European Environment Agency

Europe's biodiversity

- biogeographical regions and seas

Seas around Europe

The Baltic Sea

- the largest brackish sea in the world

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Summary

- The Baltic is the largest brackish water system in the world. Its only connection to more open seas are the shallow sounds between Sweden and Denmark.
- The sea is slowly shrinking because of geological uplifting of land after the last glaciation.
- In many respects the Baltic is similar to an inland lake or an estuary. It is unique in that there are areas where freshwater, brackish water and marine species are all present. Its salinity increases from east to west and from north to south.
- The marked vertical and horizontal salinity gradients are reflected in different species communities and species numbers. The highest biodiversity is found in the south-west of the Baltic Sea.
- Many of the marine species are at the limit of their distributions.
- The main threats to biodiversity in the Baltic Sea are:
  - Eutrophication: this has caused increased amounts of planktonic algae, increased frequencies of toxic blooms of algae, the reduction of oxygen levels in the deep waters of the Baltic and a decline or disappearance of larger perennial macroalgae.
  - Fisheries: Fishery of the main target fish species such as cod, herring, salmon and eel is presently unsustainable due to over-exploitation and impairment of conditions for reproduction. Bycatches of marine mammals, seabirds and non-target fish species are too high.
  - Pollution by contaminants and oil: Organic contaminants have caused health and reproduction problems in marine mammals and birds. Oil has killed seabirds and negatively effected benthic communities.
  - Introduction of non-indigenous species: Changes in the structure and components of the ecosystem are caused by introduced species. Intentional introduction, fouling and ballast water are three important ways organisms have been introduced into the Baltic Sea. The river connections with the brackish waters in the Black and Caspian Seas increase the risk of introduction from these areas.

1. What are the characteristics of the Baltic Sea?

1.1 General characteristics

Table 1: Statistics for the Baltic Sea

Surface area km^2	Water volume km^3	Average depth m	Surface temperature °C (Baltic Proper)
370 000	21 000	57 max. 459	August: 16–17 February: 1–2

Table 2: Salinity in different parts of the Baltic Sea (salinity in the open North Sea is within the range 32–34.5 ‰)

Salinity ‰	Northern Gulf of Bothnia	Southern Gulf of Bothnia	Baltic central	Kattegat
Surface Bottom	1–3 4	3–6 5–6	6–8 10–18	18–30 30–34

The Baltic Sea is a relatively shallow inland sea in north-east Europe, bounded by the coastlines of Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Russian Federation and Sweden. The catchment area is 1 650 000 km^2, more than four times the area of the sea itself. Almost 80 million people live within the catchment area.

The shallow sounds between Sweden and Denmark provide a limited water exchange with the North Sea. There is a clear salinity gradient from the almost oceanic conditions in the northern Kattegat to the almost freshwater conditions in the northern Gulf of Bothnia (Table 2). Most of the water input comes from rivers, with marked seasonal and also long-term variability. The freshwater generates an outflowing low-salinity surface current towards the Skagerrak and North Sea, and an inflowing bottom current of higher salinity from the Skagerrak to the Baltic Sea. Persistent westerly winds can generate large short-term inflows of higher salinity. The interval between such episodes may be several years, but they can have significant ecological effects. The distribution of plant and animal species is profoundly influenced by variations in the salinity and stratification of the water.

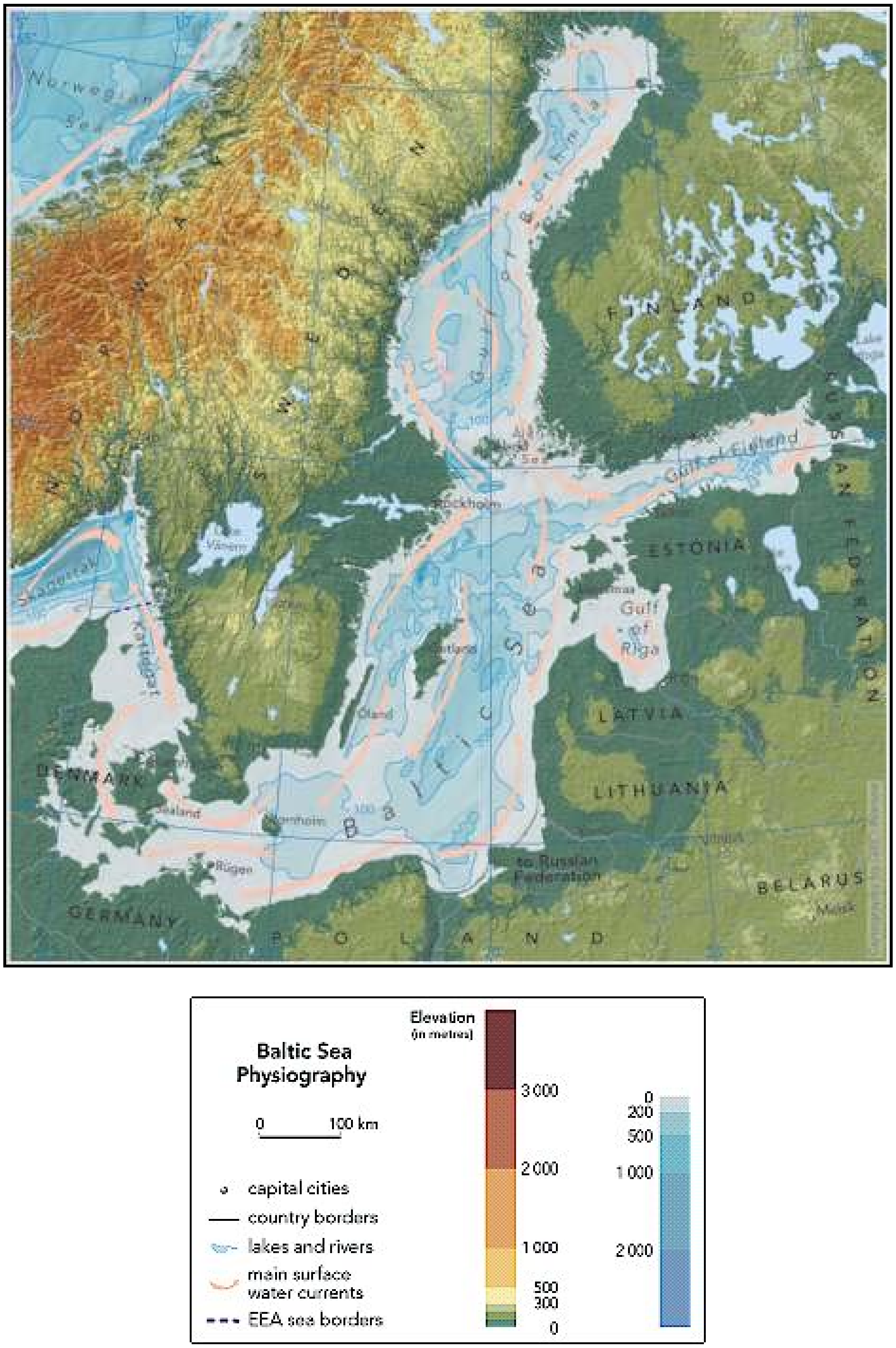
The tidal amplitude is small (8-18 cm) and it takes 25-35 years for all the water in the Baltic to be replenished by water from the North Sea and beyond (Baltic Sea Environment web site).

