HELCOM news

4/2005 Newsletter

Special issue:

The health of the Baltic Sea

HELCOM
3/2005 Newsletter

This is a special issue of the Helsinki Commission's newsletter, featuring an overview of current trends in the Baltic marine environment. The articles are based on the latest HELCOM assessments, which form the backbone of the Commission's work providing objective information on the health of the Baltic Sea, and helping to define the need for further environmental actions.

This overview provides a quick insight into the environmental issues affecting the Baltic Sea today, while also serving as a useful foundation for a wider study of the Baltic marine environment.

The scientific data contained in this issue of HELCOM News was presented at the Baltic Sea Informal Meeting for Ministers of the Environment, which took place on 23rd November 2005 in Stockholm, Sweden.

Anne Christine Brusendorff
Executive Secretary

HELCOM NEWS 4/2005
Published by: Helsinki Commission
Katajanokanlaituri 6 B
FI-00160 Helsinki, Finland

E-mail: info@helcom.fi
Web: http://www.helcom.fi

Editor: Nikolay Vlasov,
Helsinki Commission

Language revision: Fran Weaver

Design and layout: Leena Närhi

Cover photos: HELCOM

Contents

Photo: Kaj Granholm

The health of the Baltic Sea

Summary

The Baltic Sea is impacted by many human act ivities and the widespread use of its natural resources. This overview focuses on the four main areas of concern defined by HELCOM: eutrophication, hazardous substances, shipping, and the loss of biodiversity and habitats.

As the environmental focal point of the Baltic Sea, the Helsinki Commission - HELCOM - has been assessing the sources and inputs of nutrients and hazardous substances and their effects on marine ecosystems for almost 30 years. The resulting reports are unique compilations of data and analyses based on wide-ranging scientific research carried out around the Baltic Sea, including special monitoring programmes co-ordinated by HELCOM.

The Baltic Sea, as one of the world's largest bodies of brackish water, is ecologically unique. Due to its special geographical, climatological, and oceanographic characteristics, the Baltic Sea is highly sensitive to the environmental impacts of human activities in its catchment area, which is about four times larger than the sea area itself, and is home to some 85 million people.

The Baltic Sea is only connected to the world's oceans by the narrow and shallow waters of the Sound and the Belt Sea. This greatly limits the exchange of water with the North Sea, and means that water may remain in the Baltic for up to 30 years, together with any pollutants it contains.

Since the 1800s, the Baltic Sea has changed from a pristine oligotrophic clear-water sea into a eutrophic marine environment. Nitrogen inputs have more than doubled, and phosphorus inputs are on average over three times higher than about one century ago. Agriculture currently accounts for the majority of waterborne and airborne nutrient inputs.

As a result, eutrophication is an issue of major concern almost everywhere around the Baltic Sea. Average biomass production has increased by a factor of 2.5, exceptionally intense algal blooms have become more common, and oxygen depletion has considerably worsened, leading to increased internal nutrient loading. Biodiversity and fish stocks have also been seriously affected.

The loads of some hazardous substances entering the Baltic Sea have been reduced considerably over the past 20 to 30 years. But their concentrations in the Baltic are still up to 20 times higher than in the North Atlantic. Where heavy metals are concerned,


Photo: Sergey Vlasov

the best news is the clear decrease in lead concentrations in herring observed in most areas. Concentrations of several organic pollutants in marine ecosystems declined in the 1980s, but this decrease levelled off in the 1990s. Dioxin levels in fish still exceed the new EU food safety limits in some areas, particularly further north.

Several Baltic Sea species and habitats are declining or endangered. As much as 90% of the marine and coastal biotopes around the Baltic Sea area are to some degree threatened today, and many of these areas are important habitats for rare or endangered species.

Present commercial fishing practices have environmental impacts throughout the Baltic Sea, affecting species caught accidentally as by-catches, as well as the stocks of commercially exploited species.

Major impacts of shipping on the marine environment include pollution by ship-generated waste, airborne emissions, the introduction of non-native species in discharged ballast water, and spills due to accidents.

On the brighter side, signs of the success of HELCOM's environmental programmes and nature conservation measures include steady increases in the populations of top predators such as the white-tailed eagle and the Baltic's three seal species.

Eutrophication still a widespread and persistent problem

Inputs of nutrients

The total annual input of nitrogen entering the Baltic Sea amounts to some 1 009 700 tonnes, of which 25% consists of atmospheric deposition, and 75% of waterborne inputs.

The total annual input of phosphorus entering the Baltic Sea is about 34 500 tonnes. Phosphorus enters the Baltic Sea mainly as waterborne inputs, and the contribution of atmospheric deposition is only 1-5% of the total.

These figures include inputs from natural background sources as well as anthropogenic sources.

Airborne nitrogen

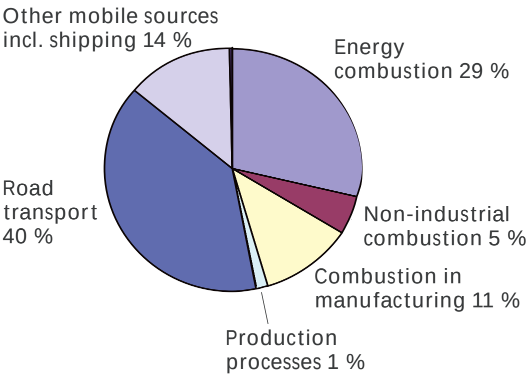
The atmospheric deposition entering the Baltic Sea originates from emission sources both inside and outside the Baltic's own catchment area.

Nitrogen compounds are emitted into the atmosphere as nitrogen oxides and ammonia. Shipping, road transport and combustion for energy are the main sources for emissions of nitrogen oxides (see diagram below). Agriculture accounts for around 90% of all ammonia emissions in the HELCOM countries, and about 40% of total nitrogen emissions.

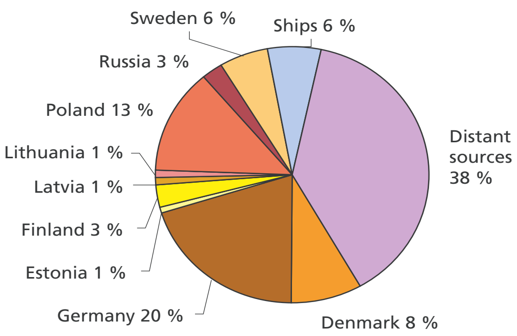
Waterborne inputs

Waterborne inputs encompass inputs entering the sea in rivers as well as emissions from point sources discharging directly into the sea. Riverine inputs include contributions from parts of the Baltic Sea catchment area which lie outside the HELCOM countries.

