

## **8 The Baltic Sea**

### **8.1 Ecosystem overview**

#### **8.1.1 Ecosystem Components**

##### **Bottom topography, substrates and circulation**

The Baltic Sea is one of the largest brackish areas in the world. It receives freshwater from a number of larger and smaller rivers while saltwater enters from the North Sea along the bottom of the narrow straits between Denmark and Sweden. This creates a salinity gradient from southwest to northeast and a water circulation characterised by the inflow of saline bottom water and a surface current of brackish water flowing out of the area.

The Baltic Sea is characterised by large areas (ca 30%) that are less than 25 m deep interspersed by a number of deeper basins with a maximum depth of 459 m. The Gulf of Bothnia and the Gulf of Riga are internal fjords, while the Baltic Proper and the Gulf of Finland feature several deep basins separated by sills. The western and northern parts of the Baltic have rocky bottoms and extended archipelagos, while the bottom in the central, southern and eastern parts consists mostly of sandy or muddy sediment.

##### **Physical and Chemical Oceanography**

The water column in the open Baltic is permanently stratified with a top layer of brackish water separated from a deeper layer of saline water. This separation limits the transport of oxygen from the surface and as a result the oxygen in the deeper layer can become depleted due to breakdown of organic matter.

A strong inflow of new saline and oxygen rich water from the North Sea can lead to a renewal of the oxygen depleted bottom water. Strong inflows can occur when a high air pressure over the Baltic is followed by a steep air pressure gradient across the transition area between the North Sea and the Baltic. Such situations typically occur in winter. Strong inflows were frequent prior to mid-1970's, but have since become rarer and as a result salinity has decreased over the last 25 years. Major inflows occurred, however, in 1976, 1983, and 1993. In 2003 an inflow of medium size (200 km<sup>3</sup>, ICES 2004) introduced salty, cold and well-oxygenated water into all main basins of the Baltic Sea, including the Gotland Deep, Figure 8.1.1.1. Since 2003 there have been no major inflow events, and the waters in the deep basins of the Baltic are returning toward the relatively stagnant conditions in the late 1990s and early 2000s. Since the winter and summer inflows in 2003 temperature and hydrogen sulfide have increased, and salinity and dissolved oxygen have decreased in all the deep basins. Bottom temperature in Bornhold Deep is now 1.8 °C above the average 1970-1990 (7.96 vs 6.12), and at least 1 °C greater in all the other basins except Gotland Deep (0.3 °C warmer) (Helcom 2006).

The Baltic receives nutrients and industrial waste from rivers, and airborne substances from the atmosphere. As a result the Baltic has become eutrophied during the 20th century. In general, nutrient concentrations in the Baltic Sea have not decreased since the mid-1990s. Through the first part of this decade nutrient levels have remain persistently high and may be increasing further in most recent years (Helcom 2003, 2006). Low oxygen conditions in deep water affect the amounts of nutrients in the water. Phosphorus is easily released from sediments under anoxic conditions. Nitrogen cycles in deep water layers also change in anoxic conditions: mineralization eventually produces ammonium, and no oxidation occurs to form nitrates. Consequently, the process of denitrification, which needs oxygen from nitrates, will not occur. The resulting nutrient surplus in the deep water layers is a potential source of nutrients for the surface layers, where primary production may be further increased (Helcom 2003). This effect may counterbalance the decrease in nutrient input into some parts of the Baltic Sea. In addition a long-term decrease in silicate concentrations is apparent in most parts of the Baltic, and silicate has recently been limiting growth of diatoms in the Gulf of Riga in spring. Silicate limitation changes the structure of the phytoplankton community rather than limiting the total production (Helcom 2002, p. 181).

Furthermore, hypoxia in shallow coastal waters seriously affects biodiversity, and seems to be an increasing problem – especially in the archipelagos of the northern Baltic Sea. These irregular events are caused by local topography, hydrography and drifting algal mats. (Helcom 2002, p. 166).

##### **Contaminants**

The Baltic Sea is severely contaminated, and contamination status is regularly assessed through Helcom (e.g., Helcom 2002, 2003), where details are available. Whereas DDT pollution has decreased substantially, the decline of PCB and Dioxin concentrations continues, but at a slow rate, suggesting that some input of these compounds continue (Helcom 2002, 2006). Contaminant levels in northern Baltic herring and salmon are so high that consumption is being regulated (Helcom 2002, 2004).

## Broad scale climate and oceanographic features and drivers

The oceanographic conditions in the Baltic are very much driven by meteorological forcing influencing inflow from the North Sea. Significant correlations have been demonstrated between the NAO and total freshwater runoff, westerly winds and salinity (Häninnen *et al.* 2000), ice conditions (Koslowski & Loewe 1994) as well as local circulation and upwelling (Lehmann *et al.* 2002). Climate variability has been shown to affect the dynamics of many of the components of the Baltic ecosystem.

### Phytoplankton

The species composition of the phytoplankton depends on local nutrients and salinity and changes gradually from the southwest to the northeast. Primary production exhibits large seasonal and interannual variability (Helcom 2002, p. 182). Normally, an intense spring bloom starts in March in the western Baltic, but only in May-June in the Gulf of Bothnia. In the southern and western parts the spring bloom is dominated by diatoms, whereas it is dominated by dinoflagellates in the central and northern parts. Over the period from 1979 to 1999 downward trends were found for diatoms in spring and summer, whereas dinoflagellates generally increased in the Baltic proper, but decreased in the Kattegat. Chlorophyll a, a proxy indicator for total phytoplankton biomass, also increased in the Baltic proper (Wasmund and Uhlig 2003).

Summer blooms of nitrogen-fixing cyanobacteria ("blue-green algae") are normal in the central Baltic, Bothnian Sea, Gulf of Finland and Gulf of Riga. Such blooms have occurred in the Baltic Sea for at least 7,000 years, but their frequency and intensity seem to have increased since the 1960s. Mass occurrences of blue-green algae are often made up of several species. Since 1992 the relative abundance of the most common species has shown a clear trend in the Arkona Basin (southern Baltic) and in the northern Baltic Sea: the toxin-producing species *Nodularia spumigena* has become more abundant compared to the non-toxic *Aphanizomenon flos-aquae*. Red tides (dinoflagellate blooms) are regularly observed, including blooms of the toxic *Gymnodinium mikimotoi* (Helcom 2002, 2003).

### Zooplankton

The zooplankton of the Baltic Sea is dominated by calanoid copepod and cladocerans. The species composition is influenced by the salinity gradient. Generally marine species (e.g. *Pseudocalanus sp.*) prevail in the southern more saline part, while brackish species (e.g. *Eurytemora affinis* and *Bosmina longispina maritima*) dominate in the northern areas. Changes in the species composition of the zooplankton have been linked to changes in salinity and temperature. For the shallower northern areas of the Baltic Sea a decline of large neritic copepods and an increase of species with freshwater origin, i.e. cladocerans has been related to a reduction of salinity caused by increased river runoff (Viitasalo *et al.* 1995, Vuorinen *et al.* 1998, Ojaveer *et al.* 1998). In the Central Baltic deep basins the abundance and biomass of *Pseudocalanus sp.* has declined since the 1980s, whereas the abundance of *Temora longicornis* and *Acartia spp.* increased (Figure 8.1.1.2). The decrease in *Pseudocalanus sp.* is correlated to the decrease in deep water salinity resulting from the reduced frequency of inflow events (Möllmann *et al.* 2000, 2003 a). Recent investigations indicate that the combination of low salinity and oxygen conditions in the halocline of the deep basins, might have a detrimental effect on the viability of *Pseudocalanus sp.* eggs and nauplii (Schmidt *et al.* 2003, Renz and Hirche 2005). The increase in *Acartia spp.* and *T. longicornis* during the 1990s is correlated with temperature (Möllmann *et al.* 2000, 2003 a), a result of the persistently strong positive state of the NAO (Alheit *et al.* 2005, Möllmann *et al.* 2005). Recent investigations indicate that temperature-dependent resting egg activation is the responsible process behind the temperature-*Acartia spp.* relationship (Alheit *et al.* 2005). Information on long-term trends of macrozooplankton (e.g. mysids) and gelatinous zooplankton is generally insufficient.

### Benthos

The composition of the benthos depends both on the sediment type and salinity, with suspension feeding mussels being important on hard substrate while deposit feeders and burrowing forms dominate on soft bottoms. The species richness of the zoobenthos is generally poor and declines from the southwest towards the north due to the drop in salinity. However, species poor areas and low benthos biomasses are also found in the deep basins in the central Baltic due to the low oxygen content of the bottom water. After major inflows a colonisation of these areas can, however, be seen.

In the south-western part of the Baltic the bivalve *Macoma balthica* characterises the community found on shallow soft bottoms while a community characterised by the bivalves *Abra alba* and *Arctica islandica* are found in the deeper parts. East of the Dars sill various polychaetes become important in the deeper parts. In the central areas the major parts of the hard bottoms are inhabited by communities of *Fucus vesiculosus* and *Mytilus edulis*, while the fauna of the main part of the soft bottoms has been classified as a *Macoma* community (Voipio, 1981). In the Bothnian Bay and the central part of the Bothnian Sea the isopod *Saduria entomon* and the amphipod *Pontoporeia spp.* dominate the zoobenthos (Laine 2003). In shallow areas seaweed and seagrass form important habitats (including nursery grounds) for many animals.

The distribution of seaweed and seagrass has changed over time, in some cases in response to eutrophication (Helcom 2003, p. 114).

## Fish

The distribution of the roughly 100 fish species inhabiting the Baltic is largely governed by salinity. Marine species (some 70 species) dominate in the Baltic Proper, while freshwater species (some 30-40 species) occur in coastal areas and in the innermost parts (Nellen and Thiel 1996, cited in Helcom 2002). Cod, sea and sprat comprise the large majority of the fish community in both biomass and numbers. Commercially important marine species are sprat, herring, cod, various flatfish, and salmon. Sea trout and eel, once abundant, are of very low population sizes. Sturgeons, once common in the Baltic Sea and its large rivers are now extinct from the area. Recruitment failures of coastal fish, e.g. perch (*Perca fluviatilis*) and pike (*Esox lucius*) in Sweden have been observed along the Swedish Baltic coast (Nilsson *et al.* 2004, Sandström and Karås 2002). Further studies show that several species have failed in the outer archipelagos and that these failures correlate with low densities of zooplankton.