The Baltic Sea has marked stratification between low-salinity surface water and the more saline water at a depth of about 40-70 m. This salinity barrier prevents the exchange of oxygen and nutrients between the two layers, and large parts of the seabed are lifeless because of oxygen depletion. The size of seabed with impaired conditions varies from year to year and may reach 100 000 km^2 (Baltic Sea Environment web site).

Annual mean temperature increases gradually from north and east to south and west. The northern part of the Gulf of Bothnia (Bothnian Bay) and the coastal zone down to the Åland Sea and the inner parts of the Gulf of Finland and Gulf of Riga usually become completely ice-covered in January. At depths more than 50 m the average annual temperature is 3-4 degrees Celsius.

The Baltic is a young sea, formed after the last glaciation as the ice retreated some 10 000 years ago. Geological uplifting of land after the glaciation continues, especially in the northern part where the uplift causes the coastline to retreat noticeably within a human generation.

Map 1: Baltic Sea physiography (depth distribution and main currents)



Source: EEA, UNEP/GRID Warsaw final map production

1.2 Main influences

The main influences included are those known to have a major effect on biological diversity in the Baltic Sea area.

- Eutrophication arising from fertilisation and sewage: the catchment area has extensive agriculture, and the southern areas are densely populated.
- Fishing: overfishing, bottom trawling and fish farming put pressure on the ecological systems in the Baltic Sea.
- Pollution (non-eutrophication): this consists mainly of pesticides, waste disposal, sewage, combustion and oil. The Helsinki Convention has identified 132 polluting 'hot spots' in the catchment area.
- Introduction of alien species.
- Construction (damming, dredging and dumping of dredged material).

1.3 Main political instruments

- The Helsinki Convention of 1974 (HELCOM), the first international agreement to cover pollution from land, ships and the air, aims to protect the marine environment of the Baltic. A new Article, *'Nature Conservation and Biodiversity*, was included in the revision of the Convention in 1992 when it became clear that the original Convention was not stopping progressive deterioration of the ecosystem.
- The 1973 International Baltic Sea Fishery Commission (IBSFC), established pursuant to Article V of the Convention on Fishing and Conservation of the Living Resources in the Baltic Sea and the Belts (the Gdansk Convention).
- The 1991 Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS), concluded under the auspices of the Bonn Convention on the Conservation of Migratory Species (UNEP/CMS) to co-ordinate and implement conservation measures for dolphins, porpoises and other toothed whales in the Baltic and North Seas. Currently eight European countries – Belgium, Denmark, Finland, Germany, the Netherlands, Poland, Sweden and the United Kingdom – are Parties to the Agreement.
- The Ramsar Convention (Convention on Wetlands), signed by all countries bordering the Baltic Sea, is an intergovernmental treaty providing a framework for national action and international co-operation for the conservation and wise use of wetlands and their resources.
- The EU Birds and Habitats Directives, which cover several coastal and marine habitats and apply to Denmark, Finland, Germany and Sweden, and will apply to more countries following EU enlargement.
- The Bern Convention (the Convention on the Conservation of European Wildlife and Natural Habitats), which is of special significance in countries outside the EU. The main objectives of the Bern Convention are to protect wild flora and fauna and their natural habitats, and to draw attention to endangered species.
- Natura 2000 is the EU network of sites designated by Member States under the Bird Directive signed in 1979 (Special Protection Areas = SPAs) and under the Habitats Directive signed in 1992 (Special Areas of Conservation = SACs). Designated sites in Denmark, Finland, Germany and Sweden.

1.4 Biodiversity status

Because of the geologically short time aspect and major changes, a very limited brackish-water flora and fauna has developed. The Baltic Sea is therefore characterised by few species, but many individuals of each species. Another characteristic of the biology is that some fresh- and salt-water plants exist side by side, e.g. the freshwater plant *Phragmites spp.* and the marine wrack *Fucus spp.*

The salinity gradient from Kattegat to the northern and eastern part of the Baltic is reflected in the species number of benthic organisms (Table 3).

Table 3: Benthic species numbers in the Baltic Sea

Region	No of benthic fauna species	No of benthic vegetation species
Kattegat	840	356
Baltic Sea, central	145	83
Gulf of Bothnia, central	50	-
Gulf of Bothnia, northern	5	32 (1 marine)

Source: Esping and Grönqvist 1995, Nielsen et al. *1995*

The salinity gradient has also resulted in phenotypic differences among some species that live both in the Kattegat/Skagerrak area and in the Baltic Sea (e.g. the common mussel Mytilus edulis and several algae species).

The variety and structures of the different biological communities found in the Baltic result mainly from differences in salinity, de-oxygenation of the deeper waters, and climatic variations during the year.

The great archipelagos along the Swedish and Finnish Baltic coasts have a rich flora and fauna; in particular a great number of ducks and waders breed there.