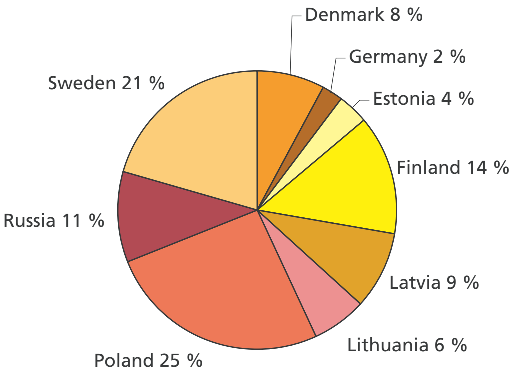
Agriculture and forestry contribute almost 60% and 50% of the waterborne nitrogen and phosphorus inputs to the sea, respectively. For nitrogen, 28% originates from natural background sources and 13% from point sources. Point sources and natural background sources each contribute approximately 25% of the phosphorus input to the Baltic Sea.

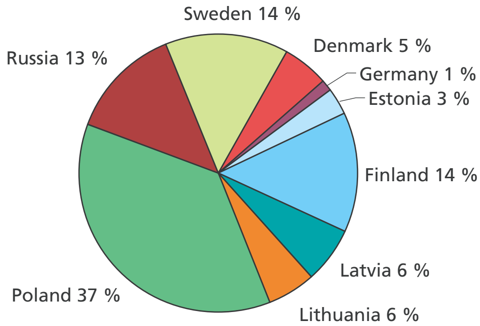


Percentage of total emissions of nitrogen oxides (NOx) from different sectors in the HELCOM Contracting Parties (EMEP 2004a)

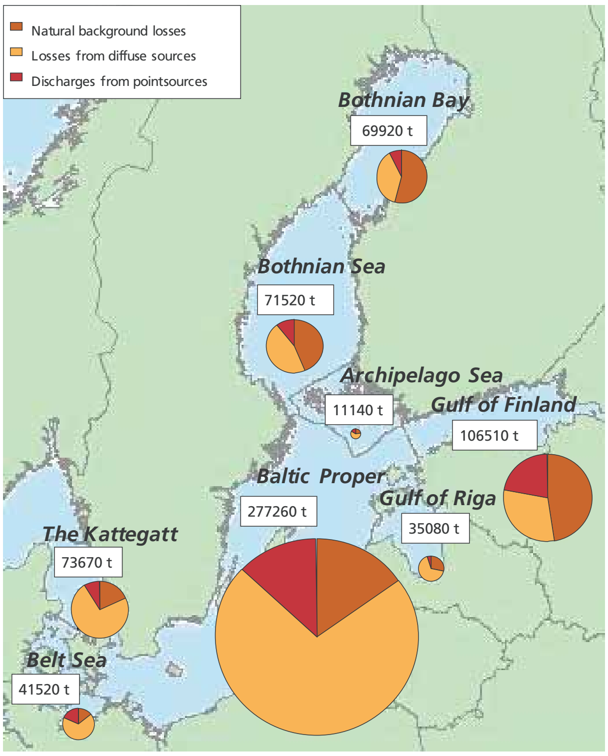


Proportion of atmospheric deposition of nitrogen entering the Baltic Sea by HELCOM contributor in 2000. The diagram shows that more than one third of the total nitrogen input originates from sources outside the HELCOM Contracting States.

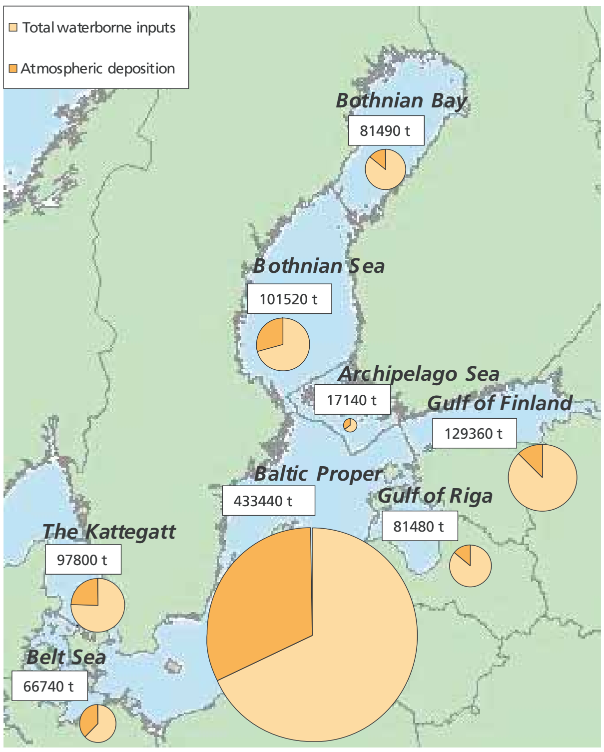




Proportions of waterborne inputs of nitrogen (left) and phosphorus (right) entering the Baltic Sea from the HELCOM countries in 2000. Figures include inputs from natural background sources as well as anthropogenic sources.



Proportions of sources contributing to waterborne nitrogen input into the Baltic Sea sub-regions in 2000



Proportions of airborne and waterborne nitrogen inputs into the Baltic Sea sub-regions in 2000

Anthropogenic nutrient loads per capita by country are shown on the right. The figures include discharges from both diffuse and point sources, but not natural background loads.

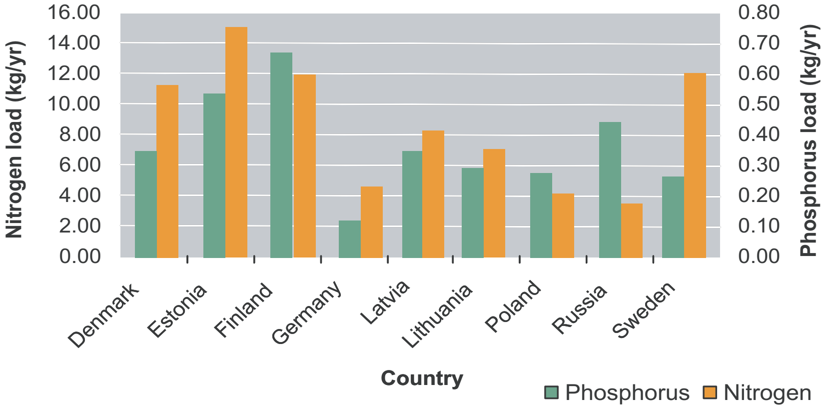
Transboundary pollution loads

Significant waterborne transboundary pollution loads flow from Belarus, the Czech Republic and Ukraine into the Baltic Sea.