Cod is the main predator on herring and sprat, and there is also some cannibalism on small cod (Köster *et al.* 2003a). Herring and sprat prey on cod eggs, and sprat are cannibalistic on their eggs, although there is seasonal and inter-annual variation in these effects (Köster and Möllmann 2000a). The trophic interactions between cod, herring and sprat may periodically exert a strong influence on the state of the fish stocks in the Baltic. To accommodate predator-prey effects in the assessment (e.g., predation by cod on herring and sprat) multispecies models are used to estimate the natural mortality of herring and sprat. Due to the coastal spawning of herring, it is also subject to interactions with freshwater species in the coastal zone. For example, pikeperch predation on young herring can decrease local herring production considerably (Hansson *et al.*, 1997). Immature cod are also commonly found in shallower areas (Baranova 1995), but the relative importance of its interactions with coastal dwelling species remains unclear.

Climate driven changes in the salinity, temperature and oxygen content of the water affect the recruitment and growth of cod, herring and sprat. The reduction in salinity and oxygen and the increase in temperature caused by the high NAO index in the 1990s resulted in a reduction of the growth rate of herring, and sprat growth declined during the 1980s and 1990s, probably due to changes in the zooplankton composition and abundance (Rönkkönen *et al.* 2004, Möllmann *et al.* 2005) and as a result of increases in food competition (Casini *et al.* 2006), while the recruitment of herring in the Gulf of Riga and sprat in the entire Baltic increased during the 1990s (MacKenzie and Köster 2004).

In the past the eastern cod stock spawned in the Bornholm, Gdansk, and Gotland Deep (Figure 8.1.1.3), but in the later years the salinity and oxygen conditions have only allowed successful spawning, egg fertilisation and egg development in the Bornholm Deep (MacKenzie *et al.* 2000). Cod eggs can only develop successfully if the oxygen concentration is larger than  $2\text{ml}\cdot\text{l}^{-1}$  and the salinity is higher than 11 psu, and the volume of water where this is fulfilled, the so-called "reproductive volume", has generally been very low or zero since the mid-1980s in the Gotland and Gdansk Deep (Figure 8.1.1.4) (MacKenzie *et al.* 2000). It increased somewhat following the 2003 inflow but has declined towards very low values in most recent years. Furthermore, recruitment to the cod stock declined as the spawning stock was reduced by heavy fishing, the decline in the biomass of *Pseudocalanus sp.* reduced the available of food for the cod larvae, and the increase in the sprat biomass meant increased the predation of cod eggs by sprat.

Hydrographic-climatic variability (i.e., low frequency of inflows from the North Sea, warm temperatures) and heavy fishing during the past 10-15 years have thus led to a shift in the fish community from cod to clupeids (herring, sprat) by first weakening cod recruitment (Jarre-Teichmann *et al.* 2000) and subsequently generating favourable recruitment conditions for sprat (Köster and Möllmann, 2000, Köster *et al.*, 2003; MacKenzie and Köster, 2004).

## Birds and mammals

The marine mammals in the Baltic consist of grey (*Halichoerus grypus*), ringed (*Phoca hispida*), and harbour seals (*Phoca vitulina*), and a small population of harbour porpoise (*Phocoena phocoena*). Seals and harbour porpoise were much more abundant in the early 1900s than they are today (Elmgren 1989; Harding and Härkönen 1999) where their fish consumption may have been an important regulating factor for the abundance of fish (MacKenzie *et al.*, 2002). Baltic seal populations – harbour seals, grey seals and ringed seals – are generally increasing. Little is known about recent changes in the abundance of the harbour porpoise (Helcom 2001).

The seabirds in the Baltic Sea comprise pelagic species like divers, gulls and auks, as well as benthic feeding species like dabbling ducks, sea ducks, mergansers and coots (ICES 2003). The Baltic Sea is more important for wintering (c.10 million) than for breeding (c.0.5 million) seabirds and sea ducks. The common eider exploits marine waters throughout the annual cycle, but ranges from being highly migratory (e.g., in Finland) to being more sedentary (e.g., in Denmark). Population trends for seabirds breeding within the different countries of the Baltic Sea show an overall decrease for nine of the 19 breeding seabird species. Black-headed gulls are assessed as decreasing throughout the Baltic Sea, whereas the eight other species are considered decreasing in parts of the Baltic Sea. The status of other species, which

predominantly breed in the archipelago areas, like common eider, arctic skua, Caspian tern and black guillemot, is uncertain, and populations of these species may be decreasing in parts of the archipelago areas (ICES 2003).

### **8.1.2 Major environmental influences on ecosystem dynamics**

Variations in the abiotic environment of the Baltic Sea are strong and depend on climate forcing. Populations of fish are affected by this variability both with respect to growth and recruitment. The growth rate of herring and sprat diminish with reduced salinity in the eastern and northern part of the Baltic (Flinkman et al., 1998; Cardinale et al., 2002 Möllmann et al., 2003a; Cardinale and Arrhenius, 2000). The recruitment of herring in the Gulf of Riga and sprat in the entire Baltic are positively related to spring temperatures and the North Atlantic Oscillation index (MacKenzie and Köster, 2004).

The recruitment of the eastern cod stock depends primarily on the volume of water with sufficient oxygen content and salinity available in the deeper basins (Sparholt, 1996; Jarre-Teichmann et al., 2000; Köster et al., 2003a). The present hydrographic situation in the central basins of the southern Baltic suggests that during the spawning season in 2006, the most favourable conditions for cod egg survival are expected still to be restricted to the Bornholm Basin and the Slupsk Furrow, and not in the more eastern basins.

## **8.2 Human impacts on the ecosystem**

### **8.2.1 The major effects of fishing on the ecosystem**

In the Central Baltic cod and sprat spawn in the same deep basins and have partly overlapping spawning seasons. However, their reproductive success is largely out of phase. Hydrographic-climatic variability (i.e., low frequency of inflows from the North Sea, warm temperatures) and heavy fishing during the past three decades have led to a shift in the fish community from cod to clupeids (herring, sprat) by first weakening cod recruitment (Jarre-Teichmann *et al.* 2000) and subsequently generating favourable recruitment conditions for sprat thereby resulting increasing clupeid predation on early life stages of cod (Köster and Möllmann, 2000, Köster *et al.*, 2003; MacKenzie and Köster, 2004). The shift from a cod to a sprat-dominated system may thus be explained by differences in the reproductive requirements of both species in a changing marine environment. Additionally, the dominance shift was supported by the continued high fishing pressure on cod (Jarre-Teichmann 1995).

Coastal commercial and recreational fisheries have also influenced ecosystem structures (Hansson *et al.*, 1997). This impact is generally more local than that of the offshore fishery, however, since most of the coastal fish species are relatively stationary.

#### **8.2.1.1 Bycatch of fish**

The total by-catch of fish in the Baltic fisheries is presently unknown. The EU has supported several very recent studies of by-catch, the results of which have been compiled by ICES (2000c). These studies primarily concern the major fisheries for cod, herring and sprat and these have low by-catches. The less important smaller fisheries can have a high proportion of by-catch (Helcom 2002).

The occurrence of lost net have been surveyed in areas where gillnet fishing are practiced and lost nets are frequent ([www.fiskeriverket.se/miljofragor/pdf/okt-rapp\\_webb.pdf](http://www.fiskeriverket.se/miljofragor/pdf/okt-rapp_webb.pdf)). Lost gillnets in the Baltic cod fishery are most likely of concern for cod fishing mortality since 30-50% of the landings originate from the net fishery. Experiments show that during the first 3 months, the relative catching efficiency of “lost” nets decrease by around 80%, thereafter stabilising around 5–6% of the initial level (Tschernij and Larsson 2003).

#### **8.2.1.2 Bycatch of seabirds and mammals**

Fishing nets, in particular set nets, have caused considerable mortality for long-tailed ducks (*Clangula hyemalis*), velvet scoters (*Melanitta fusca*), eiders (*Somateria mollissima*) and black scoters (*Melanitta nigra*). There are also reports of guillemot and razorbill (*Alca torda*) mortality in the driftnet fishery for salmon (Helcom 2003).

Reports suggest that fisheries by-catches amount to 0.5–0.8% of the porpoise population in the south-western part of the Baltic Marine Area each year, as well as 1.2% of the porpoise population in the Kiel and Mecklenburg Bays and inner Danish waters (Kock and Behnke 1996). Estimates of the harbour porpoise population are uncertain, however, and the number of porpoises by-caught in fisheries is probably underestimated. The loss of porpoises to fishery in the Baltic Marine Area may be too high to sustain the population (ICES, 1997).

Seals have been recorded caught in fyke nets, set nets and salmon driftnets, but although the recorded data almost certainly underestimate the total number of by-caught seals, the added mortality does not appear to restrain the seal populations from increasing (Helander and Härkönen, 1997).

### 8.2.1.3 Other effects of fishing on seabirds and mammals

Fishing activities will also affect the seabird community through the discarding of unwanted catch and fish offal. Studies indicate, for example, that over 50% of the offal discarded in the Baltic Marine Area will be consumed by seabirds (ICES, 2000c).

### 8.2.2 Other effects of human use of the ecosystem

Human society uses the Baltic for many purposes including shipping, tourism, and mariculture. Overviews are given in Helcom (2002, 2003) and Frid *et al.* (2003). Shipping may pose threats due to transport and release of hazardous substances (e.g., oil) and non-indigenous organisms. The former would likely have only relatively short-term effects (e.g., direct mortality of individuals in a restricted time and area), whereas the latter are more likely to have longer-term and more widespread effects (e.g., influences on energy flows or species interactions in food webs).

### 8.2.3 Conclusions

#### 8.2.3.1 Short term

The WG was unable to identify strong environmental signals likely to have implications for short term management advice.

#### 8.2.3.2 Medium-term

Depletion of cod in the Baltic has contributed to a shift in the trophic structure from a cod dominated system to a clupeoid dominated system. This has been accompanied by shift in zooplankton and phytoplankton, which may be related to a reduced inflow of saline water, higher average temperatures and to increased precipitation due to a consistently high NAO in the 1990s. There is no evidence to suggest that the current situation will reverse, given the low level of cod biomass and lack of major inflow events.

