

Baltic Sea Environment Proceedings No. 82A

# Environment of the Baltic Sea area 1994-1998



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# Preface

The Baltic Marine Area, or Baltic Sea for short, is one of the world's most extraordinary seas. The beauty and great variety of the sea and its surrounding landscapes are unique. Its natural history since the last Ice Age has been remarkable, moreover, the area having variously been a strait, a large bay, a lake and now an inland sea connected to the world's oceans by narrow straits.

The Baltic Sea has been exploited by people living and trading in the area since early times, both as a source of fish, mainly cod and herring, and for the transport of goods from one coast to another. Now the Baltic Sea has also to meet new demands such as recreation and tourism.

The marine ecosystem of the Baltic Sea is very sensitive, partly due to the natural conditions and partly due to pressure from the activities of the 85 million people living and working in the catchment area. This is starting to take its toll. Over the past few decades, pollution of the Baltic Sea has become increasingly evident, as have the threats to it. Just think of the nutrient pollution that fuels excessive algal growth and threatens to deplete the bottom waters of oxygen. Or of oil spills and the sight of oil-smearing birds and mammals – or of the hazardous pollutants that persist for generations harming animals and man alike.

Thanks to the joint endeavours of the Baltic Sea States, though, some of the earlier threats have now been defused. The concentrations of mercury, DDT and PCB have decreased significantly, for example.

The Helsinki Commission has been assessing the effects of the various pollutants on the Baltic Sea's natural resources for the past twenty years. The resulting assessment reports are unique compilations of scientific facts born of outstanding cooperation among the scientific community in the Baltic region. The present assessment – the Fourth Periodic Assessment of the State of the Environment of the Baltic Marine Area, 1994-1998 – is based on the contributions of no less than 150 scientists.

Because the current state and developmental trends in the Baltic marine environment are of concern to everybody in the area, the Helsinki Commission has prepared this popular and more easily accessible version of the scientific document.

It is my hope that this booklet will provide inspiration to all those wishing to gain a quick insight into the environmental issues affecting the Baltic Sea while concomitantly serving as a useful foundation for wider study of the Baltic marine environment.



*Peter Ehlers*  
*Chairman of the Helsinki Commission*





# Introduction

How do you turn an inch-thick scientific report into a twenty-page, easy-to-read booklet? Not an easy task you might imagine. Nevertheless, that is exactly what the Helsinki Commission project group decided to do following completion of the Fourth Periodic Assessment of the State of the Environment of the Baltic Marine Area, 1994-1998. At the cost of leaving out numerous details and topics, the aim has been to provide the reader with a brief account of the current state and developmental trends in the Baltic marine environment that nevertheless presents the main findings of the scientific assessment.

How do you assess an entire sea with its continually moving waters and currents flowing at different speeds, depths and directions? It takes a detailed and comprehensive analysis of the biological, chemical and physical features – in the case of the Baltic Sea, an analysis carried out in concert by scientists from all the Baltic States. This active co-operation has been a unique tradition for many years, going beyond both political and cultural boundaries. It serves as the very backbone of the work to describe the environmental state of the Baltic Sea, to assess developmental trends, to identify what or who is responsible for changes – be it human activities or natural variations – and finally, to determine the success of protection measures.

A task like this is naturally very time-consuming. Preparation of the periodic assessment usually takes around two years. This does not challenge the relevance of the data and the developmental trends uncovered, though, since environmental changes often take place gradually or in small steps. Scientists are usually forewarned of environmental changes by specific signs in the water. As these signs are incorporated into the trend analyses, the findings are valid for several years ahead.

This booklet aims to shed light on the main problems encountered in the Baltic Sea environment. For those wishing to examine some or all of the topics presented in greater detail, relevant sources of information are indicated in the final section “Where to obtain further information”.

# Eutrophication

The water in the Baltic Sea is generally less transparent than it was fifty years ago. Not surprisingly, nutrient levels in the seawater are much higher than they used to be. At first glance, inorganic nutrients such as nitrate and phosphate would seem to be rather harmless. At second glance, however, these nutrients reveal the potential to cause a chain reaction feared by scientists, environmentalists and fishermen alike – so-called eutrophication.

## Nutrient inputs are decreasing less rapidly

Nutrients enter the Baltic Sea in two ways: via aquatic runoff/discharges and via the atmosphere. Rivers and coastal point sources such as urban and industrial wastewater outlets account for most of the nutrient load (Figure 1). The nutrients in the rivers mainly derive from point sources and diffuse loading from farmland within their catchment areas. The rivers bring with them three times more nitrogen and ten times more phosphorus than are input to the Baltic Sea from the atmosphere.

During the assessment period 1994-98, between 550,000 and 900,000 tonnes of nitrogen were washed into the Baltic Sea via rivers. The variation in the nitrogen load reflects the magnitude of the freshwater run-off from the land (Figure 2). More

nitrogen enters the Baltic Sea during wet years than during dry years because the rain washes nitrogen out of farmland. In total, some 200 rivers transport nutrients from 13 different countries into the Baltic Sea. The top-five of these rivers – the Neva, the Daugava, the Vistula, the Oder and the Nemunas – account for nearly half of all nitrogen entering the Baltic Sea.

Phosphorus loading has been decreasing in many areas of the Baltic Sea since the end of the 1980s. In recent years the decrease has become slower, however, and riverine nutrient inputs do not seem to have decreased at all over the period 1994-98 (Figure 3).

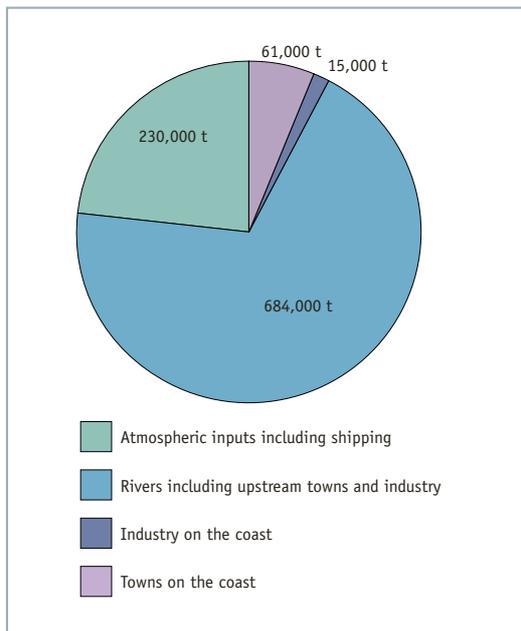
### Eutrophication is a nuisance

Eutrophication is the situation where seawater levels of inorganic nutrients become so high that they fuel the excessive growth and reproduction of plants and algae.

Green, cloudy water is the first signal. By then the nutrients have already stimulated the vigorous growth of myriads of microscopic algae floating in the water, as well as that of the plants that thrive on the seabed. The algae are short-lived, however, and when they die they sink to the bottom of the sea where they start to decompose in a process that consumes oxygen. If the amount of organic matter becomes excessive, the oxygen in the seawater is used up and natural toxic by-products poison the water. In the worst cases, the oxygen levels in the bottom water decrease dramatically, thus suffocating fish and other animals and eventually causing mass mortality.

Whether or not the worst-case scenario develops also depends on the weather. In shallow, coastal areas, wet and mild winters usually herald bad news. The rains wash nutrients out of the farmland into the rivers, which carry them into the sea. This creates just the right conditions for the mass occurrence of algae or so-called “algal blooms” in the spring. If the following summer happens to be warm and the winds calm, there is a serious risk of widespread oxygen depletion in shallow coastal areas.

**Figure 1**  
*Nitrogen inputs to the Baltic Sea from waterborne and airborne sources in 1995*  
(Source: Modified from HELCOM, 2001, Table 4.1, 4.3 and 4.7).



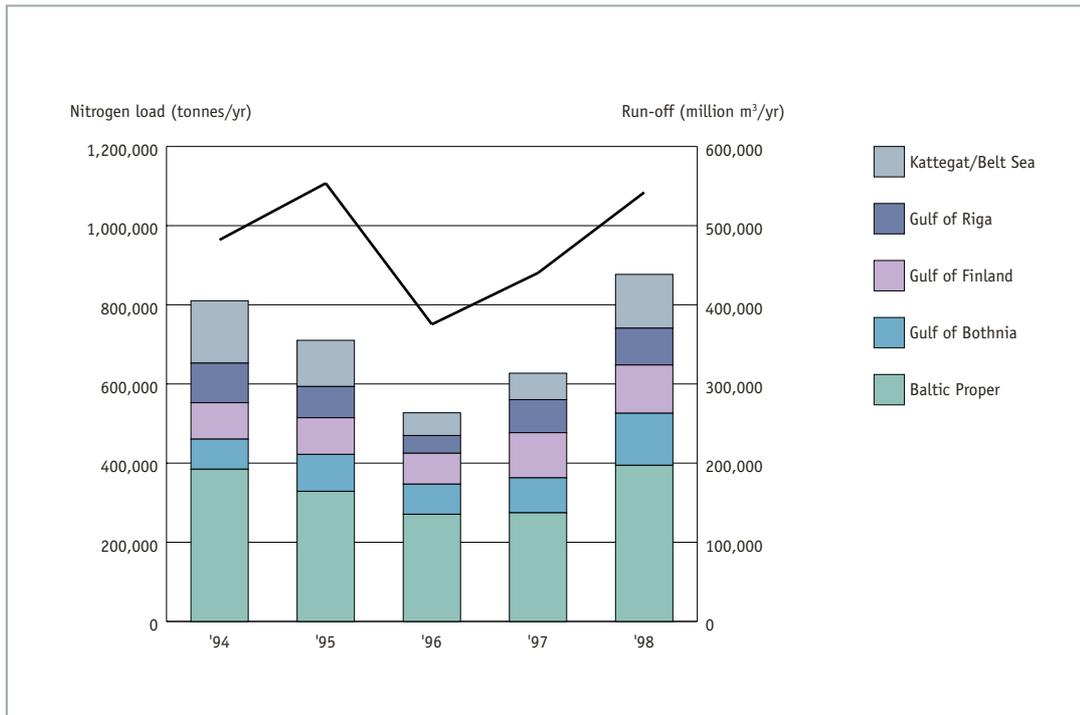


Figure 2 Annual riverine input of nitrogen to the Baltic Sea over the period 1994-98 (columns). Freshwater run-off is also shown (curve) (Source: HELCOM, 2001).

