the estimate used for the advice in April 2006. This is the main reason for the different perception of the stock size compared with the advice provided in April 2006. At the time it was predicted that a catch of 95 000 t for 2006 would result in SSB = 150 000 t in 2007. The current forecast for the SSB in 2007 is 20% lower at the same catch.

Source of information

Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, 5–14 September 2006 (ICES CM 2006/ACFM:35).

North Sea (Subarea IV)

Year	ICES Advice	Predicted catch corresp. to advice	Agreed TAC[1]	Official Landings	ACFM landings
1987	No advice	-	200	215	147
1988	No advice	-	200	187	102
1989	No advice	-	200	276	167
1990	No advice	-	200	212	140
1991	No advice	-	200	223	155
1992	No advice	-	200	335	255
1993	No advice	-	220	241	176
1994	No advice	-	220	214	176
1995	Can sustain current F	-	180	289	181
1996	Can sustain current F; take bycatches into consid.	-	220	197	122
1997	Can sustain current F; take bycatches into consid.	-	220	155	133
1998	Can sustain current F; take bycatches into consid.	-	220	72	62
1999	Can sustain current F; take bycatches into consid.	-	220	93	85
2000	Can sustain current F; take bycatches into consid.	-	220	182	175
2001	Can sustain current F; take bycatches into consid.	-	211	63	57
2002	Can sustain current F; take bycatches into consid.	-	198	93	74
2003	Can sustain current F; take bycatches into consid.		198	24	21
2004	The stock is in risk of decreasing below $\mathbf{B}_{lim}$.		198	16	14
2005	Fishery should be closed		0	1	2
2006	Fishery closed until new information assures SSB>$\mathbf{B}_{pa}$ in 2007. New advice April 2006: TAC<95 000 t.		95		
2007	Fishery closed until new information assures SSB>$\mathbf{B}_{pa}$ in 2008.				

Weights in '000 t. [1] IIa(EU), IIIa, IV(EU).

Skagerrak (Division IIIa)

Year	ICES Advice	Official landings	ACFM Catch
1987	No advice		2
1988	No advice		8
1989	No advice	17	5
1990	No advice	41	12
1991	No advice	49	38
1992	No advice	84	45
1993	No advice	37	8
1994	No advice	24	7
1995	No advice	68	50
1996	No advice	58	36
1997	See advice for North Sea	35	29
1998	See advice for North Sea	11	13
1999	See advice for North Sea	7	8
2000	See advice for North Sea	15	10
2001	See advice for North Sea	14	7
2002	See advice for North Sea	4	3
2003	See advice for North Sea	4	3
2004	See advice for North Sea	0.2	0.3
2005	See advice for North Sea	0	0
2006	See advice for North Sea		
2007	See advice for North Sea		

Weights in ‘000 t.

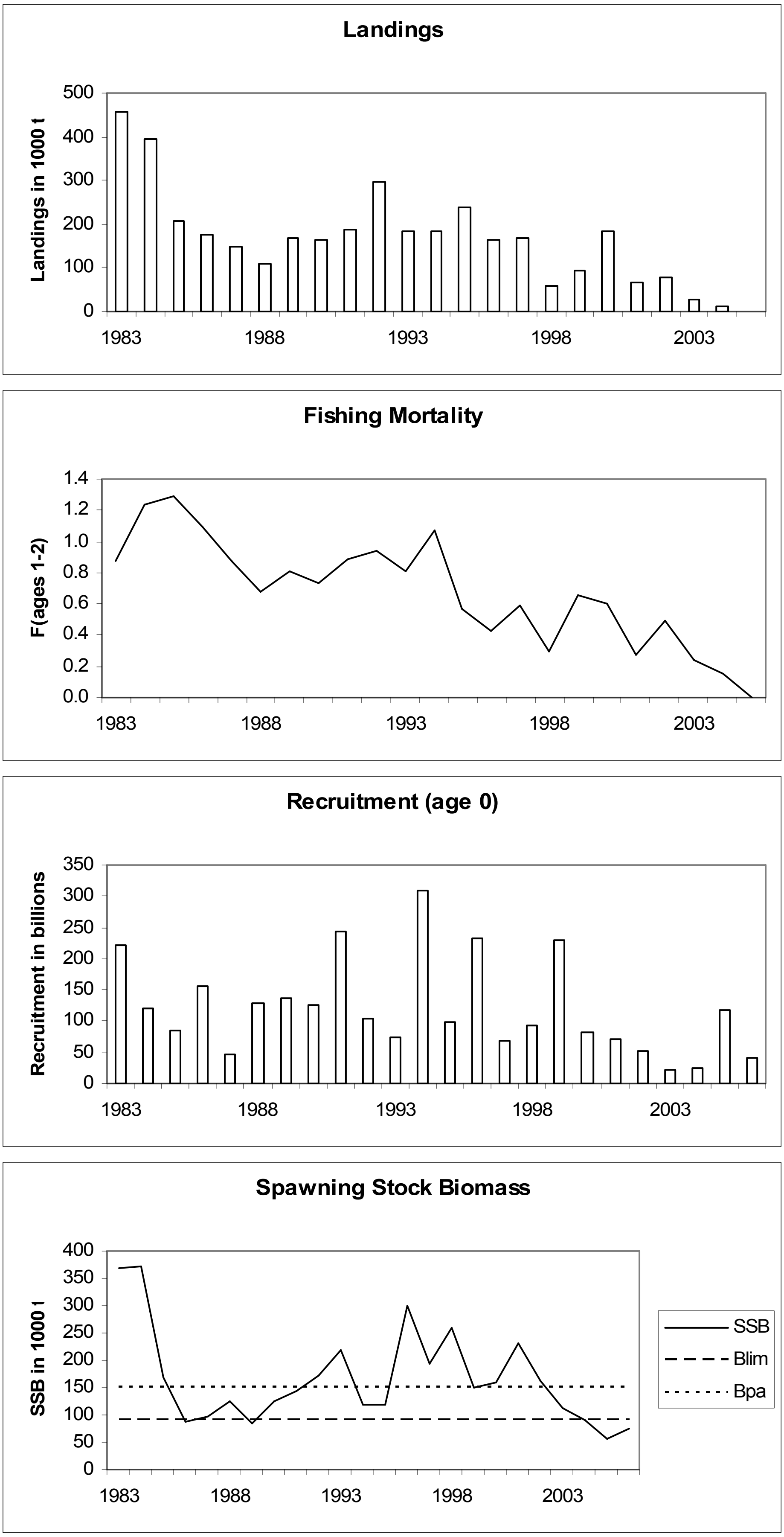


Figure 6.4.22.1 Norway pout in Sub-area IV and Division IIIa. Landings, fishing mortality, recruitment and SSB.

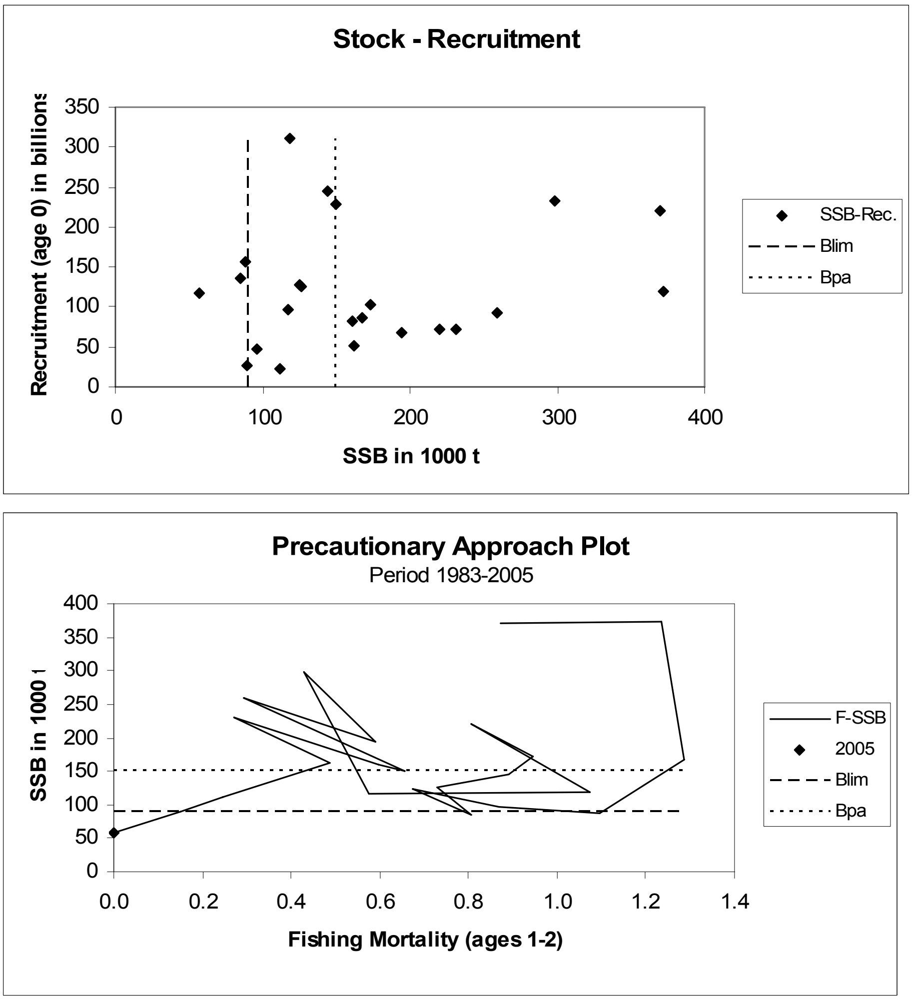


Figure 6.4.22.2 Norway pout. Stock and recruitment (top) and Precautionary approach plot (bottom)

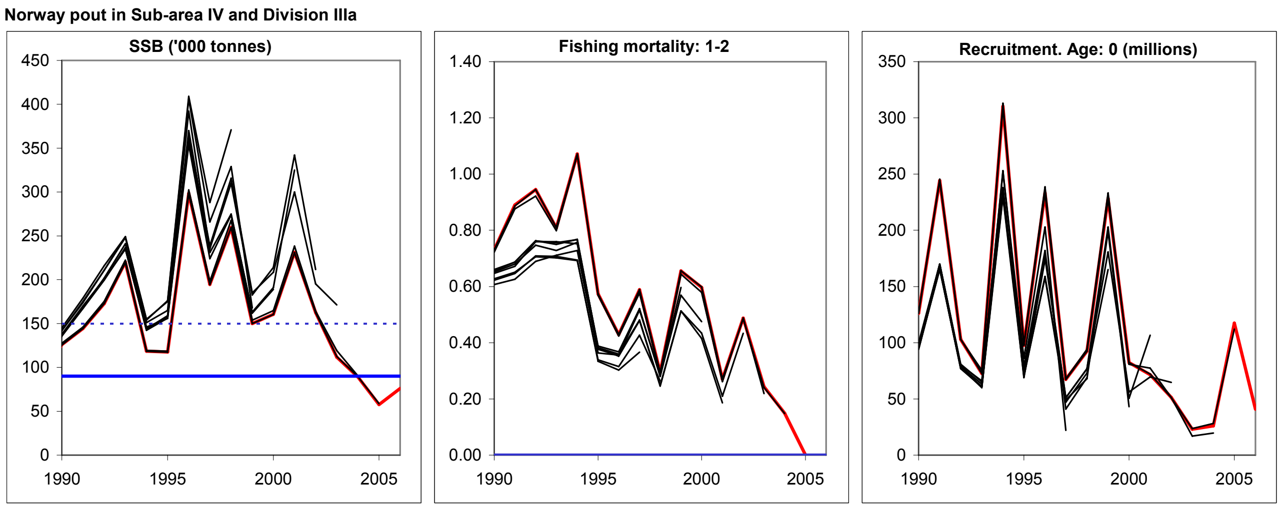


Figure 6.4.22.3 Norway pout. Historical performance of the assessment (SSB, Fishing mortality and recruitment)

Table 6.4.22.1 Norway pout in Subarea IV and Division IIIa.

Norway pout ICES area IIIa

Country	1998	1999	2000	2001	2002	2003	2004	2005
Denmark	11,080	7,194	14,545	13,619	3,780	4,235	110	-
Faroe Islands	-	-	-	-	-	50	-	-
Norway	-	-	-	-	96	30	41	-
Sweden	-	-	133	780	-	-	-	-
Germany	-	-	-	-	-	-	54	-
Total	11,080	7,194	14,678	14,399	3,876	4,315	205	0

*Preliminary.

Norway pout ICES area IVa

Country	1998	1999	2000	2001	2002	2003	2004	2005
Denmark	42,154	39,319	133,149	44,818	68,858	12,223	10,762	941***
Faroe Islands	4,707	2,534		49	3,367	2,199	-	-
Netherlands	-	-	-	-	-	-	-	-
Germany	-	-	-	-	-	-	27	-
Norway	22,213	44,841	48,061	17,158	23,657	11,357	4,958	311
Sweden	-	-	-	-	-	-	-	-
Total	69,074	86,694	181,210	62,025	95,882	25,779	15,747	1,092

*Preliminary.

Norway pout ICES area IVb

Country	1998	1999	2000	2001	2002	2003	2004	2005
Denmark	3,258	5,299	158	632	556	191	473	-
Germany	-	-	2	-	-	-	26	-
Netherlands	2	-	3	-	-	-	-	-
Norway	57	-	34	-	-	-	-	-
Sweden	-	-	-	-	-	-	2	-
UK (E/W/NI)	-	-	+	-	+	-	-	-
UK (Scotland)	-	-	-	-	-	-	-	-
Total	3,317	5,299	197	632	556	191	501	0

*Preliminary.

Norway pout ICES area IVc

Country	1998	1999	2000	2001	2002	2003	2004	2005
Denmark	-	514	182	304	-	-	-	-
Netherlands	-	+	-	-	-	-	-	-
UK (E/W/NI)	-	-	-	+	-	-	-	-
Total	0	0	0	0	0	0	0	0

*Preliminary.

Norway pout Sub-area IV and IIIa (Skagerrak) combined

Country	1998	1999	2000	2001	2002	2003	2004	2005
Denmark	56,492	51,812	147,852	59,069	73,194	16,649	11,345	941**
Faroe Islands	4,707	2,534	0	49	3,367	2,249	0	0
Norway	22,270	44,841	48,095	17,158	23,753	11,387	4,999	311
Sweden	0	0	133	780	0	0	2	0
Netherlands	2	0	3	0	0	0	0	0
Germany	0	0	2	0	0	0	107	0
UK	0	0	0	0	0	0	0	0
Total nominal landings	83,471	99,187	196,085	77,056	100,314	30,285	16,453	1,252
By-catch of other species and other	-3,671	-7,187	-11,685	-11,456	-23,614	-5,385	-2,953	-
WG estimate of total landings (IV+IIIaN)	79800	92000	184400	65600	76700	24900	13500	-
Agreed TAC	220000	220000	220000	211200	198000	198000	198000	0****

* provisional
** provisional
*** 781 ton from trial fishery (directed fishery); 160 ton from by-catches in other fisheries
+ Landings less than 1
n/a not available
**** A by-catch qouta of 5000 t has been set.

Table 6.4.22.2 Norway pout in Sub-area IV and Division IIIa

Year	Recruitment Age 0 thousands	SSB tonnes	Landings tonnes	Mean F Ages 1-2
1983	221208000	369917	457600	0.872
1984	119221000	372157	393010	1.235
1985	85748000	167331	205100	1.286
1986	156787000	87962	174300	1.096
1987	46386000	96421	149300	0.870
1988	128173000	124747	109300	0.676
1989	135397000	84978	166400	0.808
1990	126108000	125890	163300	0.730
1991	244348000	144338	186600	0.890
1992	102906000	172844	296800	0.945
1993	72550000	219825	183100	0.808
1994	310314000	118419	182000	1.072
1995	97766000	117495	236800	0.574
1996	233323000	298487	163800	0.429
1997	67321000	194657	169700	0.589
1998	92540000	259644	57700	0.295
1999	228355000	150011	94500	0.655
2000	82412000	160587	184400	0.597
2001	71628000	231193	65600	0.270
2002	51301000	162550	80000	0.487
2003	23007000	111803	27100	0.244
2004	25973000	89154	13500	0.149
2005	117425000	57474	0	0.000
2006	40798000	75908		
Average	120041458	166408	163513	0.677

6.4.23 Sandeel in Division IIIa (Skagerrak – Kattegat)

State of the stock

The available information is inadequate to evaluate spawning stock or fishing mortality relative to risk, so the state of the stock is unknown.

Management objectives

There are no explicit management objectives for this stock.

Management considerations

The fishery is an extension of the North Sea fishery into Division IIIa, but with smaller vessels working closer inshore, mostly along the coast of Jutland.

The available information suggests that Subarea IV and Division IIIa can be combined to one stock unit. No assessments of sandeel in Division IIIa have been carried out so far. Biological data for this area are sparse and would have to be evaluated before a decision is made about treating sandeels in Subarea IV and Division IIIa as one stock.

Source of information

Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, 5–14 September 2006 (ICES CM 2006/ACFM:35).

Year	ICES Advice	ACFM Catch
1987	No advice	5
1988	No advice	23
1989	No advice	18
1990	No advice	16
1991	No advice	23
1992	No advice	39
1993	No advice	45
1994	No advice	55
1995	No advice	12
1996	No advice	53
1997	No advice	81
1998	No advice	11
1999	No advice	13
2000	No advice	17
2001	No advice	25
2002	No advice	49
2003	No advice	9
2004	No advice	11
2005	No advice	5
2006	No advice	
2007	No advice	

Weights in '000 t.

6.4.24 Sandeel in Subarea IV

State of the stock

Spawning biomass in relation to precautionary limits	Fishing mortality in relation to precautionary limits	Fishing mortality in relation to agreed target.	Fishing mortality in relation to highest yield	Comment
Reduced reproductive capacity	F reference points are not defined	No agreed target	Unknown	

Based on the most recent estimates of SSB, ICES classifies the stock as having reduced reproductive capacity. SSB is estimated at below $\mathbf{B}_{\mathrm{lim}}$ since 2001.

In the absence of an F reference point, the state of the stock cannot be evaluated with regard to sustainable harvest. The fishing mortality in 2005 was close to the time-series mean and below that of the last 4 years. Fishing mortality from the completed 2006 fishery is lower than the time-series mean. Recruitment in the period 2002–2004 was low, but the 2005 year class is estimated just below average.

Management objectives

There are no explicit management objectives for this stock.

Reference points

Reference points have been unchanged since 1999.