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### Intensity of major Baltic inflows 1946-2003

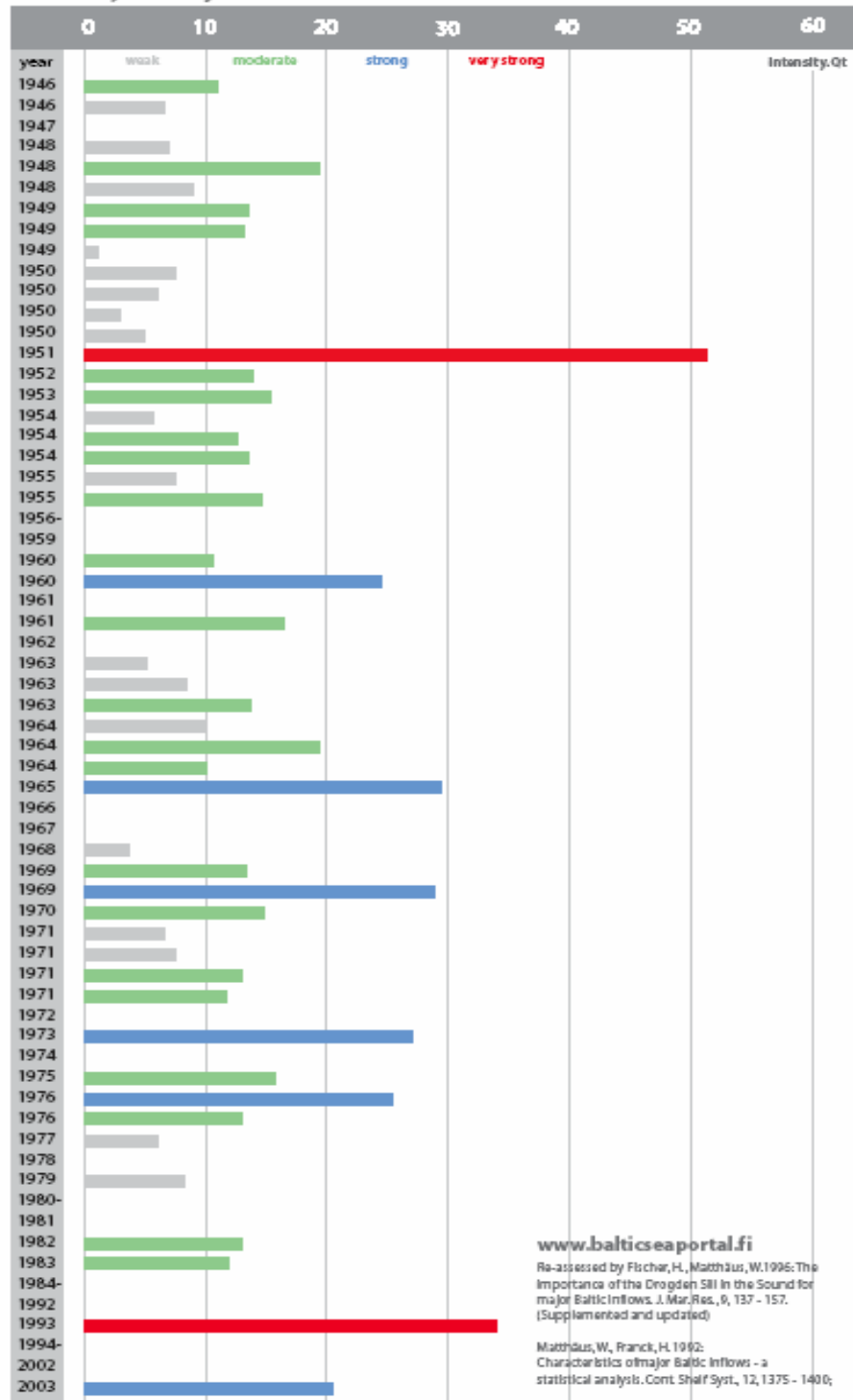
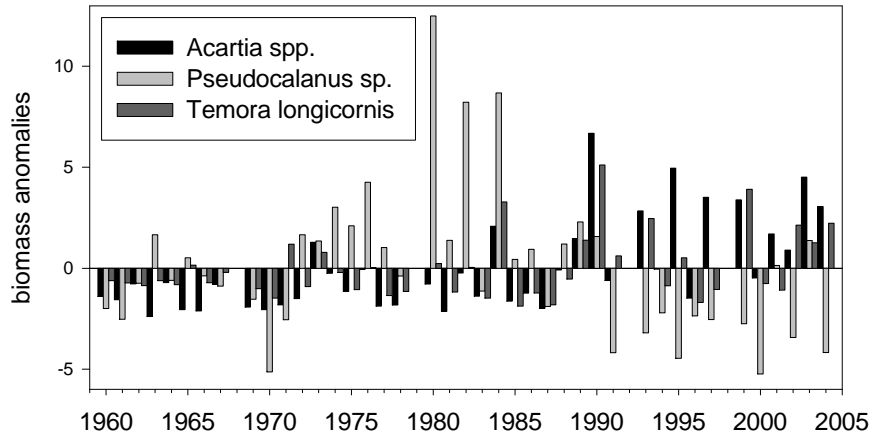
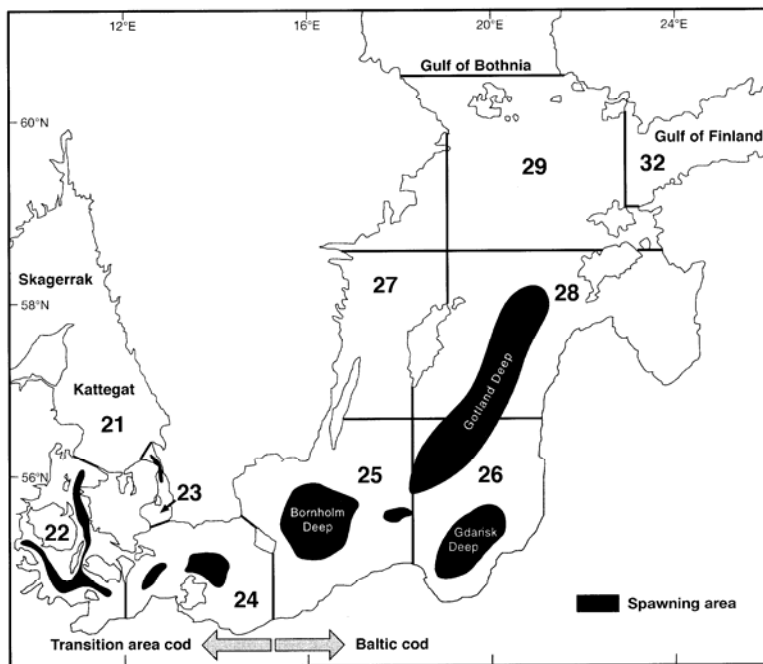


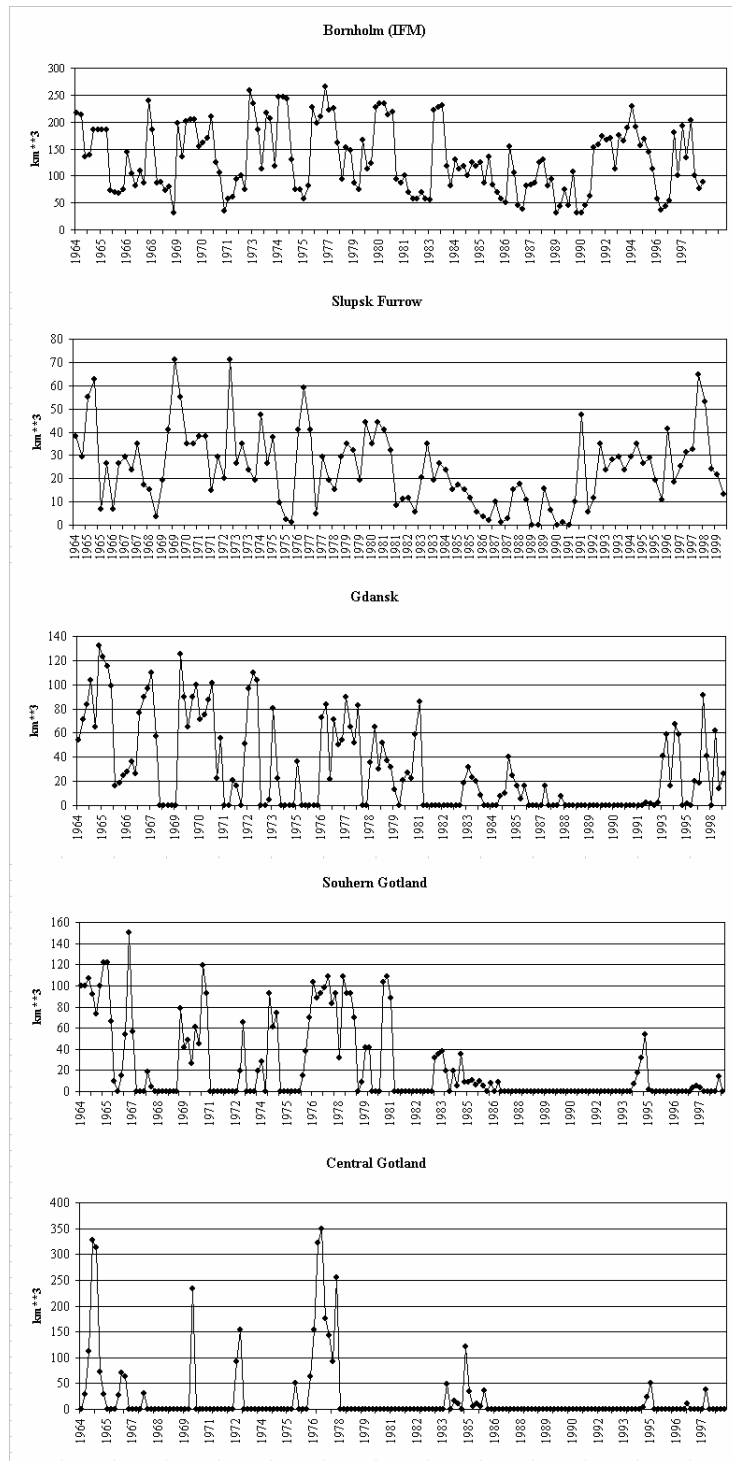
Figure 8.1.1.1 Intensity of inflows to the Baltic, 1946-2003.



**Figure 8.1.1.2** Time-series on spring biomass ( $\text{mg}\cdot\text{m}^{-3}$ ) anomalies for the dominant mesozooplankton species in the Eastern Baltic, i.e. the calanoid copepods *Acartia* spp., *Pseudocalanus* sp. and *Temora longicornis*; data are from the Latvian Fish Resource Agency LatFRA in Riga.