In contrast to loading from aquatic sources, nitrogen deposition from the atmosphere decreased 20-30% compared to that in the preceding assessment period (1989-93).

### Positive signs in some areas

In general, seawater nutrient concentrations are higher today than fifty years ago. Closer examination of the individual nutrients, i.e. nitrate and phosphate, reveals a more variable picture, however.

Despite the fact that seawater nitrate concentrations in the Baltic Sea vary, no real change is obvious during the assessment period. The concentrations more or less reflect the magnitude of the riverine nitrogen load.

With phosphate the situation is different. Compared to the 1980s, the average phosphate concentrations in the water have decreased significantly in the Kattegat and the Belt Sea, as well as in the Baltic Proper. The reasons for this are complex. In bights and estuaries, the decrease in phosphate levels is mainly attributable to improved sewage treatment. In other regions, for example in the Gulf of Riga and the Gulf of Bothnia, the phosphate levels have remained unchanged.

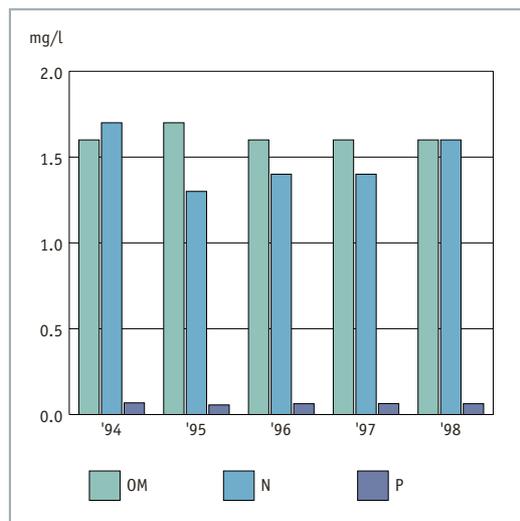


Figure 3 Adjusted concentrations of organic matter (OM), nitrogen (N) and phosphorus (P) in the rivers discharging into the Baltic Sea shown for the period 1994-98 (Source: Modified from HELCOM, 2001, Table 4.5).

## Dramatic floods had only temporary local effects

The extensive river flooding in Sweden in 1995 and in Poland and Germany in summer 1997 (Figure 4) caused considerable problems on land. Many experts were also concerned about the large quantities of nutrients and contaminants carried into the Baltic Sea by the Oder and the Vistula. The recent assessment shows that the effects were restricted to the Pomeranian Bight and the Gulf of Gdansk, and that the situation in the offshore areas returned to normal within two to three months.

Figure 4

Flow in the river Vindelälven (catchment area of the Gulf of Bothnia) and the river Oder (catchment area of the Kattegat/Belt Sea) over the period 1975-98 indicating the severe flood events in 1995 and 1997 (Source: HELCOM, 2001).

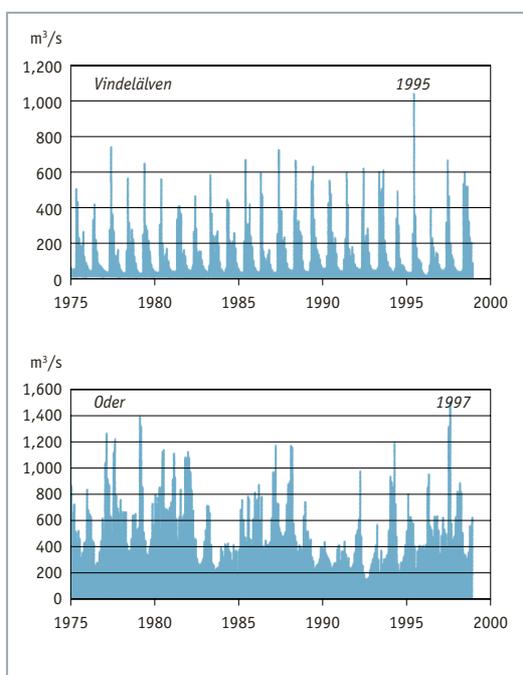
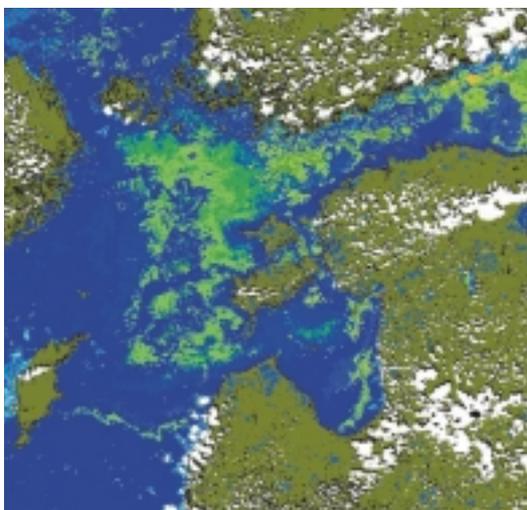


Figure 5

Satellite image of the Gulf of Finland, the northern part of the Baltic Proper and the Bothnian Sea in summer 1997 showing the area affected by mass occurrence of toxic blue-green algae in the surface water (Source: NOAA/AVHRR image processed by the Finnish Meteorological Institute and the Finnish Institute of Marine Research).



## 1996/1997: Problems in the Gulf of Finland

Expressed per square kilometre, nutrient loading in the Gulf of Finland is probably the highest anywhere in the Baltic Sea. In contrast to other regions, about half of the phosphorus load stems from the coastal towns. Over the years, this has resulted in considerable build-up of phosphorus-containing organic matter on the sea floor. Under normal conditions, this nutrient-rich material is tightly bound in marine sediment. During periods of oxygen depletion, however, the retained phosphate nutrients are released from the sediment to the overlying water, initiating the same chain of events as led to oxygen depletion problems in 1996/1997.

In winter 1993/94, storms over the North Sea and Baltic Sea drove large masses of salty North Sea water into the Baltic Sea. This in turn drove stagnant water from the deep parts of the Baltic Proper up into the bottom layer of the Gulf of Finland, causing marked stratification of the water column. This effectively sealed off the bottom layers from the oxygen-rich surface waters, whereafter it slowly but surely became depleted of oxygen. The large amounts of river water that ran into the Baltic Sea in 1995 and the early ice cover the following winter caused further stratification of the water masses in the Gulf, thereby further aggravating the unfavourable conditions in the deep.

As the oxygen levels dropped below a crucial threshold, the phosphate nutrients were released into the water column in large amounts in the summer of 1996. After this chain of unfortunate events had occurred, the stage was set for the development of the record bloom of toxic blue-green algae in the warm and calm summer of 1997 (Figure 5). Since then, the process has reoccurred with increasing frequency.

## Planktonic algae respond to environmental changes

In the daily fight for sunlight and nutrients, the drifting battlegrounds of the surface waters of the Baltic Proper have seen victories and defeats for several microscopic algae over the past twenty years. Since the 1980s, dinoflagellate algae have won ground over the diatom algae due to a spe-



*Sandy bottoms with eelgrass. Good conditions (above). Critical conditions – dense mats of white sulphur bacteria (below). Photo: Biofoto, Copenhagen.*



cial physiological characteristic.

Many dinoflagellates are half animal and half plant, and hence can switch their way of life to that which is most profitable in a given situation. Thanks to their mobility they can move up and down the water column, and select the optimal position to find food. The increase in the dinoflagellate community was accompanied by a decline in the rival diatom community. Why the percentage of diatoms in the algal spring blooms has decreased is unknown.

Dinoflagellates have increased the biomass of the phytoplankton in the central and western part of the Baltic Proper since the 1980s, whereas diatom biomass has decreased.

There are typically three main algal blooms each year in most regions of the Baltic Sea. The spring bloom usually develops when the waters are rich in nutrients and the sun is strong enough to fuel the photosynthesis of myriads of microscopic algae. This is the first step in the food chain. Early summer and autumn blooms of increasing size are increasingly following the spring blooms. These sometimes consist of myriads of blue-green algae, and sometimes of dinoflagellates. The blue-green algal bloom that filled the surface waters in summer 1997 was the most extensive ever recorded.

