



Key measures for
the Baltic Sea

An underwater photograph of the Baltic Sea. The water is clear, showing a rocky seabed covered in vibrant red and green seaweed. Two jellyfish are visible: a large, translucent one in the foreground and a smaller one further back. Sunlight filters through the water from above, creating a dappled light effect.

The Baltic Sea – time for revival

The Baltic Sea is a unique ecosystem in urgent need of better care. It faces profound challenges, from pollution to overfishing and climate change. Hence, strong action is needed. Fortunately, history shows that when people around the Baltic Sea come together and make the right decisions, significant improvements can be achieved.

Many people enjoy spending time by the sea, and tourism, recreation and fishing provide great social and economic values to the nine Baltic Sea countries. But for society to fully benefit from the sea, a healthy ecosystem is a necessity. Improvements in the aquatic environment could also increase the net uptake of greenhouse gases, making the coastal areas in particular important for climate change mitigation.

Human activities are putting immense pressure on the Baltic Sea. Many populations of fish, marine mammals and seabirds have been decimated, and others are contaminated or in poor condition. Oxygen-depleted zones, turbid water and damaged habitats are also strong reminders of human impact. The rapidly changing climate adds to the urgency of action.

The limited water exchange in the enclosed Baltic Sea leads to substances lingering for extended periods, delaying the impact of various measures. But a limited water body can also be an opportunity, where change can be seen and action can make a difference. If the countries around the Baltic Sea manage it wisely, protect the areas that remain fairly undisturbed and restore what has been lost, there is a good opportunity to regain a healthy and valuable sea.

In this leaflet, researchers and experts from the Stockholm University Baltic Sea Centre present some key measures to improve the environment of the Baltic Sea, from the Bothnian Bay to the Kattegat. Stronger decisions are needed to reduce emissions of nutrients and hazardous substances, and to ensure the development of a sustainable blue economy with ecosystem-based fisheries management and adequate marine protection.

By joint efforts and bold actions, decision-makers around the Baltic Sea can create a path towards a healthier and more resilient sea – one that will sustain both life and livelihoods for generations to come.

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Tina Elfving
Director



Christoph Humborg
Scientific Leader

Climate impact

Ocean and climate are connected. Global warming increases the pressure on the marine life, and could by extension impact the whole foodweb. But the ocean is also important for the carbon cycle and the climate, by taking up and emitting greenhouse gases. These fluxes need to be considered in climate accounting, and measures are needed to minimise methane emissions from the Baltic Sea, and to increase its ability to function as a carbon sink.



Global warming is already affecting the Baltic Sea, causing water temperatures to rise faster than in many other seas. This will have unpredictable consequences for the whole ecosystem, for example by increasing the abundance of cyanobacteria at the base of the food web at the expense of other organisms. The expected increase in precipitation will increase the nutrient run-off to the sea, and warming will aggravate the effects of eutrophication and of hazardous substances. More frequent and intense heat waves may also quickly wipe out sensitive species.

Increased carbon dioxide emissions are also causing acidification of the oceans. In a eutrophic sea like the Baltic Sea, pH exhibits large seasonal variations, and acidification leads to a more pronounced minimum, which can be difficult for marine species to cope with. To combat climate change and acidification, greenhouse gas emissions must be reduced. But to increase the resilience of marine ecosystems it is also important to reduce pressures from pollution, fishing and physical disturbances.

The sea itself also plays an important role for the climate. Carbon dioxide absorbed by the sea is used for growth of plants, algae and bacteria, and ultimately by organisms higher up the food web. As organic matter sinks to the bottom, some will be buried and can be stored for a very long time – sequestered. Some marine environments, such as seagrass meadows and potentially bladderwrack forests, are particularly effective at sequestering carbon, referred to as 'blue carbon'.

However, as organic matter in the sea decomposes, oxygen is consumed and carbon dioxide is released. Under eutrophic conditions this can cause oxygen depletion, increasing the possibility of methane – a very powerful greenhouse gas – to be formed and released to the atmosphere. In eutrophic coastal areas, greenhouse gas emissions, mainly in the form of methane, can now exceed the uptake of carbon dioxide from the atmosphere, making them a net source of greenhouse gases.

At present, neither the carbon uptake nor the emissions from the sea are included in carbon accounting and thus not considered in climate change mitigation. Including them would provide additional incentives to reduce eutrophication and restore coastal ecosystems – measures that will improve water quality, increase biodiversity and help mitigate climate change.