The total riverine loads of nitrogen and phosphorus originating in these countries, measured at the borders, amount to about 8% and 7% respectively of the total loads measured at river mouths along the Baltic Sea coast. The significance of these transboundary pollution loads in sub-catchments of certain rivers are naturally higher. Compared to loads at the river mouths, the transboundary pollution loads for nitrogen and phosphorus respectively are 31% and 56% for the River Nemunas; 63% and 60% for the Daugava; 5% and 5% for the Vistula; and 16% and 14% for the Oder, without taking into account riverine retention.

The same countries are also significant sources for airborne nitrogen deposited into the Baltic Sea. The Czech Republic is the 11th largest depositor of nitrogen into the Baltic Sea - accounting for higher contributions than Finland or Russia. Ukraine and Belarus rank 15th and 16th on the list of the most significant contributors, meaning that their inputs exceed the levels of airborne nitrogen coming from Estonia, Latvia or Lithuania into the Baltic Sea.

Anthropogenic nutrient loads per capita by country in 2000



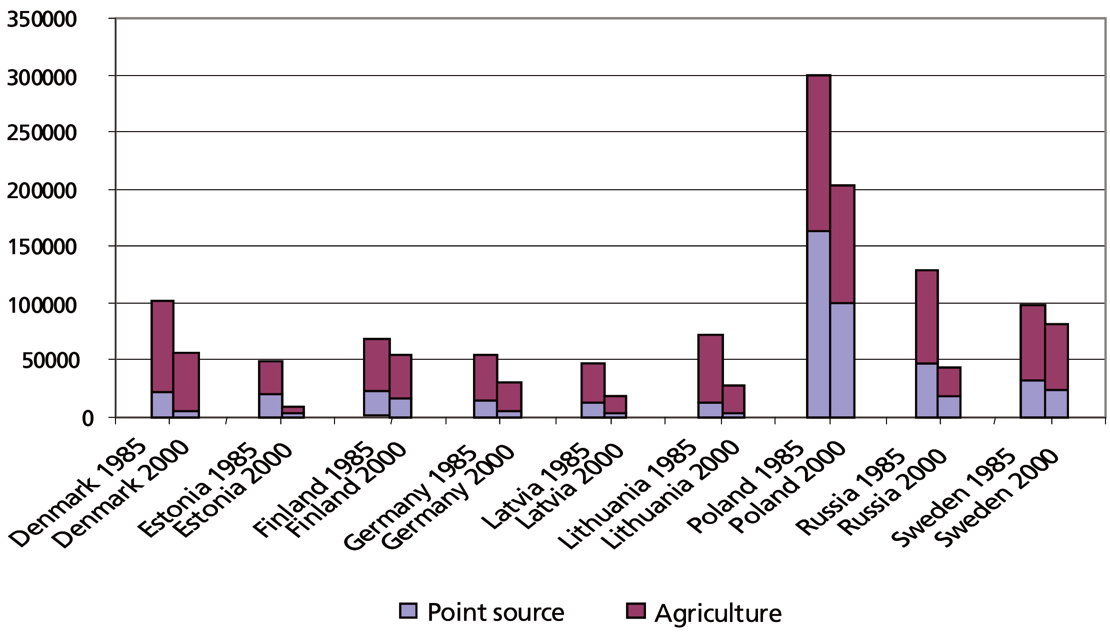
Long-term trends in nutrient inputs

Compared to the pristine conditions that prevailed in the Baltic Sea two centuries ago, nitrogen inputs have more than doubled, and phosphorus inputs are on average more than three times higher. According to HELCOM assessment, these inputs are slowly decreasing, however.

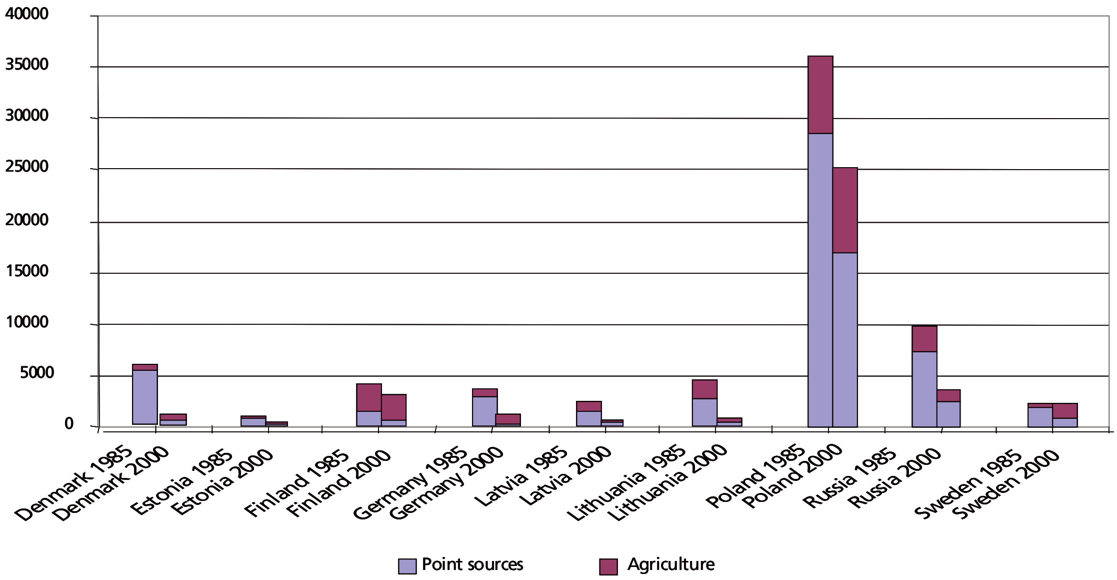
Since 1980 there has been a reduction of approximately 40% in total nitrogen emissions from the HELCOM Contracting Parties. On the other hand, deposition levels have only declined by some 15% during the same time period. This because deposition rates are highly dependent on meteorological conditions, which change from year to year, meaning that reductions in nitrogen emissions do not necessarily lead to corresponding reductions in deposition.