	ICES considers that:	ICES proposed that:
Precautionary Approach reference points	$\mathbf{B}_{\mathrm{lim}}$ is 430 000 t.	$\mathbf{B}_{\mathrm{pa}}$ be set at 600 000 t.
	$\mathbf{F}_{\mathrm{lim}}$ is undefined.	$\mathbf{F}_{\mathrm{pa}}$ is undefined.
Target reference points		$\mathbf{F}_{\mathrm{y}}$ is undefined.

Technical basis:

$\mathbf{B}_{\mathrm{lim}}$: The lowest observed biomass that gave recruitment about the average level.	$\mathbf{B}_{\mathrm{pa}}$: set to 1.4 * $\mathbf{B}_{\mathrm{lim}}$.
$\mathbf{F}_{\mathrm{lim}}$: None proposed.	$\mathbf{F}_{\mathrm{pa}}$: None proposed.
	$\mathbf{F}_{\mathrm{y}}$**:** None proposed.

Single-stock exploitation boundaries

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

Several traditional sandeel aggregations seem depleted, particularly around the northern area. Management of fisheries should try to prevent further local depletion of sandeel aggregations, particularly in areas where predators congregate. Sandeel is an important forage species and efforts should be made to keep adequate levels of biomass available as prey.

Exploitation boundaries in relation to precautionary limits

The fishery should remain closed until information is available which assures that the stock can be rebuilt to $\mathbf{B}_{\mathrm{pa}}$ by 2008. The information on which this could be based includes surveys in December 2006 by DIFRES, in April 2007 by IMR, and an exploratory fishery in April 2007.

Short-term implications

The high natural mortality of sandeel and the few year classes in the fishery make the stock size and catch opportunities largely dependent on the size of the incoming year classes. If the 2006 year class is low (~300 billion) equivalent to 135 billion at age 1 in 2007, only a total closure of the fishery in 2007 would enable the stock to attain Bpa in 2008. A recruitment just below the long-term average (~500 billion) would permit a fishery of ~300 kt in 2007.

Management considerations

ICES suggest applying real-time management in 2007 with the target to rebuild SSB above $\mathbf{B}_{pa}$ in 2008. The relation between the estimate of the 2006 year class and catch opportunities is shown in Figure 6.3.3.4.4. The real-time monitoring estimate should be based on "bias-corrected" VPA estimated stock numbers. ICES has not sufficient information to evaluate whether the management procedure suggested for 2007 is precautionary, mainly because local depletions are not handled in the simulations.

A drastic change in the stock situation of sandeels in IV seems to have occurred from 2003 and onwards. The change in 2003 came from a historic low recruitment in 2002. An apparent increase in the stock size from 2005 to 2006 is due to the recruitment in 2005. However, this increase only applies to the southern part of the North Sea, whereas the stock in the Northern part of the North Sea is still at a much lower level.

The stock structure of sandeel remains uncertain. At present sandeel in the North Sea is managed as one stock. Sandeel is sedentary once it has settled to the bottom and confines itself to specific grounds where the bottom conditions are favourable. The exchange of sandeel between different grounds takes place mainly in early life stages. In the Norwegian economical zone fishery is known to cause local depletion of sandeels. The low stock size increases the risk of local depletion, which is a matter of concern. There is therefore a need to monitor the stock situation and hence the fishery at a finer spatial scale, and to restrict the fishery on grounds that show signs of depletion. The present knowledge on defining subpopulations is too limited to establish management for 2007 which can fully take the population structure into account, but work is proceeding on defining local sub-populations so that the scale of "local depletion" can be quantified and be made operational for a North Sea-wide implementation.

Localised depletion of sandeel aggregations at a distance less than 100 km from seabird colonies may affect some species of birds, especially black-legged kittiwake and sandwich tern, whereas the more opportunistic feeding marine mammals and fish may be less vulnerable to local sandeel depletion. In the light of studies linking low sandeel availability to poor breeding success of kittiwake, all commercial fishing in the Firth of Forth area has been prohibited since 2000, except for a maximum of 10 boat days in each of May and June for stock monitoring purposes. The closure was maintained for three years and has been extended until 2006, with an increase in the effort of the monitoring fishery to 20 days, after which the effect of the closure will be evaluated. Stock monitoring from this area shows a large increase in sandeel biomass since the closure.

There has been a substantial decrease in the Danish fishing fleet due to decommission. Also for the Norwegian fleet a drastic decline in the number of vessels fishing sandeels has been observed in recent years.

Management plan evaluations

No management objectives have been set for this stock. There is a need to develop management objectives that ensure that the stock remains high enough to provide food for a variety of predator species.

ICES suggests a management procedure for 2007 as outlined in a response to a special request. An extended Harvest Control Rule which includes measures to avoid local depletions should be developed.

Ecosystem considerations

The recruitment of sandeels seems more linked to environmental factors than to the size of the spawning stock biomass.

Sandeels are important prey species for many marine predators. The reduction of sandeels has been shown to have detrimental effects on both kittiwakes and sandwich terns.

The ecosystem effects of industrial fisheries are discussed in the Report of the ICES Advisory Committee on Ecosystems, June 2003, Section 11 (*ICES Cooperative Research Report No. 262*).

Factors affecting the fisheries and the stock

The effects of regulations

The EU Council of the Ministers agreed in December 2005 that the European Commission should implement a fishing effort regulation in 2006 for vessels fishing sandeel in the North Sea and the Skagerrak, and adopted a harvest control rule based on the size of the 2005 year class. Following the advice from STECF that was based on a report from a STECF Ad Hoc WG, the fishery for the rest of the 2006 fishing season was managed through a TAC of 300 000 t and a maximum effort limit of 40% of the effort applied in 2003.

Based on estimates of the size of the 2005 year class and information about the distribution of sandeels IMR recommended not to open the fishery for the rest of 2006 in the Norwegian EEZ, this recommendation being accepted and implemented by the Norwegian government.

There was a 50% decline in the number of Danish vessels (from 200 to 98 vessels) fishing sandeels from 2004 to 2005. In 2006 124 Danish vessels participated in the sandeel fishery. The capacity of the Danish fleet participating in the North Sea sandeel fishery is not likely to increase much further, due to decommission of a substantial number of vessels during the last years.

The environment

The decline in the density of sandeel in the entire North Sea is not limited to the fished areas. If this change in the stock situation is caused by changes in the environment this may suggest that the reference points used for sandeels need to be revised. However, although the decline in recruitment in sandeels has been linked to both the NAO index and to the annual average abundance of *Calanus finmarchicus* in the central North Sea, it is presently not possible to determine the mechanisms driving recruitment in sandeels or the link between changes in the environment and sandeel population dynamics.

Other factors

Sandeel is taken by trawlers using small-mesh gear. The fishery is seasonal, taking place mostly in the spring and summer. There is a targeted 0-group fishery carried out in autumn (3rd quarter). Most of the catch consists of *Ammodytes marinus*, but other sandeel species are caught as well. There is a low percentage bycatch of other species, including species for which a TAC has been set.

Sandeels are largely stationary after settlement and the North Sea sandeel must be considered as a complex of local populations. Recruitment to local areas may not only be related to the local stock, as interchange between areas seems to take place during the early phases of life before settlement. The Shetland sandeel stock is assessed as a separate unit.

Scientific basis

Data and methods

The assessment of sandeel is carried out without fisheries-independent indices of abundance. Different sampling approaches have been tried during scientific surveys, but at present no scientific survey time-series exist that can be used for the assessment.

The assessment method used is Seasonal XSA (SXSA), which allows the use of semi-annual data. Catches from the first half of 2006 are included, and because the fishery was low in the second half the catches from the first half year were assumed to represent all the catches for 2006. As in previous assessments, effort data from the commercial fishery in the northern and southern North Sea are treated as two independent tuning fleets, separated into half-years. In order to improve the model fit, the CPUE series were split into two time periods, i.e. before and after 1999.

Uncertainties in assessment and forecast

There are large uncertainties in the assessment of sandeels in the North Sea due to:

- the assumption about stock structure used in the assessment,
- lack of fisheries-independent tuning data,
- large changes in fishing pattern in recent years,
- and possible large changes in fleet catchability in recent years.

Recruitment time-series estimates from surveys are not yet available, but the time-series are being developed. Recruitment estimates are now based exclusively on commercial catch-at-age data.
The stock development in recent years is uncertain due to a tendency of the assessment to overestimate stock size and underestimate fishing mortality.

A short-term forecast, using a revised procedure taking account of the retrospective bias in the historic assessment, estimated the SSB in 2007 at 249 000 t. The uncorrected estimate is 498 000 t.

Comparison with previous assessment and advice

The diagnostics and retrospective pattern in this year's final assessment is comparable to last year's assessment. The resulting advice remains the same as last year.

Source of information

Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, 5–14 September 2006 (ICES CM 2006/ACFM:35).

Year	ICES Advice	Catch corresponding to advice	TAC	ACFM Catch
1987	No advice[1]; No advice[2]			825
1988	No advice[1]; No advice[2]			893
1989	No advice[1]; No advice[2]			1039
1990	No advice[1]; No advice[2]			591
1991	No advice[1]; No advice[2]			843
1992	No advice[1]; No advice[2]			855
1993	No advice[1]; No advice[2]			579
1994	No advice[1]; No advice[2]			786
1995	Can sustain current F[1]; No advice[2]			918
1996	Can sustain current F			777
1997	Can sustain current F			1138
1998	Can sustain current F		1000	1004
1999	Can sustain current F		1000	735
2000	Can sustain current F		1020	699
2001	Can sustain current F		1020	862
2002	Can sustain current F		1020	811
2003	No increase in F		918	326
2004	Exploitation to be kept below level of 2003. Adjustment to be made conditional on the abundance of the 2003 year class		826	362
2005	Exploitation to be kept below level of 2003. Adjustment to be made conditional on the abundance of the 2004 year class		661	172
2006	The fishery should remain closed until information is available which assures that the stock can be rebuilt to $\mathbf{B}_{pa}$ by 2007.		300	266
2007	The fishery should remain closed until information is available which assures that the stock can be rebuilt to $\mathbf{B}_{pa}$ by 2008.			

Weights in '000 t. [1]Southern stock component. [2]Northern stock component.

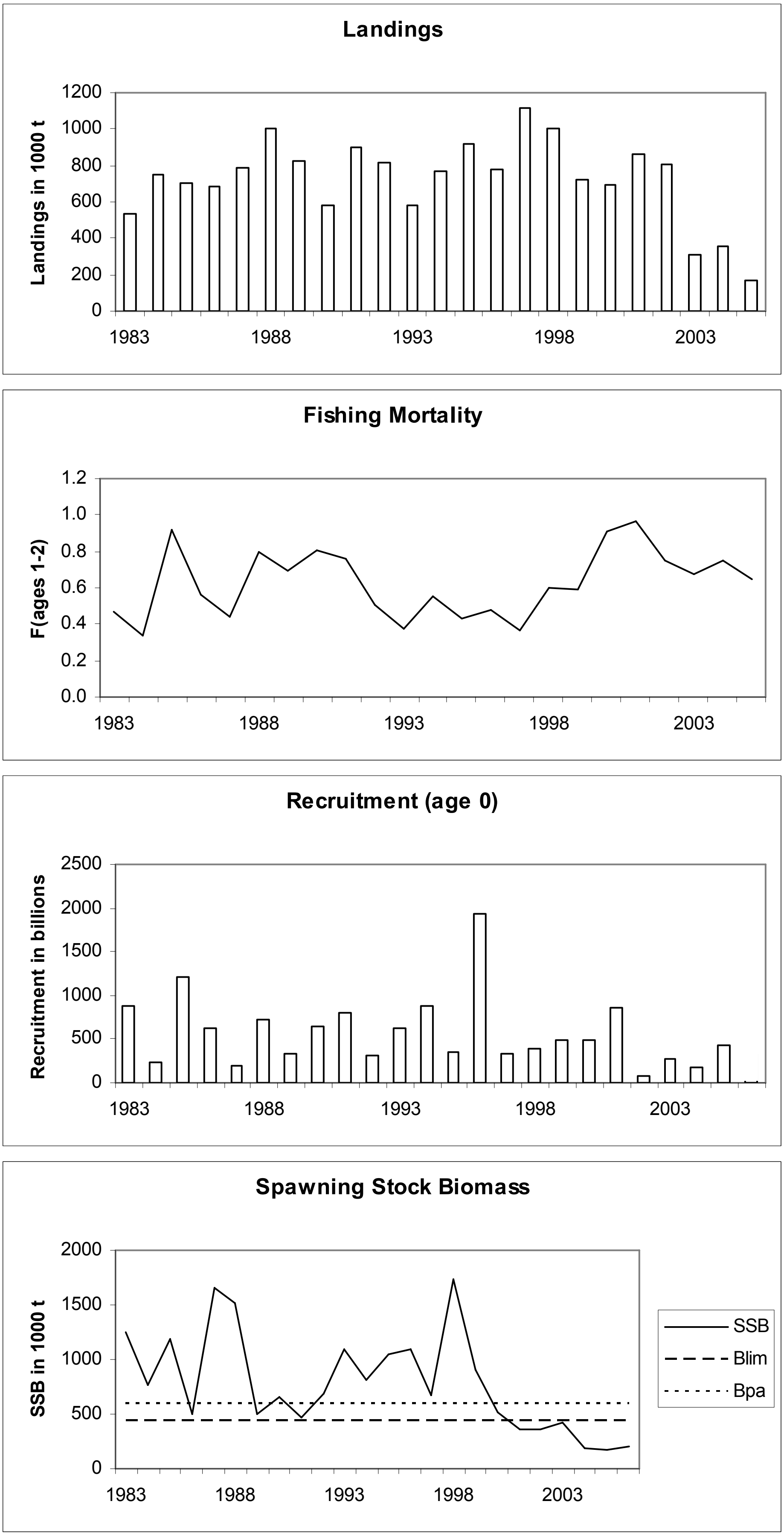
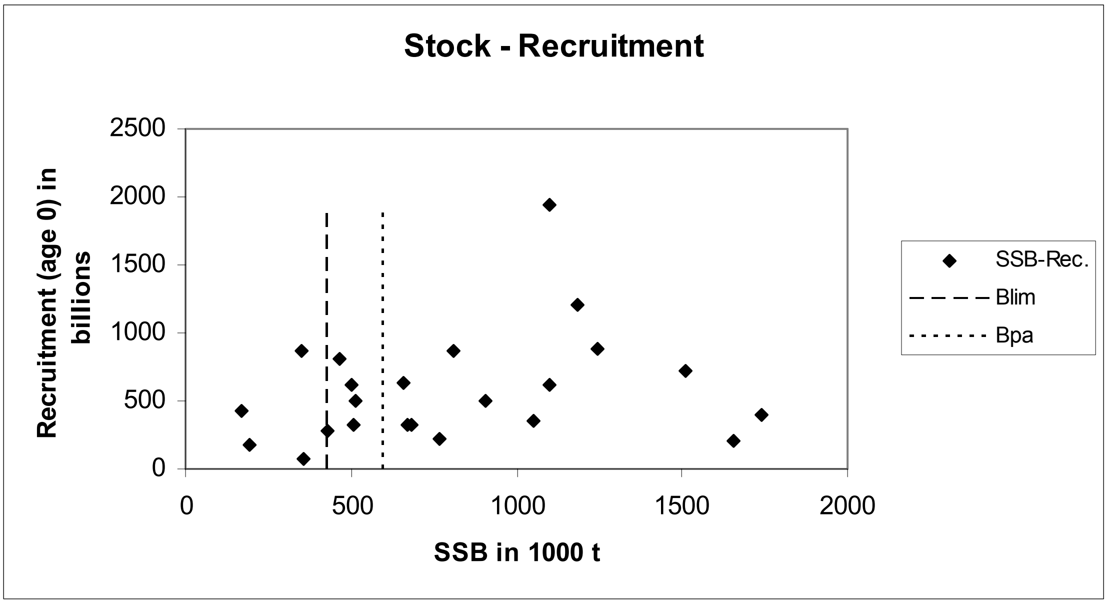


Figure 6.4.24.1 Sandeel in Subarea IV. Landings, fishing mortality, recruitment and SSB.



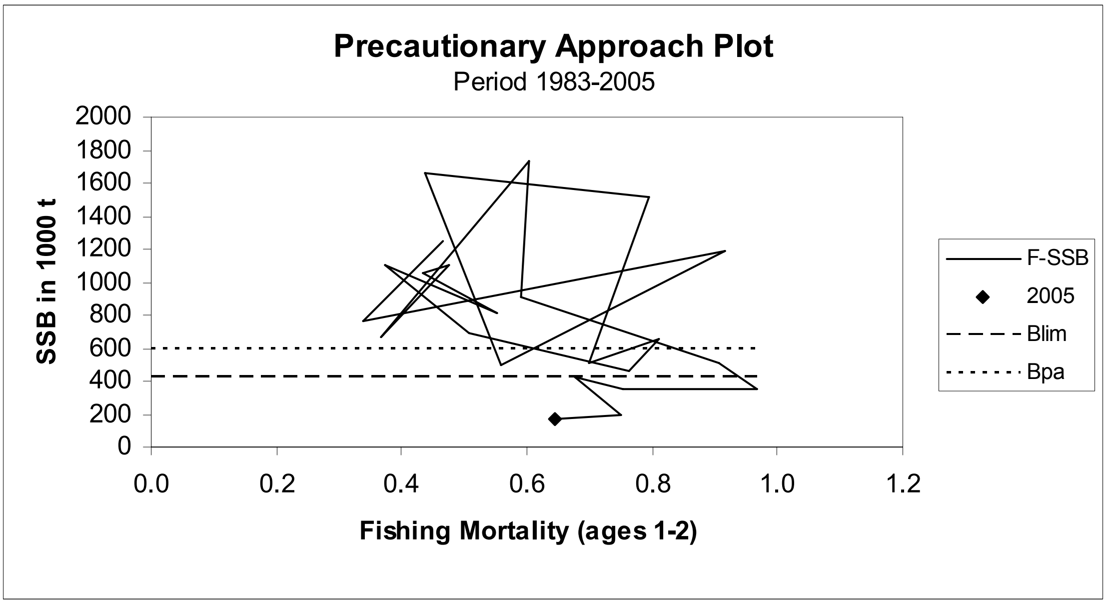


Figure 6.4.24.2 Sandeel in Subarea IV.