“In eutrophic coastal areas, greenhouse gas emissions, mainly in the form of methane, can now exceed the uptake of carbon dioxide”

Key measures:

- Reduce emissions of greenhouse gases globally, including from marine activities such as shipping and fishing.
- Reduce pressures on the coastal environment to increase its resilience to climate change and acidification, to increase its ability to store carbon, and to minimise methane emissions.
- Include carbon sequestration and greenhouse gas emissions from the sea in carbon accounting.

Eutrophication

The fight against eutrophication in the Baltic Sea is both a failure and a success. Cyanobacteria blooms and oxygen deficiency are more widespread than ever, but without the effective cooperation of the coastal countries to reduce nutrient inputs, the situation in the sea would have been even worse. To regain a viable ecosystem, continued action to reduce nitrogen and phosphorus inputs from land is crucial.



Eutrophication is the most serious environmental problem in the Baltic Sea. Despite reductions in nutrient inputs over the past four decades, excessive algal blooms and turbid waters persist. This has severely affected key habitats for many species, causing visible changes in the coastal ecosystem and is threatening biodiversity. Eutrophication also appears to increase coastal greenhouse gas emissions, contributing to climate change.

Significant efforts have been made by all Baltic Sea countries to reduce nitrogen and phosphorus inputs to the sea, in particular through major investments in wastewater treatment, reduced atmospheric emissions and improved agricultural practices. As a result, nutrient inputs peaked in the 1980s and have decreased significantly since then. Model simulations suggest that these reductions will continue to generate improvements in the future. Rapid recovery is hindered mainly by the lingering nutrient legacies in the sea. Unfortunately, ongoing climate change may exacerbate the effects of eutrophication. Further action is therefore crucial, but also increasingly complex. To be successful, all measures must be tailored to local conditions.

The agricultural sector, which remains a dominant source of nutrients, needs to move towards greater circularity. On-farm measures such as nutrient accounting, catch crops, improving soil structure and upgrading drainage systems are essential to reduce the risk of nutrient loss. They need to be complemented by the integration of crop and livestock production, more efficient use of manure and reduced use of mineral fertilisers. Other land-based measures include the restoration of wetlands and the improvement of sewage systems, particularly in environmentally sensitive areas.

Along the coasts, the variability of eutrophication impacts underlines the need for targeted interventions. Many open coastal areas are strongly affected by nutrient imports from the open sea. However, in semi-enclosed coastal areas, local measures to reduce nutrient inputs are an effective way to rapidly improve water quality and biodiversity. Active restoration can further accelerate recovery. As these areas are often important to inhabitants and tourists, successful results may increase support for further action.

“The agricultural sector, which remains a dominant source of nutrients needs to move towards greater circularity”

Key measures:

- Promote nutrient circularity in agriculture through local balance between crop and livestock production.
- Promote on-farm measures to reduce nutrient leaching and soil erosion.
- Limit livestock density in leaching prone areas.
- Ensure efficient sewage treatment, particularly in environmentally sensitive areas.

A large school of fish, likely herring, swimming in clear, shallow water. The fish are silvery and elongated, moving in a coordinated pattern. A large white circle is superimposed over the center of the image, containing the title and a paragraph of text.

Commercial fisheries

The situation is critical for several commercial fish stocks in the Baltic Sea. The cod stocks have already collapsed and most herring stocks are in a dire state. Current catch levels and fishing methods pose a major threat not only to fish, but to the entire food web. Better management is needed to secure fish as a food source and to achieve good environmental status.



The precarious situation for many of the fish stocks in the Baltic Sea is largely due to excessive fishing pressure. All scientific stock assessments are characterised by a high degree of uncertainty, which is not taken into account in the management decisions such as catch limits. Misreporting of catches is one crucial source of uncertainty that contributes to highly inaccurate estimates, another is environmental variability. Therefore, as a general rule, the annual commercial catch limits should be set at no more than 50 per cent of estimated maximum sustainable yield (FMSY) for all fish stocks. This would reduce the risk of overfishing and is likely to lead to higher and more stable yields in the long run.

The herring stocks in the Baltic Sea are of utmost importance for the whole Baltic Sea ecosystem, transferring nutrients from plankton to seals, seabirds and humans, and between the coast and the open sea. They consist of several genetically distinct subpopulations with different reproduction, growth and mortality rates and in different conditions. Ideally, a population-specific management should be implemented, but knowledge about the stock structure is still insufficient. Instead, to allow the rapidly declining herring stocks to recover and prevent the extinction of subpopulations, a moratorium on large-scale fishing which can catch herring must be implemented immediately in the Gulf of Bothnia and the central Baltic Sea.