## Nitrogen and phosphorus inputs both need to be reduced

Algal blooms require both light and the right nutrient mix. To grow, the algae need a nutrient mix consisting of 16 parts nitrogen and 1 part phosphorus (Figure 6). If too little of one of the nutrients is available, algal growth is said to be limited by that nutrient. In open marine waters, algal growth is mainly limited by nitrogen. In many coastal areas and in the Gulfs of Finland and Riga, however, phosphorus is usually the limiting nutrient. Phosphorus also limits algal production in the Bothnian Bay. Because all the water bodies in the Baltic Sea are interconnected, a general reduction in both nitrogen and phosphorus loading is necessary if good ecological quality is to be restored.

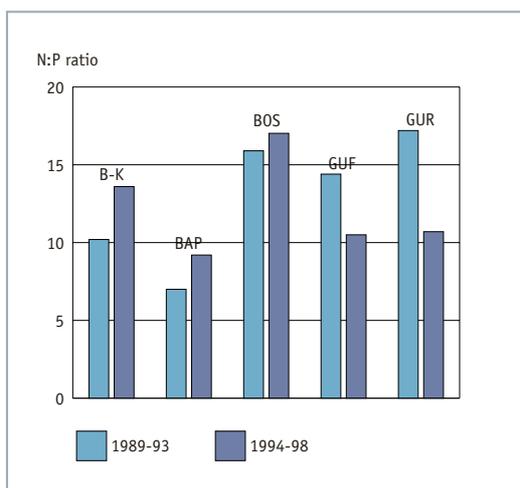
## Inflow events are important for bottom-dwelling organisms

The life of bottom-dwelling marine animals in regions east of the low thresholds formed by the Belt Sea depends on irregular inflows of salt water from the North Sea. This dependence is most obvious in the Baltic Proper, the Gulf of Finland and the Gulf of Riga.

In coastal areas of the Baltic Proper, biomass and the number of species inhabiting the sea floor have decreased over the assessment period 1994-98. In the Gulf of Riga and the southern Gulf of Finland, in contrast, they have both increased significantly.

In 1993 and 1994, inflowing oxygen-rich salt water breathed new life into the bottom-dwelling organisms in the deep areas of the Baltic Proper. Biomass and species abundance thus increased for a short time – until the problems reoccurred in 1996-97.

**Figure 6**  
Development in sea-water nitrogen:phosphorus nutrient ratio in the various regions of the Baltic Sea between the previous (1989-93) and present (1994-98) assessment periods. B-K = Belt Sea-Kattegat, BAP = Baltic Proper, BOS = Bothnian Sea (preliminary values), GUF = Gulf of Finland and GUR = Gulf of Riga (Source: Modified from: HELCOM, 2001).



# Contaminants

Seawater concentrations of most hazardous substances, including mercury, lead and DDT, have been diminishing in the Baltic Sea over the past 20-25 years due to international endeavours to protect the environment. Although the environmental effects of known contaminants are decreasing, scientists and environmentalists are still concerned however.

## **Man-made substances threaten human health and the environment**

Contaminants are substances that either do not occur naturally in the environment or that are present in concentrations exceeding the natural levels. If they harm the ecosystem, they are called pollutants or hazardous substances.

Contaminants can accumulate in marine organisms such as fish. The longer the fish are exposed and the higher the concentration of the contaminants, the greater the risk to the consumer – whether this be a bird, a seals or a human being. Some contaminants, e.g. DDT, PCB or dioxins, are readily deposited in fatty tissue.

## **Unknown contaminants raise new concerns**

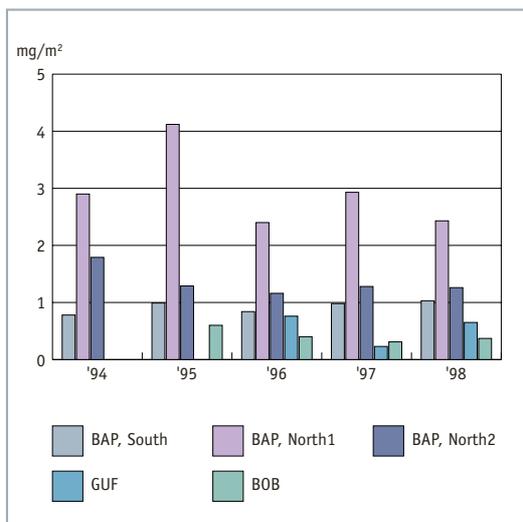
In the past, scientists focussed on contaminants rightly considered to be the most hazardous at the time. Hitherto unidentified contaminants must also be present, though, as revealed by studies of detoxifying enzymes in Baltic fish. During the ten-year period 1988-98, the fish were found to produce two to three times more detoxifying enzymes than in earlier years. As the levels of contaminants known to induce production of the enzymes have decreased, the fish must have been exposed to as yet unidentified toxic substances.

## **Contaminant inputs may be underestimated**

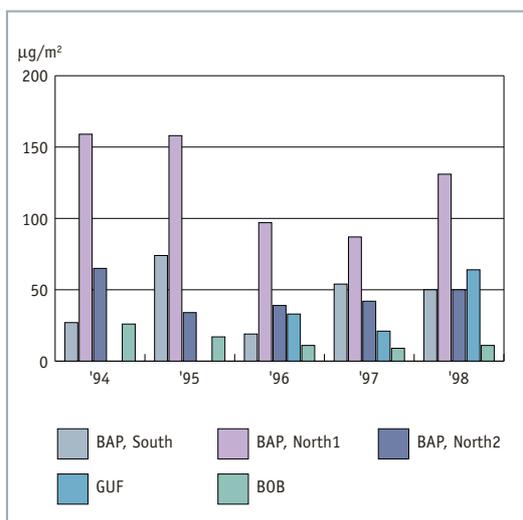
It is not yet possible to reliably determine the trend in contaminant inputs to the Baltic Sea via rivers and direct wastewater outlets. Although mercury, cadmium, zinc, lead and copper inputs are closely monitored by all Baltic States, the methods used differ from country to country and have only been harmonized over the past ten years. In some cases, moreover, the latest figures for waterborne inputs covering the assessment period 1994-98 are probably underestimates.

The contaminants originate from urban areas and industries, as well as from agricultural and forestal activities. Antifouling paints on ship hulls and illegal oil spills at sea contribute to the total burden. In spite of the existing restrictions aimed at preventing discharges of oil at sea, violations are frequent and there is no indication of any decline in the number of oil slicks observed.

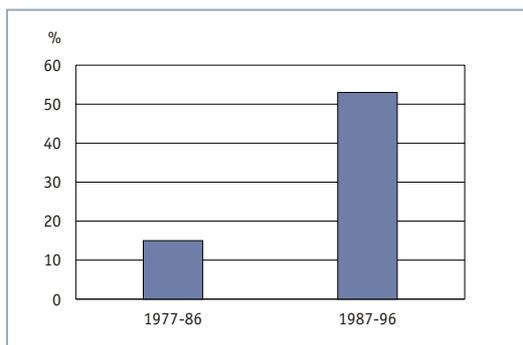
**Figure 7**  
Lead deposition on the Baltic Sea over the period 1994-98. BAP= Baltic Proper, GUF= Gulf of Finland, BOB= Bothnian Bay (Source: HELCOM, 2001).



**Figure 8**  
Cadmium deposition on the Baltic Sea over the period 1994-98. BAP= Baltic Proper, GUF= Gulf of Finland, BOB= Bothnian Bay (Source: HELCOM, 2001).



**Figure 9**  
Percentage of young grey seals (less than three years old) in the Baltic Sea with severe intestinal ulcers (Source: HELCOM, 2001).



## Atmospheric inputs are still high

One third of the total amount of lead entering the Baltic Sea derives from the atmosphere. With mercury and cadmium, one fifth is deposited from the atmosphere. The deposition rates are highest in the southwestern part of the Baltic Sea. In view of the prevailing wind directions, the inputs are likely to originate in the West European countries located on the windward side (Figure 7 and Figure 8).

Most of the heavy metals are emitted from Germany and Poland, while Great Britain is important in the case of lead and Denmark in the case of mercury. Although the amount of lead and cadmium deposited was less during the 1990s than previously, no clear trends could be identified during the present assessment period.

## The health of marine mammals is still at stake

The populations of all three seal species inhabiting the Baltic Sea are recovering thanks to diminishing levels of organic contaminants in the environment. Nonetheless, reproductive dysfunction is still widespread. Many female seals are unable to produce pups due to uterine occlusion related to PCBs and dioxins in the environment.

In the Baltic Proper, the harbour seal and grey seal populations are affected by contaminants, habitat destruction and fishery, and are recovering more slowly than in the Gulf of Bothnia (grey seals) and in the Kattegat (harbour seals).

Another emerging problem is chronic intestinal ulcers, which are affecting an increasing number of young grey seals (Figure 9). While these are probably caused by contaminants disrupting the seals' immune system, the precise mechanism remains unknown.

## Breeding success of marine birds is improving

The white-tailed sea eagle population has increased and is now capable of reproducing almost as successfully as prior to the 1950s (Figure 10). However, mean brood size seems to have levelled off at a slightly lower level than fifty years ago.