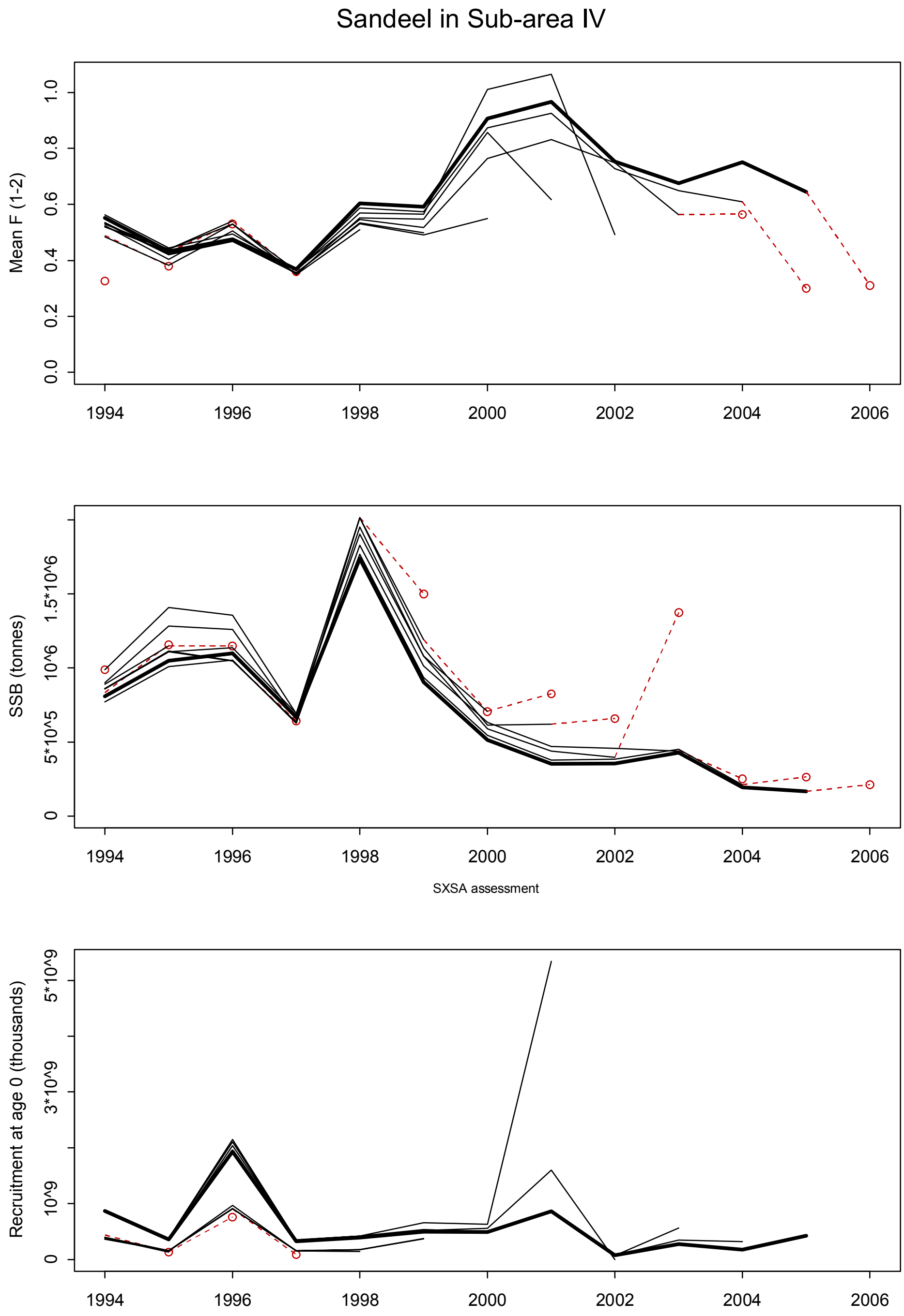


Figure 6.4.24.3 SANDEEL in IV. Comparison of historical performance of assessments. $\text{Fbar}_{1\text{-}2}$ in 2006 based on data for only first half year of 2006.

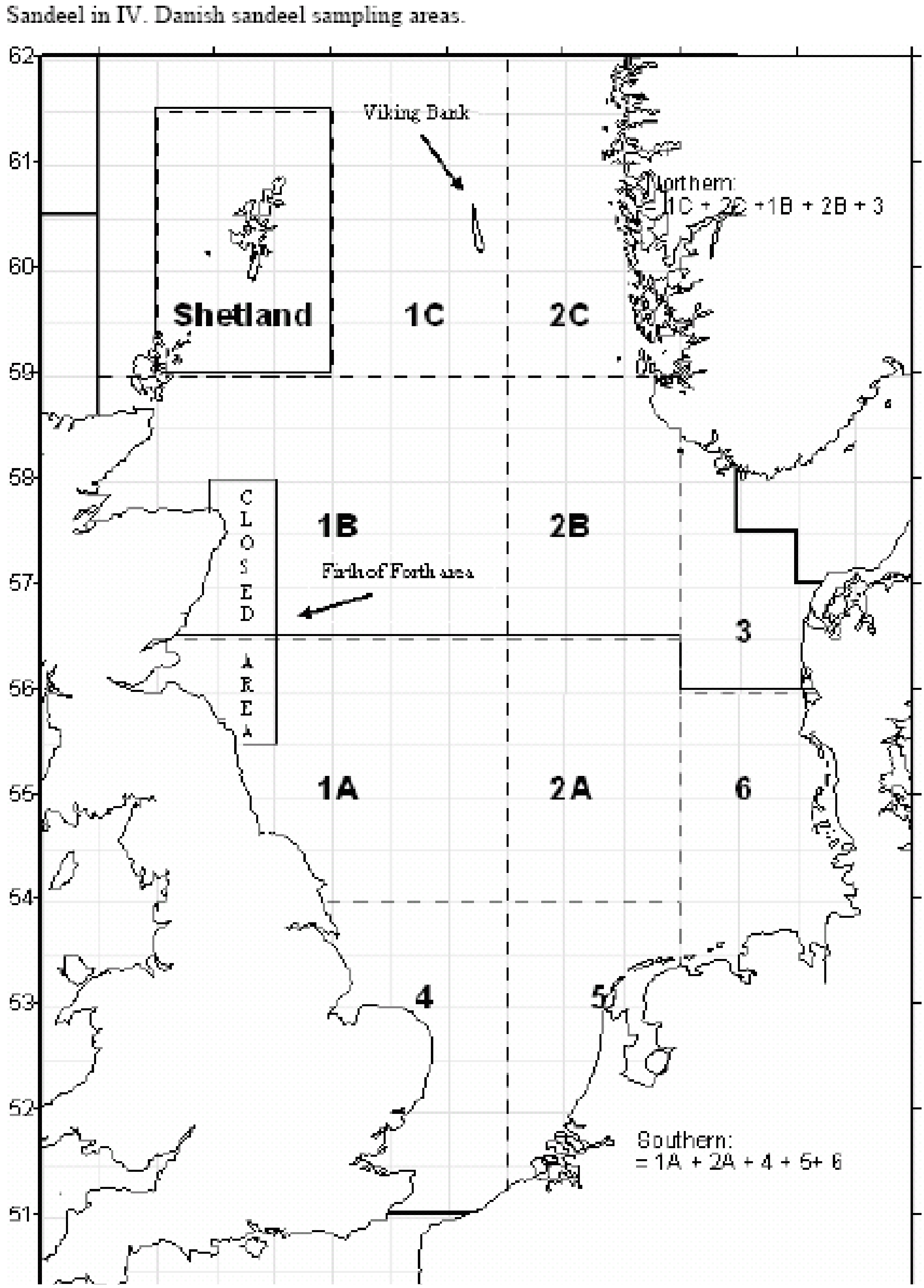


Figure 6.4.24.4 SANDEEL in IV. Danish sampling areas.

Table 6.4.24.1 SANDEEL in IV. Official landings reported to ICES.

SANDEELS IVa

Country	1998	1999	2000	2001	2002	2003	2004	2005
Denmark	23,138	3,388	4,742	1,058	111	399	N/A	N/A
Faroe Islands	11,000	6,582					N/A	N/A
Norway	172,887	44,620	11,522*	4,121*	185*	280*	N/A	N/A
Sweden	55	495	55	-	-	73	N/A	N/A
UK (E/W/NI)	-	-	-	-	-	-	N/A	N/A
UK (Scotland)	5,742	4,195	4,781	970	543	186	N/A	N/A
Total	212,822	59,280	21,100	6,149	839	938		

*Preliminary.

SANDEELS IVb

Country	1998	1999	2000	2001	2002	2003	2004	2005
Denmark	603,491	503,572	533,905	638,657	627,097	245,096	N/A	N/A
Faroe Islands	-	-					N/A	N/A
Germany	-	-	-	-	-	534	N/A	N/A
Ireland	-	389	-	-	-		N/A	N/A
Norway	170,737	142,969	107,493*	183,329*	175,799*	29,336*	N/A	N/A
Sweden	8,465	21,920	27,867	47,080	36,842	21,444	N/A	N/A
UK (E/W/NI)	-	-	-	-	-	-	N/A	N/A
UK (Scotland)	18,008	7,280	5,978	-	2,442	115	N/A	N/A
Total	800,701	676,130	675243	869066	842180	296525		

*Preliminary.

SANDEELS IVc

Country	1998	1999	2000	2001	2002	2003	2004	2005
Denmark	9,674	10,356	11,993	7,177	4,996	28,646	N/A	N/A
France	-	-	1	-	-	-*	N/A	N/A
Netherlands	+	+	-	-	+	-*	N/A	N/A
Sweden	-	-	-	-	-	160	N/A	N/A
UK (E/W/NI)	-	-	+	-	-	+	N/A	N/A
Total	9,674	10,356	11,994	7,177	4,996	28,806		

*Preliminary.

Summary table official landings

	1998	1999	2000	2001	2002	2003	2004	2005
Total IV tonnes	1,023,197	745,766	708,337	882,392	848,015	326,269	372,343	
TAC	1,000,000	1,000,000	1,020,000	1,020,000	1,020,000	918,000	826,200	660,960

By-catch and other landings

	1998	1999	2000	2001	2002	2003	2004	2005
Area IV tonnes: official-WG	18,797	10,628	9,188	20,781	37,315	00,849	N/A	N/A

Summary table - landing data provided by Working Group members

	1998	1999	2000	2001	2002	2003	2004	2005
Total IV - tonnes	1,004,400	735,138	699,149	861,611	810,700	325,420	361,600	172,100

Table 6.4.24.2 SANDEEL in IV.Landings ('000 t), 1952–2005 (Data provided by Working Group members).

Year	Denmark	Germany	Faroes	Ireland	Netherlands	Norway	Sweden	UK	Total
1952	1.6	-	-	-	-	-	-	-	1.6
1953	4.5	+	-	-	-	-	-	-	4.5
1954	10.8	+	-	-	-	-	-	-	10.8
1955	37.6	+	-	-	-	-	-	-	37.6
1956	81.9	5.3	-	-	+	1.5	-	-	88.7
1957	73.3	25.5	-	-	3.7	3.2	-	-	105.7
1958	74.4	20.2	-	-	1.5	4.8	-	-	100.9
1959	77.1	17.4	-	-	5.1	8.0	-	-	107.6
1960	100.8	7.7	-	-	+	12.1	-	-	120.6
1961	73.6	4.5	-	-	+	5.1	-	-	83.2
1962	97.4	1.4	-	-	-	10.5	-	-	109.3
1963	134.4	16.4	-	-	-	11.5	-	-	162.3
1964	104.7	12.9	-	-	-	10.4	-	-	128.0
1965	123.6	2.1	-	-	-	4.9	-	-	130.6
1966	138.5	4.4	-	-	-	0.2	-	-	143.1
1967	187.4	0.3	-	-	-	1.0	-	-	188.7
1968	193.6	+	-	-	-	0.1	-	-	193.7
1969	112.8	+	-	-	-	-	-	0.5	113.3
1970	187.8	+	-	-	-	+	-	3.6	191.4
1971	371.6	0.1	-	-	-	2.1	-	8.3	382.1
1972	329.0	+	-	-	-	18.6	8.8	2.1	358.5
1973	273.0	-	1.4	-	-	17.2	1.1	4.2	296.9
1974	424.1	-	6.4	-	-	78.6	0.2	15.5	524.8
1975	355.6	-	4.9	-	-	54.0	0.1	13.6	428.2
1976	424.7	-	-	-	-	44.2	-	18.7	487.6
1977	664.3	-	11.4	-	-	78.7	5.7	25.5	785.6
1978	647.5	-	12.1	-	-	93.5	1.2	32.5	786.8
1979	449.8	-	13.2	-	-	101.4	-	13.4	577.8
1980	542.2	-	7.2	-	-	144.8	-	34.3	728.5
1981	464.4	-	4.9	-	-	52.6	-	46.7	568.6
1982	506.9	-	4.9	-	-	46.5	0.4	52.2	610.9
1983	485.1	-	2.0	-	-	12.2	0.2	37.0	536.5
1984	596.3	-	11.3	-	-	28.3	-	32.6	668.5
1985	587.6	-	3.9	-	-	13.1	-	17.2	621.8
1986	752.5	-	1.2	-	-	82.1	-	12.0	847.8
1987	605.4	-	18.6	-	-	193.4	-	7.2	824.6
1988	686.4	-	15.5	-	-	185.1	-	5.8	892.8
1989	824.4	-	16.6	-	-	186.8	-	11.5	1039.1
1990	496.0	-	2.2	-	0.3	88.9	-	3.9	591.3
1991	701.4	-	11.2	-	-	128.8	-	1.2	842.6
1992	751.1	-	9.1	-	-	89.3	0.5	4.9	854.9
1993	482.2	-	-	-	-	95.5	-	1.5	579.2
1994	603.5	-	10.3	-	-	165.8	-	5.9	785.5
1995	647.8	-	-	-	-	263.4	-	6.7	917.9
1996	601.6	-	5.0	-	-	160.7	-	9.7	776.9
1997	751.9	-	11.2	-	-	350.1	-	24.6	1137.8
1998	617.8	-	11.0	-	+	343.3	8.5	23.8	1004.4
1999	500.1	-	13.2	0.4	+	187.6	22.4	11.5	735.1
2000	541.0	-	-	-	+	119.0	28.4	10.8	699.1
2001	630.8	-	-	-	-	183.0	46.5	1.3	861.6
2002	629.7	-	-	-	-	176.0	0.1	4.9	810.7
2003	274.0	-	-	-	-	29.6	21.5	0.5	325.6
2004	277.1	2.7	-	-	-	48.5	33.2	+	361.5
2005	154.8	-	-	-	-	17.3	-	-	172.1
2006	229.9	3.2	-	-	-	5.6	27.8	-	266.5

2006 only include first half year.
+ = less than half unit.
- = no information or no catch.

Table 6.4.24.3 SANDEEL in IV. Monthly landings (tonnes) by Denmark, Norway, and Scotland from each area defined in Figure 6.4.24.4. Data provided by Working Group members.

	1A	1B	1C	2A	2B	2C	3	4	5	6	Shetland	Total
2000												
Mar	800	42	0	3257	5618	0	739	0	0	393	687	11536
Apr	30931	19012	0	15259	71384	281	33583	479	0	595	1436	172959
May	110128	6843	0	24941	42647	0	53911	6685	3089	662	1651	250558
Jun	73632	3262	26	18564	16440	0	17287	11240	2503	29205	0	172160
Jul	10610	33	4	25193	3286	11	5996	2024	2692	12201	0	62049
Aug	0	0	0	3	113	0	117	0	1	127	560	921
Sept	0	0	0	21	393	0	18	0	0	145	0	577
Oct	0	0	0	0	0	0	2	0	0	1	0	3
Total	226102	29192	30	87238	139882	292	111652	20428	8285	43329	4334	670763
2001												
Mar	3205	0	0	5235	2078	0	915	218	334	180	144	12309
Apr	60040	10891	0	19956	16609	0	1968	916	0	265	295	110940
May	96489	2014	0	71446	20668	0	15266	4829	510	3767	589	215578
Jun	72384	0	1556	15160	8103	120	8265	4790	4291	22748	0	137417
Jul	6703	90	0	67814	24065	0	8769	1664	2204	13747	0	125056
Aug	473	0	0	51965	61169	0	8679	0	0	2927	236	125449
Sep	578	0	0	24926	31178	0	4802	0	0	4840	0	66324
Oct	0	0	0	6464	14027	0	972	0	0	500	0	21963
Total	239872	13026	1556	262966	177898	120	49635	12417	7339	48974	1264	815067
2002												
Mar	3077	0	0	3911	2715	0	928	322	0	0	0	10953
Apr	104033	1745	0	66992	51007	0	15466	904	59	475	109	240790
May	176437	3341	0	78497	37385	0	37058	915	151	3272	12	337068
Jun	118879	125	0	27386	19380	10	10561	8673	2531	12498	0	200043
Jul	1128	0	0	90	48	0	193	2744	204	9869	0	14276
Aug	0	0	0	109	261	0	397	0	0	5146	422	6335
Sept	0	0	0	0	74	0	290	0	0	0	0	364
Oct	0	0	0	1	0	0	0	0	0	2	0	3
Dec	0	0	0	0	0	0	0	0	2	0	0	2
Total	403554	5211	0	176986	110870	10	64893	13558	2947	31262	543	809834
2003												
Mar	1947	52	0	97	380	7	225	325	0	0		3033
Apr	28806	5026	0	8341	6072	0	1900	81	0	662	49	50937
May	59890	1812	24	8884	9357	0	4532	10995	1020	9991	16	106521
Jun	11737	49	0	11906	398	10	2140	20891	13318	21639		82088
Jul	3604	0	0	9857	2013	0	3272	2738	1697	5790		28971
Aug	960	6	0	4381	4687	0	11293	16	175	687	121	22326
Sept	0	255	73	35	1551	0	2955	0	0	1094		5963
Oct	0	0	0	114	0	0	1589	0	0	127		1830
Nov	0	0	0	0	0	0	2070	0	0	0		2070
Dec	0	0	0	0	0	0	45	0	0	0		45
Total	106944	7200	97	43615	24458	17	30021	35046	16210	39990	186	303784
2004												
Feb	0	0	0	0	0	0	0	0	0	7		7
Mar	326	0	0	1001		0	37		260	2		1626
Apr	15893	627	0	15824	4847	0	10732	471	322	834		49550
May	46631	1044	0	21607	5495	0	22629	20484	233	8578		126701
Jun	21841	146	0	5077	1800	0	13821	13680	4789	35909		97063
Jul	1146	116		813	2272		6019	7430	1184	12923		31903
Aug	325			3963	5449		2589			3357		15683
Sept					3006		116			2		3124
Oct												
Total	86162	1933	0	48285	22869	0	55943	42065	6788	61612	0	325657
2005												
Apr	4017			71	1476		462	144		57		6227
May	34506	57		9536	7512		6507	13333	30	1549		73030
Jun	19216	21		8952	2545		8107	8224	17956	14111		79132
Jul				1668			987	922	1416	8726		13719
Aug				3			2			13		18
Sep												0
Okt										1		1
Total	57739	78	0	20230	11533	0	16065	22623	17986	24456	0	172127
%	34%	0%	0%	12%	7%	0%	9%	13%	10%	14%	0%	99%
Average 2000-2005												
	36%	2%	0%	21%	16%	0%	11%	5%	2%	8%	0%	100%
2006												
Apr	10141			8733	1387		188	111		82		20642
May	81547			25020	3096		3830	201		6455		120149
Jun	59827	34		3184	47		4815	12035	5236	9506		94684
Total	151515	34	0	36937	4530	0	8833	12347	5236	16043	0	235475
%	64%	0%	0%	16%	2%	0%	4%	5%	2%	7%	0%	100%

Table 6.4.24.4 Sandeel in Subarea IV.