Progress in reducing waterborne nutrient discharges from point sources such

Photo: Tadas Navickas



Nitrogen inputs from point sources and agriculture within the Baltic Sea catchment area by HELCOM countries in 1985 and in 2000



Phosphorus inputs from point sources and agriculture within the Baltic Sea catchment area by HELCOM countries in 1985 and in 2000

as municipal and industrial wastewater treatment plants has been good, with the 50% reduction target for phosphorus achieved by almost all the HELCOM countries.

Measures to reduce nutrient loads from agriculture, contrastingly, have fallen short of their aims, although this is partly due to the fact that it can take decades for such measures to achieve their full effects. Furthermore, climatic conditions should also be taken into account when comparing figures for agriculture from 1985 with 2000.

The overall reductions in discharges for both phosphorus and nitrogen have been roughly 40% from all sources.

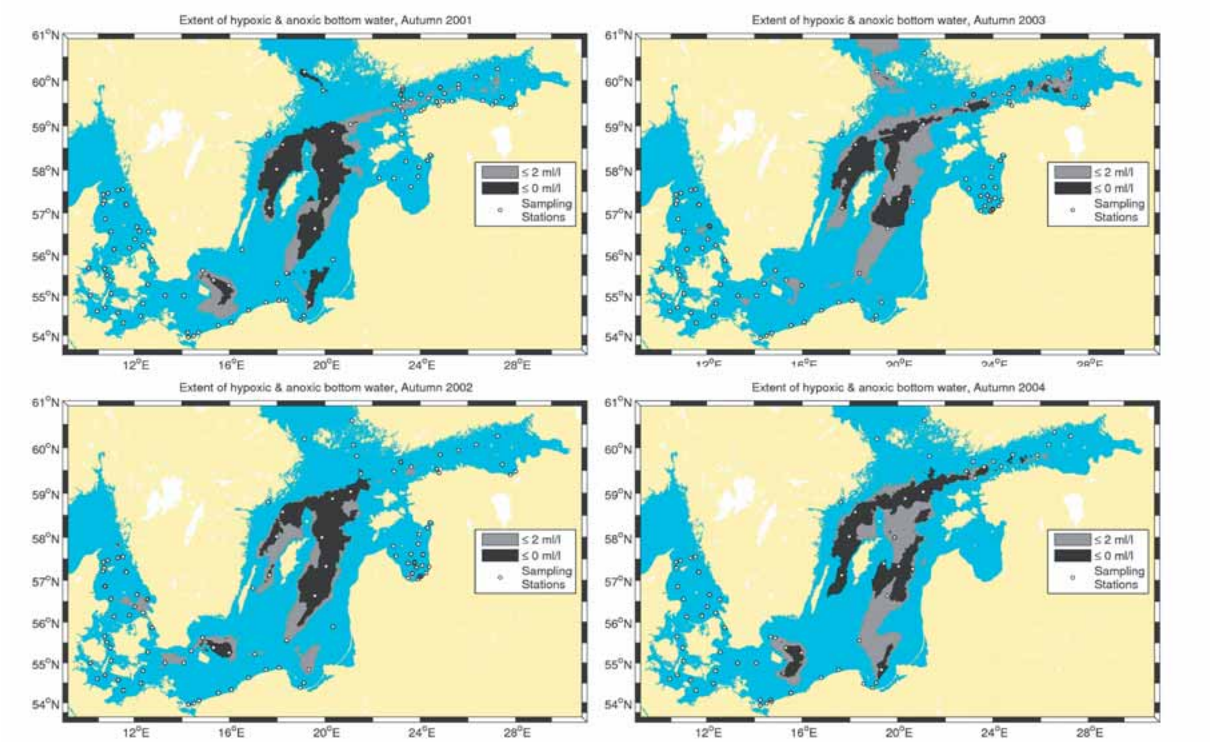
Impacts of nutrient inputs

Since the 1800s, the Baltic Sea has changed from an oligotrophic clear-water sea into a eutrophic marine environment.

Nitrogen and phosphorus are important natural nutrients, which as such do not pose any direct hazards to marine organisms. Where eutrophication occurs, however, aquatic ecosystems become burdened by excessively high nutrient inputs, stimulating algal growth, and leading to imbalances in the functioning of ecosystems. Problems caused by eutrophication include:

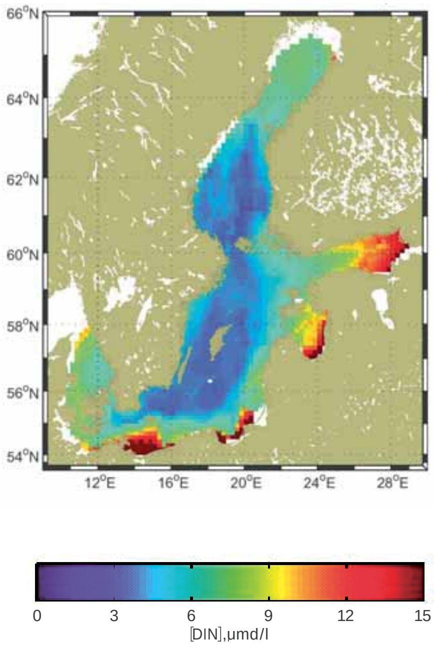
- intense algal growth: excessive filamentous algae and phytoplankton blooms
- production of excess organic matter
- increase in oxygen consumption
- oxygen depletion
- death of benthic organisms, including fish

Eutrophication remains an issue of major concern almost everywhere around the Baltic Sea. The problems described above have been recorded in both coastal waters and the open sea. The maps below show the regional distributions of bottom areas with oxygen concentrations below the critical level of 2 ml/l. The large salt-water inflows during 1993 and 1994 oxygenated the bottom waters in the Baltic Proper. However, due to the lack of any further inflow events and the strong stratification built up by the inflows, oxygen levels decreased again due to the excessive sedimentation of organic material in comparison to the amounts of oxygen transported into deep waters.