The guillemot is also benefiting from the improved environmental conditions, and the thickness of its eggshells has increased since the mid 1970s. The shells were much thinner in the 1960s due to the effects of severe DDT pollution of the Baltic Sea, but have now returned to the pre-1940 thickness (Figure 11).

## Concentrations of organochlorine compounds have ceased falling

Over the past 30 years, the concentrations of organochlorine compounds have decreased throughout the Baltic region. The situation of many birds of prey and mammals has consequently improved (Figure 12). Some species still struggle with reproductive problems, however. The concentrations of dioxins and PCBs seem to have remained stable during the 1990s, thus indicating that some input of the substances to the Baltic Sea still occurs.

The negative impact of dioxin and organochlorine compounds in the food chain is now widely recognized and there is a need to pay particular attention to the possible risk to humans. In Sweden, for example, the Food Administration recommended in 1995 that women of childbearing age should limit their consumption of Baltic herring and salmon.

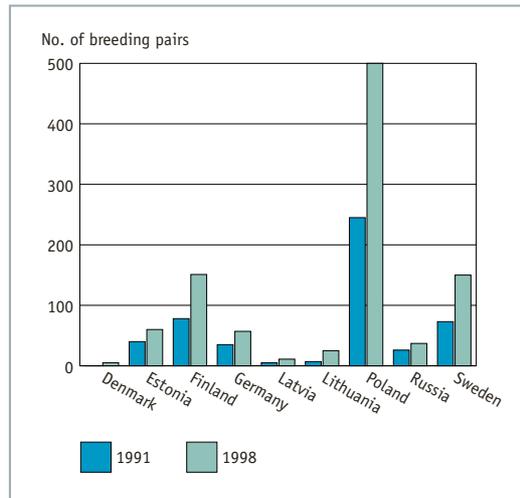


Figure 10  
Development in the number of white-tailed sea eagle breeding pairs between 1991 and 1998. Germany: the left-hand column represents data collected in the 1994 census. Poland: the 1998 figure is an estimate (Source: Modified from HELCOM, 2001, Table 10.1).

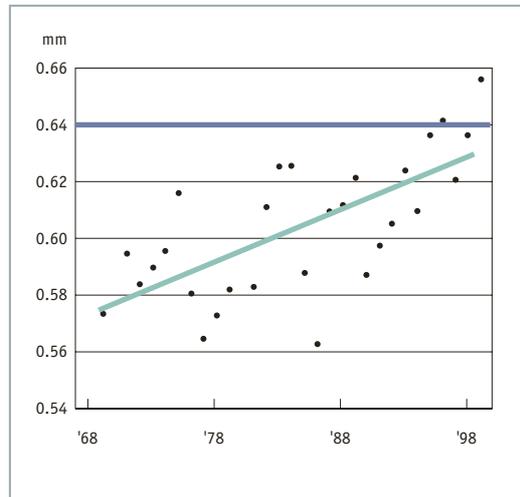


Figure 11  
Thickness of guillemot eggshells collected in Stora Karlsö in the central Baltic Proper since 1968. The solid blue line indicates the thickness prior to 1940 (Source: Modified from HELCOM, 2001).

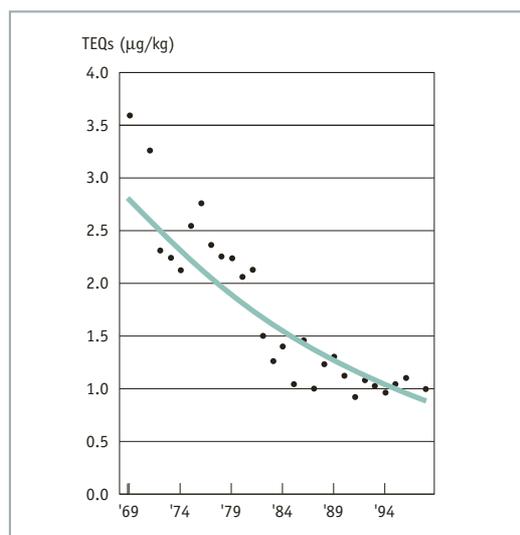
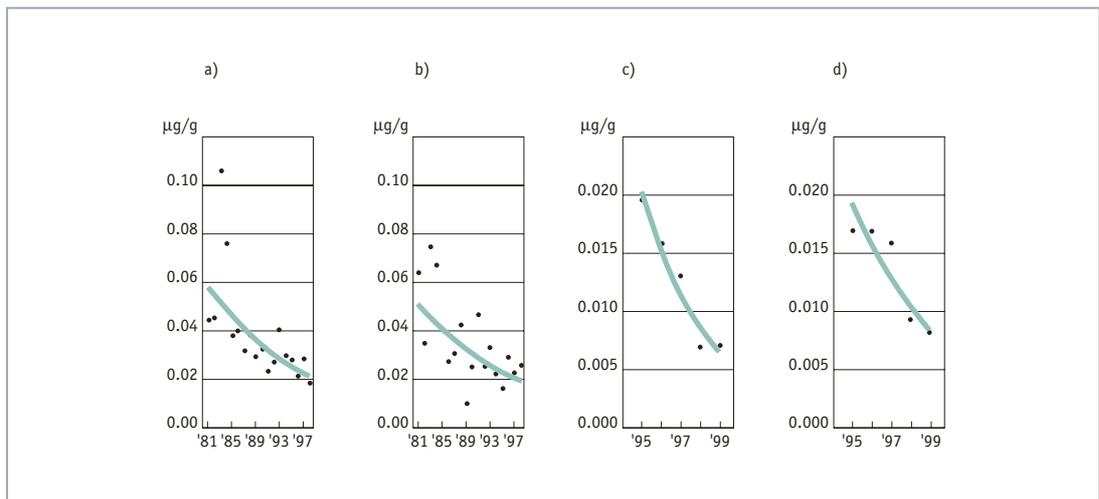


Figure 12  
Dioxin concentration in guillemot eggs from Stora Karlsö, west Gotland in the central Baltic Proper, over the period 1969-98 (Source: Modified from HELCOM, 2001).

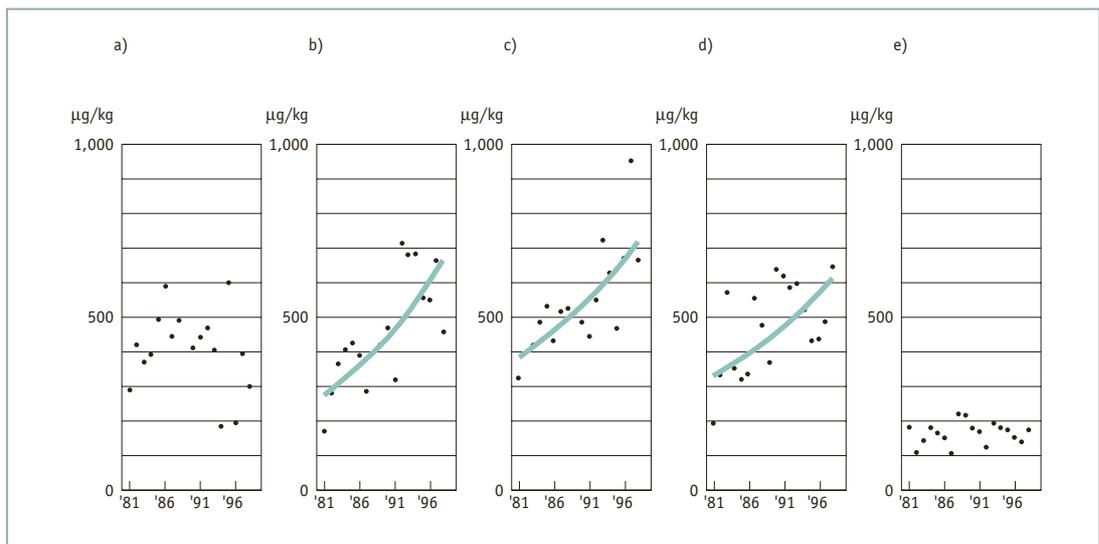
## Cadmium levels are increasing in baltic herring

The concentrations of most heavy metals measured in organisms inhabiting the Baltic Sea are stable or even decreasing. An exception is cadmium, the concentration of which increased in fish living in the central Baltic Sea during the 1990s. The reason is unclear, however. The concentrations are higher in organisms living in the southern part of the Gulf of Bothnia and in the Baltic Proper (Figures 13-15).

**Figure 13**  
Lead concentration in fish liver during the 1980s and 1990s: a) cod, the Baltic Proper, b) cod, the Kattegat, c) perch, the Gulf of Bothnia, and d) perch, the Baltic Proper (Source: Modified from HELCOM, 2001).



**Figure 14**  
Cadmium concentration in herring liver collected along the Swedish coast during the 1980s and 1990s: a) the Bothnian Bay, b) the southern Bothnian Sea, c) the northern Baltic Proper, d) the southern Baltic Proper and e) the Kattegat. If statistically significant a solid line shows the trend (Source: Modified from HELCOM, 2001).



### Antifouling agents cause problems

The antifouling agents continually released from the hulls of ships end up in marine sediments and living organisms, as has been shown in the Kattegat and Belt Sea. One of the agents, tributyl tin, can cause hormonal disturbances in a number of invertebrate animals. In some snail species, for example, tributyl tin blocks the production of the female sex hormone, causing females to grow male sex organs. How much damage the chemicals inflict in other parts of the Baltic marine environment remains to be elucidated.