Year	Recruitment Age 0 thousands	SSB tonnes	Landings tonnes	Mean F Ages 1-2
1983	880899000	1245668	530640	0.466
1984	227376000	766256	750040	0.337
1985	1206994000	1182263	707105	0.916
1986	624245000	502097	685950	0.559
1987	199804000	1658417	791050	0.436
1988	719031000	1511668	1007304	0.794
1989	325696000	505717	826835	0.698
1990	636688000	657273	584912	0.810
1991	806364000	464186	898959	0.764
1992	319293000	685424	820140	0.506
1993	623087000	1097235	576932	0.372
1994	872670000	807352	770747	0.552
1995	358947000	1048836	915043	0.433
1996	1937319000	1097364	776126	0.476
1997	328718000	668294	1114044	0.368
1998	390379000	1738525	1000375	0.603
1999	496476000	905471	718668	0.592
2000	495117000	514386	692498	0.907
2001	860696000	352302	858619	0.967
2002	77439000	355872	806921	0.753
2003	277503000	427871	309725	0.676
2004	176857000	193536	359361	0.751
2005	425496000	166304	171790	0.646
2006	na	210756		
Average	566232875	781795	724947	0.625

6.4.25 Sandeel in the Shetland area

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
Unknown	Unknown	Unknown	

The available information is inadequate to evaluate spawning stock or fishing mortality relative to risk, so the state of the stock is unknown.

It is believed that fishing mortality is well below natural mortality. This means that natural processes largely drive stock variations. Landings in 2004 were 186 t, substantially lower than landings in preceding years, and below the TAC of 7000 t.

An assessment made in 2001 based on survey data alone suggests that the SSB in 2000 is close to its lowest observed value and that recent recruitment has been weak.

Management objectives

There is a national management plan in force taking both fisheries and wildlife conservation in consideration.

Reference points

No reference points have been defined for this stock.

Single-stock exploitation boundaries

ICES considers that no advice can be given for the stock.

Short-term implications

No short-term forecast is given for this stock.

Management considerations

The Shetland sandeel fishery re-opened in 1995 subject to a multi-annual management regime. This was revised for the 1998 fishing season onwards. The new regime consists of an annual TAC of 7000 t and a closure during the months of June and July. The seasonal closure is to avoid any possibility of direct competition between the fishery and seabirds during the chick-rearing season. There is also a limit on vessel size to boats of 20 m or less. These arrangements were renewed in 2001 for another three years.

The landings in 2004 are only a small fraction of the agreed TAC.

Management plan evaluations

ICES suggested in October 2001 that the management plan be evaluated before the agreed end date. The evaluation has been carried out and all interest groups have agreed to the continuation of the current measures.

Ecosystem considerations

Fishing grounds are close inshore and often adjacent to large colonies of seabirds for which the sandeel population is an important food supply, especially during the breeding season. For some seabird species the availability of 0-group sandeel as prey is very important.

In some years, most of the recruitment comes from spawning areas away from Shetland. The availability of 0-group sandeel is, therefore, not closely linked to the local spawning population. The sandeel population is also an important food source for other predator species in the Shetland area.

Factors affecting the fisheries and the stock

Other factors

The sandeel population at Shetland is not a separate stock, but forms part of a larger complex of sub-populations. Estimates of the consumption of sandeel by seabirds and other predators greatly exceed the quantities taken by the fishery in recent years.

Source of information

Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, 5–14 September 2006 (ICES CM 2006/ACFM:35).

Year	ICES Advice	Predicted Catch corresp. to advice	Agreed TAC	ACFM Catch
1987	No advice	-		7.2
1988	No advice	-		4.7
1989	No advice	-		3.5
1990	No advice	-		2.3
1991	Low fishing	-		+
1992	No fishing prudent	-		-
1993	No fishing prudent	-		-
1994	TAC	3		-
1995	TAC	3	3	1.2
1996	No advice	-	3	1.0
1997	No advice	-	3	2.1
1998	No advice	-	7	5.2
1999	No advice	-	7	4.2
2000	No catch advice	-	7	4.9
2001	No advice	-	7	1.3
2002	No advice	-	7	0.5
2003	No advice	-	7	0.2
2004	No advice	-	7	0.2
2005	No advice	-	-	
2006	No advice	-		
2007	No advice	-		

Weights in '000 t.

6.4.26 *Pandalus* on Fladen Ground (Division IVa)

State of the stock

The shrimp stock on Fladen Ground has not been assessed since 1992, due to insufficient data. Landings have declined gradually from 1999 to 2003, but in 2004 and 2005 nearly no catches were recorded.

Management objectives

There are no explicit management objectives for this stock.

Reference points

No reference points have been defined.

Short-term considerations

In the absence of information on stock development, ICES recommends that effort should not be allowed to expand to levels above the average for the years prior to the present absence of fishing activities and that the fishery must be accompanied by mandatory programmes to collect catch and effort data on both target and bycatch fish

Management considerations

The development in the landings could indicate a low stock level. For the Fladen Ground stock such events have occurred previously, notably in 1987–1988. However, a recovery of the stock after that decline was observed already in 1989–1990 without any management actions.

The decline in landings could also be caused by the low price for shrimp combined with the high fuel costs.

Catches from Fladen Ground consist mainly of two age groups. During the first two quarters of the year age groups 2 and 3 normally dominate the catches. In the fourth quarter, age group 3 usually disappears from the catches, while age group 1 enters the catches.

Scientific basis

Only landings data are available for this stock.

ICES maintains the view that shrimp caught on the Fladen Ground constitute a stock separate from the *Pandalus* in the Norwegian Deeps and Skagerrak. This assumption is under review and there are indications that the Fladen Ground shrimp and the shrimp in the Norwegian Deep are correlated.

Source of information

Report of the NAFO/ICES *Pandalus* Assessment Group, Copenhagen, 25 October–2 November 2006 (ICES CM 2007/ACFM:37).

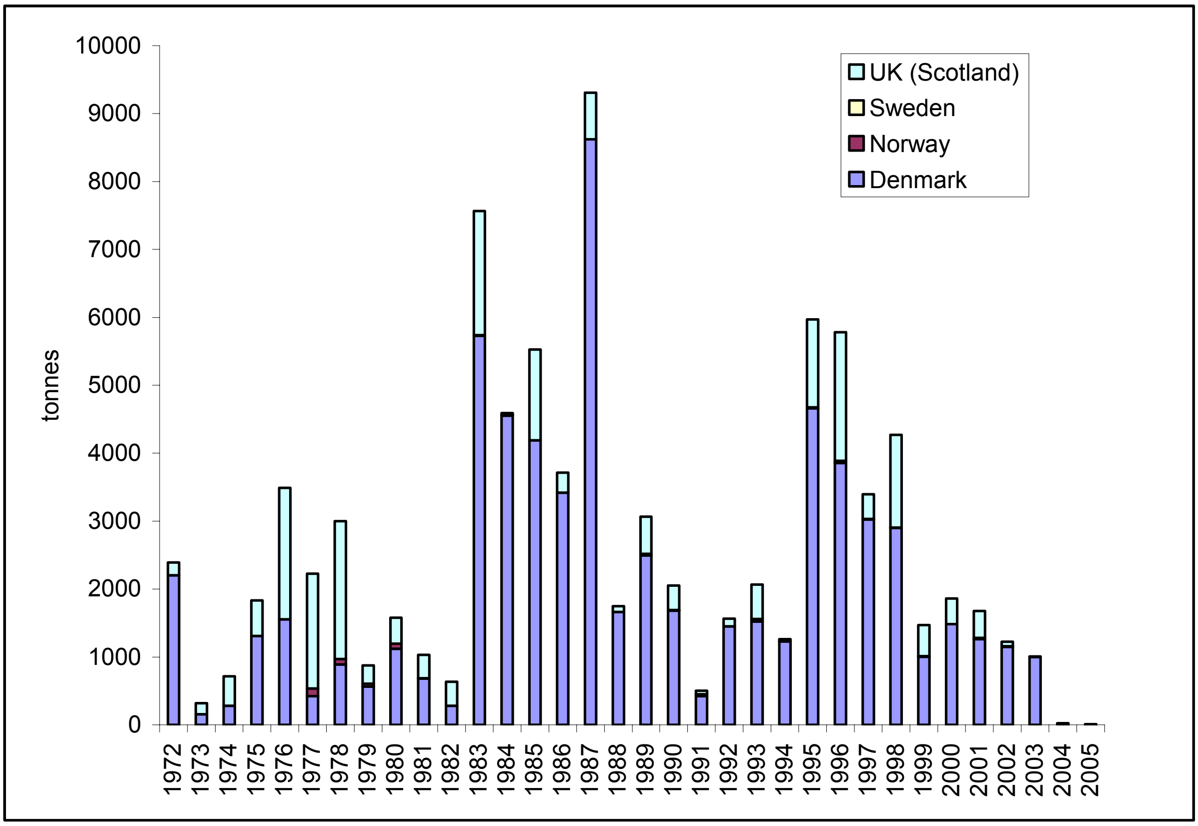


Figure 6.4.26.1 *Pandalus* on Fladen Ground (Division IVa). Total landings as estimated by ICES.

Table 6.4.26.1 *Pandalus* on Fladen Ground (Division IVa). Total landings as estimated by ICES.

Year	Denmark	Norway	Sweden	UK (Scotland)	Total
1972	2204			187	2391
1973	157			163	320
1974	282			434	716
1975	1308			525	1833
1976	1552			1937	3489
1977	425	112		1692	2229
1978	890	81		2027	2998
1979	565	44		268	877
1980	1122	76		377	1575
1981	685	1		347	1033
1982	283			352	635
1983	5729	8		1827	7564
1984	4553	13		25	4591
1985	4188			1341	5529
1986	3416			301	3717
1987	8620			686	9306
1988	1662	2		84	1748
1989	2495	25		547	3067
1990	1681	3	4	365	2053
1991	422	31		53	506
1992	1448			116	1564
1993	1521	38		509	2068
1994	1229	0		35	1264
1995	4659	15		1298	5972
1996	3858	32		1893	5783
1997	3022	9		365	3396
1998	2900	3		1365	4268
1999	1005	9		456	1470
2000	1482			378	1860
2001	1263	18		397	1678
2002	1147	9		70	1226
2003	999	8	1		1008
2004	23	0	0	0	23
2005	10	0	0	0	10

6.4.27 Shrimp (*Pandalus borealis*) in Division IIIa and Division IVa East (Skagerrak and Norwegian Deeps)

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 stock was at an all time high in 2004, but has since then shown a decreasing trend.

The assessment consists of trends in LPUE and survey indices. The stock indicators show an increase since 1988 to an all time high in 2004 and subsequently declining, but remaining at an average level.

Management objectives

There are no explicit management objectives for this stock.

Reference points

No precautionary reference points have been established for this stock.

Single-stock exploitation boundaries

Exploitation boundaries in relation to precautionary considerations

Because the stock appears to be at a relatively high level and recent catches have apparently been sustainable, ICES recommends that the total landings from IIIa and IVa East in the 2006 are not increased above the recent average landings (2003–2005) of 14 000 t.

Management considerations

Data on bycatch recorded in logbooks are compiled by the working group, but these data include only the landed component. It is known that deep-sea species such as Argentines, roundnose grenadier, rabbitfish, and sharks are frequently caught in shrimp trawls in the deeper parts of Skagerrak and the Norwegian Deep. Sorting grids or other means of facilitating the escape of fish should be implemented in this fishery.

Factors affecting the fisheries and the stock

Regulations and their effects

The main regulation tool is a TAC, which is not fully fished by all countries.

Changes in fishing technology and fishing patterns

The Danish and the Norwegian fleets have undergone major restructuring in recent years. Within the last 5 to 10 years almost all Danish trawlers have started to fish with twin trawls. This change allows the individual vessels to increase the swept area (wing end to wing end) by approximately 50% without increasing demands to the vessel's engine capacity or noticeably increasing fuel consumption. Quantitative information on the gear changes in the Danish fleet are not available from the logbooks but have been approximated, based on information from fishers. No quantitative information was available for the Norwegian fleet.

The environment

Strong fluctuations in the *Pandalus* stocks are frequently observed. Predator pressure, as well as the fact that the stock consists of only few age groups contributes significantly to such fluctuations. The natural mortality for *Pandalus* is likely to be substantially higher than the fishing mortality and is dependent on the abundance of predators.

Scientific basis

Data and methods

The assessment consists of trends in two LPUE series and survey information. The LPUE series are a Norwegian LPUE (2000–2006) that is standardized by area, month and vessel and a Danish LPUE (1984–2005) that is standardized for technological development. The Norwegian shrimp survey has had large changes in recent years, both in terms of the timing of the survey, the gear used, and the vessel used. These changes mean that the series cannot be interpreted on a common scale and should be treated as four different surveys for the following sets of years: (1) 1984–2002, (2) 2003, (3) 2004–2005, and (4) 2006 (Figure 6.4.27.3).

Comparison with previous assessment and advice

Last year's assessment was based on a Bayesian stock production model. This model could not be applied for the current year because of a lack of manpower. The assessment this year is therefore based on trends in LPUE and survey information. The overall perception of the stock development is similar to last year. The advice is similar to last year.

Source of information

Report of the NAFO/ICES *Pandalus* Assessment Group, Copenhagen, 25 October–2 November 2006 (ICES CM 2007/ACFM:37).

Year	ICES Advice	Single-Stock Exploitation Boundaries	Predicted lndgs corresp. to advice[1]	Predicted lndgs corresp. to Single-Stock Exploitation Boundaries [1]	Agreed TAC IIIa	Agreed TAC IIIa + IV	ACFM catches Discards.	ACFM catches Landings	ACFM catches Total
1987	Not assessed						0.7	14.2	14.9
1988	Catches significantly below 1985–1986[3]						0.8	12.2	12.9
1989	No advice				3.1[1]		1.1	11.0	12.1
1990	F as F(pre-85)[3]; TAC[3]; No increase in F[4]; TAC[4]		10.0		2.75[1]		1.2	10.2	11.4
1991	No increase in F; TAC		12.0		8.55		0.5	11.6	12.1
1992	Within safe biological limits		15[2]		10.50	15.0	0.5	13.0	13.6
1993	Within safe biological limits		13[2]		10.50	15.0	0.9	12.6	13.5
1994	Within safe biological limits		19[2]		12.60	18.0	0.2	11.5	11.7
1995	Within safe biological limits		13[2]		11.20	16.0	0.3	14.2	14.5
1996	No advice		11[2]		10.50	15.0	0.3	14.2	14.5
1997	No advice		13[2]		10.50	15.0	1.0	15.1	16.1
1998	No increase in F; TAC		19[2]		13.16	18.8	0.4	15.4	15.8
1999	Maintain F		19[2]		13.16	18.8	0.6	11.2	11.9
2000	Maintain F		<11.5[2]		9.10	13.0	0.7	10.8	11.5
2001	Maintain F		13.4		10.15	14.5	0.7	11.0	11.7
2002	Long-term average landings		12.6		10.15	14.5	0.9	12.1	12.3
2003	Maintain F		14.7		10.15	14.5	0.9	13.3	14.6
2004	No increase in F [5]			15.3[5]	10.71	15.69	1.8	15.4	17.2
2005	No increase in catch above recent level			~13[5]	10.71	15.60	1.5	13.7	15.2
2006	No increase in catch above recent level			~13.5[5]	11.2	16.2			
2007	No increase in landings above recent level			~ 14.0					

Weights in '000 t.
[1]EU zone only.
[2] Catch at *status quo* F.
[3] IIIa.
[4]Norwegian Deep.
[5] Single-stock boundaries and the exploitation of this stock should be conducted in the context of mixed fisheries protecting stocks outside safe biological limits.

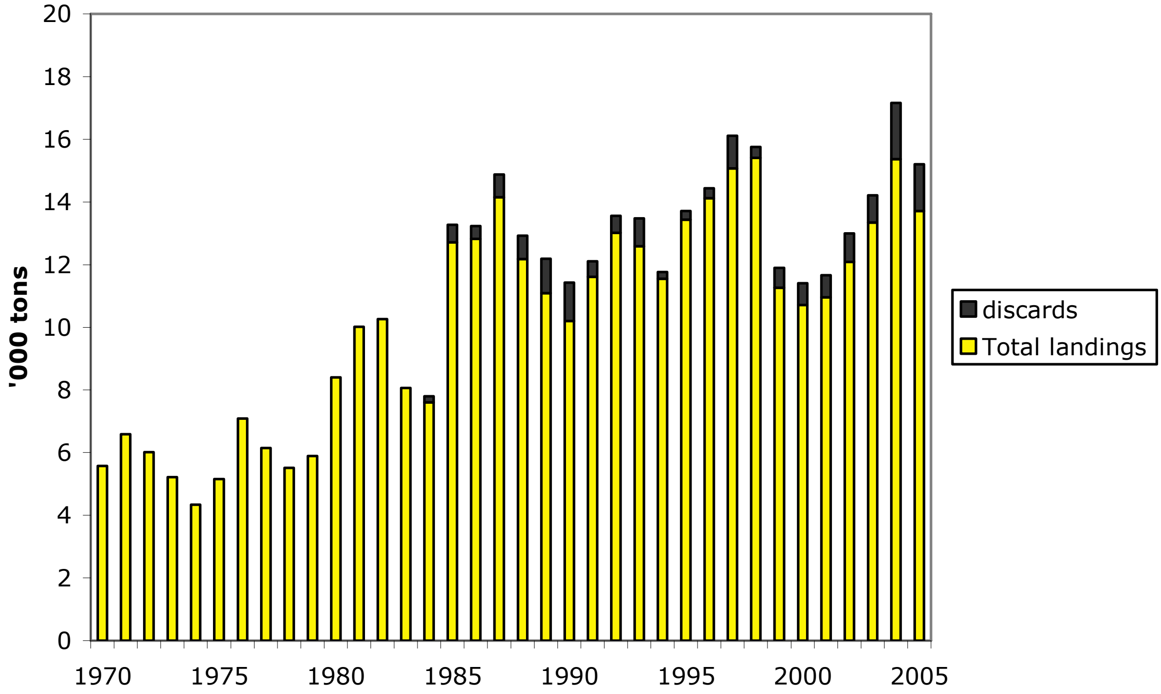


Figure 6.4.27.1 *Pandalus* in IIIa and IVa. Landings and discards as estimated by ICES.