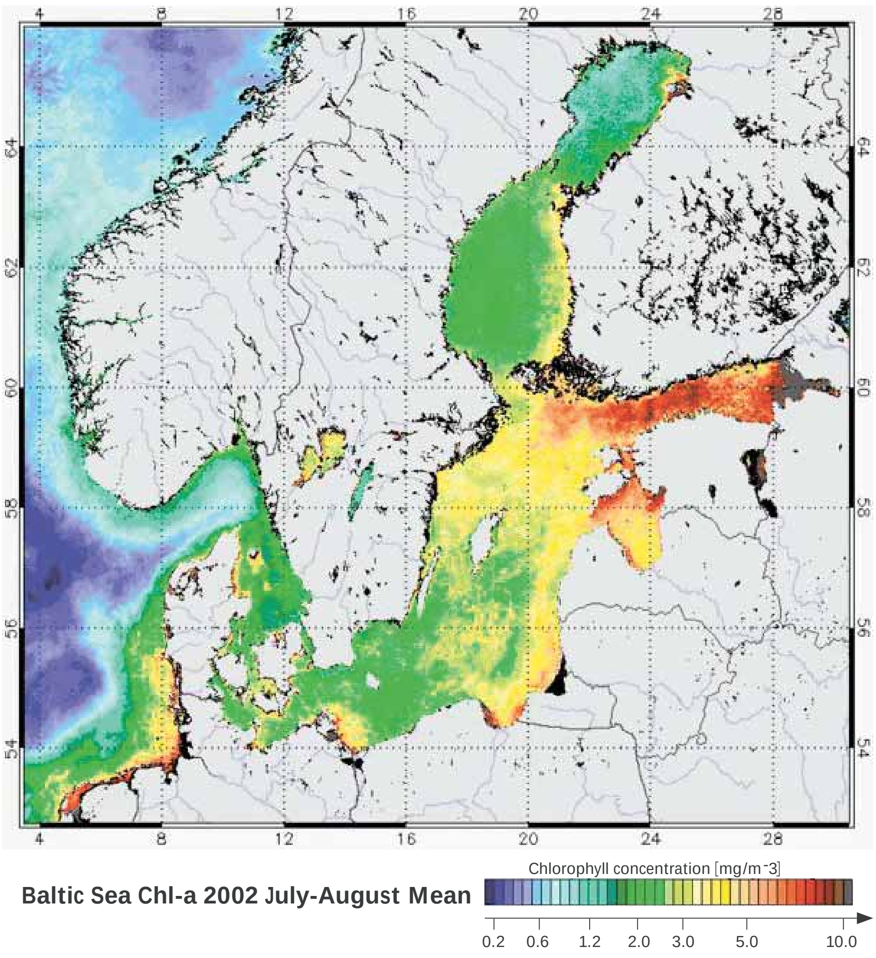
Extents of hypoxic and anoxic bottom water (oxygen content below 2 ml/l and 0 ml respectively) observed annually in Autumn 2001 – 2004

The map on the right shows how high winter concentrations of nutrients in coastal waters (shown in red) are mainly located where major rivers enter the Baltic Sea. Nutrient enrichment of these waters stimulates the growth of phytoplankton, leading, in certain circumstances, to algal blooms and subsequent sedimentation and anoxia in the lower part of the water column. This can in turn lead to the widespread death of benthic organisms. The regional distribution of phytoplankton growth shown in the map below reflects the related impacts as observed near the mouths of major rivers during the summer months.



Mean winter surface concentrations of dissolved inorganic nitrogen over the period 1996 – 2004, showing high accumulations in areas affected by major rivers

Chlorophyll-a map of the Baltic Sea compiled from remote sensing satellite data, showing the regional distribution of phytoplankton, reflecting the primary impacts of the excess nutrient inputs illustrated in the preceding map



Baltic Sea Chl-a 2002 July-August Mean

More action still needed on hazardous substances

Inputs of hazardous substances

The loads of some hazardous substances entering the Baltic Sea have been reduced considerably over the past 20 to 30 years. Discharges of heavy metals have particularly decreased, although no clear general trends have been observed for the concentrations of certain heavy metals in marine biota since 1990.

Riverine inputs and direct discharges are the main sources of mercury (50%), lead (60-70%) and cadmium (75-85%). The remaining shares are mainly accounted for by atmospheric deposition of these heavy metals.

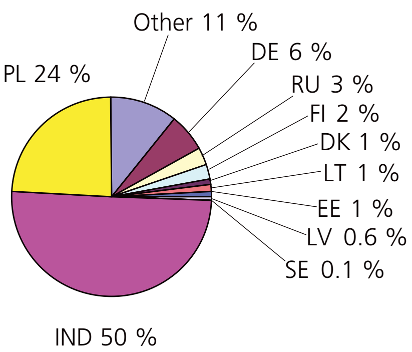
Airborne inputs

In 2002, total annual emissions by the HELCOM countries amounted to 120 tonnes of cadmium, 65 tonnes of mercury, and 3,320 tonnes of lead.

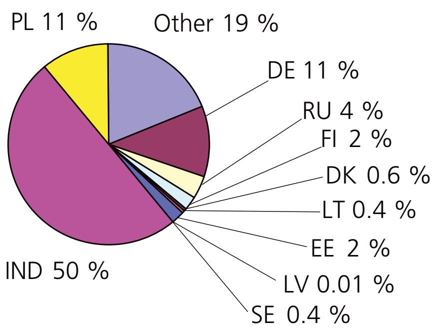
Deposition rates for cadmium and lead show a decrease from south to north, due to the distance from the main emission sources. The total annual atmospheric deposition rates for heavy metals entering the whole of the Baltic Sea are over 7 tonnes for cadmium, 3 tonnes for mercury, and about 149 tonnes for lead. The highest levels of heavy metal deposition are experienced in the Belt Sea sub-basin.

Anthropogenic emission sources of heavy metals, such as industries, energy production and waste incineration in the HELCOM countries accounted for about 40-50% of the total atmospheric deposition into the Baltic Sea in 2002. Natural sources and distant sources from outside the Baltic Sea catchment area also contributed significantly. By individual countries, the most significant depositions of lead and cadmium originated from sources in Poland, Germany, and Russia. For mercury, the largest contributions came from Germany, Poland, and Denmark (see diagrams below).

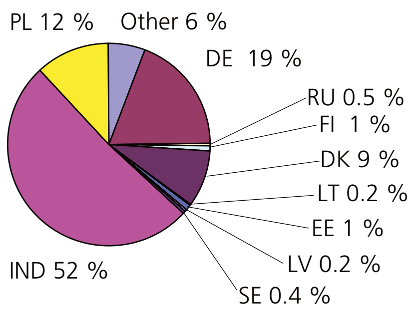
Cadmium



Lead



Mercury



Main cadmium, lead, mercury emission sources contributing to deposition over the entire Baltic Sea Basin in 2000. Other = all other European countries; IND = indeterminate sources, incl. natural, previous and remote anthropogenic sources.