1.4.1 Plankton and benthos

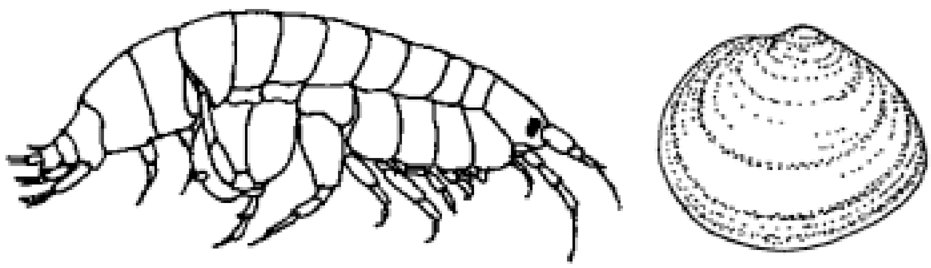
- **Plankton**

The spring bloom of phytoplankton is made up of a succession of different phytoplankton assemblages, where species of diatoms and dinoflagellates are common. Cyanobacteria (blue-green algae) form blooms, often toxic, later in the year, when surface-water temperature exceeds 15ºC. The species composition and annual production of zooplankton vary considerably with time (Autio *et al.* 1990).

- **Zoobenthos**

Among the invertebrate fauna three groups dominate, i.e. molluscs, polychaetes (marine worms) and crustaceans. In the central part of the Baltic Sea (Baltic Proper), four species are particularly common and often constitute almost 100 % of the benthic-fauna biomass: the bivalves blue mussel (*Mytilus edulis*) and Baltic macoma (*Macoma balthica*), the ice-age relics *Pontoporeia affinis* (amphipod) and *Saduria entomon* (isopod). Baltic macoma and Pontoporeia constitute the main biomass in the Gulf of Bothnia (HELCOM 1996). The majority of benthic fauna species are found in shallow areas. Deeper areas have very few species, e.g. fewer than 10 species in the Baltic Proper, and not more than 1-2 species in the northern part of the Gulf of Bothnia (Bothnian Bay).

Illustration: Common members of Baltic fauna: the amphipod *Pontoporeia affinis* and the bivalve *Macoma balthica*



Source: Petter Wang

Long periods of low-oxygen conditions, unfavourable to life, occur in the deepest parts of the Bornholm Basin, Danzig Basin, Central Basin, Kiel Bay and Gulf of Finland. These conditions result in impoverished low-diversity communities, dominated by polychaetes.

• **Phytobenthos**

The number of marine macroalgae in the Baltic Sea decrease from more than 356 species in the Kattegat to fewer than 100 species in low-salinity (5-6 ‰) waters in the Gulf of Bothnia. Most of the benthic vegetation in the Baltic is of marine origin, but a small number of freshwater species have migrated into it, mainly into the Gulf of Bothnia. In the northern part of the Gulf of Bothnia 32 species have been recorded, of which all but one are of freshwater origin (Nielsen *et al.* 1995).

The upper meter of the littoral zone is in most parts of the sea dominated by filamentous algae, with perennial fucoids growing from approximately 1 m depths. The benthic vegetation of hard bottoms reaches down to a maximum depth of 15 m. Several species confined to the littoral zone in the North Sea grow submerged in the Baltic. For example, the bladder wrack (*Fucus vesiculosus*) is found down to a depth of at least 7-8 m in the Swedish part of the Baltic Proper (Bäck *et al.* 1996).

1.4.2 Large fauna

• **Fish**

There are about 100 fish species living in the Baltic, introduced into the region at different times in different ways. The distribution pattern of the various species reflects their original habitat and tolerance of salinity (IBSFC web site). The ratio of the number of marine to freshwater species varies from north to south, as well as between coasts and open waters. Many species have their spawning and nursery grounds in the coastal zone where archipelagos, river mouths and bays are especially important. The fish include marine species like cod (*Gadus morhua*), sprat (*Sprattus sprattus*) and herring (*Clupea harengus*), freshwater species like pike (*Esox lucius*) and perch (*Perca fluviatilis*), and species that live part of their lives in the sea and part in freshwater like Atlantic salmon (*Salmo salar*), sea trout (*Salmo trutta*) and European eel (*Anguilla anguilla*). Most species living in the Baltic have adapted to the environment in various ways and differ from fish of the same species living in, for example, the North Sea or in freshwater.

• **Seabirds**

About 9 million birds of some 30 species use the Baltic as a wintering area (HELCOM 1996b). The most important areas are the shallow lagoons, estuaries and sandy bottoms between Denmark, Germany and Poland, in the Gulf of Riga, and in the north-western Kattegat. Characteristic species along the Baltic coasts are red-breasted merganser (*Mergus serrator*), tufted duck (*Aythya fuligula*), common eider (*Somateria mollissima*), sandpiper (*Actitis hypoleucos*), herring gull (*Larus argentatus*), common tern (*Sterna hirundo*), Arctic tern (*Sterna paradisaea*), cormorant (*Phalacrocorax carbo sinensis*), and waders such as redshank (*Tringa totanus*). The small islands and skerries contain an estimated 600 000 pairs of eiders, and southern areas of the Baltic are important wintering areas for species such as the long-tailed duck (*Clangula hyemalis*). Razorbill guillemot (*Alca torda*), black guillemot (*Cepphus grylle*) and guillemot (*Uria aalge*) are truly marine bird species nesting on small islands or steep rocks. Among the birds of prey, the white-tailed eagle (*Haliaeetus albicilla*) is slowly recovering from serious pollution damage in the 1960s and 1970s.