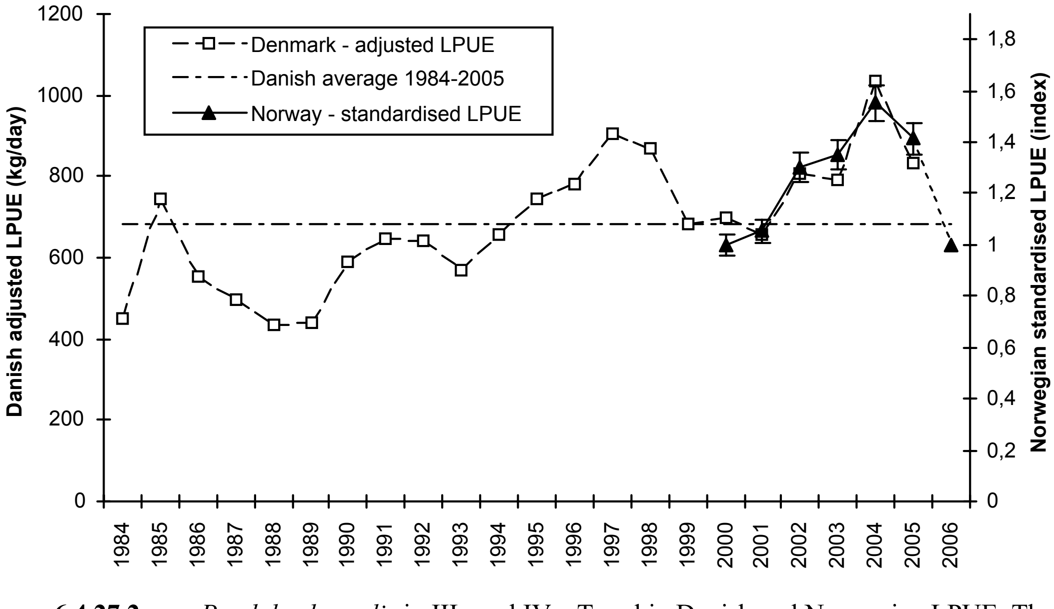


Figure 6.4.27.2 *Pandalus borealis* in IIIa and IVa. Trend in Danish and Norwegian LPUE. The 2006 value for the Norwegian LPUE is based on the first quarter only.

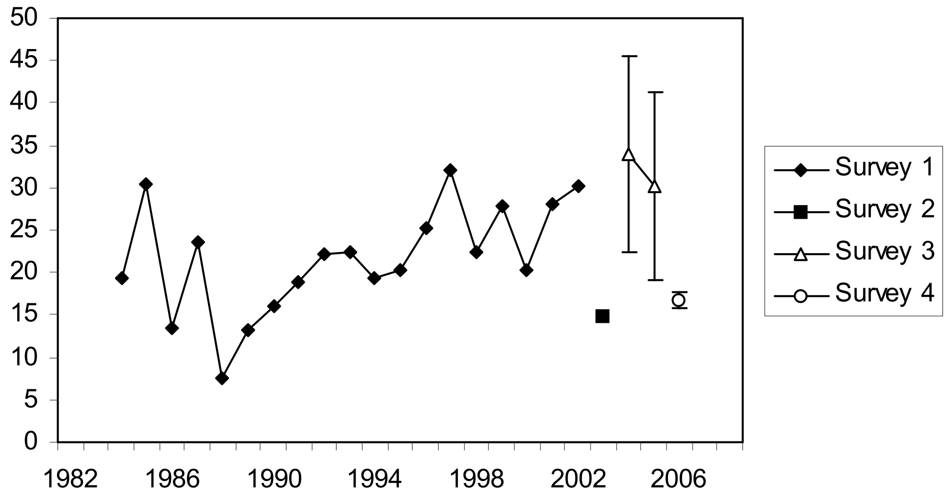


Figure 6.4.27.3 *Pandalus borealis* in IIIa and IVa. Trends in Norwegian shrimp survey biomass. The four surveys are not calibrated to a common scale. Survey 1: October–November 1984–2002 with Campelen trawl; Survey 2: October–November 2003 with shrimp trawl 1420; Survey 3: May–June 2004–2005 with Campelen trawl; Survey 4: February 2006 with Campelen trawl.

Table 6.4.27.1 *Pandalus borealis* landings from Divisions IIIa (Skagerrak) and IVa (eastern part) as estimated by ICES.

Year	Denmark	Norway	Sweden	Total landings	Estimated discards	Agreed TAC	Catch
1970	1102	1729	2742	5573			
1971	1190	2486	2906	6582			
1972	1017	2477	2524	6018			
1973	755	2333	2130	5218			
1974	530	1809	2003	4342			
1975	817	2339	2003	5159			
1976	1204	3348	2529	7081			
1977	1120	3004	2019	6143			
1978	1459	2440	1609	5508			
1979	1062	3040	1787	5889			
1980	1678	4562	2159	8399			
1981	2593	5183	2241	10017			
1982	3766	5042	1450	10258			
1983	1567	5361	1136	8064			
1984	1800	4783	1022	7605	200		7805
1985	4498	6646	1571	12715	558		13273
1986	4866	6490	1463	12819	414		13233
1987	4488	8343	1322	14153	723		14876
1988	3240	7661	1278	12179	750		12929
1989	3242	6411	1433	11086	1107		12193
1990	2479	6108	1608	10195	1226		11421
1991	3583	6119	1908	11610	497		12107
1992	3725	7136	2154	13015	541	15000	13556
1993	2915	7371	2300	12586	889	15000	13475
1994	2134	6813	2601	11548	214	18000	11761
1995	2460	8095	2882	13437	275	16000	13713
1996	3868	7878	2371	14117	318	15000	14436
1997	3909	8565	2597	15071	1039	15000	16110
1998	3330	9606	2469	15406	348	18800	15753
1999	2072	6739	2445	11256	639	18800	11895
2000	2371	6118	2225	10714	687	13000	11401
2001	1953	6895	2108	10956	701	14500	11657
2002	2466	7318	2301	12085	908	14500	12993
2003	3244	7715	2389	13348	868	14500	14216
2004	3905	8998	2464	15367	1797	15690	17164
2005	2952	8507	2257	13716	1483	15600	15199

*) Swedish landings have been corrected for loss in weight due to boiling.

6.4.28 Northern Shrimp (*Pandalus borealis*) in the Barents Sea, ICES Divisions 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
Acceptable	Acceptable	Below $\mathbf{F}_{msy}$	NA	This year's assessment was based on a new quantitative assessment framework.

The stock estimates have varied above the $\mathbf{B}_{MSY}$ level throughout the history of the fishery. Biomass at the end of 2006 is estimated to be well above $\mathbf{B}_{msy}$ and fishing mortality well below $\mathbf{F}_{msy}$.

Management objectives

There are no explicit management objectives for this stock.

Reference points

For stocks assessed with production models, the NAFO Scientific Council has developed limit reference points for stock size ($\mathbf{B}_{lim}$ at 30% of $\mathbf{B}_{msy}$) and for fishing mortality ($\mathbf{F}_{lim} = \mathbf{F}_{msy}$) (SCS Doc. 04/12). ICES proposes that these limit reference points should also apply to the Barents Sea shrimp stocks.

Single-stock exploitation boundaries

Exploitation boundaries in relation to precautionary limits

ICES recommends that a TAC management system should be implemented. The TAC for 2007 should not be set higher than 50 000 t in order to have a high probability of F being below $\mathbf{F}_{lim}$ and B being above $\mathbf{B}_{lim}$.

Short-term implications

Outlook for 2007

Because the stock is estimated to be considerably above $\mathbf{B}_{msy}$, risk of stock biomass falling below $\mathbf{B}_{msy}$ within one year is low. In order to keep the risk of F exceeding $\mathbf{F}_{lim}$ to below 5%, a total catch of 50 000 t could be taken. Risk associated with six optional catch levels for 2007 are presented below:

Catch option (ktons)	30	50	70	90	110	130
Risk of falling below B_{lim}	<1%	<1%	<1%	<1%	<1%	1 %
Risk of falling below B_{MSY}	4 %	4 %	5 %	5 %	5 %	6 %
Risk of exceeding F_{MSY}	2 %	4 %	8 %	12 %	17 %	21 %

Management considerations

There is no overall management system for Barents Sea Pandalus fishery. Fishing licences are required for all shrimp vessels. In the Svalbard Fishery Protection Zone (SFPZ), effort regulations based on historical rights are implemented. However, this has not limited the fishing effort of Russian and Norwegian fleets because the high effort ceiling has not been reached. The effort regulations are restrictive for third countries fishing in the SFPZ. In the Russian zone a TAC is applicable.

Predation of shrimp by cod has been estimated to be on average five times the catches. If predation on shrimp were to increase rapidly outside the previously observed range, the shrimp stock might decrease in size more than the model results have indicated.

Management plan evaluations

The risk profile associated with ten-year projections of stock development assuming annual catches of 50, 70, and 90 kt indicates that for all options the risk of the stock falling below $\mathbf{B}_{msy}$ in the short to medium term (1–5 years) is below 11% (Figure 6.4.28.4). The stock has a less than 1% risk of being below $\mathbf{B}_{lim}$ and none of these catch options are likely to increase that risk above 5% over a 10-year period. Catch levels of 70 and 90 kt imply probabilities of exceeding $\mathbf{F}_{lim}$ that are above 5%.

Factors affecting the fisheries and the stock

Regulations

The fishery is regulated by effort control. Licences are required for the Russian and Norwegian vessels, and third-country fleets operating in the Svaldbard zone are regulated by the number of effective fishing days and the number of vessels by country. The minimum stretched mesh size is 35 mm. Other species are protected by mandatory sorting grids and by the temporary closing of areas with excessive bycatch of juvenile cod, haddock, Greenland halibut, redfish, and shrimp <15 mm carapace length (CL).

Changes in fishing technology and fishing patterns

A major restructuring of the fleet towards fewer and larger vessels has taken place since the mid-1990s. In 1995 6% of the catches reported in logbooks were taken by large factory trawlers (>2000 HP); this fleet component accounted for more than 95% in 2006.

The environment

Shrimp consumption by cod is estimated to be on average five times that of the catches. Nevertheless, the effect of predation is only weakly correlated with the dynamics of the shrimp stock. The scaling and variation originating from the underlying spatial structure of the shrimp stock and the consumption by cod could be an explanation for the lack of correlation.

Scientific basis

Method and data

The available data consists of landings by country, a Norwegian standardized commercial CPUE series, and two surveys: (1) a Norwegian shrimp survey (1982–2004) and (2) a joint Norwegian-Russian ecosystem survey (2004–2006). The new ecosystem survey has not been calibrated with the old shrimp survey and has been treated as a separate survey. A Russian shrimp survey which was discontinued in 2003 (except for a one-off survey in 2005) was not used in the assessment.

A Bayesian version of a surplus-production model was used to assess the stock. Absolute biomass estimates had relatively high variances. To reduce the uncertainty in the estimates, biomass was expressed on a scale relative to $\mathbf{B}_{msy}$ and F relative to $\mathbf{F}_{msy}$.

Comparison with previous assessment and advice

Last year the advice was based on trends in LPUE and surveys. This year a Bayesian stock-production model was used to estimate stock trends. The overall perception of stock dynamics is similar to last year.

The advice last year was to keep catches at the recent average (40 000 t). This year the advice is based on a long-term simulation approach which indicates that a catch of 50 000 t gives a low risk of exceeding $\mathbf{F}_{lim}$ or going below $\mathbf{B}_{lim}$.

Source of information

Report of the NAFO/ICES *Pandalus* Assessment Group, Copenhagen, 25 October–2 November 2006 (ICES CM 2007/ACFM:37).

Year	ICES Advice	Single-stock exploitation boundaries	Predicted lndgs corresp. to advice	Predicted lndgs corresp. To single-stock exploitation boundaries	Agreed TAC	ACFM Landings
2005	No increase compared to 2004			43.6	-	40.8
2006	No increase in catch above recent level			40	-	39
2007	Catch that will prevent exceeding $\mathbf{F}_{lim}$ in the long term			50		

Weights in thousand tonnes.

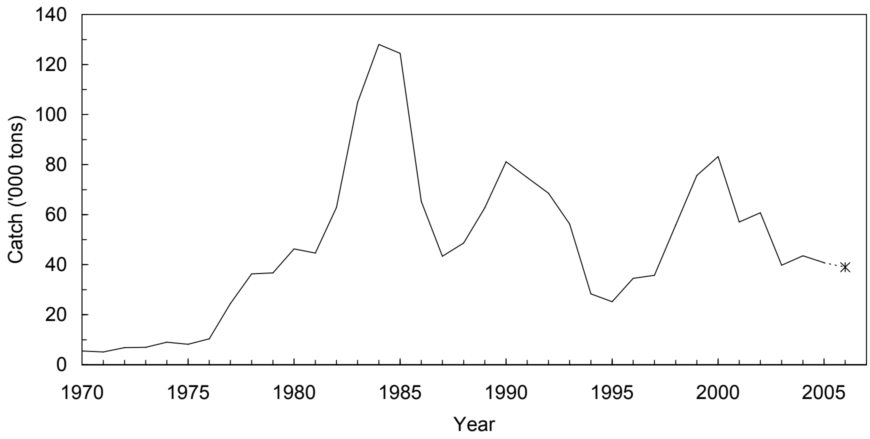


Figure 6.4.28.1 *Pandalus borealis* in the Barents Sea, ICES Div. I and II. Landings estimated by ICES (2006 projected to the end of the year).

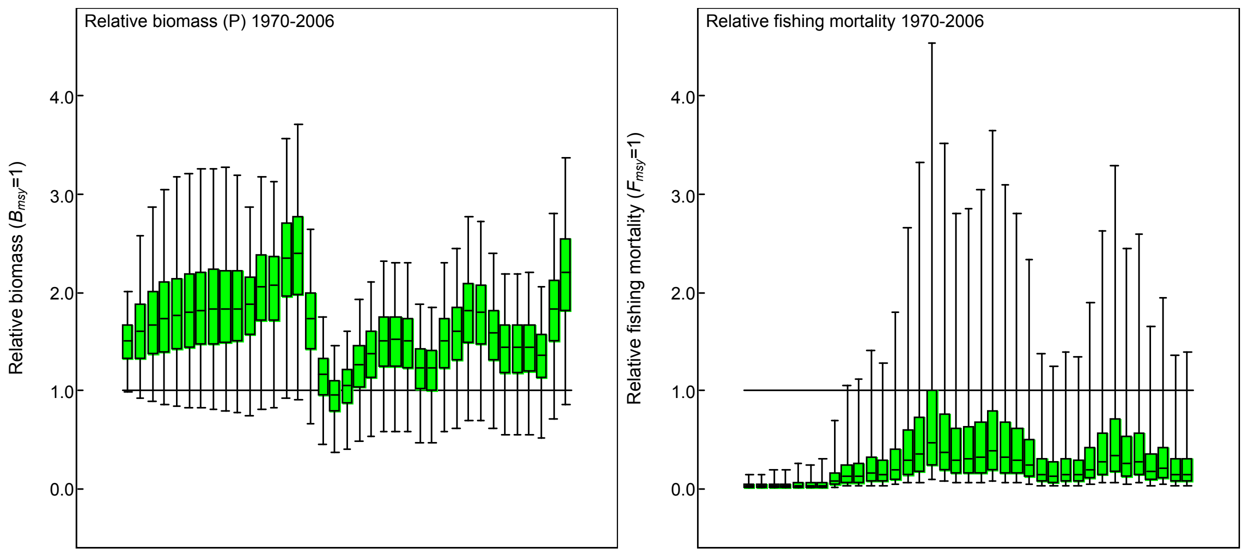


Figure 6.4.28.2 *Pandalus borealis* in the Barents Sea, ICES Div. I and II. Estimated relative biomass (**B**$_t$/**B**$_{msy}$) and fishing mortality (**F**$_t$/**F**$_{msy}$) 1970–2006. Boxes represent inter-quartile ranges and the solid black line at the (approximate) centre of each box is the median; the arms of each box extend to cover the central 95 per cent of the distribution.

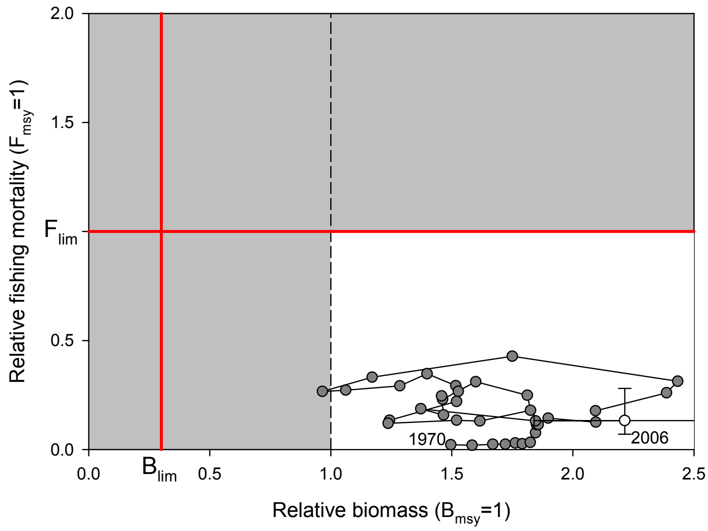


Figure 6.4.28.3 *Pandalus borealis* in the Barents Sea, ICES Div. I and II. Estimated annual median biomass-ratio (B/$\mathbf{B}_{MSY}$) and fishing mortality-ratio (F/$\mathbf{F}_{MSY}$) 1970–2006. $\mathbf{B}_{lim}$, and $\mathbf{F}_{lim}$, are indicated by red lines. Error bars on the 2006 value mark the inter-quartile range.