**Figure 8.1.1.3** Historical spawning areas for cod in the Baltic Sea. From Bagge, O., Thurow, F., Steffensen, E., Bay, J. 1994. *The Baltic Cod*. Dana Vol. 10:1-28, modified by Aro, E. 2000. The spatial and temporal distribution patterns of cod (*Gadus morhua callarias*) in the Baltic Sea and their dependence on environmental variability – implications for fishery management. Academic dissertation. University of Helsinki and Finnish Game and Fisheries Research Institute, Helsinki 2000, ISBN-951-776-271-2, 75 pp.



**Figure 8.1.1.4** Time-series of reproductive volume for each spawning site. From MacKenzie, B. R., Hinrichsen, H.-H., Plikshs, M., Wieland, K., Zezera, A. 2000. Quantifying environmental heterogeneity: estimating the size of habitat for successful cod *Gadus morhua* egg development in the Baltic Sea. [Marine Ecology Progress Series 193: 143-156](#). With updates by Maris Plikshs (Pers. Comm.).

## 8.3 Assessments and advice

### 8.3.1 Stock trends

Assessments are carried out for cod, herring, sprat, salmon and trout stocks. Results of the assessments are presented in the subsequent sections of the report.

**Cod in Subdivisions 22-24 (Western Baltic cod).** The cod stock in the Western Baltic has historically been much smaller than the neighbouring Eastern Baltic stock, from which it is biologically distinct. It appears to be a highly productive stock, which has sustained a very high fishing mortality for many years. Recruitment is rather variable and the stock is highly dependent upon the strength of incoming year classes. Spawner biomass has been at or below Bpa since 2002.

**Cod in Subdivisions 25-32 (Eastern Baltic cod).** The Eastern Baltic cod Stock is biologically distinct from the adjacent Western Baltic (Subdivisions 22-24) stock although there is some migration of fish between areas. Spawning is confined to the deep basins where egg survival depends on oxygen concentration in the deep saline water layer where fertilized eggs are neutrally buoyant. The total and spawning stock biomass increased by the end of the 1970s due to the extremely abundant year classes of 1976, 1977 and 1980 and favourable reproduction conditions in the southern and central Baltic Sea. The spawning stock declined from the historically highest level during 1982–1983 to the lowest level on record in the most recent years. The decline of the stock was a result of an increase of effort in the traditional bottom trawl fishery, introduction of gillnet fishery, and decreased egg and larval survival due to unfavourable oceanographic conditions (i.e., low oxygen concentrations impeding egg development and low food supply for larvae). Since the mid-1980s cod reproduction has only been successful in the southern spawning areas - Bornholm Basin and Slupsk Furrow. Although the present estimates of stock are uncertain due to misreporting of landings, discarding and age reading problems, all available information indicates that the SSB is at a very low level and the stock is considered to be below the biological reference points. Recruitment since the late 1980s has continued to be at a low level, although the year classes 2000 and 2003 may be stronger than other recent year classes.

**Flounder in Subdivisions 22-32.** The stock structure of the flounder in the Baltic Sea is uncertain. Stock identifications differ between studies relying on migration patterns (Aro 1989, Bagge and Steffensen 1989), spawning behaviour (Nissling et al. 2000), or microsatellite analyses (Florin and Höglund, in prep.). Migration studies indicate that there are several rather distinct flounder stocks (populations). Flounder is regularly distributed in all parts of the Baltic Sea, except in the Bothnian Bay, the most eastern part of the Gulf of Finland and the deepest areas of the Gotland Deep. According to migration studies (Aro 1989), there are at least three stocks in the south-western and south-eastern Baltic (ICES Subdivisions 22-26), three in the central and north eastern Baltic (ICES Subdivisions 27-28), in the Åland Sea, one in the Archipelago Sea and the southern Bothnian Sea, and two in the Gulf of Finland.

The migrations between the mature flounder stocks are quite sparse (Aro 1989). The natural boundaries of the stock in the south-western and central southern Baltic (ICES Subdivisions 24 and 25) may be drawn from the southern part of the Öland Island to the Rozewie on the Polish coast in the east and the Darßer Schwelle in the west. Spawning takes place in the Arkona Deep, the Slupsk Furrow and the Bornholm Deep at a depth of 40-80 m in the period from the second half of February to May. After spawning feeding migrations are directed to the shallow coastal areas, southwards to the coasts of Germany (to the west up to the Island Rügen) and Poland (to the east up to the areas of Rozewie) and northwards to the south coast of Sweden. During the late autumn and early winter there is a spawning migration to the main spawning grounds, and some part of the mature stock feeding in the Arkona region migrates to the Bornholm Basin to spawn.

A preliminary genetic study (Florin and Höglund, in prep.) of flounder from 12 different places ranging from Åland in the northern Baltic Sea to the Danish west coast supports the notion of genetically differentiated flounder stocks, by showing that genetic distance is significantly correlated to geographic distance. However, the results indicate that rather than a high number of small stocks, three major different groups of flounder could be identified: (1) Skagerrakk/Kattegat (subdivisions 20-21), (2) Southwest Baltic Sea (subdivisions 22-25), and (3) Western Baltic Sea (subdivisions 26-32) (for more details, see Gårdmark and Florin, 2006).

**Herring in Sub-divisions 25-29&32 excl. Gulf of Riga (Central Baltic herring)** is the largest herring stock assessed for the Baltic and it comprises a number of spawning components. This stock complex experienced a high biomass level in the early 1970s, but has then declined until 2001. The proportion of the various spawning components has varied in both landings and in stock. The southern components growing to a relatively large size have declined and at present the more northerly components with individuals reaching a maximum length of only about 18-20 cm are dominating in the landings. The recruitment has been below the long-term average since the beginning of the 1990s. The 2002 year class is relatively large and the spawning stock has increased slightly in the most recent years. Reported landings might be imprecise as this stock is caught together with sprat.

**Gulf of Riga herring.** This stock is classified to have a full reproductive capacity. The spawning stock biomass of the Gulf of Riga herring has been increasing in the late 1980s, and has been in the range of 85,000-120,000 t since. The year-class abundance of this stock is significantly influenced by hydro-meteorological conditions (by the severity of winter, in particular). Mild winters in the second half of 1990s have supported the formation of series of rich year-classes and increase of SSB. Due to low and only occasional presence of sprat in the Gulf, there is no mixed pelagic fishery in the Gulf of Riga.

**Herring in Subdivision 30.** The spawning stock of Bothnian Sea herring was at a relatively low level of 100 000 – 150 000 t until the mid-1980s, after which the SSB more than tripled by 1994. SSB fluctuated between 270 000 and 370 000 t in recent years. Although recruitment has been on average much higher during the high biomass period, favourable environmental conditions (i.e. warm summers in late-1980s, 1997, 2001 and 2002) have contributed to the production of the large year classes. The 2002 year class is estimated to be more than twice the size of the second largest year class in the time series.

**Herring in Subdivision 31** is one of the smallest herring stocks in the Baltic. The dynamics of the stock appears to be largely influenced by the environmental factors. In the absence of an agreed assessment, the present stock status is unclear.

**Sprat in Subdivisions 22-32** is the largest stock assessed in the Baltic and is considered to be exploited sustainably and to have full reproductive capacity. The spawning stock biomass has been low in the first half of the 1980s. In the beginning of the 1990s the stock started to increase rapidly and in 1996-1997 it reached the maximum observed spawning stock biomass of 1.8 million tonnes. The stock size increased due to the combination of strong recruitment and declining natural mortality (effect of low cod biomass). Since 1998, the stock is fluctuating between 800 000 t and 1 440 000 t. The main part of the sprat catches is taken for industrial purposes with bycatches of herring, and the species composition of these catches is very imprecise in some fishing areas /periods.

**Salmon in the Main Basin and the Gulf of Bothnia (Subdivisions 22 - 31)** consists of stocks in 5 different assessment units with similar biological and genetic characteristics inside each assessment unit. Stocks of a particular unit are assumed to exhibit similar migration patterns. It can therefore be assumed that they are subjected to the same fisheries, experience the same exploitation rates, and could be managed in the same way (e.g. through the use of coastal management measures it might be possible to improve the status of stocks in a specific assessment unit). The total wild smolt production has increased about fourfold in the main assessment units since management action was taken in 1997. However, the post-smolt survival in the last years has been very low. This leads to decreasing numbers of feeding and maturing salmon and an advice for reduction in catches and effort is recommended.

**Salmon in the Gulf of Finland (Subdivision 32)** consists of only a few small wild populations together with a number of mixed/reared stocks. The wild salmon populations are genetically distinct from each other, which indicates that these are still original salmon stocks. Surveys show that rivers where the stock mainly depends on enhancement releases still support fractions of the original wild salmon populations.

**Sea Trout in the Baltic** consists of approximately 1000 stocks of which about half are wild. There are no estimates of the historical numbers of sea trout populations or quantitative estimates of the total natural smolt production in past years. The status of these populations is very variable - some appear to be in a good state whereas others appear to be in a poor state.

#### **Mixed fisheries and fisheries interactions**

Officially reported fish catches in the Baltic until 2006 are given in Tables 8.3.2.1–8.3.2.5. These are the catches officially reported to ICES by national statistical offices for publication in the *ICES Fishery Statistics*. For use in the assessments, ICES estimates discards and landings which are not officially reported, and the composition of bycatches. These amounts are included in the estimates of total catch for each stock and are presented separately for each stock in the stock summaries in Section 8.4. These estimates vary considerably between different stocks and fisheries, being negligible in some cases and constituting important parts of the total removals from other stocks. Furthermore, the catches used in assessments are divided into subdivisions, whereas the officially reported catches by some countries are reported by the larger Divisions IIIb, c, and d. The trends in Table 8.3.2.1 may, therefore, not correspond to those on which assessments have been based, and are presented for information only.

Baltic cod is taken in a targeted fishery, in most areas with minimal bycatches of other commercially important fish. There are directed flatfish fisheries in some Baltic areas with bycatches of cod and non-commercial species.

There are indications of high removals by recreational fishing in the Baltic, especially of cod and salmonids. These are presently not included in the assessments.