- **Mammals**

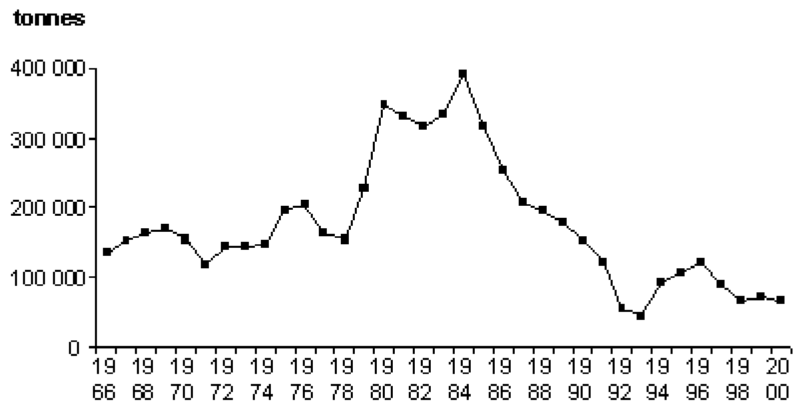
The three species of seal found in the Baltic, the grey seal (*Halichoerus grypus*), the harbour (common) seal (*Phoca vitulina*) and the Baltic ringed seal (*Phoca hispida botnica*), live mainly in the archipelagos. The maximum number of grey seals counted in the Baltic in recent years is 6 000 individuals, which is considered a small number compared with pre-war conditions. The population is slowly increasing (HELCOM 1999). The harbour seal counts only a few hundred in the southern Baltic and the situation is alarming. The ringed seal counts about 3 000 individuals in the Gulf of Bothnia, but only a few hundred in the Gulfs of Finland and Riga where the populations are still particularly vulnerable (HELCOM 1996). The harbour porpoises (*Phocoena phocoena*) in the Baltic are probably genetically specific and reproduce exclusively within this area. There is a possibility of total extinction in the Baltic Proper. Otters (*Lutra lutra*) used to be common in the archipelagos but numbers have fallen dramatically during the past few decades, probably due to polychlorinated biphenyl (PCB) poisoning. Otter recovery projects in adjacent countries are, however, beginning to succeed and may result in an increase in the Baltic population.

1.5 Fisheries and other marine living resources

Fishing in the Baltic is mainly for marine species, but also for some freshwater species and those which migrate between the sea and rivers. The marine species are caught mainly in the open sea, while species tolerant of large variations in salinity (euryhaline) are caught in coastal areas. Cod, herring, sprat and salmon are the major species in the sea fisheries (Table 4), and the only species regulated by quotas within the IBSFC. Other important target species are sea trout (*Salmo trutta*), pike-perch (*Stizostedion lucioperca*), whitefish (*Coregonus lavaretus*), eel (*Anguilla anguilla*), bream (*Abramis brama*), perch (*Perca fluviatilis*) and pike (*Esox lucius*) (IBSFC sector report, 1998).

There are two populations of cod, overall the most important commercial species, in the Baltic: a small western population and a large eastern population. High exploration rates of cod since the early 1980s have resulted in a decline in abundance and the eastern population is now outside its safe biological limit. Total landings in 2000 were estimated to be 66 000 tonnes. This total is lower than in any previous years except for 1992 to 1993 when severe catch restrictions were in place, and it continues the general decline seen since 1996.

Figure 1: Development of the eastern cod stock in the Baltic Sea illustrated by total landings of cod in tonnes from the eastern stock (total international catch)



Source: ICES 2001

The fisheries for sprat and herring have been kept within safe biological limits for several years.

At present, wild salmon populations occur in 13 out of 60 original salmon rivers in the Gulf of Bothnia. All populations are considered to be outside safe biological limits with a smolt (juvenile salmon ready to go out in the sea) production of about 20 % of the potential. Large-scale rearing and stocking of smolt has taken place, and Baltic salmon resources are currently determined by artificial reproduction. The fishery has exploited the stock at a level suitable for the reared component, simultaneously overexploiting the wild component.

Table 4: The most important commercial species in the Baltic Sea

Species		Status of stock	Exploitation level
Cod – western stock	*Gadus morhua*	wsbl	high
Cod – eastern stock	*Gadus morhua*	osbl	high
Herring – western	*Clupea harengus*	?	uncertain
Herring – eastern	*Clupea harengus*	wsbl	moderate
Sprat	*Sprattus sprattus*	wsbl	moderate
Salmon (main basin and Gulf of Bothnia)	*Salmo salar*	osbl (wild stock)	high
Salmon (Gulf of Finland)	*Salmo salar*	osbl (wild stock)	high
Flounder	*Platichthys flesus*	?/wsbl	moderate
Plaice	*Pleuronectes platessa*	?	?
Dab	*Limanda limanda*	?	?
Turbot	*Psetta maxima*	?	?
Brill	*Scophthalmus rhombus*	?	?
Eel	*Anguilla anguilla*	declining	probably high

Status of stock: wsbl = within safe biological limit; osbl = outside safe biological limit; ? = uncertain

Source: ICES 1999/IBSFC sector report 1998

There is relatively little fish farming in the Baltic because of the unfavourable natural conditions. Most production is from quite small farms, often combined with either a fishery or further processing such as smoking. Rainbow trout is by far the most common species farmed.

2. What is happening to biodiversity in the Baltic Sea?

Input of pollutants is particularly serious for a nearly enclosed sea such as the Baltic, where the residence time of the water is 25 to 35 years.

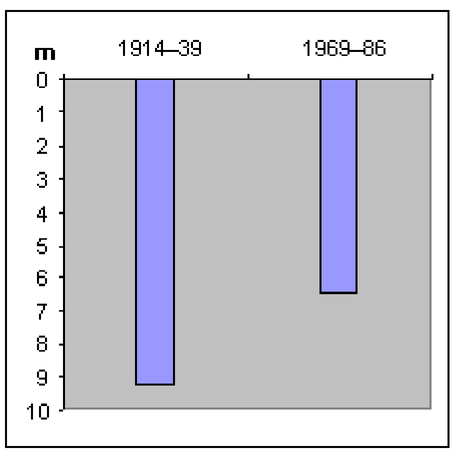
Approximately 90 % of the marine and coastal biotopes in the Baltic are to some degree threatened, either by loss of area or reduction in quality (HELCOM 2001, von Nordheim and Boedecker 1998).

2.1 Eutrophication

Eutrophication is one of the major environmental problems in the Baltic. A decrease in the concentrations of nitrogen and phosphorus, the nutrients that together with sunlight may cause eutrophication, was observed during the mid-1990s. Measurements during 1999 have not shown a continuation of this improvement - indeed, there is evidence of increasing levels of nitrate in near-bottom water in some areas (HELCOM 1999). Effects of eutrophication in the Baltic include the following.