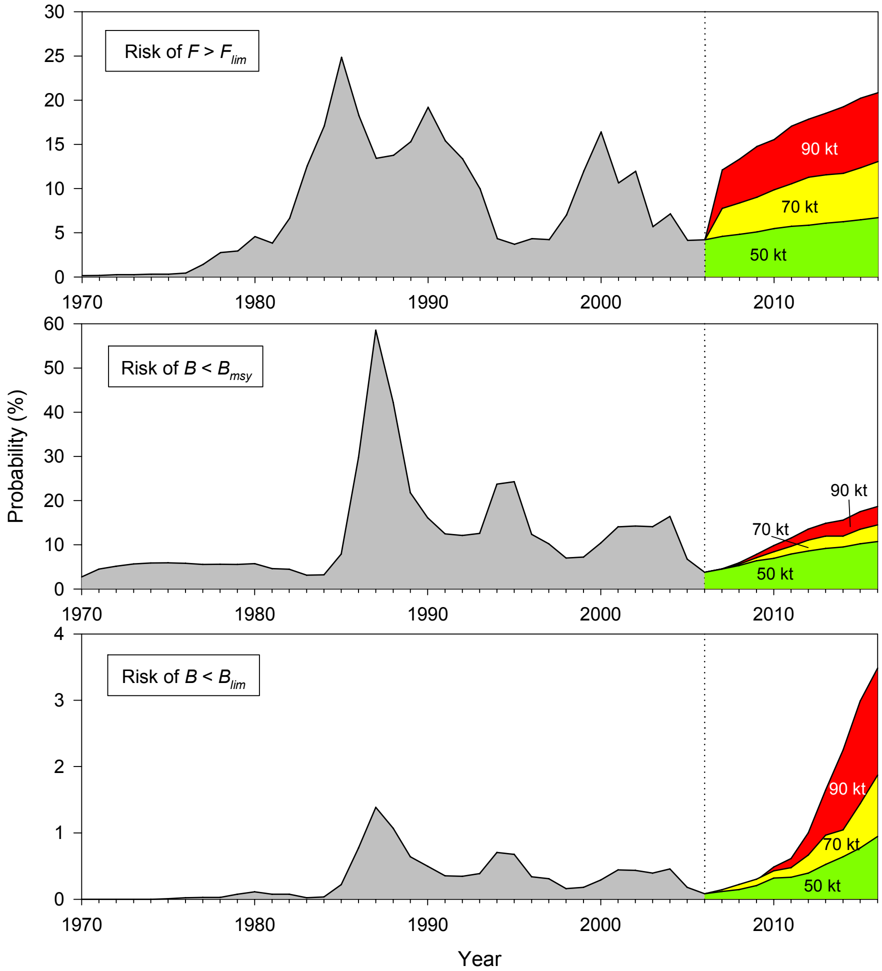


Figure 6.4.28.4 *Pandalus borealis* in the Barents Sea, ICES Div. I and II. Shrimp in the Barents Sea: Estimated risk of exceeding $\mathbf{F}_{\mathrm{lim}}$ (upper panel) or going below $\mathbf{B}_{\mathrm{msy}}$ (middle panel) and $\mathbf{B}_{\mathrm{lim}}$ (lower panel) for the period 1970–2006 (greyed area) and future (coloured area) until 2016. Projections are shown for 3 optional catches 50 (green), 70 (yellow), and 90 kt/yr (red). The dotted line is at 2006.

Table 6.4.28.1 *Pandalus borealis* in the Barents Sea, ICES Div. I and II. Model input data series: Catch by the fishery; three indices of shrimp stock biomass – a standardized catch rate index based on fishery data (CPUE), a research survey index (the "shrimp survey", discontinued in 2004), and the current "Ecosystem survey" started in 2004.

Year	Catch (ktons)	CPUE (index)	Survey 1 (ktons)	Survey 2 (ktons)
1970	5.5	-	-	-
1971	5.1	-	-	-
1972	6.8	-	-	-
1973	6.9	-	-	-
1974	9.0	-	-	-
1975	8.2	-	-	-
1976	10.3	-	-	-
1977	24.4	-	-	-
1978	36.3	-	-	-
1979	36.7	-	-	-
1980	46.3	0.767	-	-
1981	44.6	0.890	-	-
1982	62.8	0.845	327	-
1983	104.8	0.963	429	-
1984	128.1	1.006	471	-
1985	124.5	0.799	246	-
1986	65.3	0.482	166	-
1987	43.4	0.365	146	-
1988	48.7	0.400	181	-
1989	62.7	0.522	216	-
1990	81.2	0.522	262	-
1991	74.9	0.551	321	-
1992	68.6	0.634	239	-
1993	56.3	0.678	233	-
1994	28.3	0.536	161	-
1995	25.2	0.472	193	-
1996	34.5	0.606	276	-
1997	35.7	0.594	300	-
1998	55.8	0.716	341	-
1999	75.7	0.731	316	-
2000	83.2	0.656	247	-
2001	57.0	0.659	184	-
2002	60.7	0.650	196	-
2003	39.3	0.645	212	-
2004	43.4	0.577	151	129
2005	41.3	0.841	-	145
2006	0.0	1.000	-	188

6.4.29 Demersal elasmobranchs in the North Sea, Skagerrak, and eastern English Channel

State of the stocks

Landings of skates and rays in the North Sea, Skagerrak, and eastern English Channel have generally declined, and this is associated with changes in species composition and relative abundance. Trends of individual species are largely based on the analysis of IBTS surveys.

Thornback ray *(Raja clavata)* – distribution area and abundance have strongly decreased over the past century. The area occupied has significantly decreased since 1990. Although local abundance remains high, the North Sea stock is considered depleted. The stock appears to have been stable in the last 30 years within this reduced area of distribution.

Spotted ray *(Raja montagui)* – area occupied and abundance has fluctuated without trend. Stock status is uncertain.

Starry ray *(Amblyraja radiata)* – survey catch rates increased from the early 1970s to the early 1990s and stabilized thereafter.

Cuckoo ray *(Leucoraja naevus)* – since 1990 the area occupied has fluctuated without trend. Survey catch rates increased from the early 1970s to the early 1990s and declined thereafter. Stock status is uncertain.

Common skate *(Dipturus batis)* – is depleted. It was formerly widely distributed in the North Sea but is now only rarely found and only in the northern part of the North Sea.

Blonde ray *(Raja brachyura)* – has a patchy occurrence in the North Sea. It is at the edge of its distributional range in this area and consequently ICES does not provide advice for this species.

Lesser spotted dogfish *(Scyliorhinus canicula)* – abundance and area occupied are increasing.

Smooth hound and starry smooth hound *(Mustelus mustelus* and *M. asterias)* – abundance appears to have been increasing in recent years. Identification by species is considered unreliable in the surveys.

Angel shark *(Squatina squatina)* is still extinct in the North Sea.

Single-stock exploitation boundaries

The stocks of common skates and thornback rays are depleted. Target fisheries should not be permitted and bycatch in mixed fisheries should be reduced to the lowest possible level.

If the fisheries for rays continue to be managed with a common TAC for all ray species, this TAC should be set at zero for 2007.

Management considerations

North Sea demersal elasmobranches are being landed as a bycatch in the demersal fisheries for teleosts. Only a few inshore vessels target skates and rays. They are usually landed and reported in mixed categories such as “skates and rays” or “sharks”. For assessment and management purposes species-specific landings data are essential.

Elasmobranches are typically slow-growing, have a high age-at-maturity and a low reproductive capacity. Measures to afford protection to the largest individuals are required.

Given the relatively low commercial value of rays, they are largely taken as bycatch. TACs only regulate the landings, and a low TAC on a low-value bycatch species could induce more discards. Because the elasmobranch species are caught as a bycatch in demersal fisheries, they would benefit from a reduction in the overall demersal fishing effort.

At least 12 species of rays have been reported from North Sea surveys, but only 4 of them are common. Also 8 demersal shark species have been reported, of which only lesser spotted dogfish is common.

The most vital part of the thornback ray spawning stock occurs in the southwestern North Sea. Measures to protect thornback ray in this area are needed.

Given the increased abundance of lesser-spotted dogfish and smooth hounds, there is no immediate need to initiate regulation for this species.

Factors affecting the fisheries and the stock

The effects of regulations

In 1999 the EC introduced a TAC for skates and rays. This TAC was gradually decreased. The current TAC may become restrictive for some countries which may increase discarding. Discard survivorship, however, is unknown.

Scientific basis

Data and methods

Survey data are the basis for the assessments of skates, rays, and demersal sharks in the North Sea.

Uncertainties in assessment and forecast

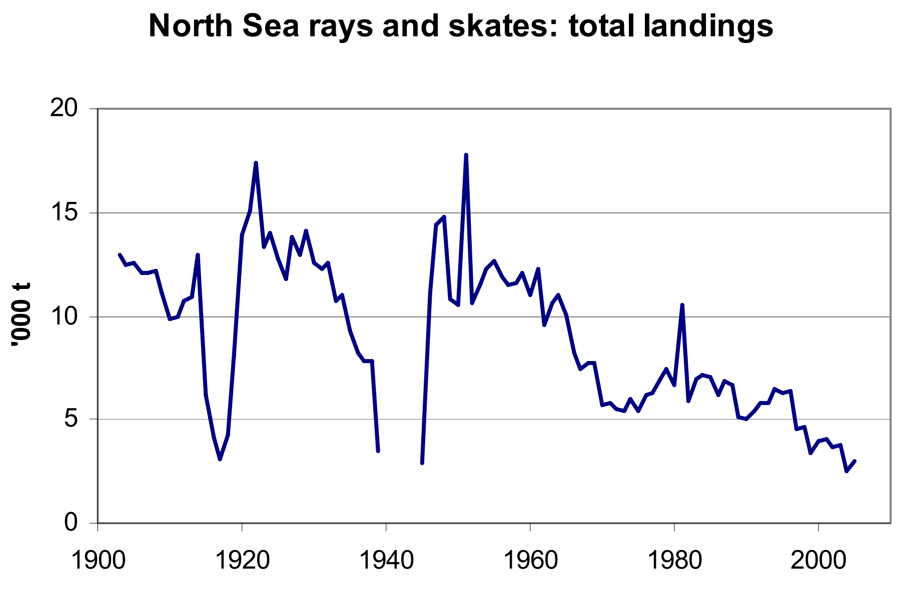
In most countries skates and rays are landed together, most often sorted in particular size categories, rather than by species. They are usually gutted, and sometimes only wings are being landed. For assessment purposes, species-specific catch data are essential. Only some countries report (part of) the landings by species, e.g. Sweden, Belgium, and France. As a result of market sampling programmes the individual species composition of the landings can now be estimated for part of the countries landing skates and rays.

Comparison with previous assessment and advice

In 2005 ICES produced advice for these species for the first time. However, in 1997 and 2004, ACFM gave an overview of the relative status of the main ray species in the North Sea. The present advice is consistent with that given in 2005.

Source of information

Report of the Working Group on Elasmobranch Fishes 2006 (ICES CM 2006/ACFM:31).



Year	ICES Advice	Single-stock exploitation boundaries	Predicted catch corresponding to advice	Predicted catch corresponding to single-stock exploitation boundaries	Agreed TAC[1]	ACFM landings	Disc. slip.	ACFM Catch
1992	No advice					5.8		
1993	No advice					5.8		
1994	No advice					6.4		
1995	No advice					6.3		
1996	No advice					6.4		
1997	No advice					4.6		
1998	No advice					4.6		
1999	No advice				6.1	3.4		
2000	No advice				6.1	4.0		
2001	No advice				4.8	4.0		
2002	Reduce exploitation				4.8	3.6		
2003	No advice				4.1	3.8		
2004	No advice				3.5	2.5		
2005	No advice				3.2	3.0		
2006	Zero catch	F=0		0	2.7			
2007	Zero catch	F=0		0				

Weights in '000 t.
[1)] EU only.
Landings and TAC in this table refer to skates and rays only.

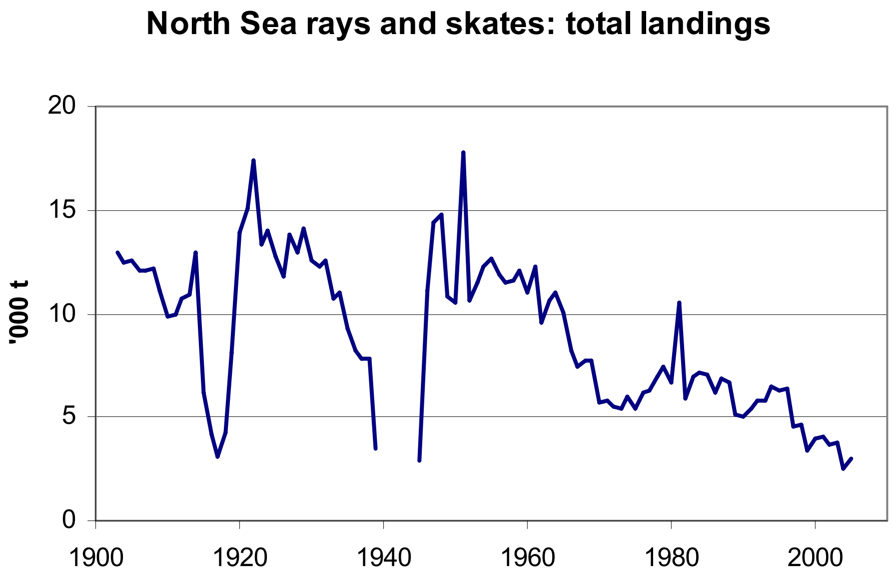


Figure 6.4.29.1 Rays and skates: landings (in ‘000 t) in the North Sea, Skagerrak, and eastern English Channel. All species combined.

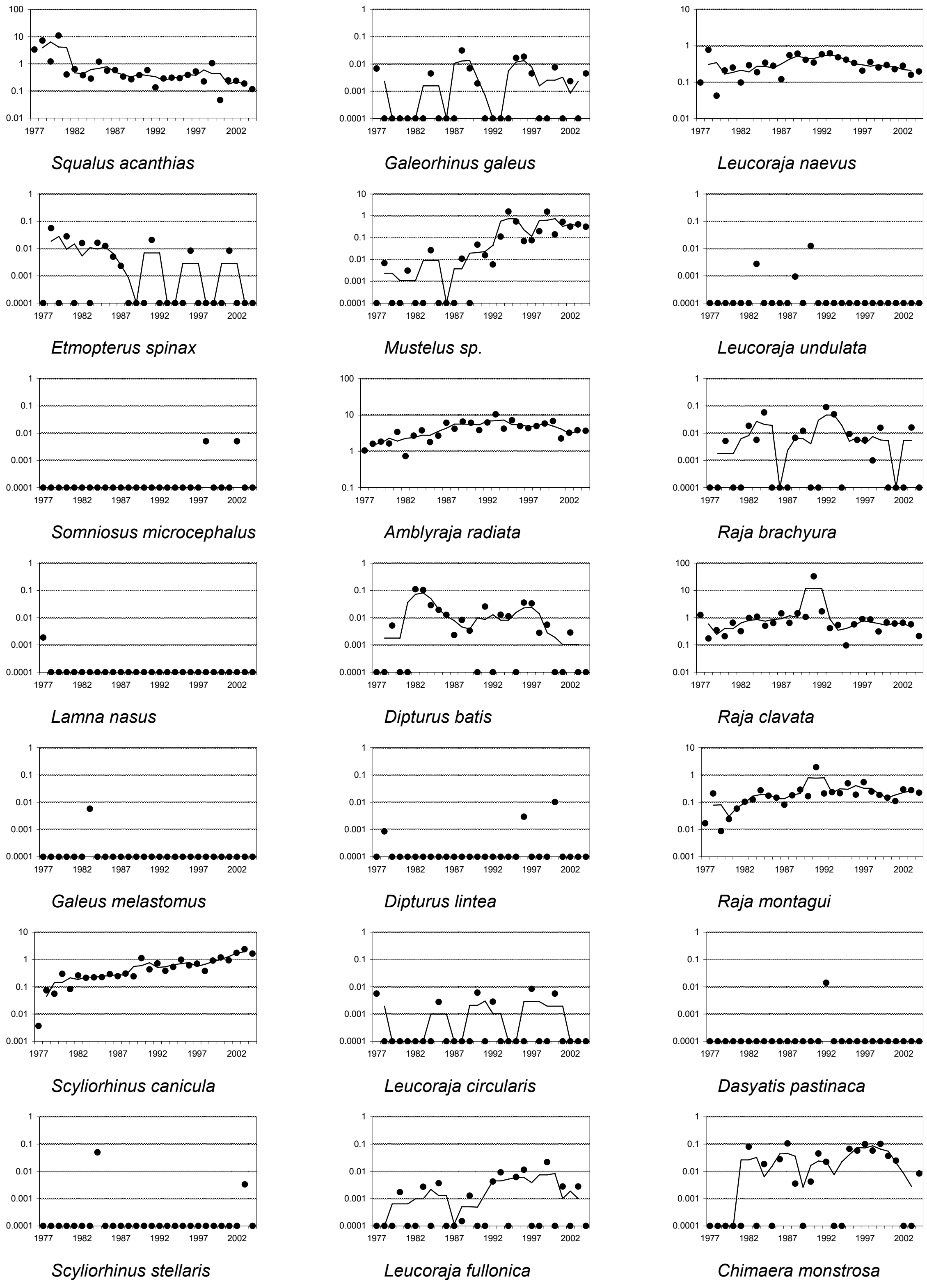


Figure 6.4.29.2 Demersal elasmobranchs in the North Sea, Skagerrak, Kattegat, and eastern Channel: annual catch rates (at a log-scale) and a 3-year moving average during the quarter 1 IBTS, 1977–2004.

6.4.30 *Nephrops* in Divisions IVb,c, West of 1°E (Management Area I)

There are two Functional Units in this Management Area: a) Farn Deeps (FU 6) and b) Firth of Forth (FU 8).

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	Unknown		

The available information is inadequate to use analytical methods to evaluate spawning stock or fishing mortality relative to risk. Results from TV surveys, however, suggest that the stocks in this Management Area are exploited at a sustainable level.

a) Farn Deeps: The TV fall survey estimates of abundance for *Nephrops* in the Farn Deeps indicate that the population has increased from 2002 to 2005. Effort currently appears to be at its lowest level since 1984 and LPUE appears to be at its highest in the series. Mean size of the smaller length groups for males and females has increased in recent years, but the LPUE for these length groups has remained fairly static.
b) Firth of Forth: The TV survey estimate of abundance for *Nephrops* in the Firth of Forth suggests that the population declined between 1993 and 1998, but has increased since then and has been at a relatively high level in the last four years. The increases in abundance in the late 1990s and most recent years have been reflected in CPUE and mean size data, in that they suggest an increase in recruitment in 1998 and 2003.
c) Some landings are made outside the Functional Units, but inside the Management Area.