Herring and sprat are taken in pelagic trawl fisheries, which include fisheries taking both species simultaneously. The actual composition of pelagic catches is poorly known for some fisheries because landings are assigned to species according to the target species in some landings statistics. In **Denmark** trawlers using mesh sizes smaller than 32 mm fish for industrial purposes, and the species composition is determined by logbooks/sale-slips and corroborated by samples. The landings not sampled are allocated to species according to a “dominant species” rule. When using meshes larger than 31 mm, trawlers are assumed to fish for human consumption and species composition is based on logbooks. The landings are allocated to fishing area according to information in logbooks. In **Estonia** species compositions are based on logbooks. Some (mostly visual) estimation by the Environmental Inspection is carried out. In **Finland** species compositions are by catch notifications and logbooks. Some inspections are made in harbours by regional Employment and Economic Development Centres. In **Germany** landings of herring from gillnets and trapnets with negligible amounts of sprat dominated the pelagic fishery till 2001. Thereafter a substantial increase in trawling pelagic fish has occurred. Species composition is determined by logbooks. In **Latvia** and **Lithuania** species composition is based on logbooks. In **Poland** species composition is based on logbooks and landing declarations. In **Russia** species composition is based on logbooks and sporadically checked by fishery inspectors in harbours. In **Sweden** species composition is based on logbooks. The samples taken by the Coast Guard for control purposes have so far not been used for the officially reported landings.

Overall, estimates of pelagic catch compositions are mainly based on logbooks and landing declarations, with limited supplementary sampling of catches. This means that the actual composition is uncertain. A comparison between the composition of pelagic landings and acoustic survey data indicates large discrepancies in the proportion of herring. This could mean that commercial fleets are fishing more discriminatory than the research vessels, or that the reported proportions do not reflect the species composition particularly well.

### Single-stock exploitation boundaries and critical stocks

The state of stocks and single-stock exploitation boundaries are summarised in the table below.

Species	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 2008
	SSB in relation to precautionary limits	F in relation to precautionary limits	F in relation to high long-term yield	F in relation to high long-term target	In relation to agreed management plan	In relation to precautionary limits	In relation to target reference points / high long term yield	
Cod in 22–24	At risk of reproductive capacity	Undefined	Overexploited	No target agreed	No formally accepted plan, proposed long-term plan: 22 695 t	Rebuild SSB > Bpa in 2008; <13 500 t	No targets agreed / F = 0.3-0.6; 7000 t – 12 000 t	13 500 t
Cod in 25–32	Reduced reproductive capacity	Harvested unsustainably	Overexploited	No target agreed	No formally accepted plan, proposed long-term plan: 50 945 t	No fishing	No targets agreed	0 t
Herring in IIIa and 22–24	Undefined	Undefined	Overexploited	No target agreed	No management plan	Reduce F by 20% to reach $F_{0.1}$ in 3-5 yrs	No targets agreed / $F > F_{0.1}$	71 000 t
Herring in 25–29 (excl GoR) and 32	Undefined	Harvested sustainably	Undefined	No target agreed	No management plan	F below $F_{pa}$ 0.19; <194 000 t	No targets agreed / $F = F_{0.1}=F_{pa}$ ; 194 000 t	194 000 t
Herring in the Gulf of Riga	Full reproductive capacity	Harvested sustainably	Overexploited	No target agreed	No management plan	F below $F_{pa}$ =0.4; <30 100 t	No targets agreed / $F = F_{0.1}$ ; 20 000 t	30 100 t
Herring in 30	Full reproductive capacity	Harvested sustainably	Undefined	No target agreed	No management plan	F below $F_{pa}$ =0.21 <67 300 t	No targets agreed	67 300 t
Herring in 31	Unknown	Unknown		No target agreed	No management plan	Below Recent catches <3000 t	No targets agreed	3000 t.
Sprat in 22–32	Full reproductive capacity	Harvested sustainably	Underfished	No target agreed	No management plan	F below $F_{pa}$ =0.4; <432 000 t.	No targets agreed	432 000 t.
Flounder	Unknown	Unknown		No target agreed	No management plan	Unknown	No targets agreed	
Plaice	Unknown	Unknown		No target agreed	No management plan	Unknown	No targets agreed	
Dab	Unknown	Unknown		No target agreed	No management plan	Unknown	No targets agreed	
Turbot in 22–32	Unknown	Unknown		No target agreed	No management plan	Unknown	No targets agreed	
Brill in 22-32	Unknown	Unknown	Unknown	No target agreed	No management plan	Unknown	No targets agreed	
Salmon in Main Basin and Gulf of Bothnia	<u>Low at-sea survival in recent years threatens stocks.</u>			No target agreed	Substantial reduction of catches and fishing effort necessary for directed salmon fishery compared to the present levels. Long-term benefits for smaller stocks are expected from a reduction of F. ICES cannot provide a quantitative estimate of the required reductions.			
Salmon in Gulf of Finland	The condition of the wild stocks is poor			No target agreed	No catch of wild salmon in the Gulf of Finland. Fisheries should only be permitted at sites where there is virtually no chance of taking wild salmon from the Gulf of Finland stocks along with reared salmon.			
Sea trout				No target agreed	Very variable state of the approx. 1000 different stocks in the Baltic. No framework for stock evaluation – no advice			

### Identification of critical stocks

The table above identifies the one stock outside precautionary limits, i.e. Eastern Baltic cod.

#### 8.3.2 ICES advice for fisheries management

Fisheries in the Baltic should in 2007 be managed according to the following rules:

- For Baltic Cod:
  - for eastern Baltic cod, fishery should be closed;
  - for western Baltic cod, a catch not exceeding 13 500 t;
- for Herring in Division IIIa and Subdivisions 22–24: the combined catch of spring-spawning herring in Division IIIa and the herring catch in Subdivision 22–24 should not exceed 71 000 t;
- for Herring in Subdivisions 25–29+32 (excl. Gulf of Riga): catches should be less than 194 000 t ;
- for Sprat in Subdivisions 22–32: the mixed pelagic fishery should be restricted so that herring catches in the Subdivisions 25–29+32 (excl. Gulf of Riga) are less than 194 000 t. Data on species compositions in the mixed pelagic fishery have not been available from all participating countries in the past and the expected sprat share of the mixed pelagic fishery can only be calculated if a proper monitoring system is in place. For EC member countries a monitoring system is required from 1 January 2005 (EC TAC and Quota regulation).
- The low post-smolt survival of salmon in recent years in combination with the high harvest rate implies that the spawning populations of salmon are low. Because the survival estimates are uncertain, the application of the precautionary approach is necessary and substantial reduction of salmon catches and fishing effort in directed salmon fishery is necessary compared to present levels.
- for Salmon in the Gulf of Finland: There should be no catch of wild salmon. Fisheries should only be permitted at sites where there is virtually no chance of taking wild salmon. To improve selectivity of harvesting, coastal fisheries at sites likely to be on migration paths of wild salmon from Estonian rivers should be prohibited. Poaching occurs in these rivers and must be stopped. Fishing in rivers and river mouths supporting wild stocks should be prevented.;
- for other stocks (herring in the Gulf of Riga, in the Bothnian Sea, in the Bothnian Bay) fisheries should be managed according to the precautionary limits stated in the table of individual stock limits above.

### Information from the fishing industry

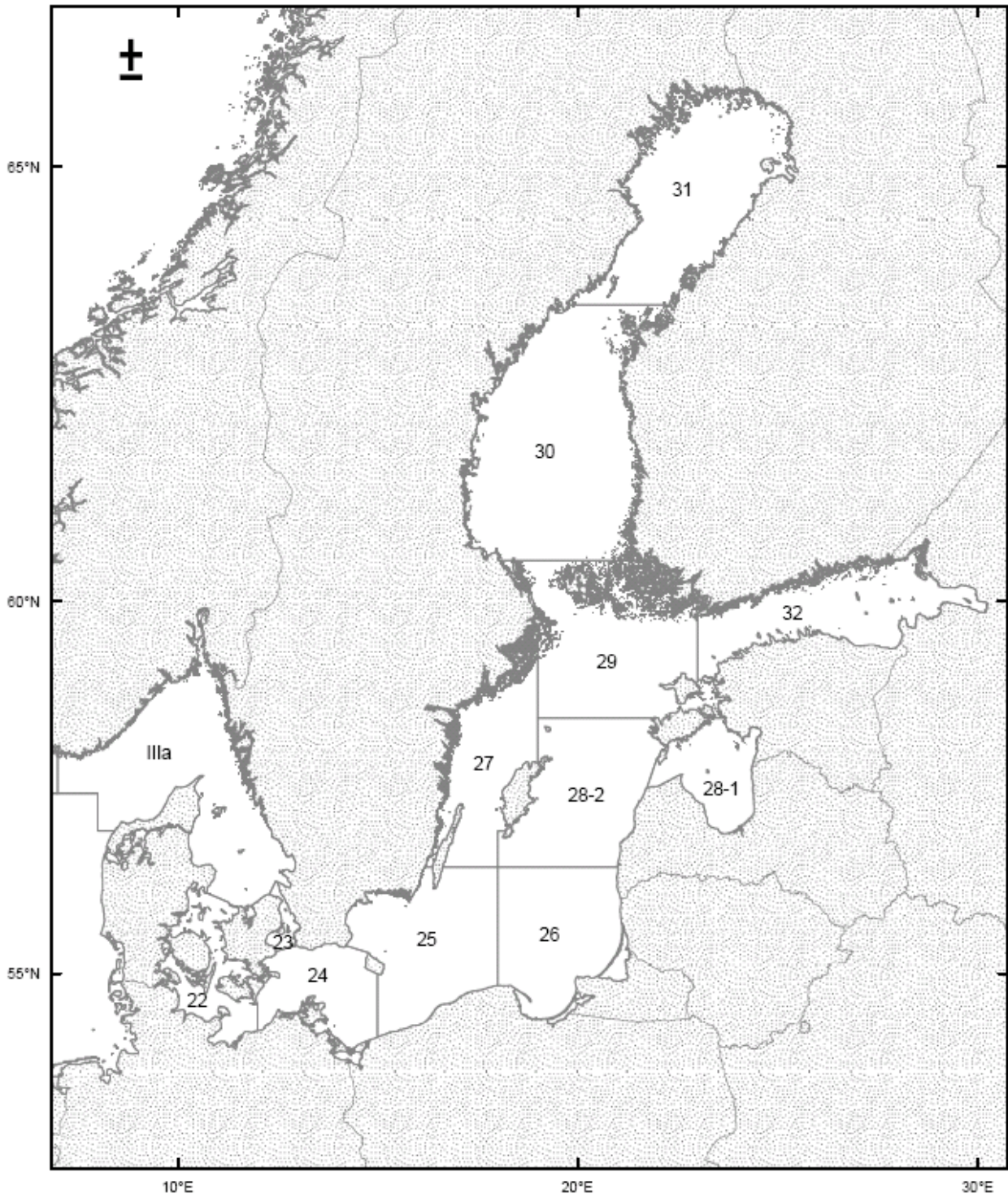
Information from the fishing industry and inspectors has been obtained in relation to estimates of unreported landings of cod.