- **Increased amounts of planktonic algae (Figure 2), leading to turbid water, in particular along the coasts**

Figure 2: The mean water transparency (measured as secchi-depth in metres) in northern Baltic Proper 1914–39 and 1969–86 (water transparency indicates the amount of plankton or particles in the water)

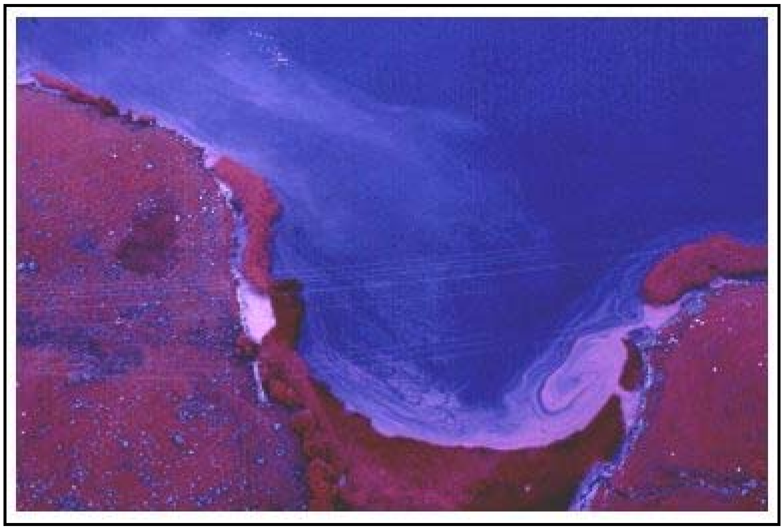


Source: Dahlberg and Jansson 1997

- **Increased frequency of toxic blooms of algae**

In the Baltic Sea about 30 phytoplankton species have been proved harmful. Toxic effects from cyanobacteria (blue-green algae) were reported several times during 1988-99, mainly from the Baltic Proper area (ICES 1999). The accumulation of blue-green algae that occurred during the summer of 1997 was the most extensive ever recorded. Both toxic and non-toxic species formed blooms in 1999, causing disturbances of recreational life and suspected death of livestock. Blooms of potentially toxic species also occurred in the Kattegat area. There are indications that the frequency and the spatial coverage of harmful blooms in the Baltic Sea have increased.

Photo: Infra-red aerial photo of a heavy cyanobacteria development along the shoreline in eutrophicated water. Cyanobacteria regularly form huge blooms from early summer.



Source: Olav Skulberg

- **Reduction of oxygen levels in the deep waters of the Baltic during the 20th century**

The decaying of plankton in the bottom water increases the oxygen demand, resulting in oxygen deficiency and the production of toxic gas (*hydrogen sulphide*). In 1999, the area of the Baltic Proper affected by hydrogen sulphide and oxygen deficiency was the largest in 15 years. In the Baltic Proper as well as in the western Gulf of Finland, the oxygen deficiency has resulted in dead bottoms. The bottom fauna in these areas was previously important food for fish (Dahlberg and Jansson 1997). In the northern Baltic Proper no macrofauna were recorded below a depth of 100 m in 1999 (HELCOM 1999). Low oxygen content together with decreasing salinity has a serious impact on the reproduction of cod. The inflow of fresh, well-oxygenated salt water from the North Sea continues to be irregular and weak, and under such conditions the reproduction of cod is less successful because their eggs sink into bottom waters which are low in oxygen.

Photo: Low oxygen levels result in impoverished bottom fauna. Photo shows mats of the sulphate-reducing bacteria *Beggiatoa* sp.

Source: Heye Rumohr

• Decline or disappearance of larger perennial macroalgae such as bladder wrack (*Fucus vesiculosus*) because of competition with short-lived, fast-growing species, and reduced penetration of sunlight in the water.

Case study – Decline of bladder wrack

In many areas of the Baltic, bladder wrack, *Fucus vesiculosus*, disappeared quite dramatically in the 1970s, and was replaced by filamentous algae (see Dahlberg and Jansson 1997, Bäck *et al*. 1996). Investigations indicate that the lower growth limit for bladder wrack has been displaced about 2.5 m upwards since the 1940s, and that growth is less dense than it was in earlier years (Eriksson *et al*. 1998). The main reason for this is probably increased competition from annual, fast-growing filamentous algae, profiting from the increased nutrient levels, and the reduced light conditions, an effect of eutrophication. Reduced distribution of bladder wrack will also affect the species that are associated with it. These include invertebrates living in the seaweed belt, and fish that uses it as spawning and nursery ground. Borg *et al*. (1997) emphasised that eutrophication-induced changes in habitat structure, such as an increased dominance by filamentous algae, could alter the availability of predation, refuges and foraging habitats for juvenile cod. The community changes in the Baltic are minor in offshore areas, where effects from nutrients and other contaminants are less pronounced (Rönnberg and Mathiesen 1998). During recent years a decrease in nutrient input has caused *Fucus* and *Zostera* to return to former habitats in deep regions (HELCOM 1996).

Photo: Bladder wrack (*Fucus vesiculosus*)

Source: NIVA

2.2 Fisheries

Although the International Baltic Sea Fishery Commission regulates offshore fishing efforts, over-exploitation is the common practice, even resulting in exploitation of stocks beyond safe biological limits. Fishery of main target fish species such as cod, salmon and eel is presently unsustainable due to over-exploitation and impairment of conditions for reproduction. Bycatches of marine mammals, seabirds and non-target fish species are too high, thus threatening the ecological function and biodiversity of the Baltic marine area (HELCOM 2001). Bottom trawling negatively impacts benthic ecosystems by altering sediment structure and destroying benthic organisms. The damage to substrates and benthic habitats is heavy, but primarily local.

The decline of harbour porpoises in the Baltic to very low levels requires urgent action, particularly to reduce deaths in fishing nets. The establishment of protected areas should also be considered.