Management objectives

There are no management objectives for this fishery.

Reference points

No reference points have been proposed for *Nephrops*.

Single-stock exploitation boundaries

Exploitation boundaries in relation to precautionary limits

The effort in this fishery should not be allowed to increase relative to the past three years. In addition to the ceiling on effort ICES advises that the harvest ratio in these stocks should be no more than 15% until more reliable catch information becomes available. This corresponds to landings of less than 3500 tonnes for the Farn Deeps stock and 1500 tonnes for Firth of Forth stock. The fishery in other statistical squares in this area should be less than 600 t, the average of the last three years.

Short-term implications

Outlook for 2007

Harvest rate	Farn Deeps landings in t	Firth of Forth landings in t	'Other Squares' (Average 03–05) landings in t
15%	3465	1446	593
20%	4620	1928	
25%	5775	2411	

Management considerations

Both Functional Units in this Management Area have high *Nephrops* discard rates, and there is an urgent need to reduce these and to improve the exploitation pattern. An additional reason for suggesting improved selectivity in this area relates to bycatch. The abundance of cod as 1-year-olds still appears to be relatively high. Similar comments can be made about the emerging 2005 haddock year class which will begin entering the fishery in 2007 and according to forecasts will result in large discard numbers under the present exploitation pattern. It is important that efforts are made to ensure that both of these species and others are not taken as unwanted bycatch. Technical measures that improve the exploitation pattern would be beneficial in the fisheries of this Management Area.

In the North Sea TAC (which comprises eight *Nephrops* stocks), the present aggregated management approach runs the risk of unbalanced effort distribution. Adoption of management initiatives to ensure that effort can be appropriately controlled in smaller areas within the overall TAC area is recommended.

Between 1993 and 2002, landings from this Management Area have exceeded the TAC recommended by ICES. Up to the early 1990s, effort has increased much faster in the Farn Deeps than in the Firth of Forth. While effort has recently decreased in both FUs, there is still the potential for an imbalance in the exploitation rates. With the current large North Sea TAC area (which comprises eight *Nephrops* FUs), there is no mechanism for controlling effort locally. Management should therefore be carried out at the FU level recommended by ICES.

The increasing catches from the Devils Hole area have provided new opportunities in this MA. Due allowance needs to be made for the emergence of new areas for exploitation.

Landings divided by survey biomass indices is a proxy of the exploitation rate. Available information indicate that landings in recent years are most likely an underestimate of actual landings. The reported landings in the 1990s are considered more accurate. The lower bound of the harvest ratio for the inshore stocks during that period was around 15%. The general increase in *Nephrops* abundance in recent years indicates that a 15% harvest ratio will probably not have detrimental effect on the stocks.

The STCEF concluded that a 20% harvest rate was acceptable, derived from an estimate of $\mathbf{F}_{0.1}$ from a length-based yield-per-recruit analysis. Deriving target rates from an analytical framework and applying it to survey indices are among other things very sensitive to the assumption of the length-based model and the assumption that survey indices are an absolute measure of biomass. These assumptions have not been evaluated.

Ecosystem considerations

Throughout its distribution, *Nephrops* is limited to a muddy habitat, and requires sediment with a silt and clay content of between 30–100% to excavate its burrows, and this means that the distribution of suitable sediment defines the species distribution. Adult *Nephrops* only undertake very small-scale movements (a few hundred metres), but larval transfer may occur between separate mud patches in some areas. In the Farn Deeps area the *Nephrops* stock inhabits a large continuous area of muddy sediment extending North from 54°45’–54°35’N and 0°40’–1°30’N, with smaller patches to the east and west.

Factors affecting the fisheries and the stock

Since the beginning of the time-series, the UK fleet has accounted for virtually all landings from the Farn Deeps. Landings from the Firth of Forth fishery are predominantly reported from Scotland, with very small contributions from England.

Effort currently appears to be at its lowest level since 1984, while LPUE appears to be at its highest in the series.

Estimated discarding rates during this period have fluctuated around 60% by number (40% by weight of the catch) in the Farn Deeps and 43% by number (24% by weight) in the Firth of Forth, similar to levels recorded since the beginning of the data series in 1985.

The effects of regulations

Restrictions on other fisheries, e.g. cod recovery measures—catch composition regulations and days at sea—and technical conservation measures have already impacted the effort on these stocks.

Changes in fishing technology and fishing patterns

Changes in fleet capacity, average size of vessels, and power and fuel prices will affect the spatial dispersal of effort. Smaller vessels will not fish so far out and will be limited far more by weather. There are observations of shifts of *Nephrops* fishing to grounds such as the Devil’s Hole.

The differences between LPUE figures for individual vessels suggest that aggregated data for earlier years could have included boats whose effort was not fully directed at *Nephrops*. Restrictions on finfish fishing over the last five years will have restricted total effort in FU 6, thereby reducing the more occasional effort on *Nephrops*.

There is a concern that the use of multiple (3- to 4-net) trawls will lead to an unsustainable increase in effective effort through a step change in technological creep – this development is inconsistent with keeping effort constant.

The environment

This species is essentially sedentary and stocks are limited geographically to muddy sediments. Weather and sea temperature will effect the dispersal and settlement of larvae which to be successful depends on retention gyres and the speed in development of the zoea (larvae). Catch rates and length compositions are dependent on burrow density and are affected by weather, tides, and light intensity.

Reduction in the size and number of predators, primarily cod, may have been beneficial to these stocks.

Other factors

Catch rates are affected by emergence behaviour which in turn is affected by tides, light intensity, moult cycles, and sexual development.

Scientific basis

Data and methods

There is considerable uncertainty about landings, discard and effort data for these stocks. Underwater TV surveys of the Farn Deeps have been conducted at least once a year from 1996 onwards, and for the Firth of Forth since 1993 (missing surveys in 1995 and 1997).

Information from the fishing industry

For FU 6 the NSCFP fishermen's survey shows an increase between 2001 and 2002, a relatively stable period to 2004, but a small decline in 2006.

For FU 8 the NSCFP survey shows a continuous increase in *Nephrops* since 2001. This supports the suggestion of an increase in abundance since 2001, with generally moderate or high numbers of recruits.

Uncertainties in assessment and forecast

There are concerns regarding the accuracy of landings and effort data and because of this the final assessment adopted is independent of official statistics.

LPUE may also be affected by changes in catchability (due to sudden changes in the environmental conditions), or by changes in selectivity and/or in gear efficiency.

Discards could reflect the strength of the recruitment, but also depend on selectivity of the gear and on discarding practices. Thus trends in mean size of the whole catch are difficult to interpret, but those of larger size categories (>35 mm) are more informative.

Farn Deeps: the distinct seasonality in this fishery leads to higher exploitation in males than females. Bearing this in mind, a harvest ratio which is considered appropriate for stocks with a more balanced exploitation, may be too high for this stock.

Comparison with previous assessment and advice

The method and the basis of the advice is the same as last year. It seems that the advice now includes ceilings on catches

Sources of information

Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, 5–14 September 2006 (ICES CM 2006/ACFM:35).
Commission Staff Working Paper. 21st Report of the Scientific, Technical and Economic Committee for Fisheries (Second Plenary Meeting). Brussels, 7–11 November 2005.

Year	ICES advice	Recommended TAC	Agreed TAC[1]	ACFM Landings[2]
1987				4.0
1988				5.3
1989				5.1
1990				4.6
1991				3.8
1992		~4.6	12.0	3.5
1993		4.17	12.0	5.7
1994		4.17	13.0	5.9
1995		4.17	15.2	4.7
1996		4.17	15.2	4.6
1997		4.17	15.2	4.7
1998		4.17	15.2	4.6
1999		4.17	15.2	5.0
2000		4.17	17.2	4.4
2001		4.17	15.48	4.7
2002		4.17	16.623	3.9
2003		4.17	16.623	4.0
2004		4.17	21.350	4.4
2005		4.17	21.350	5.6
2006	No increase in effort	-	28.147	
2007	No increase in effort, harvest rate <15%	5.6[3]		

Weights in '000 t.
[1] EU Zone of IIa and IV.
[2] Does not include discards.
[3] $\mathbf{F}_{0.1}$-based harvest rate applied to TV survey abundance estimate.

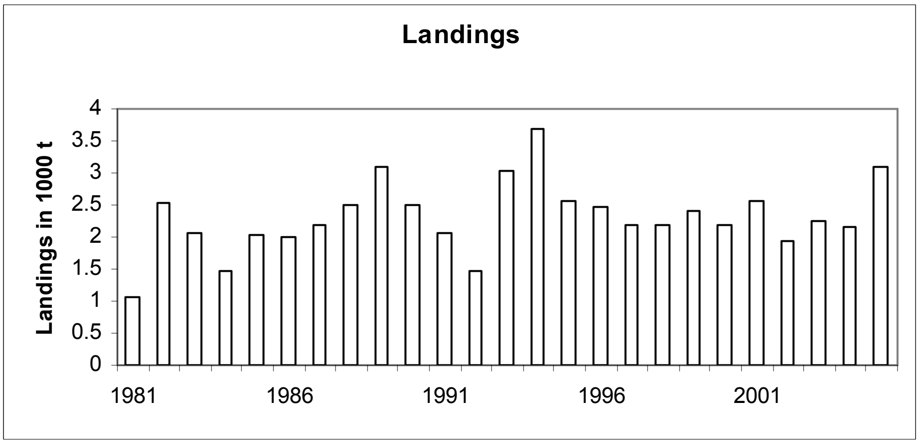


Figure 6.4.30.1 *Nephrops* in Division IVb,c, west of 1ºE (Management Area I) FU 6 (Farn Deeps).

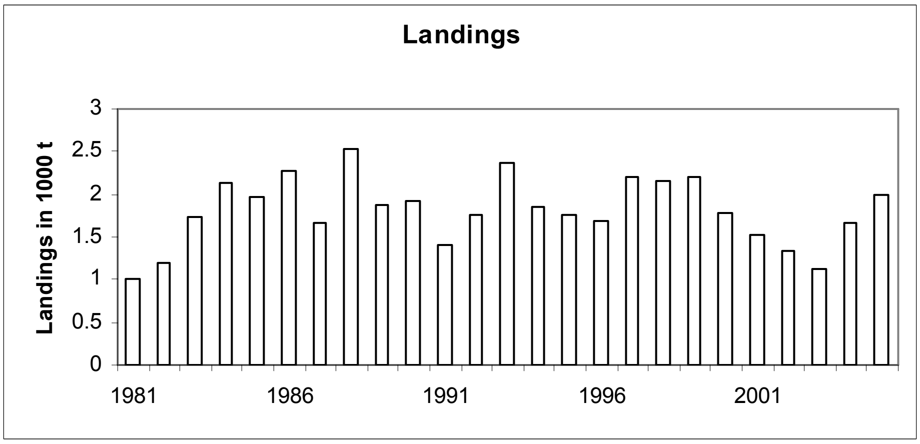


Figure 6.4.30.2 *Nephrops* in Division IVb,c, west of 1ºE (Management Area I) FU (Firth of Forth).

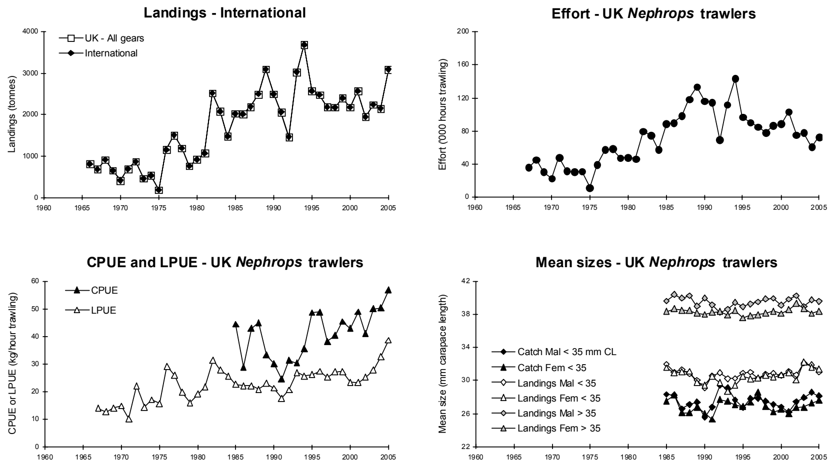


Figure 6.4.30.3 *Nephrops*, Farn Deeps (FU 6): Long-term trends in landings.

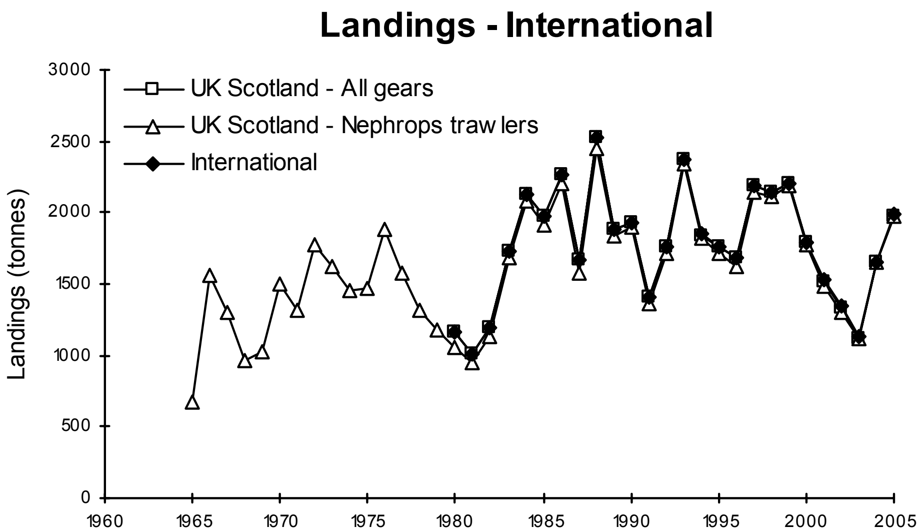


Figure 6.4.30.4 *Nephrops*, Firth of Forth (FU 8). Long-term trends in landings.

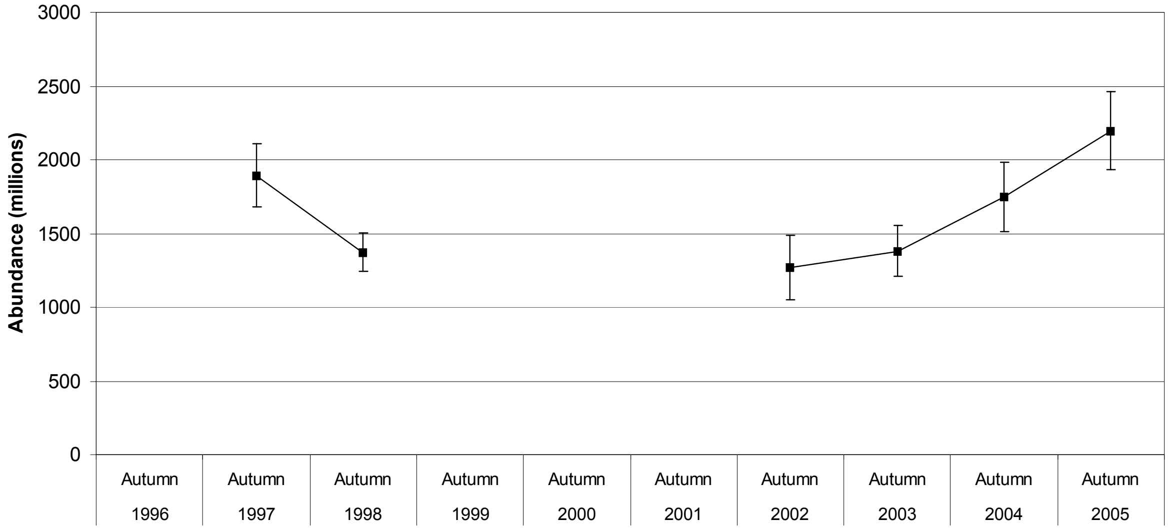


Figure 6.4.30.5 *Nephrops*, Farn Deeps (FU 6). Time-series of TV survey abundance estimates, with 95% confidence intervals, 1996–2005.

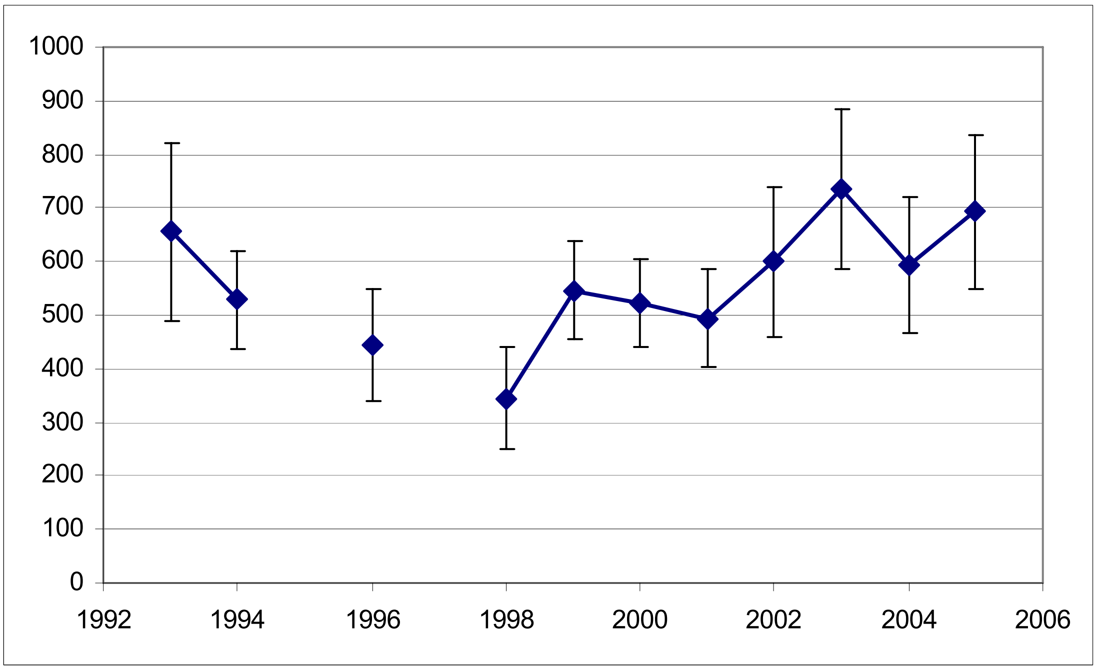
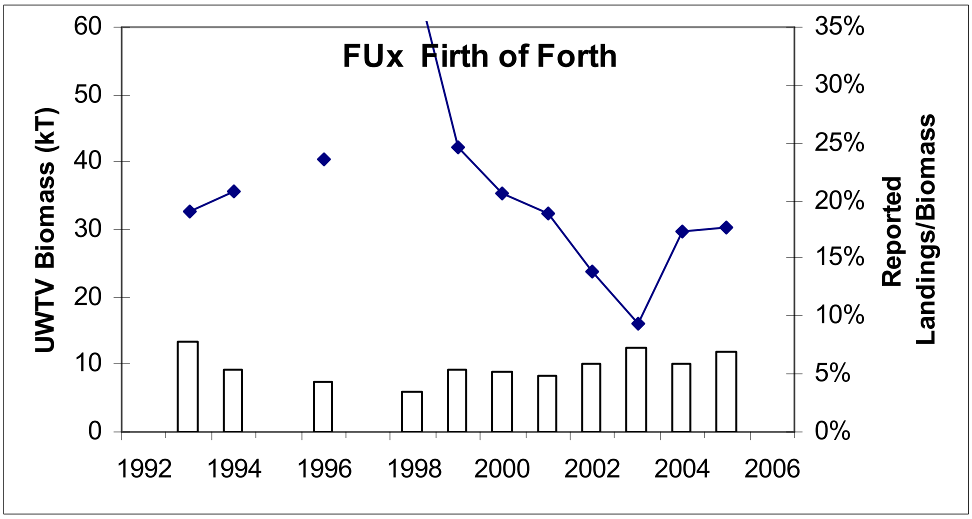


Figure 6.4.30.6 *Nephrops*, Firth of Forth (FU 8). Time-series of TV survey abundance estimates (in millions), with 95% confidence intervals, 1993–2005.