### Quality of assessments and uncertainties

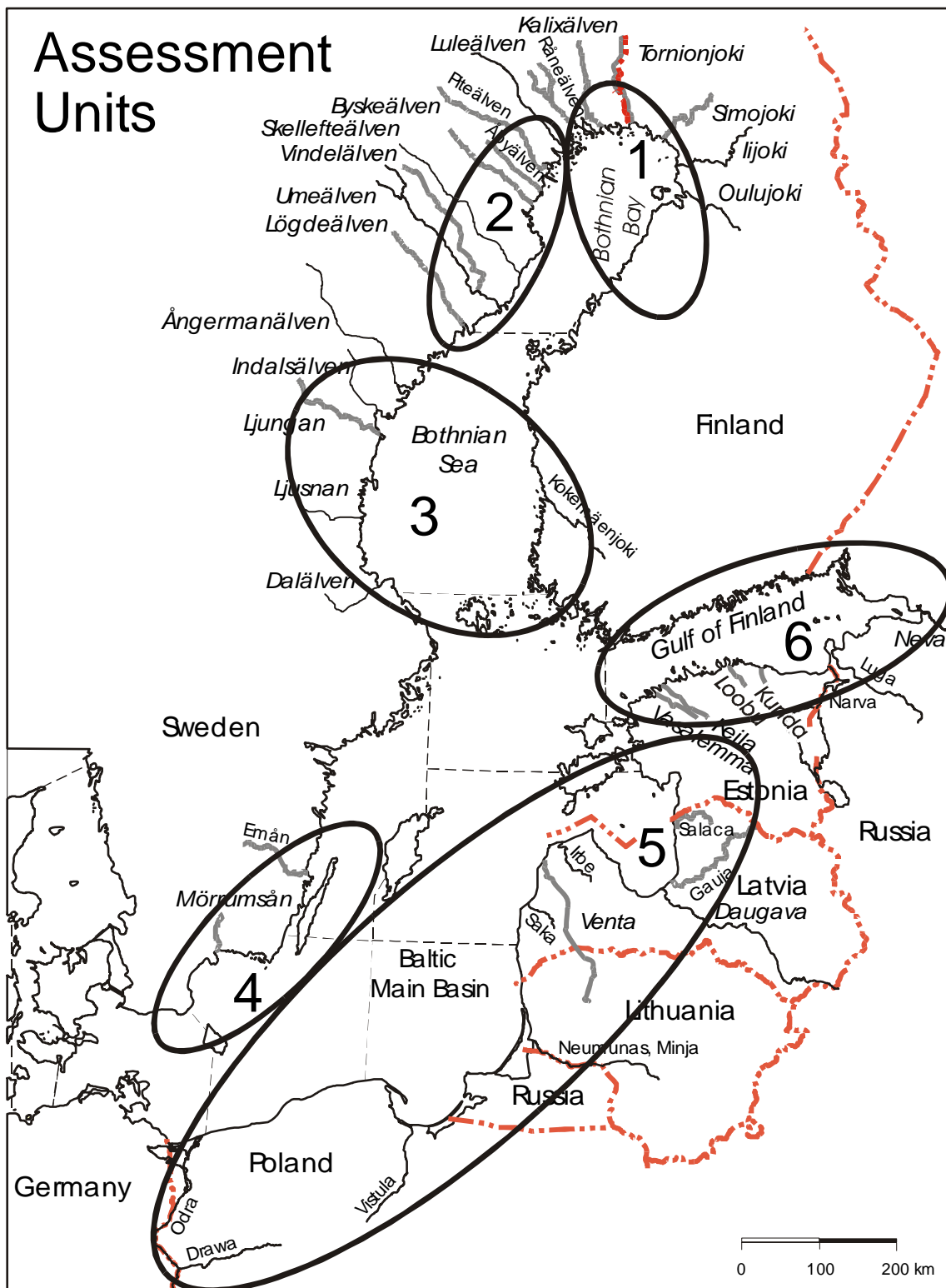
There are considerable problems with the quality of recent catch data for several stocks. For herring and sprat the estimates of catch compositions of some pelagic fisheries remain imprecise. For cod there have been significant unreported landings in recent years similar to the situation in the early 1990s. Age readings of cod and flounder are considered uncertain. Commercial fishing effort data for some species is poorly resolved due to unknown and variable levels of targeting and this affects the data quality of tuning fleet data series. Details of data quality and uncertainties are provided for each stock in the stock summaries in Section 8.4.

## Literature cited

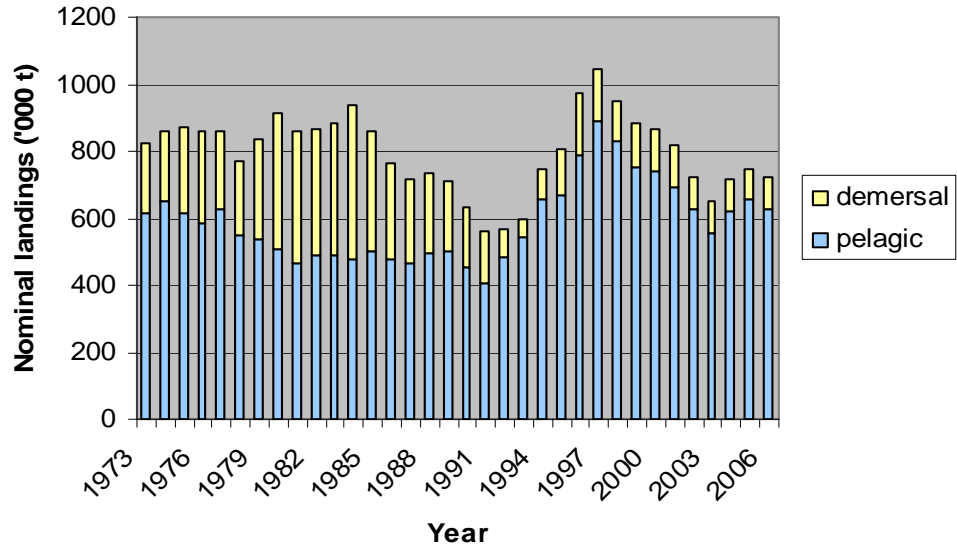
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**Figure 8.3.2.1** Subdivisions in the Baltic Sea.



**Figure 8.3.2.2** Grouping of salmon stocks in 6 assessment units in the Baltic Sea. The genetic variability between stocks of an assessment unit is smaller than the genetic variability between stocks of different units. In addition, the stocks of a particular unit exhibit similar migration patterns.



**Figure 8.3.2.3** Baltic Sea nominal catches.

**Table 8.3.2.1** Nominal fish catches in the Baltic (in '000 t). Anadromous species, except salmon, are not included. (Data as officially reported to ICES.)

Year	Species							Total
	Cod	Herring	Sprat	Flatfish	Salmon	Freshwater species	Others	
1973	189	404	213	18	2.7	23	55	905
1974	189	407	242	21	2.9	21	54	937
1975	234	415	201	24	2.9	20	60	957
1976	255	393	195	19	3.1	21	46	932
1977	213	413	211	22	2.4	22	42	925
1978	196	420	132	23	2.0	22	44	839
1979	273	459	78	24	2.3	20	47	903
1980	388	453	57	18	2.4	14	29	961
1981	380	419	47	16	2.4	13	31	908
1982	361	442	45	17	2.2	13	30	910
1983	376	459	31	16	2.4	13	20	917
1984	442	426	52	15	3.7	13	17	969
1985	344	431	69	17	4.0	11	16	892
1986	271	401	75	18	3.5	12	19	800
1987	238	373	91	16	3.8	13	24	759
1988	225	407	86	14	3.2	13	31	779
1989	192	414	89	14	4.2	14	18	745
1990	167	360	92	12	5.6	11	18	666
1991 <sup>1</sup>	139	295	111	14	4.6	17	19	600
1992 <sup>1</sup>	72	339	146	12	4.7	8	13	595
1993 <sup>1</sup>	41	352	194	12	3.4	10	7	619
1994 <sup>1</sup>	75	353	301	18	2.9	9	8	767
1995 <sup>1</sup>	117	343	326	22	2.7	9	17	837
1996 <sup>1</sup>	164	326	464	22	2.6	9	6	994
1997 <sup>1</sup>	134	370	520	20	2.6	12	7	1,066
1998 <sup>1</sup>	103	383	446	18	2.1	11	3	966
1999	117	343	408	18	1.7	11	4	903
2000 <sup>2</sup>	105	371	369	20	2.0	20	4	891
2001 <sup>2</sup>	103	339	354	23	1.7	20	4	845
2002 <sup>2</sup>	74	281	345	24	1.5	20	4	750
2003	74	232	325	20	1.3	-	-	-
2004	73	233	388	23	1.8	-	-	-
2005	63	222	434	25	1.5	-	-	-
2006 <sup>1</sup>	71	243	386	21	1.1	-	-	-

<sup>1</sup>Preliminary.

<sup>2</sup>Includes recreational catches from Finland.