A number of fish diseases have been reported from fish farming, the most serious threat in coastal areas being Furunculosis. There is concern, but as yet no evidence, about the spread of diseases to fish (e.g. salmon and sea trout) migrating through the rearing areas. Fish farming may also have, at least locally, eutrophication effects.

Status of fish stocks in the Baltic Sea

The cod in the Baltic is under pressure. The spawning stock size of the large eastern stock in the central Baltic has declined from over 800 000 tonnes in 1980 to under 100 000 tonnes in 1992 (an historically low level) and the status of the stock is now outside the safe biological limit (FAO web site). Annual catches have decreased from 400 000 tonnes in 1980 to 45 000 in 1992, 122 000 tonnes in 1996, 67 000 tonnes in 1998 and 66 000 in 2000 (ICES web site). The agreed TACs (total allowable catches) have, in the past, generally been higher than those recommended by ICES. In conformity with the Long Term Management Strategy for Baltic Cod adopted in 1999, the Contracting Parties of the International Baltic Sea Fishery Commission agreed in September 2001 to establish a comprehensive recovery plan for the Baltic cod (*inter alia* reduction of the fishing mortality in the eastern stock, extension of the summer ban on cod fishing, changes to the Fishery Rules concerning bycatch of cod, strengthening of control and enforcement measures).

The pelagic stocks of fish in the Baltic (herring and sprat) are exploited at a low-to-medium level, and stocks are above long-term average levels with no immediate risk of depletion. Annual catches in the 1990s have amounted to about 300 000 tonnes for herring and 630 000 tonnes for sprat (FAO web site, ICES web site).

2.3 Contaminants

Although concentrations of most of the hazardous substances have decreased over the past 30 years in the Baltic area, a number of them are still of environmental concern.

- Cadmium concentrations in organisms in the central Baltic basin and in the southern Gulf of Bothnia are increasing despite a reduction in water concentration.
- Concentrations of dioxins and PCBs in biota have not decreased during the 1990s in the Baltic Proper, which indicates a continuous input or resuspension.
- Organotin compounds used as antifouling agents on ships have been found in sediment and organisms in the Kattegat and Belt Sea area, where damage has been detected in the reproductive organs of certain species (imposex).
- Health and reproduction in birds of prey and in mammals are impaired, possibly indicating that present levels of organo-chlorine compounds such as PCB and dioxins are still too high (HELCOM 2001).

Case study – Possible effects of contaminants on organisms

A large number of female grey seals (*Halichoerus grypus*) are sterile, probably due to PCB poisoning. The ringed seal (*Phoca hispida*) shows similar symptoms. Until recently there was a fairly large population of harbour porpoises (*Phocoena phocoena*) in the southern Baltic. The number is one-tenth of 1950s figure, probably due in part to toxic pollutants. Otters (*Lutra lutra*), inhabiting the archipelagos, have decreased dramatically in number in the last few decades, probably also due to PCB poisoning.

Photo: The grey seal (*Halichoerus grypus*). The population is reduced compared with the first half of the 20th century.

Source: Klavs Nielsen, Biofoto

2.4 Oil

Due to growing maritime transport in the Baltic Sea region, ship accidents causing marine pollution become more probable. HELCOM estimates that over 500 million tonnes of marine cargoes are transported in the Baltic Sea area annually. In March 2001 the collision of a cargo ship with an oil tanker in the Baltic Sea spilled about 2 700 tonnes of oil into the water - the biggest oil spill in the Baltic Sea in 20 years. Within three days 2 000 of around 10 000 seabirds present in the area had been killed (HELCOM). Oil affects the birds directly, coating their plumage and reducing its waterproofing properties. When birds preen the oiled plumage, toxic residues can be ingested and adversely affect their metabolism leading to dehydration and poisoning. Significant impact on benthic communities from oil spills in the Baltic Sea had been identified earlier by Elmgren *et al.* (1983) and Korolev *et al.* (1993).

Accidental spills are, however, not the major source of oil to the Baltic Sea. On average more oil is spilled into the sea by illegal discharges from ships. As a reaction to this, HELCOM will further improve the aerial surveillance of the Baltic Sea. In total, these operational discharges account for 10 % of the total input of oil into the Baltic Sea. Around 80 % of oil and oil residues in the Baltic Sea come from installations along the coast, by rivers and as atmospheric deposit.

2.5 Construction

Most rivers flowing into the Baltic have been dammed to provide hydropower, impeding the migration of salmon to their spawning grounds. In the 1940s all salmon in the Baltic were wild, but currently 85 % are of cultivated origin from hatcheries. Marine construction activities and dredging and dumping of dredged material have mainly local influence and are primarily affecting benthic organisms. Constructions may alter hydrodynamics locally, and thus the access to food and oxygen for benthic animals. Dredging and dumping may disturb or destroy benthic habitat and temporarily increase siltation.

2.6 Introduced species

The introduction of new species has been an increasing problem during the past decade. Alien species can change the existing ecosystem and food chains, and have severely affected fisheries and industrial water intakes, causing economic losses. HELCOM is currently developing a database on introduced species. A list, NEMO (Non-Indigenous Estuarine and Marine Organisms), maintained by a group of non-governmental Baltic marine biologists (NEMO web site), shows close to 100 alien species arrivals since mid-1800, including plankton, invertebrates, fish, birds and mammals. Since 1990, 10 new species have been introduced to the Baltic.

Table 5: Introduced species to the Baltic Sea

Taxon	No of introduced species
Fish	29
Crustaceans	21
Molluscs	13
Polychaeta/oligochaeta	7
Phytoplankton	8
Macroalgae	7
Mammals	2
Others	13

Source: NEMO web site

Case study – Examples of introduced species to the Baltic Sea

- The first Baltic record of the jellyfish *Maeotias inexspectata* was made in summer 1999 on the Estonian coast. *M. inexpectata* is native to the Black Sea basin and a true brackish-water species. It had earlier been introduced to the Loire estuary in France, and the Atlantic and Pacific coasts of North America. This is the first boreal record of *Maeotias* and generally the first find of a jellyfish in the coastal waters of the northern Baltic Proper.