### No environmental threat from chemical munitions and radioactive substances

Dumped chemical munitions are not causing any appreciable harm to the Baltic marine environment, the situation having neither improved nor deteriorated since the last assessment (HELCOM, 1996). Radioisotopes do not pose a health risk in the Baltic Sea either, the calculated radiation doses from man-made radioisotopes being below the limits considered to be of concern in the EU Basic Safety Standards.

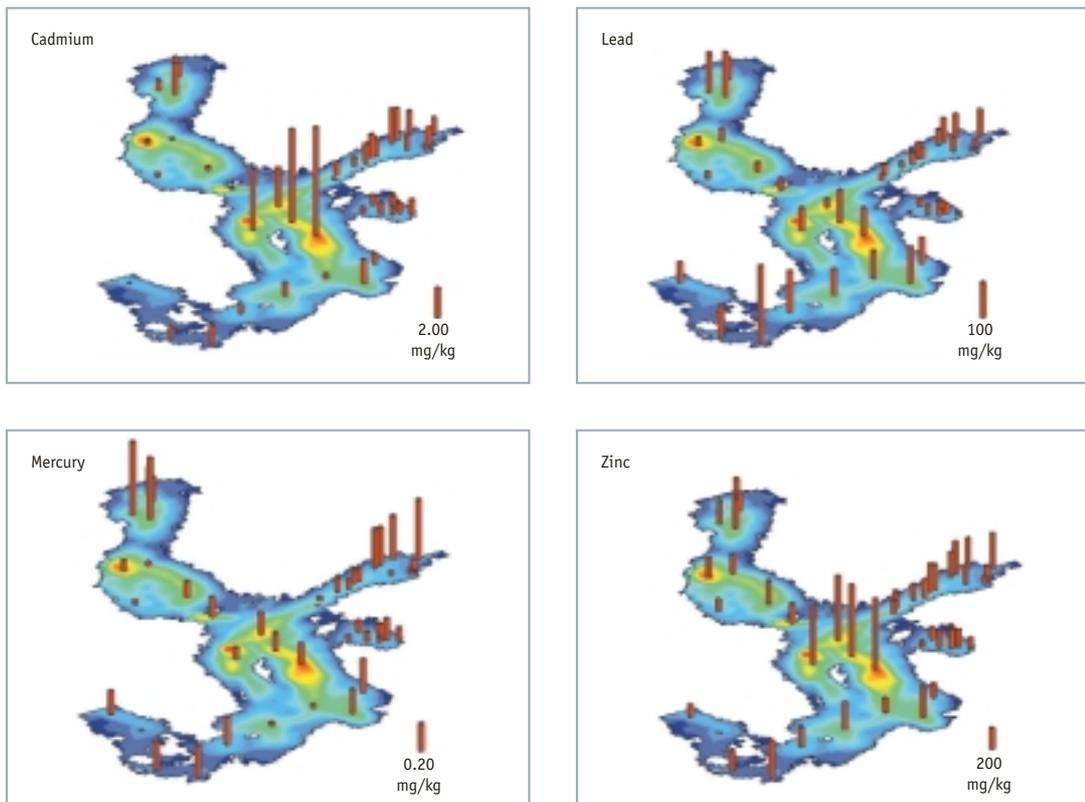


Figure 15  
Cadmium, lead, mercury and zinc levels in Baltic Sea surface sediments. The yellow and orange areas indicate the deep basins (Source: HELCOM, 2001).

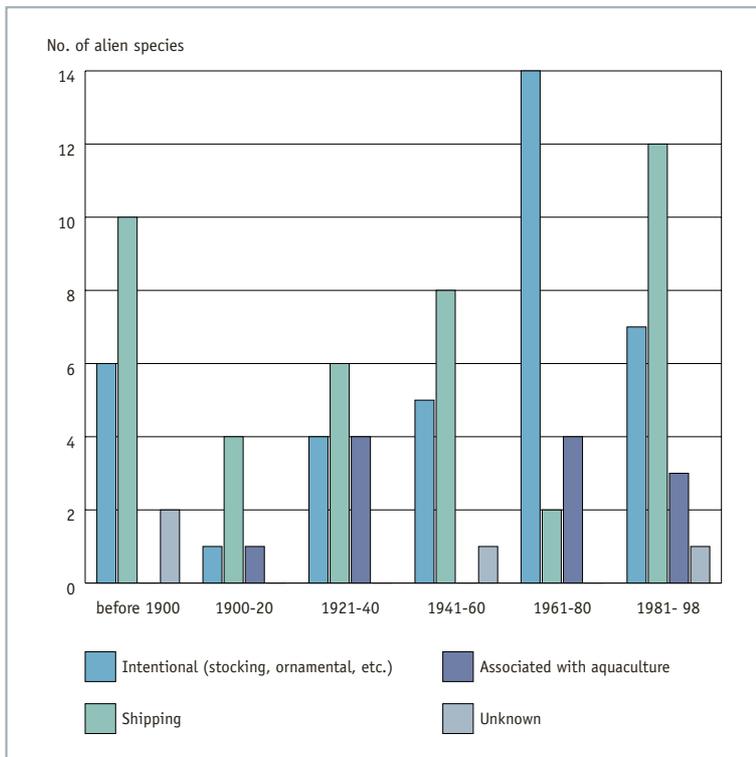
# Nature conservation and biodiversity

Human impacts continually challenge biodiversity in the Baltic region. Today, close to 90% of the marine and coastal biotopes are rated as threatened by either destructive land use or deteriorating environmental quality.

Enhanced nutrient loading has caused marked changes in the Baltic Sea environment. Due to the increased presence of planktonic algae blocking its path, light no longer penetrates as deeply into the water as it did 30-50 years ago. In most areas, plants have been forced out of the deeper waters because insufficient light reaches them to support their photosynthesis. Large areas of the sea bottom are thus thinly vegetated or barren.

Similarly, the bladder wrack has become less common along the rocky shorelines, although it seems to have recovered slightly in some coastal areas. Eutrophication has also reduced the abundance and distribution of eelgrass, which is the ecologically most important flowering plant so typical of the sandy sea floor of the southern and western parts of the Baltic Sea.

**Figure 16**  
Introductions of species previously unknown to occur in the Baltic Sea (so-called alien species) indicating how they arrived (Source: Modified from HELCOM, 2001).



## Invasion by new species continues

Over the past twenty years, a growing number of new species have been transported into the Baltic Sea from around the world. As ship traffic increases, more and more “stowaway species” arrive in the Baltic Sea from abroad. In some cases, alien species have been intentionally introduced (Figure 16).

Inland waterways such as those connecting the Baltic Sea to the Black Sea and the Caspian Sea provide alien species with handy gateways to the Baltic Sea. Because of the low salinity, both freshwater and brackish water species from abroad are capable of colonizing the area. Once they have established a foothold, such species are able to

### Variety of life in the Baltic Sea

The Baltic Sea area hosts numerous plants, animals and microorganisms in a number of different habitats. Productivity is highest in the coastal areas. These serve as breeding grounds, nurseries, shelters and food sources for most of the species living in the sea. At the same time, 15 million people live permanently in the coastal zone. They are joined by millions of tourists who travel to the coastal zones for recreation.

In total, 133 marine and coastal biotopes and 13 selected biotope complexes were classified by the Helsinki Commission in 1998 for protective purposes. The majority of biotopes and species are to some degree threatened by the effects of eutrophication, contaminants, marine transport, abusive fishing practices and coastal development.

The anthropogenic pressures are aggravated by the challenging natural conditions in the Baltic Sea. Its brackish waters push many species to the edge of their osmotic capacities, considerably reducing biodiversity. Traveling east and north in this huge water body, salinity decreases to almost freshwater levels. The organisms inhabiting the area have not had much time to adapt to these environmental conditions since the Baltic Sea ecosystem is rather young, having been created only some 10,000 years ago by the last Ice Age.

spread to other regions of the Baltic Sea at speeds of 30-480 kilometres per year.

Memories of the nuisance problems resulting from the arrival of an alien water flea species in the Gulf of Riga and the Gulf of Finland in 1992 are still fresh in the minds of fishermen. Back then, myriads of the tiny organisms clogged their fishing nets and the gills of the fish. For one Russian fishing company off the Neva estuary, the fleas resulted in an economic loss of more than 50,000 ECU annually (1996-98). By 1998, six years after their arrival, the water fleas had travelled west to the Baltic Proper as well as to the Stockholm archipelago and Gotland.

### Cod, salmon and sturgeon urgently need a helping hand

The Baltic wild salmon faces extinction, partly due to physical obstructions in salmon rivers that hinder adult fish from reaching their spawning grounds. The mass rearing of salmon in hatcheries also contributes to the demise of the wild population. The hatchery fry have a low genetic variability and when they reproduce with wild salmon, they diminish the latter's gene pool. Wild salmon accounted for only 8% of the population in 1998 as compared with 14% in 1994.

The populations of the commercially important cod are declining due to overexploitation and environmental degradation, and the species thus needs help. The Baltic sturgeon is presumed to have disappeared from Baltic waters but the Helsinki Commission has launched a sturgeon restoration project in 1997.