Bottom trawling fishing is inherently destructive to the benthic habitats by tearing up the seabed, killing animals and increasing turbidity and dispersion of nutrients and pollutants, and releasing stored carbon from the seafloor. More and larger areas need to be closed for bottom trawling, not to mention in marine protected areas.

The number of young eels reaching the shores of the Baltic Sea and the North Sea has declined by more than 99 percent, compared to the 1960-1979s reference period. Still, many countries continue to fish eels commercially. The stocking of glass eels also continues – without any evidence of it helping the eel. Fishing for eel in all life stages should be closed, and eel migration should be freed by the removal of migration obstacles.

“A moratorium on large-scale fishing which can catch herring must be implemented immediately in the Gulf of Bothnia and the central Baltic Sea”

Key measures:

- Set a moratorium on large-scale fisheries which can catch herring, until the stocks have recovered.
- As a general rule, set commercial catch limits at a maximum of 50 per cent of FMSY.
- Close more and larger areas for bottom trawling.
- Stop all fishing for European eel in all life stages, and stop restocking.

The background of the entire page is a close-up photograph of numerous red water droplets of various sizes. These droplets are scattered across a dark red, finely textured fabric surface, possibly a mesh or a fine-weave cloth. The lighting creates bright highlights on the peaks of the droplets, giving them a three-dimensional appearance. The overall color palette is monochromatic, consisting of various shades of red.

Chemicals management

The Baltic Sea is one of the most polluted seas in the world. Some fish are still unsafe for human consumption and new chemicals are constantly entering the environment. To tackle this, pre-market testing and assessment must be improved and groups of problematic chemicals, such as PFAS, must be banned.



The use of chemicals is widespread in the countries around the Baltic Sea. Pollutants with unknown properties enter the sea in a variety of ways, including deposition from the air, surface runoff and sewage treatment plants. Due to the limited water exchange in the Baltic Sea, hazardous chemicals can accumulate and persist for a very long time, endangering humans, animals and plants. Environmental monitoring is still largely focused on a few ‘old’ chemicals like PCB and heavy metals, that have been banned and whose levels in the environment are decreasing. It is important to expand the monitoring to include novel chemicals, that are used in society today.

The current system of pre-market testing and risk assessment of chemicals is not sufficient to ensure safe use. Today, manufacturers and importers of chemicals are responsible for testing and assessing the safety of their own products. This introduces a conflict of interest into the system, making transparency crucial. It is important that all data and assessments are made publicly available to allow third party scrutiny.

Chemicals are assessed for risk individually, but in reality they are used and discharged as mixtures – cocktails. Adverse effects from mixtures can be triggered even when each individual chemical is present at a level that is considered safe when assessing a single substance. The current system therefore underestimates real exposures and risks. To account for this so-called ‘cocktail effect’, the safety margin for all chemicals on the market should be increased by a factor of ten.

Managing the risks of one chemical at a time is slow and can lead to ‘regrettable substitution’, where a banned chemical is replaced by another one with similar or even worse toxicological properties. To avoid this, grouping of chemicals for risk assessment and management should always be the first choice. A striking example is PFAS – sometimes called ‘forever chemicals’ because they do not degrade once they are released into the environment. Thousands of PFAS chemicals have been identified, hundreds are produced industrially and around 100,000 sites in Europe release them into the environment, where they contaminate drinking water and affect both animals and humans. The spread and accumulation of PFAS must be stopped, both by banning them as a group and by cleaning up heavily contaminated areas.

“To account for this so-called ‘cocktail effect’, the safety margin for all chemicals on the market should be increased”

Key measures:

- Improve environmental monitoring of new hazardous chemicals in the Baltic Sea.
- Make all chemical data and assessments publicly available to allow third party scrutiny.
- Introduce a safety margin by a factor of 10 in risk assessment to address chemical mixtures.
- Ban all PFAS, with only few and time-limited exemptions for those with essential uses.



Protection and restoration

To safeguard biodiversity in the Baltic Sea, it is necessary to protect areas that still have high value, as well as threatened habitats and species. The size of marine protected areas should be increased, but it is even more important to ensure that they include adequate restrictions on harmful activities. For severely degraded areas, active restoration should also be part of the solution.