Waterborne inputs

The total reported riverine loads of hazardous substances entering the Baltic Sea, including direct discharges from coastal areas, amounted to 7.3 tonnes of mercury, 285.8 tonnes of lead and 8.1 tonnes of cadmium. The riverine inputs of the heavy metals cadmium, lead and copper are highest in the Gulf of Finland, while mercury inputs are highest in the Baltic Proper. A few large rivers account for very large proportions of the total riverine heavy metal loads.

Transboundary pollution

Significant transboundary pollution loads of heavy metals originate from Belarus, the Czech Republic and Ukraine. The proportions of the total pollution loads entering the Baltic Sea originating from these upstream countries are in the range of 5% to 15% for heavy metals such as mercury, cadmium and lead. The significance of this transboundary pollution is naturally higher in certain sub-catchments than in the Baltic Sea overall.

Long-term trends in inputs of hazardous substances

Emissions of heavy metals from the HELCOM countries decreased during the period 1990-2002 by 46% for cadmium, 62% for mercury, and 61% for lead.

The reductions in heavy metal emissions to the atmosphere are largely due to the increased use of lead-free fuels and the wider use of cleaner production technologies, as well as the economic decline and industrial restructuring that occurred in Poland, Estonia, Latvia, Lithuania, and Russia in the early 1990s.

Total annual emissions of cadmium (Cd), mercury (Hg), and lead (Pb) to air from HELCOM countries, 1990-2002 (as % of 1990 figures)

Annual deposition rates of these heavy metals have halved since 1990 in the Baltic Sea as a whole. Deposition rates for mercury have not decreased since the mid 1990s, however. During the 1990s the use of lindane in HELCOM countries was practically ceased, and atmospheric depositions of lindane in the Baltic Sea region have consequently decreased significantly. Due to variations in meteorological conditions the decreases in emissions do not always lead to corresponding reductions in deposition rates.

Since the mid 1990s, riverine loads of heavy metals (notably cadmium and lead) have decreased in several countries. Research has indicated that the 50% reduction target has been largely achieved for the 46 hazardous substances prioritised by HELCOM.

Impacts of hazardous substances

Despite reductions in inputs, concentrations of heavy metals and organic pollutants in the Baltic Sea are still up to 20 times higher than in the North Atlantic.

Heavy metal	North Atlantic	Baltic Sea
Mercury	0.15-0.3	5-6
Cadmium	2-6	12-16
Lead	5-9	12-20
Zinc	10-75	600-1000
Copper	65-85	500-700

Concentrations of dissolved trace metals in the North Atlantic and the Baltic Sea (ng/kg)

The concentrations of some metals, such as cadmium, are declining in marine organisms in some areas (e.g. the Gulf of Bothnia and the Gulf of Finland) but increasing in others (e.g. the western Baltic Proper).

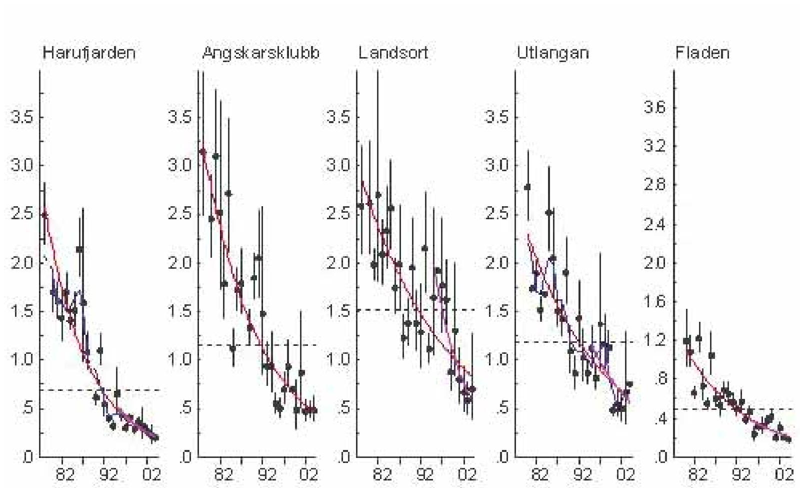
The best news is the clear decrease in lead concentrations in herring observed in most areas.

Concentrations of HCH-isomers (lindane) in water and biota have decreased considerably since the early 1980s.

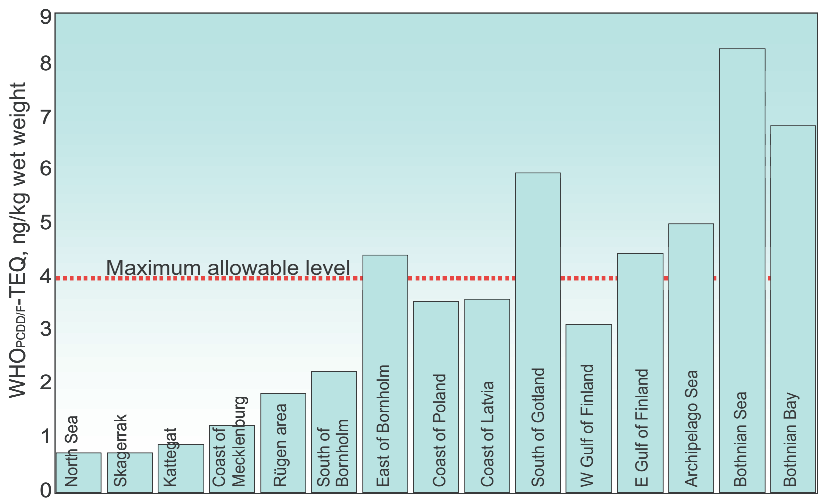
Concentrations of dioxin and PCBs in marine ecosystems declined in the 1980s, but this decrease levelled off in the 1990s. Dioxin levels in fish still exceed the new EU food safety limits in some areas, particularly further north.

TBT concentration levels are still so high that they have potential biological effects, at least in the Kattegat, the Belt Sea and the Sound. For other endocrine disrupting substances and new contaminants, such as flame retardants, a full assessment of their levels or effects is not possible due to the lack of monitoring data.

The chemical weapons dumped in the deep waters of the Baltic Sea in the 1940s are not currently seen as a serious threat to marine ecosystems. Research also indicates that any attempt to recover these munitions would be more likely to cause harm than good.