**Table 8.3.2.2** Nominal catch (tonnes) of HERRING in Divisions IIIb,c,d. (Data as officially reported to ICES.)

Year	Denmark	Finland	German Dem.Rep.	Germany, Fed.Rep.	Poland	Sweden	USSR	Total
1963	14,991	48,632	10,900	16,588	28,370	27,691	78,580 <sup>1</sup>	225,752
1964	29,329	34,904	7,600	16,355	19,160	31,297	84,956	223,601
1965	20,058	44,916	11,300	14,971	20,724	31,082 <sup>2</sup>	83,265	226,216
1966	22,950	41,141	18,600	18,252	27,743	30,511	92,112	251,309
1967	23,550	42,931	42,900	23,546	32,143	36,900	108,154	310,124
1968	21,516	58,700	39,300	16,367	41,186	53,256	124,627	354,952
1969	18,508	56,252	19,100	15,116	37,085	30,167	118,974	295,202
1970	16,682	51,205	38,000	18,392	46,018	31,757	110,040	312,094
1971	23,087	57,188	41,800	16,509	43,022	32,351	120,728	334,685
1972	16,081	53,758	58,100	10,793	45,343	41,721	118,860	344,656
1973	24,834	67,071	65,605	8,779	51,213	59,546	127,124	404,172
1974	19,509	73,066	70,855	9,446	55,957	60,352	117,896	407,081
1975	18,295	69,581	71,726	10,147	68,533	62,791	113,684	414,757
1976	23,087	75,581	58,077	6,573	63,850	41,841	124,479	393,488
1977	25,467	78,051	62,450	7,660	60,212	52,871	126,000	412,711
1978	26,620	89,792	46,261	7,808	63,850	54,629	130,642	419,602
1979	33,761	83,130	50,241	7,786	79,168	86,078	118,655	458,819
1980	29,350	74,852	59,187	9,873	68,614	92,923	118,074	452,873
1981	28,424	65,389	56,643	9,124	64,005	84,500	110,782	418,867
1982	40,289	73,501	50,868	8,928	76,329	92,675	99,175	441,765
1983	32,657	83,679	51,991	9,273	82,329	86,561	112,370	458,860
1984	32,272	86,545	50,073	8,166	78,326	65,519	105,577	426,478
1985	27,847	88,702	51,607	9,079	85,865	57,554	110,783	431,437
1986	21,598	83,800	53,061	9,382	77,109	39,909	115,665	400,524
1987	23,283	82,522 <sup>3</sup>	50,037	6,199	60,616	36,446	113,844	372,947
1988	29,950	92,824 <sup>3</sup>	53,539	5,699	60,624	41,828	122,849	407,313
1989	26,654	81,122 <sup>3</sup>	54,828	5,777	58,328	65,032	121,784	413,525
1990	16,237	66,078 <sup>3</sup>	40,187 <sup>8</sup>	5,152 <sup>8</sup>	60,919	55,174	116,478	360,225

Year	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Sweden	Russia	Total
1991	23,995	27,034 <sup>4</sup>	51,546 <sup>3</sup>	16,022	33,270	6,468 <sup>5</sup>	45,991	59,176	31,755	295,257 <sup>6</sup>
1992	33,855	29,556	72,171 <sup>3</sup>	17,746	25,965	3,237 <sup>6</sup>	52,864	75,907	27,979	339,280 <sup>6</sup>
1993	34,945	32,982	77,353 <sup>3</sup>	20,143	21,949	3,912 <sup>6</sup>	50,833	86,497	23,545	352,159 <sup>6</sup>
1994	45,190	34,493	97,674 <sup>3</sup>	12,367	22,676	4,988 <sup>6</sup>	49,111	70,886	15,904	353,411 <sup>6,7</sup>
1995	37,762	43,482	94,613 <sup>3</sup>	7,898	24,972	3,706 <sup>6</sup>	45,676	68,019	16,970	343,099 <sup>6</sup>
1996	34,340	45,296	93,337 <sup>3</sup>	7,737	27,523	4,257 <sup>6</sup>	31,246	67,116	14,780	325,632 <sup>6</sup>
1997	30,876	52,436	90,334 <sup>3</sup>	12,755	29,330	3,321 <sup>6</sup>	28,939	110,463	11,801	370,255 <sup>6</sup>
1998	38,800	42,721	85,545 <sup>3</sup>	9,514	24,417	2,368 <sup>6</sup>	21,873	147,706	10,544	383,488 <sup>6</sup>
1999	37,974	44,039	82,237 <sup>3</sup>	10,115	27,163	1,313	19,229	108,316	12,756	343,142
2000	49,727	41,735	81,648 <sup>3</sup>	9,475	26,768	1,198	24,516	120,887	15,063	371,017
2001	46,297	41,737	82,867 <sup>3</sup>	11,447	26,652	1,639	37,611	75,194	15,797	339,241
2002	18,406	36,251	76,242 <sup>3</sup>	22,661	25,284	1,539	35,512	51,194	14,168	281,257
2003	8,254	27,359	64,021	22,637	24,187	2,109	30,703	39,350	13,363	231,983
2004	8,572	27,358	71,073	22,244	23,559	1,845	27,764	43,922	6,585	232,922
2005	7,175	22,099	66,978	24,754	22,202	748	21,766	48,940	7,016	221,678
2006 <sup>6</sup>	6,989	23,192	79,955	26,206	21,762	1,172	20,544	53,166	9,780	242,766

<sup>1</sup>Including Division IIIa.<sup>2</sup>Large quantity of herring used for industrial purposes is included with "Unsorted and Unidentified Fish".<sup>3</sup>Includes some bycatch of sprat.<sup>4</sup>As reported by Estonian authorities; 32,683 t reported by Russian authorities.<sup>5</sup>As reported by Lithuanian authorities; 6,456 t reported by Russian authorities.<sup>6</sup>Preliminary.<sup>7</sup>Includes catches from the Faroe Islands of 122 t.<sup>8</sup>The 1990 catches listed under the Federal Republic of Germany and the German Democratic Republic refer to catches by vessels from the respective former territories during the whole of 1990, before and after the political union. Thus, catches taken by vessels registered in the former German Democratic Republic in the months after unification are included in the German Democratic Republic figures.

**Table 8.3.2.3** Nominal catch (tonnes) of SPRAT in Divisions IIIb,c,d. (Data as officially reported to ICES.)

Year	Denmark	Finland	German Dem.Rep.	Germany, Fed.Rep.	Poland	Sweden	USSR	Total
1963	2,525	1,399	8,000	507	10,693	101	45,820 <sup>1</sup>	69,045
1964	3,890	2,111	14,700	1,575	17,431	58	55,753	95,518
1965	1,805	1,637	11,200	518	16,863	46	52,829	84,898
1966	1,816	2,048	21,200	66	13,579	38	52,407	91,454
1967	3,614	1,896	11,100	2,930	12,410	55	40,582	72,587
1968	3,108	1,291	10,200	1,054	14,741	112	55,050	85,556
1969	1,917	1,118	7,500	377	17,308	134	90,525	118,879
1970	2,948	1,265	8,000	161	20,171	31	120,478	153,054
1971	1,833	994	16,100	113	31,855	69	133,850	184,814
1972	1,602	972	14,000	297	38,861	102	151,460	207,294
1973	4,128	1,854	13,001	1,150	49,835	6,310	136,510	212,788
1974	10,246	1,035	12,506	864	61,969	5,497	149,535	241,652
1975	9,076	2,854	11,840	580	62,445	31	114,608	201,434
1976	13,046	3,778	7,493	449	56,079	713	113,217	194,775
1977	16,933	3,213	17,241	713	50,502	433	121,700	210,735
1978	10,797	2,373	13,710	570	28,574	807	75,529	132,360
1979	8,897	3,125	4,019	489	13,868	2,240	45,727	78,365
1980	4,714	2,137	151	706	16,033	2,388	31,359	57,488
1981	8,415	1,895	78	505	11,205	1,510	23,881	47,489
1982	6,663	1,468	1,086	581	14,188	1,890	18,866	44,742
1983	2,861	828	2,693	550	8,492	1,747	13,725	30,896
1984	3,450	374	2,762	642	10,954	7,807	25,891	51,880
1985	2,417	364	1,950	638	22,156	7,111	34,003	68,639
1986	5,693	705	2,514	392	26,967	2,573	36,484	75,328
1987	8,617	287 <sup>2</sup>	1,308	392	34,887	870	44,888	91,249
1988	6,869	495 <sup>2</sup>	1,234	254	25,359	7,307	44,181	85,699
1989	9,235	222 <sup>2</sup>	1,166	576	20,597	3,453	53,995	89,244
1990	8,858	162 <sup>2</sup>	518	905	14,299	7,485	59,737	91,964

Year	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Sweden	Russia	Total
1991	21,781	14,124 <sup>3</sup>	99 <sup>2</sup>	736	17,996 <sup>4</sup>	3,569	23,200	8,328	20,736	110,569 <sup>5</sup>
1992	28,210	4,140	893 <sup>2</sup>	608	17,388	1,697 <sup>5</sup>	30,126	53,558	9,851	146,471 <sup>5</sup>
1993	27,435	5,763	206 <sup>2</sup>	8,267	12,553	2,798 <sup>5</sup>	33,701	92,416	10,745	193,884 <sup>5</sup>
1994	69,644	9,079	497 <sup>2</sup>	374	20,132	2,789 <sup>5</sup>	44,556	135,779	16,719	300,535 <sup>5,6</sup>
1995	76,420	13,052	4,103 <sup>2</sup>	230	24,383	4,799 <sup>5</sup>	37,280	150,435	14,934	325,636 <sup>5</sup>
1996	123,549	22,493	14,351 <sup>2</sup>	161	34,211	10,165 <sup>5</sup>	77,472	163,087	18,287	463,776 <sup>5</sup>
1997	153,765	39,692	19,852 <sup>2</sup>	428	49,314	6,000 <sup>5</sup>	105,298	123,207	22,194	519,750 <sup>5</sup>
1998	111,003	32,165	27,014	4,551	44,858	5,132 <sup>5</sup>	59,091	141,209	21,078	446,122 <sup>5,7</sup>
1999	97,686	36,407	18,886 <sup>2</sup>	182	42,834	3,117	71,705	106,000	31,627	408,444
2000	55,521	41,394	23,242 <sup>2</sup>	22	46,186	1,682	84,325	85,981	30,369	368,722
2001	53,189	40,776	15,849 <sup>2</sup>	792	42,769	3,135	85,757	79,553	31,959	353,779
2002	47,630	40,717	17,258 <sup>2</sup>	950	47,540	2,800	81,244	74,109	32,854	345,102
2003	39,528	29,366	8,961	18,023	41,743	3,032	84,097	71,188	28,663	324,601
2004	44,289	37,308	16,584	26,354	52,399	6,185	95,798	83,949	25,109	387,975
2005	53,696	55,285	17,894	28,975	64,647	8,635	74,329	100,797	29,749	434,007
2006 <sup>5</sup>	42,323	46,689	19,020	30,779	54,638	10,814	55,890	97,584	28,324	386,061

<sup>1</sup>Including Division IIIa.<sup>2</sup>Some bycatch of sprat included in herring.<sup>3</sup>As reported by Estonian authorities; 17,893 t reported by Russian authorities.<sup>4</sup>As reported by Latvian authorities; 17,672 t reported by Russian authorities.<sup>5</sup>Preliminary.<sup>6</sup>Includes catches from the Faroe Islands of 966 t.<sup>7</sup>Includes catches from the Faroe Islands of 21 t.