### Birds are gaining ground

The cormorant has returned to the Baltic region after having been hunted close to extinction at the beginning of the 20th Century. During the 1990s, the southwestern population stabilized at around 50,000 breeding pairs (Figure 17). The first breeding pair in Finland was reported in 1996. Based on experience with the southwestern population, the size of the eastern population is expected to increase until about 2010. The conservationist community advises against the introduction of cor-

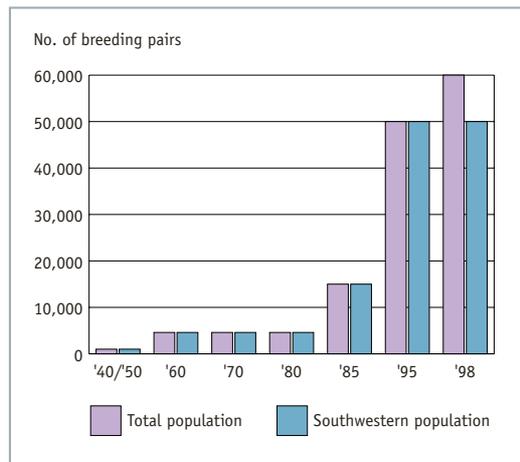


Figure 17  
Development of the cormorant population in the Baltic Sea (Source: HELCOM, 2001).

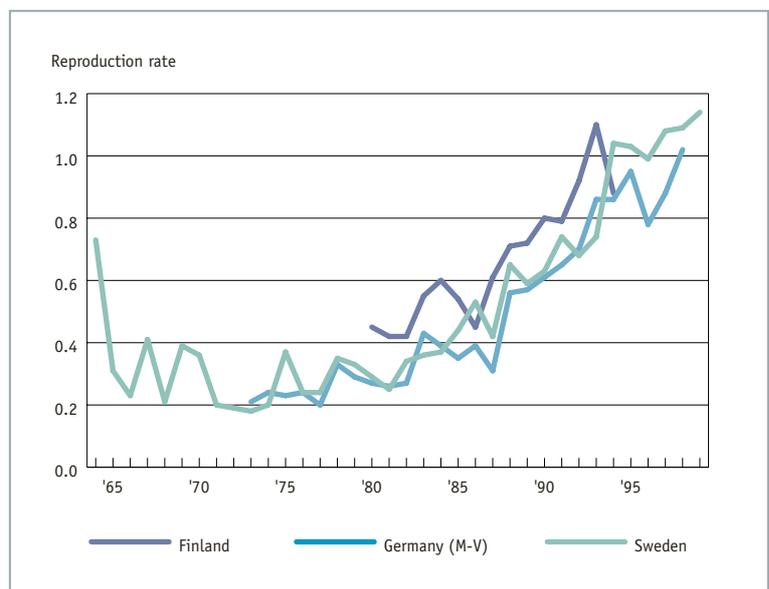


Figure 18  
Development in the number of white-tailed sea eagle fledglings per breeding pair in Sweden, Finland and the Federal German State of Mecklenburg-Vorpommern since 1964 (Source: HELCOM, 2001).

morant hunting on the grounds that it mainly feeds on fish of minor economic value. However, as cormorants also raid fishing nets and mariculture facilities, an international management plan prepared for the Bonn Convention has advocated population control by restricted culling and destruction of new colonies, etc.

The white-tailed sea eagle is recovering in the Baltic region (Figure 10). Due to remarkably high growth rates in the 1990s, the population almost doubled between 1991 and 1998 (Figure 18). With the rising number of breeding pairs, its distribution range has also widened. The eagle has now returned to areas where it has not bred for decades, e.g. Lithuania in 1987 and Denmark in 1996. The white-tailed sea eagle still needs protection, though. Being a predator, it is highly susceptible to pollution hazards.

Grey seals at the coast of Rügen.



Photo: J. Schwarz

### Seals – a cause for concern

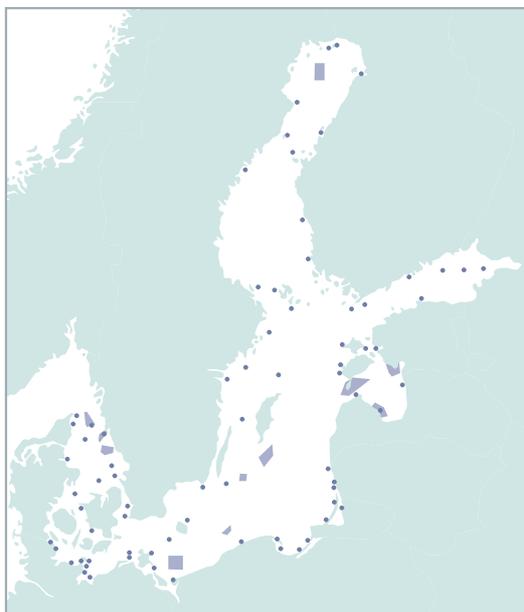
Baltic seal populations – harbour seals, grey seals and ringed seals – are generally increasing. At the same time, conflicts with fishermen are becoming more common. In the Gulf of Finland, seal predation on salmon caught in nets or traps is claimed to be partly responsible for the halving of salmon landings in 1998.

Some of these species are considered to be vulnerable in most Baltic States, however, and in some areas their health condition and reproductive success are poor.

### Porpoises are still at risk

The harbour porpoise is the only whale species inhabiting and breeding in the Baltic Sea. Two distinct populations have been identified. The population in the Belt Sea is doing well, whereas the status of the population inhabiting the Baltic Proper is unknown. Based on historical data, the harbour porpoises can be ranked as vulnerable. Fisheries by-catch poses a threat to the species in the Baltic Sea.

Figure 19  
Location of the 62 coastal and offshore areas nominated in 1995 for HELCOM's system of Baltic Sea Protection Areas (Source: Modified from HELCOM, 2001).



### Action needed on Baltic Sea Protected Areas

In 1995, 62 marine and coastal areas were designated as Baltic Sea Protected Areas (Figure 19). Millions of seabirds use these areas as staging posts during migration and more than 30 species breed in them. Despite the fact that preference was given to areas that are already under some form of protection, very few of the designated areas have yet been formally incorporated into the system. In the EU countries, most of the areas were nominated as parts of the NATURA 2000 system. This entails management obligations locally and within the broader EU system. There still remains a need to designate additional offshore areas that could be accorded an enhanced level of protection, however.

# Marine, migratory and freshwater fish

## Fish stocks are becoming dangerously low

Although landings of the commercially important species are stable at 0.9 to 1 million tonnes of fish per year, this does not imply that all is well with the fish populations in the Baltic Sea. A closer look at the landings of individual species such as sprat and cod reveal wide fluctuations indicative of ecological turmoil. As the number of cod decreases, the number of sprat increases, reflecting their direct predator-prey relationship. Analysis of the main target species over the period 1994-98 indicates that cod, herring, salmon and eel fishery is presently unsustainable in the Baltic Sea. Collapse of the stocks can only be kept at bay if these species are allowed to reproduce more extensively and to rebuild populations considered biologically safe (Figures 20-22).

Mariculture is unevenly distributed throughout the area and its impact on the Baltic marine environment is considered to be negligible.

## Intricate food web dynamics tangle up cod

Commercial fishery is undoubtedly responsible for altered food web dynamics and dwindling spawning stocks of some fish species. For example, cod has almost disappeared from the Archipelago Sea, the Bothnian Sea and the coastal areas of the Baltic Proper – areas that it formerly inhabited. The decline in the cod population was exacerbated by unfavourable natural conditions. Cod eggs float in water of a certain salinity, but in some areas this lies at depths at which the water is depleted of