Temporal trends in PCB concentrations (µg/g lipid) in herring muscle tissue since the 1980s

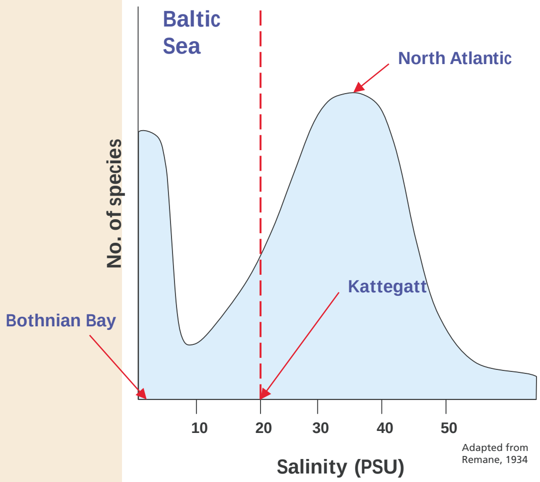


Dioxin content in the muscle tissue of herring from different fishing waters

Habitats and biodiversity at risk

Natural sensitivity and human threats

The biodiversity of the Baltic Sea is naturally limited by its unique brackish water conditions, but is now also considerably affected by human activities. Significant factors include pollution with nutrients and hazardous substances, coastal development, fisheries and the introduction of non-native species. As the diagram below shows, marine biodiversity is very much influenced by salinity levels, and the numbers of species present in ecosystems vary greatly by sub-region. Variations in salinity levels make the Baltic Sea a harsh environment for many species, and external pressures can easily disrupt such delicately balanced ecosystems.



The influence of salinity on species diversity

Impacts

Nearly all of the Baltic's top predators, including marine mammals and several bird species, still suffer from pollution, fisheries' by-catch and habitat destruction. The Baltic harbour porpoise is still endangered and all of the Baltic's seal species are still to some degree threatened.

About 100 non-native species have been recorded in the Baltic Sea, and almost 70 of them have been able to establish viably reproducing populations.

Some of the commercially important fish stocks in the Baltic Sea are currently exploited in excess of "safe biological limits". This overfishing can put entire marine ecosystems under pressure by changing their species composition and predator-prey ratios. Overfishing of Baltic cod is currently a particularly serious problem. Spawning stocks of herring have also decreased steadily since the 1970s, mainly due to changing environmental conditions.

Reproduction failures have been observed among coastal fish stocks since the mid 1990s. While the reason for these problems is not fully understood, increasing eutrophication is widely implicated. The spawning areas of several coastal fish species are situated in the inner archipelago and coastal bays, where their reproduction may be affected by the pronounced effects of eutrophication, changes in the sea-bed and oxygen depletion.

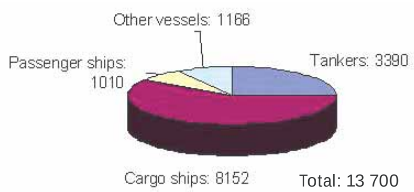
The species make-up of fish communities in coastal waters has also changed due to eutrophication.

As much as 90% of the marine and coastal biotopes around the Baltic Sea area are to some degree threatened today, and many of these areas are important habitats for rare or endangered species.

Trends

HELCOM's aims are comprehensive, and concern the health and ecological balance of the the whole Baltic Sea ecosystem, but trends in the populations of top predators and the status of biotopes can be seen as indicators of the overall health of the Baltic Sea.

One sign of the success of HELCOM's environmental programmes and nature conservation measures is the steady increase over recent decades in the breeding success rates of top predators, such as the white-tailed eagle and the Baltic's three seal species. But seals still face health problems, with sterility levels high among young ringed seals, other pollution-related disorders evidently increasing in grey seals, and harbour seals suffering from an epidemic of seal distemper in 2002. A more positive sign is an increase in the annual productivity of wild salmon of one million young fish a year over the period 1995-2001.



Number of ships passing the Skaw, July-October 2005

Increasingly crowded shipping lanes

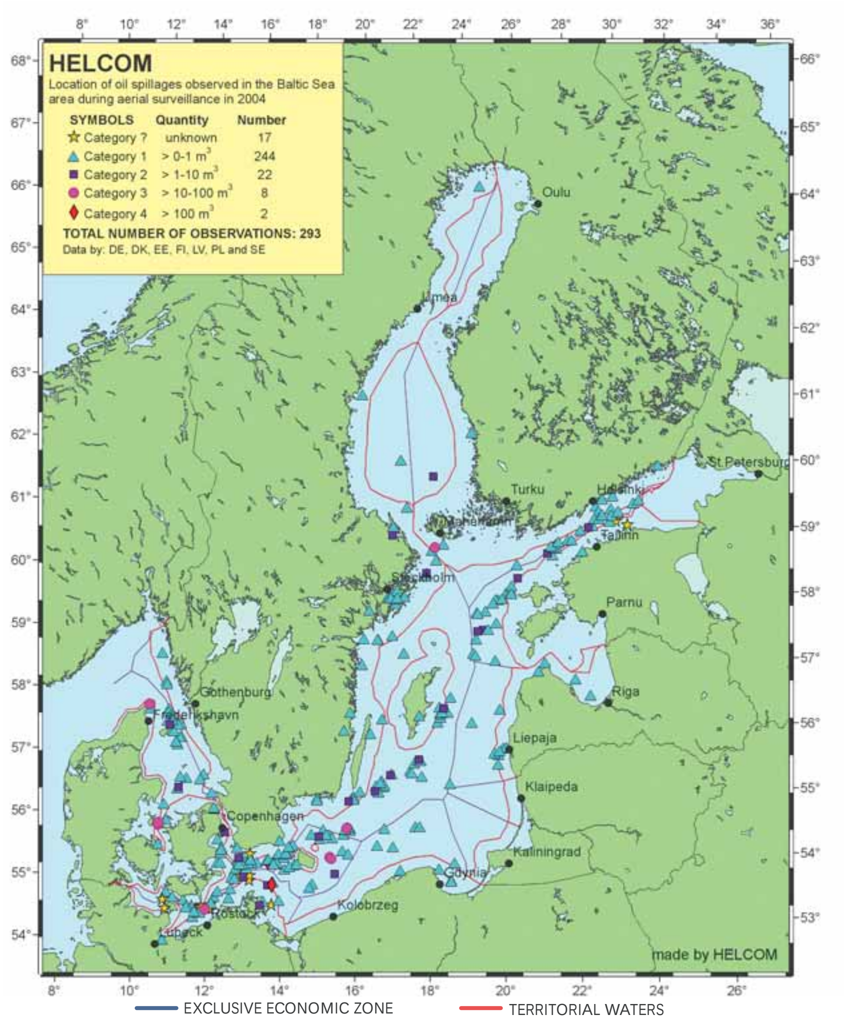
Impacts of shipping

Shipping traffic densities in the Baltic Sea are among the highest anywhere in the world. The transportation of oil and other potentially hazardous cargoes is growing steeply and steadily. According to the new HELCOM ship traffic monitoring system, which was launched in July 2005, during a three month period almost 14,000 ships passed the Skaw at the northernmost tip of Denmark on their way into or out of the Baltic. Approximately 25% of these ships were tankers.