**Table 8.3.2.4** Nominal catch (tonnes) of COD in Divisions IIIb,c,d. (Data as officially reported to ICES.)

Year	Denmark	Faroe Islands	Finland	German Dem.Rep.	Germany Fed.Rep.	Poland	Sweden	USSR	Total
1963	35,851		12	7,800	10,077	47,514	22,827	30,550 <sup>1</sup>	154,631
1964	34,539		16	5,100	13,105	39,735	16,222	24,494	133,211
1965	35,990		23	5,300	12,682	41,498	15,736	22,420	133,649
1966	37,693		26	6,000	10,534	56,007	16,182	38,269	164,711
1967	39,844		27	12,800	11,173	56,003	17,784	42,975	180,606
1968	45,024		70	18,700	13,573	63,245	18,508	43,611	202,731
1969	45,164		58	21,500	14,849	60,749	16,656	41,582	200,558
1970	43,443		70	17,000	17,621	68,440	13,664	32,248	192,486
1971	47,563		3	9,800	14,333	54,151	12,945	20,906	159,701
1972	60,331		8	11,500	13,814	56,746	13,762	30,140	186,301
1973	66,846		95	11,268	25,081	49,790	16,134	20,083	189,297
1974	58,659		160	9,013	20,101	48,650	14,184	38,131	188,898
1975	63,860		298	14,740	21,483	69,318	15,168	49,289	234,156
1976	77,570		278	8,548	24,096	70,466	22,802	51,516	255,276
1977	74,495		310	10,967	31,560	47,703	18,327	29,680	213,042
1978	50,907		1,446	9,345	16,918	64,113	15,996	37,200	195,925
1979	60,071		2,938	8,997	18,083	79,697	24,003	78,730	272,519
1980	76,015	1,250	2,317	7,406	16,363	123,486	34,089	124,359	388,186 <sup>2</sup>
1981	93,155	2,765	3,249	12,938	15,082	120,942	44,300	87,746	380,177
1982	98,230	4,300	3,904	11,368	19,247	92,541	44,807	86,906	361,303
1983	108,862	6,065	4,677	10,521	22,051	76,474	54,876	92,248	375,774
1984	121,297	6,354	5,257	9,886	39,632	93,429	65,788	100,761	442,404
1985	107,614	5,890	3,793	6,593	24,199	63,260	54,723	78,127	344,199
1986	98,081	4,596	2,917	3,179	18,243	43,237	48,804	52,148	271,205
1987	85,544	5,567	2,309	5,114	17,127	32,667	50,186	39,203	237,717
1988	75,019	6,915	2,903	4,634	16,388	33,351	58,027	28,137	225,374
1989	66,235	4,499	1,913	2,147	14,637	31,855	55,919	14,722	191,927
1990	56,702	3,558	1,667	1,630	7,225	28,730	54,473	13,461	167,446

Year	Denmark	Estonia	Faroe Islands	Finland	Germany	Latvia	Lithuania	Poland	Sweden	Russia	Total
1991	50,640	1,805 <sup>3</sup>	2,992	1,662	8,637	2,627	1,849	25,748	39,552	3,196	138,708 <sup>4</sup>
1992	30,418	1,369	593	460	6,668	1,250	874 <sup>4</sup>	13,314	16,244	404	71,594 <sup>4</sup>
1993	10,919	70	558	203	5,127	1,333	904 <sup>4</sup>	8,909	12,201	483	40,707 <sup>4</sup>
1994	19,822	905	779	520	7,088	2,379	1,886 <sup>4</sup>	14,426	25,685	1,114	74,604 <sup>4</sup>
1995	34,612	1,049	777	1,851	14,681	6,471	3,629 <sup>4</sup>	25,001	27,289	1,612	117,265 <sup>4,5</sup>
1996	48,505	1,392	714	3,132	20,607	8,741	5,521 <sup>4</sup>	34,856	36,932	3,304	163,993 <sup>4,5</sup>
1997	42,581	1,173	33	1,537	14,483	6,187	4,497 <sup>4</sup>	31,659	29,329	2,803	134,282 <sup>4</sup>
1998	29,476	1,070	-	1,033	10,989	7,778	4,187 <sup>4</sup>	25,778	17,665	4,599	102,575 <sup>4</sup>
1999	38,169	1,060	-	1,570	15,439	6,914	4,371	26,581	17,476	5,211	116,791
2000	32,049	513	n/a	1,824	13,079	6,280	4,721	22,120	19,801	4,669	105,056
2001	29,126	755	n/a	1,724	12,738	6,298	3,852	21,992	21,120	5,032	102,637
2002	21,558	36	n/a	1,053	8,767	4,867	2,964	15,892	15,203	3,793	74,133
2003	22,338	559	n/a	1,168	8,125	4,634	2,900	16,029	14,686	3,707	74,147
2004	20,693	1,278	n/a	888	8,407	5,027	3,382	15,090	15,201	3,410	73,367
2005	19,043	588	n/a	286	9,346	3,996	2,993	12,767	10,558	3,434	63,011
2006 <sup>4</sup>	21,425	703	n/a	673	9,558	2,993	3,301	15,080	12,252	3,747	71,306

<sup>1</sup>Including Division IIIa.<sup>2</sup>Includes catches from United Kingdom (England & Wales) of 2,901 t.<sup>3</sup>As reported by Estonian authorities; 1,812 t reported by Russian authorities.<sup>4</sup>Preliminary.<sup>5</sup>Includes catches from Norway of 293 t for 1995 and 289 t for 1996.

**Table 8.3.2.5** Nominal catch (tonnes) of FLATFISH in Divisions IIIb,c,d. (Data as officially reported to ICES.)

Year	Denmark	Finland	German Dem.Rep.	Germany, Fed.Rep.	Poland	Sweden	USSR	Total
1963	9,888	-	3,390	794	2,794	1,026	1,460 <sup>1</sup>	19,862
1964	9,592	-	4,600	905	1,582	1,147	4,420	22,246
1965	8,877	-	2,300	899	2,418	1,140	5,471	21,105
1966	7,590	-	2,900	647	3,817	1,113	5,328	21,395
1967	8,773	-	3,400	786	2,675	1,077	4,259	20,970
1968	9,047	-	3,600	769	4,048	1,047	4,653	23,164
1969	8,693	-	2,800	681	3,545	953	4,167	20,839
1970	7,937	-	2,200	606	3,962	464	3,731	18,900
1971	7,212	-	2,500	553	4,093	415	4,088	18,861
1972	6,817	-	3,200	542	4,940	412	3,950	19,861
1973	6,181	-	3,419	655	4,278	724	2,550	17,807
1974	9,686	55 <sup>2</sup>	2,390	628	4,668	653	2,515	20,595
1975	8,257	100	2,172	937	5,139	658	6,455	23,718
1976	7,572	194	2,801	836	4,394	582	3,018	19,397
1977	7,239	203	3,378	960	4,879	484	4,754	21,897
1978	9,184	390	4,034	1,106	5,418	396	2,500	23,028
1979	10,376	399	4,396	665	5,137	450	2,670	24,093
1980	8,276	52	3,286	460	3,429	427	2,305	18,235
1981	6,674	78	3,031	704	2,958	434	2,323	16,202
1982	5,818	50	3,608	543	4,214	250	2,596	17,079
1983	6,000	39	3,957	751	2,809	217	2,371	16,144
1984	5,165	43	3,173	662	3,865	176	1,859	14,943
1985	6,506	37	4,290	542	3,533	170	1,528	16,606
1986	6,808	52	3,480	494	5,044	250	1,438	17,566
1987	5,734	58	2,457	757	4,468	273	2,194	15,941
1988	5,092	69	3,227	759	3,030	281	1,605	14,063
1989	4,597	70	3,822	644	2,946	245	1,723	14,047
1990	5,682	59	1,722	820	2,253	257	1,427	12,220

Year	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Sweden	Russia	Total
1991	5,583	248 <sup>3</sup>	76	3,055	445 <sup>4</sup>	n/a	4,009	224	317 <sup>5</sup>	13,957 <sup>6</sup>
1992	4,579	164	64	2,287	624	399 <sup>6</sup>	3,906	337	75	12,435 <sup>6</sup>
1993	3,275	165	85	2,156	475	155 <sup>6</sup>	5,101	271	159	11,842 <sup>6</sup>
1994	5,094	162	79	6,634	337	270 <sup>6</sup>	4,900	314	173	17,963 <sup>6</sup>
1995	6,556	102	89	5,146	411	209 <sup>6</sup>	8,964	661	268	22,406 <sup>6</sup>
1996	6,387	297	98	3,134	336	401 <sup>6</sup>	8,836	1,597	774	21,860 <sup>6</sup>
1997	6,357	334	85	3,311	413	696 <sup>6</sup>	6,168	1,374	1,131	19,869 <sup>6</sup>
1998	5,862	355	81	2,955	400	811 <sup>6</sup>	5,835	677	1,188	18,164 <sup>6</sup>
1999	5,579	416	82	3,239	563	571	5,787	439	1,013	17,689
2000	6,994	420	453	3,475	434	641	5,602	462	1,445	19,926
2001	8,183	482	503	2,919	619	1,155	6,725	565	1,420	22,571
2002	7,478	515	452	3,011	608	1,100	9,232	447	1,364	24,207
2003	5,684	443	199	2,617	682	1,115	7,343	380	1,430	19,893
2004	6,818	406	121	3,082	777	909	8,828	308	1,292	22,541
2005	5,904	403	105	2,489	1,720	967	11,239	415	1,428	24,670
2006 <sup>6</sup>	5,486	352	103	2,541	1,169	386	9,583	301	1,237	21,158

<sup>1</sup>Including Division IIIa.<sup>2</sup>Excluding subsistence fisheries.<sup>3</sup>As reported by Estonian authorities; 236 t reported by Russian authorities.<sup>4</sup>As reported by Latvian authorities; 466 t reported by Russian authorities.<sup>5</sup>Includes 141 t reported by Russian authorities for Lithuania.<sup>6</sup>Preliminary.