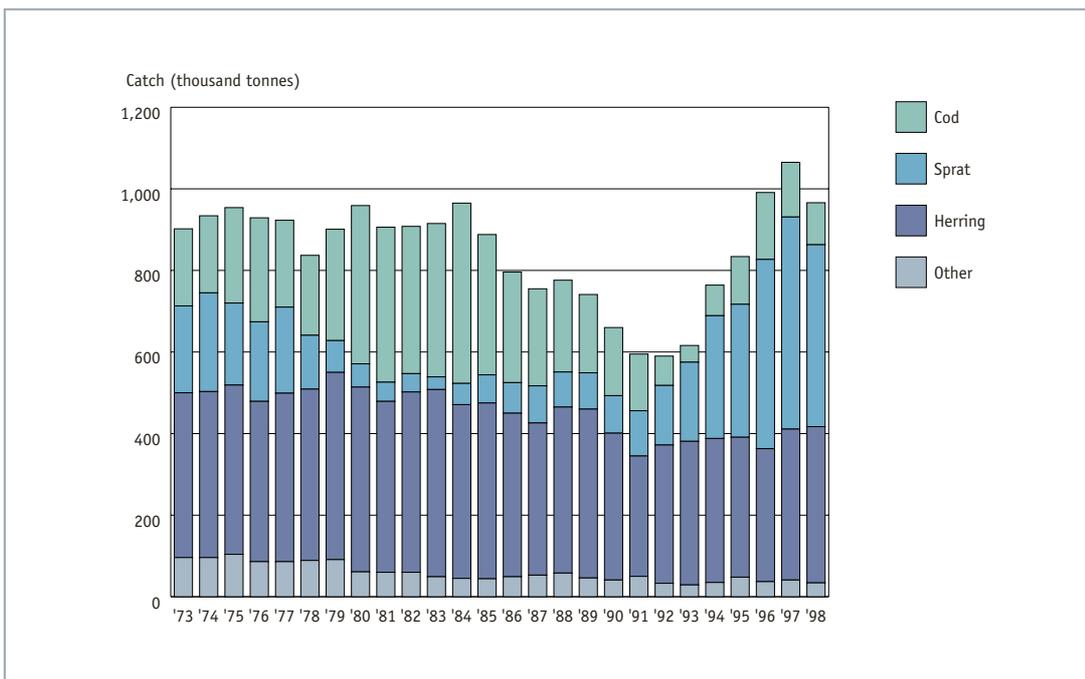


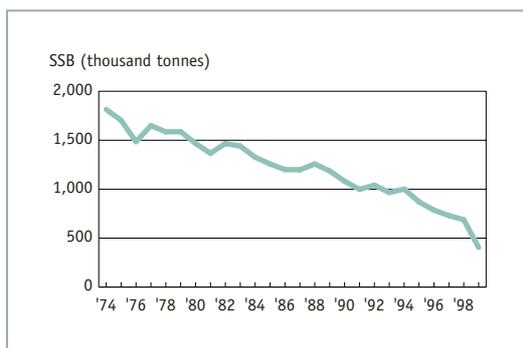
Figure 20  
Catch of the main target species cod, sprat, herring and "others" in the Baltic Sea from 1973-98 (Source: HELCOM, 2001).

Harbour porpoise caught in fishing net.



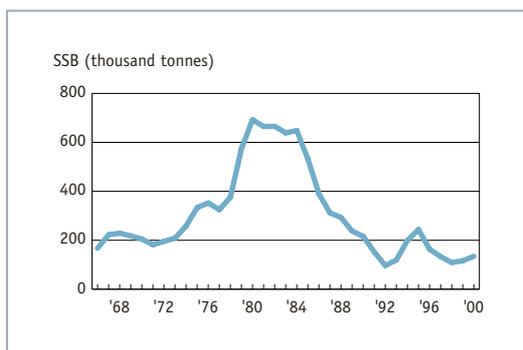
Photo: Biofoto

**Figure 21**  
Development in herring spawning stock biomass (SSB) in the Baltic Proper, the Gulf of Riga and the Gulf of Finland since 1974 (Source: Modified from HELCOM, 2001).



oxygen. The cod eggs thus die, reducing the reproductive success of the populations. Another disadvantageous change has also decimated the numbers of cod eggs and larvae. As a result of the shifting food web dynamics in the Baltic Sea, the offshore fish community is no longer controlled by cod predation, but instead by planktivorous fish such as herring and sprat which consume large quantities of cod eggs and larvae.

**Figure 22**  
Development in cod spawning stock biomass (SSB) in the Baltic Proper, the Gulf of Riga and the Gulf of Finland since 1966 (Source: Modified from HELCOM, 2001).



### By-catches need to be reduced

By-catches of marine mammals and some fish species are so high that they endanger the sustainability of the populations. More detailed information is needed on the total by-catch of mammals and birds, as is a more accurate system for recording by-catch statistics.

# Hydrography and hydrology

During the period 1994-98, the natural conditions in the Baltic Sea varied considerably. Several extreme periods and events caused marked inter-annual variation, making it difficult for the scientists involved in preparing the assessment to differentiate between natural causes and man-made impacts.

## Unusual events are becoming more common

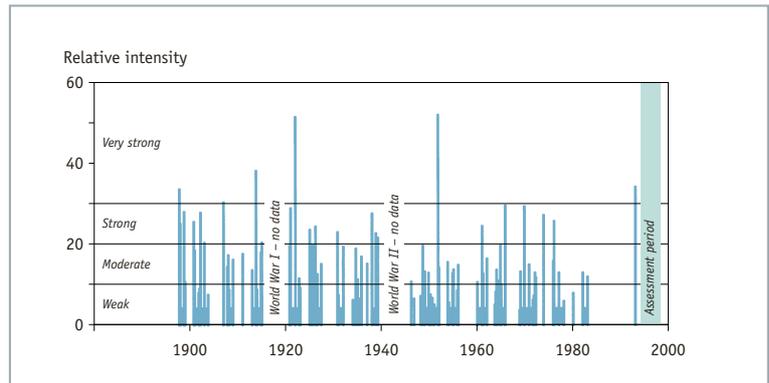
The summers of 1994 and 1997 were markedly warmer than usual while 1998 was wetter than usual. In 1998, moreover, riverine run-off was the highest since 1924.

After a long period of stagnation, major inflow of oxygen-rich salt water into the Baltic Sea in 1993 and 1994 re-established good conditions for the marine organisms (Figure 23). The revival did

### Main natural mechanisms

Three main factors determine environmental conditions in the Baltic Sea. These so-called driving forces are: Large-scale and local meteorological conditions, hydrological processes in the drainage area and hydrographic events in the sea itself.

Together these factors control the water temperature and salinity, the regional inflow of river water and the transport of pollutants. Moreover, they steer the exchange of water with the North Sea and the transport and mixing of water within the different water bodies comprising the Baltic Sea.



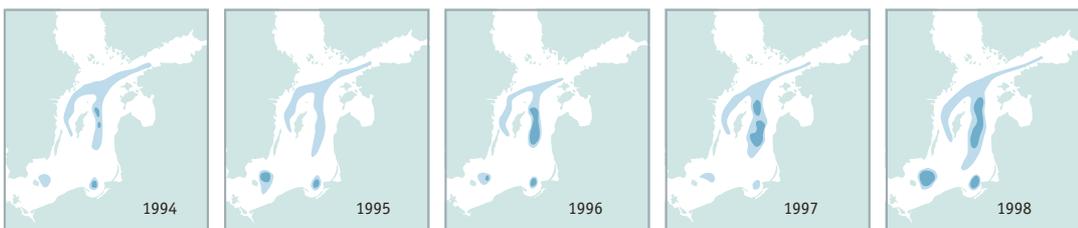
**Figure 23**  
Inflow of oxygen-rich salt water to the Baltic Sea from the North Sea/Skagerrak during the past century (Source: HELCOM, 2001).

not last long, however, and stagnation set in again in 1995. Oxygen levels (1994) dropped to zero and hydrogen sulphide was released into the water from the sea floor (1998) (Figure 24).

In 1998, annual mean temperature and salinity in the deep waters of most parts of the central Baltic Sea were the highest recorded during the 1990s. This was attributable to the generally high temperatures in the region and the inflow of warm, saline water from the North Sea in autumn 1997, which drove down beneath the more brackish Baltic water.

## Possible signs of climate change

The variations in water exchange between the North Sea and the Baltic Sea during the assessment period were within the range of natural fluctuation and are hardly likely to be attributable to a permanent change in climatic conditions. The increased rainfall and freshwater run-off and the resulting drop in salinity of the surface waters of the Baltic Sea might be connected to global warming, however.



**Figure 24**  
Maximum extent of areas affected by oxygen depletion (light blue) and/or hydrogen sulphide (dark blue) in the deep basins of the Baltic Proper and the Gulf of Finland during the assessment period 1994-98 (Source: HELCOM, 2001).

# Monitoring and assessment

## Assessments are the basis for protection efforts

In order to establish a sound scientific foundation for environmental protection measures in the Baltic region the Helsinki Commission runs a number of programmes to monitor environmental conditions in the area. The COMBINE programme monitors the state of the marine environment while the Pollution Load Compilation concentrates on inputs of nutrients and potentially harmful substances. In addition, regular aerial surveillance flights detect illegal oil discharges by ships.

The resulting data form the basis for the period-



Photo: Biofoto



Photo: Biofoto



Photo: Biofoto

ic assessments, as well as for the Waterborne and Airborne Pollution Load Compilations.

International harmonization requirements make considerable demands on the monitoring programmes. To ensure that they are effective and relevant they are continuously evaluated and adjusted to meet the needs of new reporting formats, for example short-term indicator-based reports.

## Keeping up steam on the assessments

The periodic assessment of the Baltic Sea environment is only as good as the data provided by the individual Baltic States. Despite some shortcomings, data quality and cooperation have generally improved since the Third Periodic Assessment (1989-93).

The Helsinki Commission greatly appreciates the commitment of the countries bordering the eastern part of the Baltic Sea to actively participate in the joint monitoring and assessment work. This has enabled previously blank spaces on the maps to be filled out with environmental information from the coastal areas of the eastern part of the Baltic Proper, the Gulf of Finland and the Gulf of Riga. Unfortunately, though, economic constraints have again reduced the general level of the monitoring activity.

The Fourth Periodic Assessment is the first to address socioeconomic factors. This is an important addition because socioeconomic shortcomings at the local level can degrade the marine environment on an international scale.

## New types of report

The Helsinki Commission publishes the periodic assessment every fifth year. Consideration is now being given to supplementing the periodic assessments with annual reports focussing on so-called environmental indicators. These would allow a quick overview of the environmental situation, while the periodic assessments would continue to serve as the platform for identifying developmental trends and providing a more detailed and comprehensive analysis.