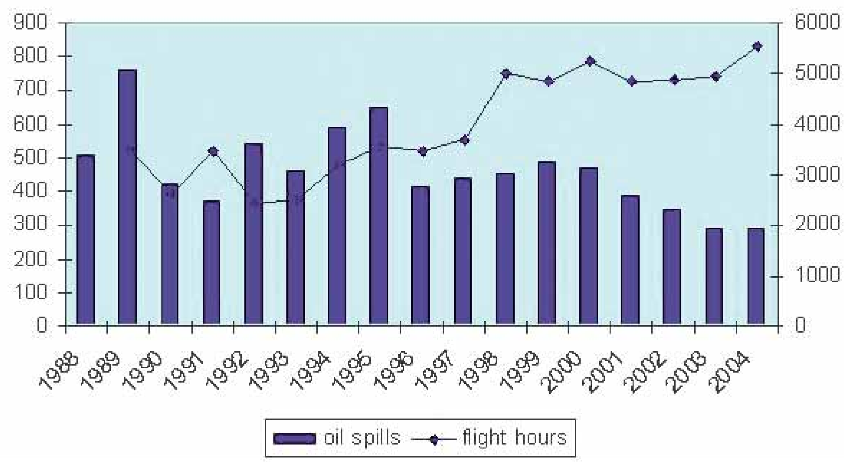
The major impacts of shipping on the marine environment include pollution by ship-generated waste or from accidents, air emissions and the introduction of non-native species in discharges of ballast water.

Illegal discharges

Deliberate illegal oil discharges from ships have been regularly surveyed within the Baltic Sea since 1988. Around 300-400 illegal discharges are detected every year. The average number of observed illegal oil discharges has been gradually decreasing recently, thanks to the increasing likelihood of offenders being spotted and reported by increased surveillance flights or other ships. Although the numbers of observations of illegal oil discharges have been decreasing overall for the last 5 years, it should be noted that reliable figures are not available for some areas where aerial surveillance is not regularly carried out.

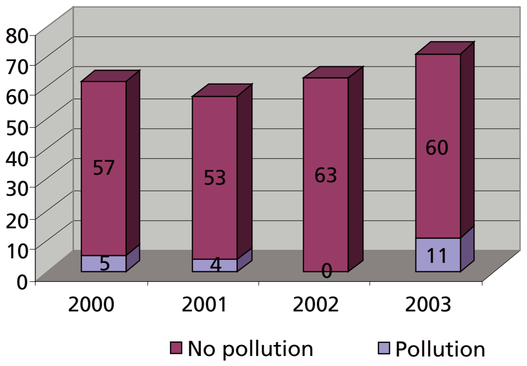


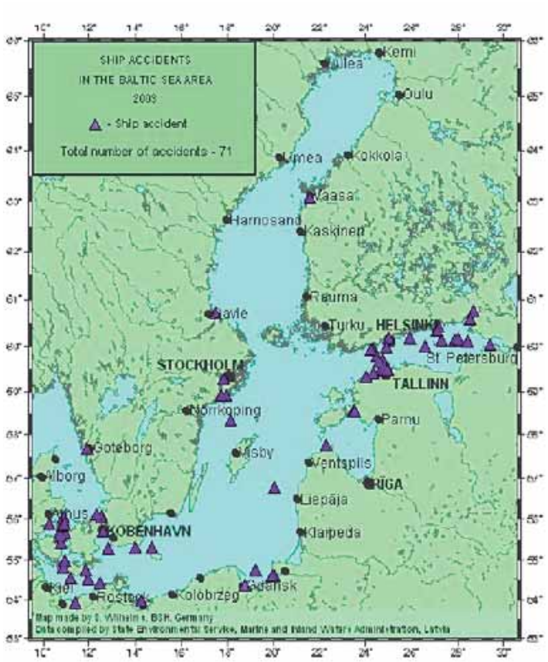
Location of oil spills observed in the Baltic Sea during aerial surveillance in 2004



Trends in the numbers of oil spills (left-hand scale) observed during the HELCOM co-ordinated aerial surveillance flights since 1988. Annual totals for surveillance flight hours are indicated on the right-hand scale.

Ship accidents in the Baltic 2000–2003





Locations of ship accidents in the Baltic Sea area in 2003

Accidents

Every year 60-100 ship accidents are reported to HELCOM, with an average of 8% of these accidents resulting in some kind of pollution. Two of the five most serious accidents in the Baltic have occurred since 2001 – "Baltic Carrier" in 2001 (2,700 tonnes of oil spilt); and "Fu Shan Hai" in 2003 (1,200 t).

Air pollution from shipping

Increasing maritime transport also means increases in air pollution, including nitrogen oxide (NOx) emissions. According to recent estimates NOx emissions from international shipping traffic on Europe's seas increased by more than 28% between 1990 and 2000. Emissions from international shipping are expected to increase by two-thirds by the year 2020, even after the implementation of the current MARPOL requirements concerning air pollution by ships. By 2020 NOx emissions from international shipping across Europe are expected to surpass emissions from all land-based sources in the 25 EU member states combined.

Non-native species

The Baltic Sea is considered to be particularly sensitive to invasions of non-native species due to its naturally low biodiversity. These risks are compounded by the large amounts of ballast water brought into the Baltic by the rapidly growing numbers of ships coming from all of the world's oceans.

Impacts

Oil spills contaminate the water by creating an oily layer on the surface, or by mixing and dissolving in the water. The most visible effects of oil spills are caused by oil on the surface. Seals and birds can easily become smothered with oil, and their chances of survival are hampered by problems with their mobility or the insulating properties of their feathers or skin. Oil pollution also destroys the habitats of many plants and animals, including the spawning areas of fish. Moreover, many of the chemicals in oil spills are toxic, and can have serious effects on plankton, fish and animals living on the sea floor. Oil decomposes slowly in the cold waters of the Baltic. Coastal areas contaminated by oil spills need to be actively cleaned up, which is a slow and laborious process. The necessary clean-up operations may themselves unavoidably harm marine life and coastal habitats. Oil spills can also have serious repercussions for tourism and commercial fisheries.