- The zebra mussel (*Dreissena polymorpha*) was first recorded in the Gulf of Finland in 1995. This species has caused severe problems in freshwater in other countries, but has not yet been recorded in freshwater areas in Finland. In many sites in the Russian part of the Gulf of Finland, the zebra mussel has become the dominant species on hard bottom (Valovirta and Porkka 1996).

Photo: Zebra mussel (*Dreissena polymorpha*)

Source: Lars Gejl, Biofoto

- In 1995, fishermen from the eastern Baltic coast reported the first mass occurrence of the cladoceran *Cercopagis pengoi* (crustacea). This alien species derives from the Caspian and Black Seas and was first observed in 1992 in the low-salinity water of the Gulfs of Finland and Riga. The species can reproduce rapidly and it is thought that *Cercopagis* thrives well along the south coast of Finland and forms stable populations.

- North American mink (*Mustela vison*), introduced in 1925 to the Baltic, are having a serious impact on ground-nesting birds along coasts and on islands.

Photo: Mink

Source: Elvig Hansen, Biofoto

- The black-spotted goby (*Neogobius melanostomus*), a fish of Caspian origin, was first recorded in the Gulf of Gdansk in 1990, probably introduced via ballast water. It may become a serious competitor for food and hiding places with other species in the coastal zone (especially crustaceans and molluscs feeders). If the black-spotted goby becomes abundant and accessible, it will become a new food item for other fish and birds. This will probably result in reduced preying intensity on traditionally consumed major species (sand eels, sprat, large crustaceans).

3. What policies are at work in the Baltic Sea?

In recent in years, HELCOM has agreed a large number of recommendations and guidelines for dealing with several of the adverse impacts of human activities on the Baltic. While there have been some improvements, a recent environmental assessment (von Nordheim and Boedecker 1998) has shown limited overall progress, due in part to slow or no implementation of the HELCOM recommendations by the Contracting Parties.

3.1 Nature protection

3.1.1 Protected areas

All countries in the region have taken significant steps toward the protection of important marine areas in the Baltic, through national or international regulations. In 1994 a list of priority marine areas was accepted by HELCOM as a first step toward the development of

Baltic Sea Protected Areas (BSPA), planned to cover coastal as well as marine areas. Of more than 60 proposed BSPAs, nine had been fully implemented by May 2000 (see map in general introduction chapter).

All countries have designated sites of importance for migrating waterbirds in accordance with the Ramsar Convention; many are coastal or marine sites.

Particularly Sensitive Sea Areas, as defined by the International Maritime Organization, are under consideration along the Danish, Estonian, Finnish and Swedish coasts. Such designation, in conjunction with the EU Birds and Habitats Directives, should result in significant protection of coastal and marine areas in EU countries.

3.1.2 Red List species

In 1998, HELCOM compiled a status report on biotopes and biotope complexes of the HELCOM area (von Nordheim and Boedeker 1998), including a classification system for Baltic coastal and marine biotopes. Of the 66 pelagic and benthic marine biotopes described in the report, 2 biotopes was classified as heavily endangered, 58 as endangered, 4 as potentially endangered, and 2 had no data available.

IUCN–The World Conservation Union lists globally threatened species of plants and animals (www.redlist.org). In addition, the fishbase (www.fishbase.org) provides easily accessible lists of threatened fish. Other sources of information on Red Lists for the Baltic are Ingelög et al. (1993), Nordic Council of Ministers (1995) and Gärdenfors (2000).

The following animals are examples of species listed as endangered or vulnerable in the Baltic Sea area: the sturgeon (*Acipenser sturio*) has been found only sporadically during the last century and is classified as extinct on the Swedish Red List (Gärdenfors 2000), while it is generally listed as critically endangered by IUCN. The grey seal (*Halichoerus grypus*), Saimaa ringed seal (*Phoca hispida saimensis*) and European mink (*Mustela mustela*) are classified as endangered species. The Baltic ringed seal (*Phoca hispida botnica*), harbour porpoise (*Phocoena phocoena*) and otter (*Lutra lutra*) are all species classified as vulnerable on the Swedish and the IUCN Red Lists.

3.2 Protection of marine resources by restrictions on fishing and hunting

Since the establishment of the International Baltic Sea Fishery Commission (IBSFC) in 1973, the governments of the coastal states have co-operated with a view to preserving and exploiting all fish species and other living marine resources of the Baltic Sea and the Belts, excluding internal waters. This resulted in the adoption of annual total allowable catches (TACs), technical regulations for fisheries and - more recently - a multi-annual Salmon Action Plan and a request to ICES for advice to pave the way for similar action plans for cod, herring and sprat. Management decisions are based on the best available scientific advice, generally obtained from the ICES responsible for the promotion and co-ordination of marine research.

The European Commission has adopted a Green Paper on the Common Fisheries Policy (CFP) in order to launch a wide-ranging debate about its future shape. Many of the most important fish stocks are on the verge of collapse, and decisive action is required to ensure the sustainability of the fisheries sector (European Commission web site).

Denmark and Germany have protected their sensitive benthic ecosystems from bottom trawling disturbance by prohibiting this kind of fishing in large areas.

Marine species protected in the Baltic Sea

• Nature protection

ASCOBANS (Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas) aims to co-ordinate and implement conservation measures for dolphins, porpoises and other toothed whales in the Baltic and North Seas. Within the HELCOM framework, the Contracting Parties have agreed a ban on hunting seals.

• Resource protection

The major species in the sea fisheries - cod, herring, sprat and salmon - are regulated by quotas within IBSFC. A Long Term Management Strategy for Baltic Cod was adopted in 1999 by the Contracting Parties of the IBSFC. A Salmon Action Plan, implemented to safeguard and increase the present wild populations, has also been adopted by IBSFC. The countries of the Baltic Sea region will, within the appropriate fora and subject to relevant legislation, further integrate fisheries and environmental policies to ensure the sustainability of fish stocks.