The EU has committed to protect 30 per cent of its coastal and marine areas by 2030, with 10 per cent to be strictly protected. At present, this coverage target is far from being met, but a more immediate concern is that the quality of existing protection often is poor. Many areas currently defined as ‘protected’ still allow harmful activities, including bottom trawling. For marine protected areas to be truly effective, management must include restrictions on activities such as fishing, shipping and boating. More no-take zones – areas specifically protected from fishing – should also be established to protect and rebuild decimated fish and shellfish stocks.

Shallow coastal areas are among the most species-rich and productive in the Baltic Sea. They provide habitats and nurseries for many fish species, and they are also the areas where humans enjoy swimming, fishing and recreational boating. Today, however, many of the coastal habitats are threatened and degraded by the combined effects of eutrophication, exploitation and overfishing. This leads to turbid water, loss of seagrass and other important underwater vegetation, and a reduced number of predatory fish, such as perch and pike. To halt this loss of biodiversity and to protect what remains, more action is needed to preserve coastal habitats. This could include limiting dredging and new construction, reducing nutrient inputs and restricting recreational boating and fishing in sensitive areas.

In degraded areas, where removal of negative impacts is not sufficient to restore ecosystem functions, active restoration may also be needed. In the coastal areas of the Baltic Sea, active restoration could include the establishment of coastal wetlands, treatment to increase nutrient retention in the sediment, measures to reduce coastal erosion and the planting of underwater vegetation such as bladderwrack.

Many restoration projects lack crucial pre- and post-implementation measurements, making it impossible to evaluate their success. To ensure cost-effective environmental improvements, budgets for restoration projects and marine protected areas should include pre- and post-implementation monitoring, impact evaluation, and maintenance. Properly implemented, protection and restoration can increase biodiversity, the resilience of the ecosystem to climate change and its ability to act as a carbon sink.

“Protection and restoration can increase biodiversity, the resilience of the ecosystem to climate change and its ability to act as a carbon sink”

Key measures:

- Establish well-managed marine protected areas and provide adequate protection in existing ones.
- Promote active restoration of important and valuable coastal habitats in degraded areas.
- Allocate resources for monitoring and evaluation of restoration projects and protected areas.



Blue economy

Shipping accounts for a large proportion of society's transport, and the demand for offshore wind power and marine aquaculture is growing. These activities could be part of a sustainable blue economy, providing jobs, renewable energy and seafood. But they also have a negative impact on the environment and need to be well managed.



Politicians around the Baltic Sea are looking to the sea to develop a blue economy that could bring social and economic benefits. But the development of a blue economy must be done in a sustainable way, using clean technologies and circular materials, and without harming the environment.

Offshore wind power could be a significant and important addition to renewable energy. The main risks are associated with the siting of wind turbines in important seabird wintering and migratory corridors, fish spawning areas and important harbour porpoise habitats. However, if placed in the right locations, foundations could be used to create reef habitats. The siting of wind farms should be facilitated by science-based and inclusive maritime spatial planning processes. Measures should also be taken to reduce the risk of seabirds colliding with turbines and to reduce noise and sediment dispersal during construction.

The Baltic Sea is one of the busiest shipping areas in the world, and despite being designated a 'Particularly Sensitive Sea Area' by the International Maritime Organisation (IMO), shipping remains a major polluter. New regulations came into force in 2015 to reduce sulphur emissions from marine fuels to the air. Unfortunately, instead of switching to cleaner fuel, many ships have installed scrubber systems that use seawater to clean exhaust gases. When this scrubber water is discharged, it carries sulphur oxides, other hazardous substances and particles into the sea, exacerbating marine pollution and acidification. This practice should not be allowed in the Baltic Sea or anywhere else.

Fish aquaculture using open net pen technology is established in many parts of the Baltic Sea and is expected to increase. They allow the free exchange of feed, chemicals, parasites and diseases between the pen and the open sea – and are therefore a source of eutrophication and risk of infecting wild fish in these areas. There is also a risk of farmed fish escaping and genetically polluting their wild relatives. Considering all these risks in an already eutrophied system, aquaculture in the Baltic Sea should be carried out in closed aquaculture systems.

*“The
development
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Key measures:

- Avoid placing windmills in important wildlife areas and take measures to reduce the risk of bird collisions.
- Prohibit scrubber water discharge from ships.
- Mitigate negative effects from fish aquaculture by using closed aquaculture systems.



Stockholm University Baltic Sea Centre aims to bridge the gap between science and policy. Scientists, policy analysts and communication experts work together to compile, analyse and synthesise scientific research on Baltic Sea-related issues and communicate it to the right actor at the right moment.

Science and communication with focus on the sea

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