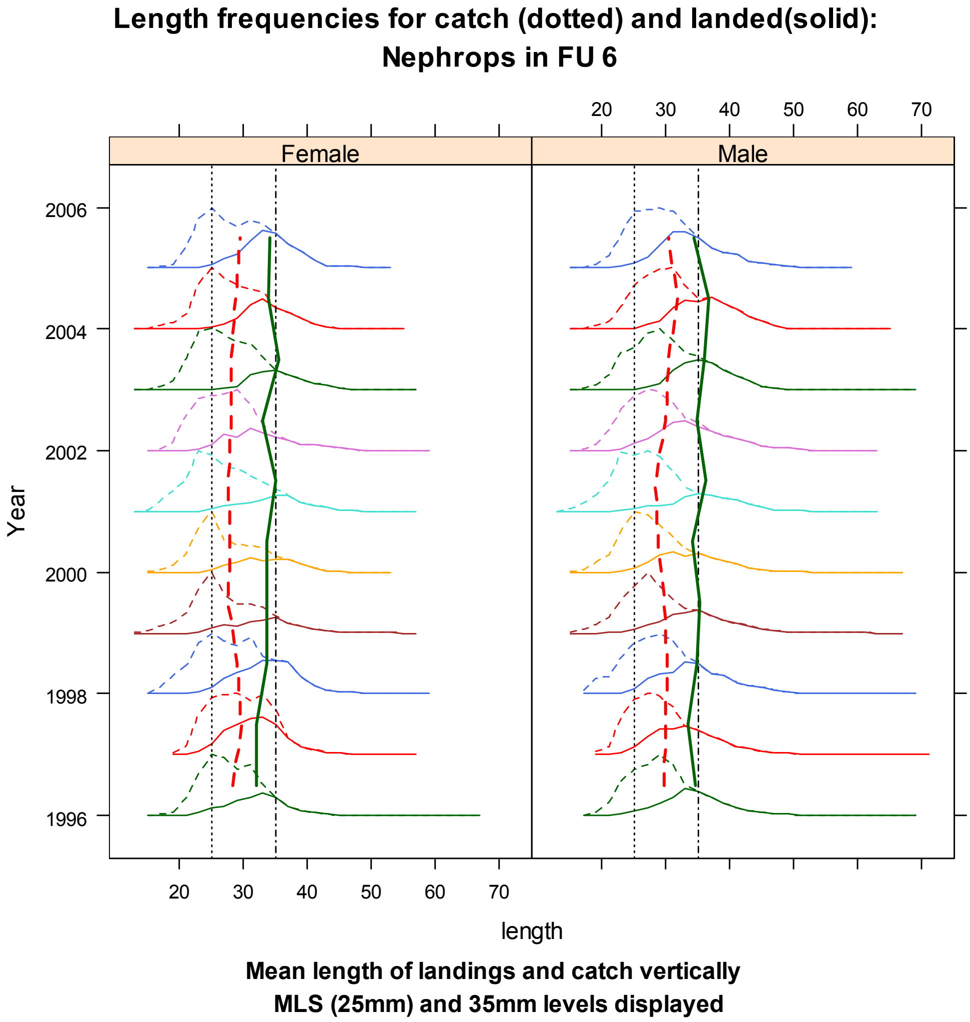


Figure 6.4.30.7 *Nephrops* Farn Deeps (FU 6). Length composition of catch (dotted) and landed (solid) of males (right) and females left from 1996 (bottom) to 2005 (top). Mean sizes of catch and landings (using same line types) is shown in relation to MLS.

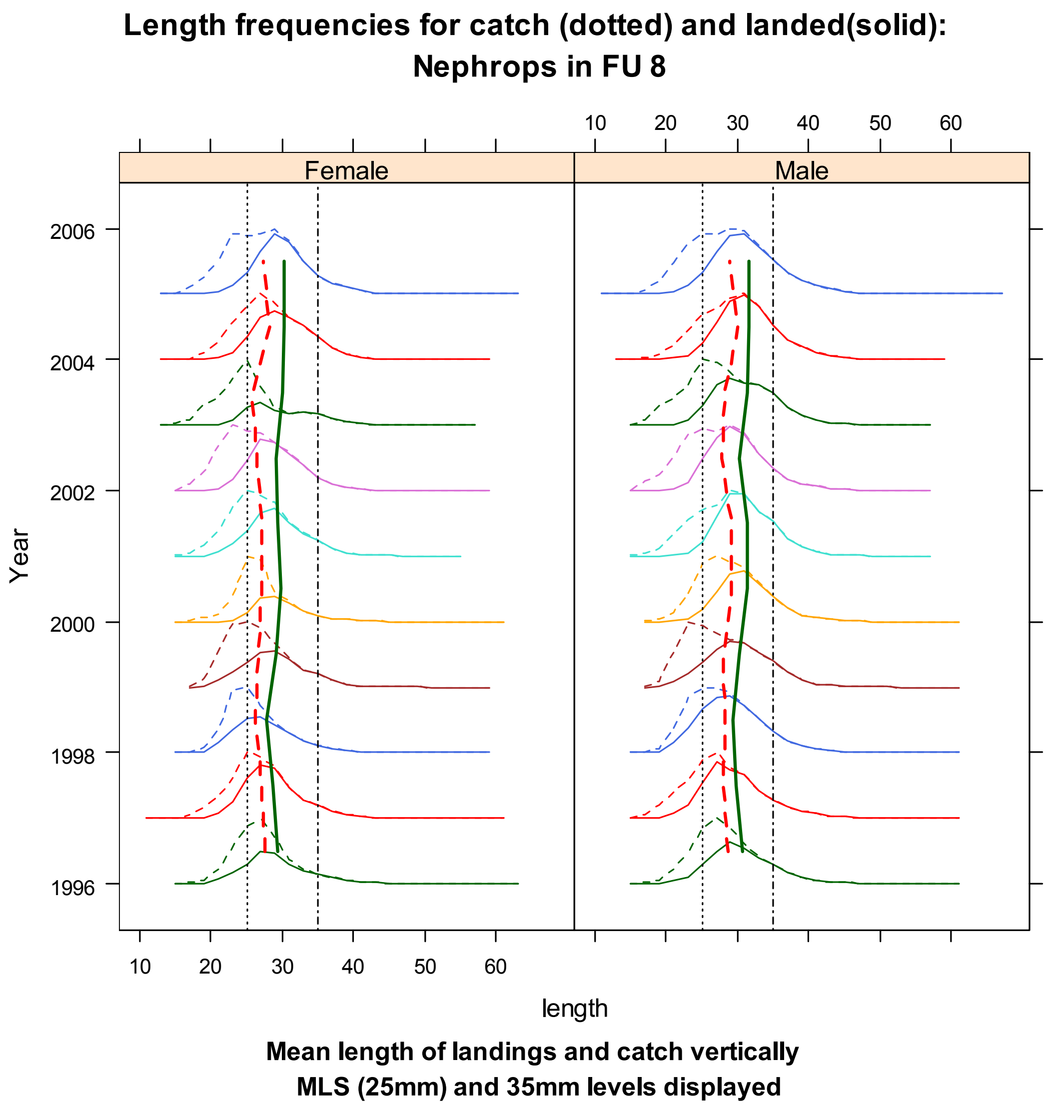


Figure 6.4.30.8 *Nephrops* Firth of Forth (FU 8). Length composition of catch (dotted) and landed (solid) of males (right) and females left from 1996 (bottom) to 2005 (top). Mean sizes of catch and landings (using same line types) is shown in relation to MLS.

Table 6.4.30.1 *Nephrops*, Management Area I: Total *Nephrops* landings (tonnes) by Functional Unit plus Other rectangles, 1981–2005.

Year	FU 6	FU 8	Other	Total
1981	1073	1006	74	***2153***
1982	2524	1195	156	***3875***
1983	2078	1724	100	***3902***
1984	1479	2134	78	***3691***
1985	2027	1969	106	***4103***
1986	2015	2263	143	***4421***
1987	2191	1674	147	***4012***
1988	2505	2528	308	***5341***
1989	3098	1886	158	***5142***
1990	2498	1930	134	***4561***
1991	2064	1404	355	***3823***
1992	1463	1757	271	***3491***
1993	3030	2369	262	***5661***
1994	3684	1850	407	***5940***
1995	2568	1763	373	***4704***
1996	2482	1688	387	***4557***
1997	2189	2194	339	***4722***
1998	2176	2145	278	***4599***
1999	2401	2205	403	***5008***
2000	2178	1785	391	***4353***
2001	2574	1528	633	***4735***
2002	1953	1340	637	***3930***
2003	2245	1126	653	***4024***
2004	2152	1658	589	***4399***
2005*	3094	1990	536	***5619***
* provisional na = not available				

6.4.31 *Nephrops* in Division IVa, East of 2°E + rectangles 43 F5–F7 (Management Area S)

There is only one Functional Unit in this Management Area: Norwegian Deep (FU 32).

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	Unknown		

The available information is inadequate to evaluate spawning stock or fishing mortality relative to risk.

This stock has mainly been exploited by Danish vessels. LPUEs from the Danish fishery have been rather stable over the last 10 years with increasing trend during the most recent 2 years. A slight decrease in mean size in the catches and landings in 2004 and 2005 could indicate a high exploitation pressure in recent years, and that this *Nephrops* stock is fully exploited. However, the trends in Danish LPUE figures do not indicate any decline in stock abundance.

Management objectives

There are no management objectives set for this fishery.

Reference points

No reference points have been determined for *Nephrops*.

Single-stock exploitation boundaries

Exploitation boundaries in relation to precautionary limits

Information on this stock is considered inadequate to provide advice based on precautionary limits.

Management considerations

The Danish LPUE figures for this FU increased dramatically from 1992 to 1994, and then levelled off. Since 1995 they have fluctuated around 200 kg/day. In the last 2 years an increasing trend is seen. It could be that only part of the stock is exploited at present. Sediment maps for this Management Area indicate that there are possibilities to let the fishery expand into new grounds, which have scarcely been fished to date.

Factors affecting the fisheries and the stock

Around 80% of the landings from this FU are made by Denmark. During the last five years, landings have fluctuated between 750 t and 1216 t, with the highest figures recorded in 2002. The LPUEs of Danish vessels have increased from 50–75 kg/day in the early 1990s to more than 200 kg/day in late 2004. Mean sizes in both research vessel catches and commercial landings are high compared to neighbouring areas (Skagerrak and Kattegat).

The effects of regulations

Due to changes in the management regime (mesh size regulations in the Norwegian zone of the northern North Sea in 2002) there was a switch to increasing Danish effort targeting *Nephrops* in the Norwegian Deep.

Traditionally, the Norwegian effort for *Nephrops* has been low, and the majority of the Norwegian *Nephrops* landings from FU 32 have largely been as bycatch from the *Pandalus* fishery. Because of the landings restrictions for *Pandalus*, shrimp trawlers have started fishing more specifically for *Nephrops* in the most recent years. Also, there are an increasing number of boats that target *Nephrops* year-round, making one-week trips and landing their catches in Denmark.

Scientific basis

Data and methods

The perception of the stock status is based on Danish LPUE data.

Information from the fishing industry

The NSCFP stock survey shows an increase in *Nephrops* between 2001 and 2002, a slight decrease to 2003, and a marked increase since this date. This supports the suggestion of an increase in abundance for this area, but does not indicate any change in the levels of discards or recruits.

Uncertainties in assessment and forecast

Due to "technological creeping" there are concerns over effort data, because of possible changes in selectivity or in gear efficiency. Furthermore, LPUE may be affected by changes in catchability (due to sudden changes in the environmental conditions).

Discards could reflect the strength of the recruitment, but are also dependent on selectivity of the gear and on discarding practices. Thus trends in mean size of the catch are difficult to interpret without any information on changes in the fishing pattern and practices.

Comparison with previous assessment and advice

No assessment is presented for this stock.

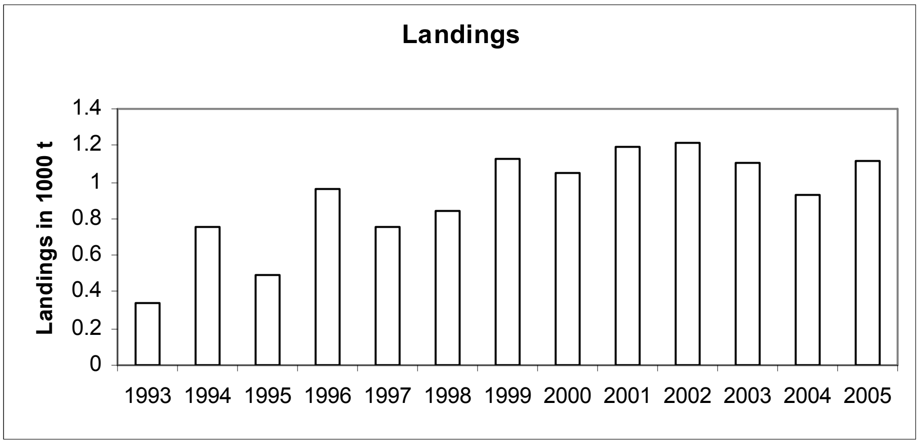
Source of information

Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, 5–14 September 2006 (ICES CM 2006/ACFM: 35).

Year	ICES advice	Recommended TAC	TAC agreed	ACFM landings
1987				< 0.1
1988				< 0.1
1989				< 0.1
1990				0.2
1991				0.2
1992				0.2
1993				0.3
1994				0.8
1995				0.5
1996				1.0
1997				0.8
1998				0.8
1999				1.1
2000				1.1
2001				1.2
2002		1.2	No TAC agreed	1.2
2003		1.2	No TAC agreed	1.1
2004		1.5	1.0	0.9
2005		1.5	1.0	1.1
2006	No increase in effort		1.3	
2007	No advice			

Weights in '000 t.

Nephrops in Division IVa, east of 2ºE, + Rectangles 43 F5-F7 (Management Area S)



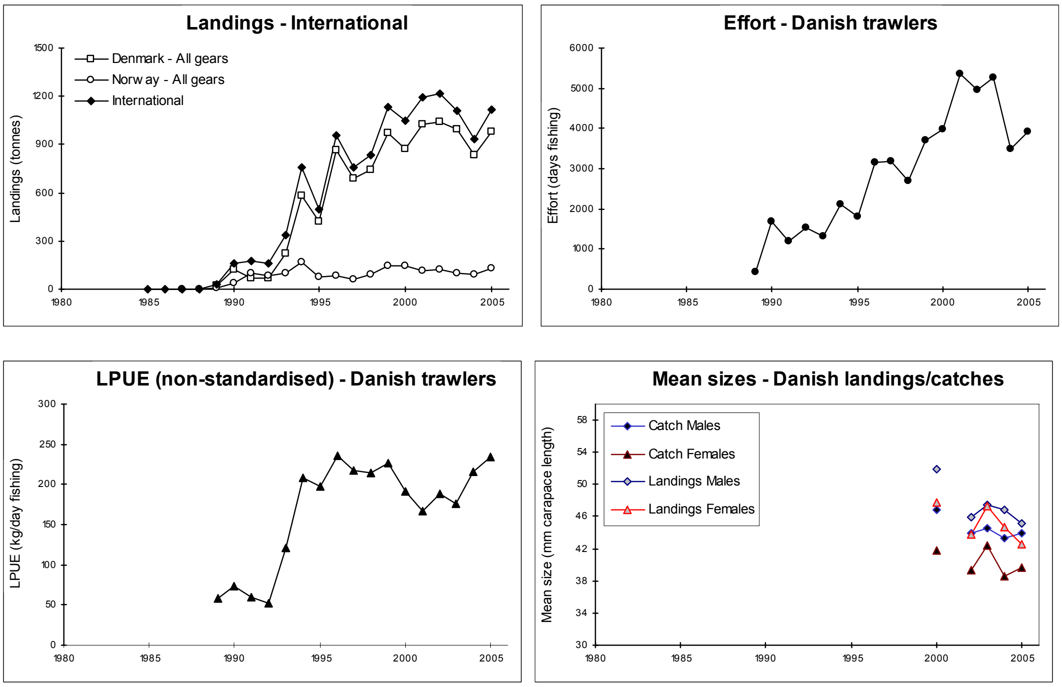


Figure 6.4.31.1 ***Nephrops*** Norwegian Deep (FU 32): Long-term trends in landings, effort, CPUEs and/or LPUEs, and mean sizes of *Nephrops*.

Table 6.4.31.1 *Nephrops* in Division IVa, east of 2ºE, + Rectangles 43 F5–F7 (Management Area S).

Year	Landings tonnes
1993	338
1994	759
1995	494
1996	960
1997	760
1998	838
1999	1129
2000	1051
2001	1191
2002	1216
2003	1110
2004	934
2005	1117
Average	915