# Description of the Baltic Sea and its catchment area

The Baltic Sea covers 415,266 square kilometres while its catchment area is about four times as large. Baltic oceanographers traditionally divide the Baltic Sea into five main subareas (Table 1).

From the narrow straits of the Belt Sea and the Sound in the west, the Baltic Sea stretches east and north through a series of basins separated by submarine sills that restrict horizontal water exchange. The average depth is slightly more than 50 metres. The deepest part is in the Landsort Deep in the Baltic Proper, where depths of 459 metres have been recorded.

Nearly 85 million people inhabit the Baltic Sea catchment area. Population density varies from over 500 inhabitants per square kilometre in the urban areas of Poland, Germany and Denmark to less than 10 inhabitant per square kilometre in the northern areas of Finland and Sweden (Table 2). About 22 million people (26%) live within metropolitan areas, whilst 45% live in towns or small cities and 29% in rural areas. Nearly 15 million people live within 10 kilometres of the coast.

A remarkably large part (60-70%) of the territory is agricultural land in Germany, Denmark and Poland. Forests, wetlands and lakes constitute from 65 to 90% of the catchment area in Finland, Russia, Sweden and Estonia.

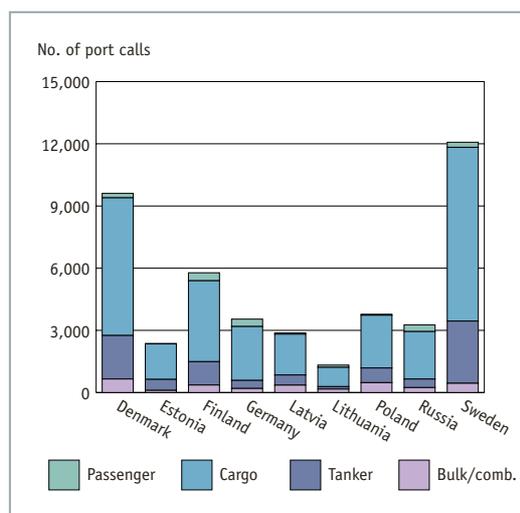
The Baltic Sea contains numerous busy seaborne cargo links. The maritime transport of goods between the Baltic States plays an essential role and over 500 million tonnes of cargo are transported across the Baltic Sea each year. Approximately 50 ferries ply fixed routes between Baltic ports (Figure 25).

**Table 1**  
Characteristic data on the Baltic Sea and its five main subareas (Source: HELCOM, 2001)

Subarea	Sea area km <sup>2</sup>	Sea volume km <sup>3</sup>	Maximum depth m	Average depth m	Freshwater input km <sup>3</sup> /yr
Baltic Proper	211,069	13,045	459	62.1	100
Gulf of Bothnia	115,516	6,389	230	60.2	193
Gulf of Finland	29,600	1,100	123	38	100-125
Gulf of Riga	16,330	424	>60	26	18-56
Belt Sea-Kattegat	42,408	802	109	18.9	37
Baltic Sea Area	415,266	21,721	459	52.3	

Country	Population
Poland	38.1
Russian Fed.	10.2
Sweden	8.5
Finland	5
Denmark	4.5
Belarus	4
Lithuania	3.7
Germany	3.1
Latvia	2.7
Ukraine	1.8
Czech Rep.	1.6
Estonia	1.4
Slovak Rep.	0.2
Total	85.0

**Table 2**  
Population (millions) in the Baltic Sea catchment area (Source: HELCOM, 2001).



**Figure 25**  
Number of port calls in Baltic Sea States in the second half of 1998 apportioned by vessel type. Passenger vessels not reported by Estonia. One port call = ship arrival and departure (Source: HELCOM, 2001).

## Where to obtain further information

Alg@line database "State of the marine environment of Gulf of Finland".

Website: <http://meri.fimr.fi>

Atmospheric supply of nitrogen, lead, cadmium, mercury and lindane to the Baltic Sea.

EMEP/MSC-W 3/98. ISSN 0332-9879

Bonn Convention, 1999. Action Plan for the Management of the Great Cormorant in the African-Eurasian Region. Prepared by the Netherlands and Denmark

HELCOM, 1996. Coastal and Marine Protected Areas in the Baltic Sea Region, Baltic Sea Environment Proceedings No. 63. ISSN 0357-2994

Guidelines for the Fourth Pollution Load Compilation.

Website: <http://www.helcom.fi>

HELCOM, 2001. Fourth Periodic Assessment of the State of the Environment of the Baltic Marine Area, 1994-1998. Baltic Sea Environment Proceedings No. 82

HELCOM, COMBINE Manual

HELCOM, Project "Save the Common Sturgeon, *Acipenser sturio*, in the Baltic Sea", 1977/1978-2000/2001

HELCOM, Project Database on Alien Species in the Baltic Sea, 1998/1999-2000/2001

Website:

<http://www.ku.lt/nemo/nd/mainnemo.htm>

HELCOM, Project on Seals, 1998/1999-2000/2001

HELCOM, 1997. Airborne Pollution Load to the Baltic Sea 1991-95. Baltic Sea Environment Proceedings No. 69

IBSFC and HELCOM, 1999. Baltic Salmon Rivers – status in the late 1990s as reported by the countries in the Baltic Sea Region. ISBN 91-972770-3-7

Proposals for Offshore Baltic Sea Protected Areas, HELCOM, September 1998. Expert Report of HELCOM EC-Nature prepared by Bertil Hägerhäll, Ardeau Miljö AB and Henrik Skov, Ornis Consult a/s

Red List of Marine and Coastal Biotopes and Biotope Complexes of the Baltic Sea, Belt Sea and Kattegat, Baltic Sea Environment Proceedings No. 75. ISSN 0357-2994

Reports of the ICES Advisory Committee on the Marine Environment, 1995-99, ICES Cooperative Research Report Series

The Red Data Book of the Baltic Region, Part 1. List of threatened vascular plants and vertebrates

Third Baltic Sea Pollution Load Compilation, Baltic Sea Environment Proceedings No. 70. ISSN 0357-2994

*Additional information* may be obtained from the HELCOM Secretariat.

Telephone: +358-(0)9-6220 220

Telefax : +358-(0)9-6220 2239

# Colophon

## Published by:

Helsinki Commission,  
Katajanokanlaituri 6 B  
FIN-00160 Helsinki, Finland  
E-mail: [Helcom@helcom.fi](mailto:Helcom@helcom.fi)  
Internet: <http://www.helcom.fi>

## Editor:

Tonny Niilonen, Danish Environmental Protection Agency, Denmark.

## Scientific editors:

Ole Norden Andersen, National Forest and Nature Agency, Denmark; Eugeniusz Andrulawicz, Sea Fisheries Institute, Poland; Britta Pedersen, National Environmental Research Institute, Denmark; Sten Bergström, Swedish Meteorological and Hydrological Institute, Sweden; Anders Bignert, Swedish Museum of Natural History, Sweden; Dieter Boedeker, Federal Agency for Nature Conservation, Germany; Hans Dahlin, Swedish Meteorological and Hydrological Institute, Sweden; Göran Dave, University of Gothenburg, Sweden; Sverker Evans, Swedish Environmental Protection Agency, Sweden; Heike Herata, Federal Environmental Agency, Germany; Kjeld Frank Jørgensen, Danish Environmental Protection Agency, Denmark; Alexandr Korshenko, State Oceanographic Institute, Russia; Włodzimierz Krzyminski, Institute of Meteorology and Water Management, Poland; Juha-Markku Leppänen, Finnish Institute of Marine Research, Finland; Urmas Lips, Estonian Marine Institute, Estonia; Georg Martin, Estonian Marine Institute, Estonia; Wolfgang Matthäus, Baltic Sea Research Institute, Germany; Günther Nausch, Baltic Sea Research Institute, Germany; Sven Nielsen, Risø National Laboratory, Denmark; Jørgen Nørrevang, International Council for the Exploration of the Sea; Mats Olsson, Swedish Museum of Natural History, Sweden; Janet Pawlak, International Council for the Exploration of the Sea; Eeva-Liisa Poutanen, Ministry of the Environment, Finland; Tuija Ruoho-Airola, Finnish Meteorological Institute, Finland; Bernd Schneider, Baltic Sea Research Institute, Germany; Algirdas Stankevicius, Marine Research Institute, Lithuania; Zoja Stukova, Environmental Protection Ministry, Lithuania; Gunni Ærtebjerg, National Environmental Research Institute, Denmark; Aivars Yurkovskis, Marine Monitoring Centre, Latvia

Text: Kjell Grip, HELCOM; Ulrike Hassink, HELCOM; and Tonny Niilonen, Danish Environmental Protection Agency, Denmark

Language revision: David I. Barry, On Line Activities, Raklev Høje 40, DK-4400 Kalundborg, Denmark

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*Tonny Niilonen,  
Project Manager for the  
Fourth Periodic Assessment*



*Ulrike Hassink,  
HELCOM Information  
Secretary*



*Kjell Grip,  
HELCOM Professional  
Secretary*



Helsinki Commission,  
Katajanokanlaituri 6 B  
FIN-00160 Helsinki, Finland  
Telephone: +358-(0)9-6220 220  
Telefax: +358-(0)9-6220 2239  
E-mail: [Helcom@helcom.fi](mailto:Helcom@helcom.fi)  
Internet: <http://www.helcom.fi>