3.3 Research projects and monitoring programmes

The Baltic Monitoring Programme (BMP). The aims of Co-operative Monitoring in the Baltic Marine Environment (COMBINE) are to identify and quantify the effects of anthropogenic discharges/activities in the Baltic Sea in the context of the natural variations in the system, and to identify and quantify the changes in the environment as a result of regulatory actions. The programme includes hydrographic measurements, effects of anthropogenic inputs of nutrients on marine biota, levels of contaminants in selected organisms and the effects of contaminants on community structure.

The Baltic Monitoring Programme, as part of COMBINE, is implemented by the Helsinki Commission. The monitoring programme provides a good basis for establishing a common view of environmental conditions in the Baltic and ways of improving them. In addition, bilateral agreements have been signed covering environmental monitoring of parts of the Baltic Sea, such as the Gulf of Bothnia between Finland and Sweden and the Sound between Denmark and Sweden. There is further co-operation by Denmark, Norway and Sweden in the Kattegat and the Skagerrak. These programmes provide some temporary compensation for the lack of monitoring programmes in the Marine Protected Areas (MPAs) themselves.

Bibliography

(Links/URLs last visited 2002)

Autio, R. *et al.* 1990. *Ecological Plankton Research of the Baltic Sea*. Final report 1987-1989. Tvärminne zoological station. Pelag Press, Helsinki. 172 pages.

Bäck, S., Kautsky, H., Kruk-Dowgiallo, L. and D. Jurgilaite 1996. *Mapping and Monitoring Phytobenthic Biodiversity in the Northern Baltic Sea*. TemaNord Environment. Nordic Council of Ministers.

Borg A., Pihl L. and H. Wennhage 1997. *Habitat choice by juvenile cod* (Gadus morhua L.) on sandy soft bottoms with different vegetation types. Helgol. Meeresunters> 51: 2, pp. 197-212.

Dahlberg and Jansson 1997. *The Environmental Status of the Baltic Sea in the 40s, Now and in the Future*. Stockholm Marine Research Centre. Technical Report No 24. ISSN 1104-8298.

Elmgren R., Hansson S., Larsson U., Sundelin B. and P.D. Boehm 1983. *The "Tsesis" oil-spill: Acute and long-term impact on the benthos.* Mar. Biol. 73, pp. 51-65.

Eriksson B., Johansson K. and P. Snoeijs 1998. *Long-term changes in the sublittoral zonation of brown algae in the southern Bothnian Sea.* Eur. J. Phycol. 33: 3. pp. 241-249.

Esping L.-E. and G. Grönqvist 1995. Region 6: Baltic. In: Kelleher G., Bleakeley C. and S. Wells (eds). *A global Representative System of Marine Protected Areas 1995. Vol 1. Antarctic, Arctic, Mediterranean, Northwest Atlantic, Northeast Atlantic and Baltic*. The International Union for Nature Conservation (IUCN), Great Barrier Reef Marine Park Authority, World Bank, Washington DC.

Gärdenfors, U. (ed.) 2000. *Rödlistade arter i Sverige - The 2000 Red List of Swedish Species*. ArtDatabanken, SLU Uppsala.

HELCOM 1996. *3rd Periodic Assessment of the State of the Marine Environment of the Baltic Sea*. (www.baltic.vtt.fi/bsw_index.htm).

HELCOM 1996a. *Coastal and Marine Protected Areas in the Baltic Sea Region*. Baltic Sea Environment Proceedings No 63.

HELCOM 1996b. *The Environmental State of the Baltic Sea*. From the 2nd ECO-BALTIC Conference, Environmental Management in the Baltic Sea Region, 9-11 October 1997, Gdansk, Poland.

HELCOM 1999. *The State of the Baltic Marine Environment in 1999*. Prepared by the Environment Committee of HELCOM, October 1999.

HELCOM 2001. *Conclusions of the 4th Periodic Assessment*. (www.helcom.fi).

ICES 1999. *Report of the ICES Advisory Committee on the Marine Environment 1998*. ISSN 10117-6195. 375 pages.

ICES 2001. *Report of the ICES Advisory Committee on Fisheries Management 2001*. ICES Cooperative Report No. 246.
(www.ices.dk/committee/acfm/comwork/report/2001/may/cod-2532.pdf)

Ingelög T., Andersson R. and M. Tjernberg 1993. *Red Data Book of the Baltic Sea Region. Part 1. List of Threatened Vascular Plants and Vertebrates*. Swedish Environment Protection Commission.

Korolev A., Kuznetsova T. and V. Drozdetsky 1993. *Investigations of the Furcellaria lumbricalis distribution and abundance at the Eastern coast of the Baltic Sea*. ICES, C.M. 1993/L 39, 16 pages.

Nielsen, E., Kristiansen, A., Mathiesen L. and H. Mathiesen (eds) 1995. *Distributional index of the benthic marine macroalgae of the Baltic Sea area*. Acta Bot. Fennica 155, pp. 1-51.

Nordic Council of Ministers 1995. *Threatened Animals and Plants of the Nordic Countries*. TemaNord, Copenhagen. 520 pages.

Rönnberg O. and L. Mathiesen 1998. *Long-term changes in the marine macroalgae of Lågskär, Åland Sea (N Baltic)*. Nord. J. Bot. 18, pp. 379-384.

Valovirta, I. and M. Porkka 1996. *The distribution and abundance of* Dreissena polymorpha *(Pallas) in the eastern Gulf of Finland*. Memoranda Soc. Fauna Flora Fennica 72, pp. 63-78.

von Nordheim H. and D. Boedecker 1998. *Red List of Marine and Coastal Biotopes and Biotope Complexes of the Baltic Sea, Belt Sea and Kattegat*. Baltic Sea Environment Proceedings No 75.

Internet addresses [URLs]

(Last visited January 2003)

Baltic Sea Environment web site:
www.envir.ee/baltics

BASICS (Baltic Sea region statistical database):
www.balticuniv.uadm.uu.se/basics/

European Commission web site:
www.europa.eu.int/comm/fisheries

FAO web site:
www.fao.org/fi/

IBSFC, International Baltic Sea Fishery Commission homepage:
www.ibsfc.org/

ICES web site:
www.ices.dk

NEMO web:
www.ku.lt/nemo/mainnemo.htm