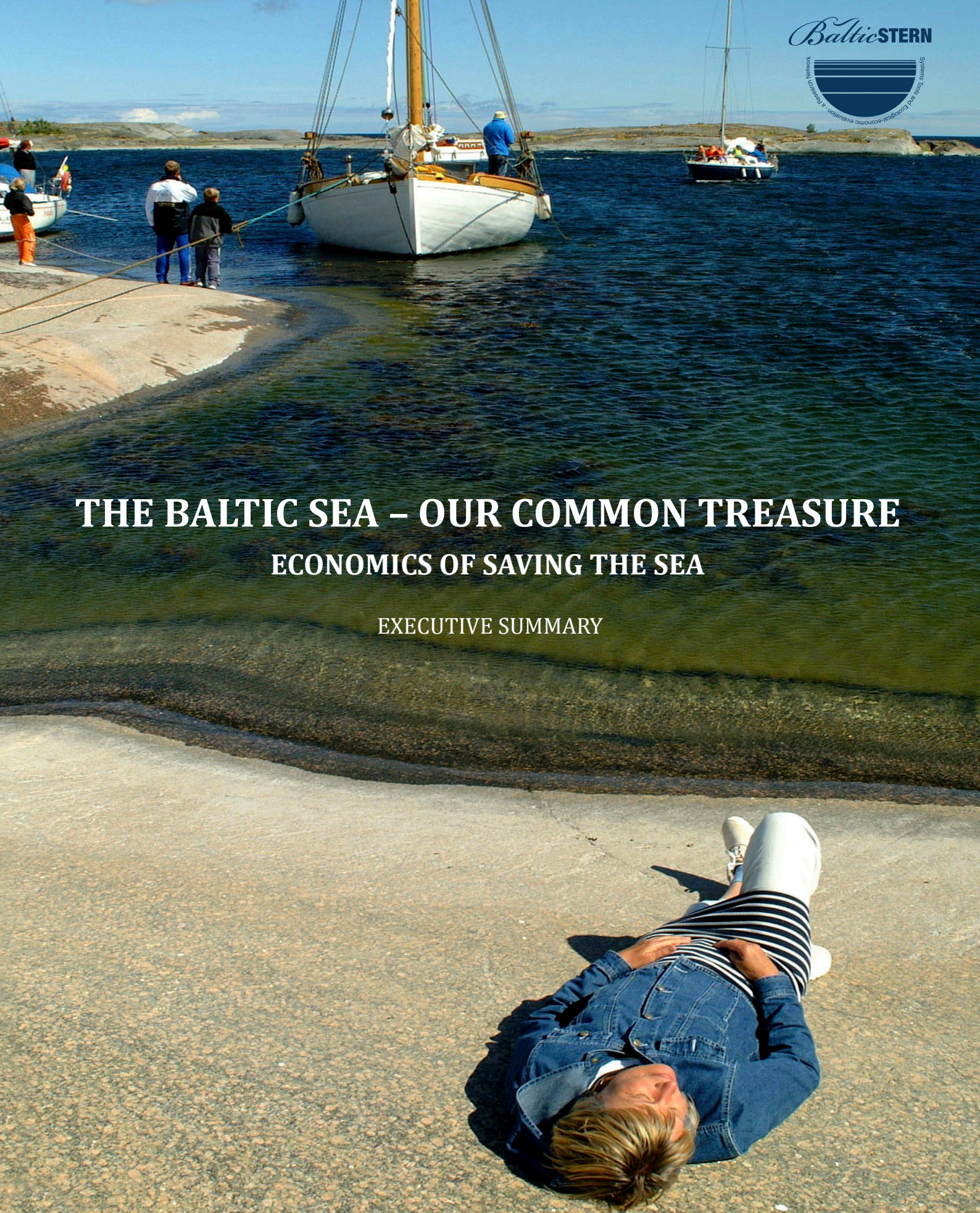


BalticSTERN

Systems tools and Ecological-economic evaluation - a Research Network

THE BALTIC SEA – OUR COMMON TREASURE

ECONOMICS OF SAVING THE SEA

EXECUTIVE SUMMARY

Save the Sea and gain 1 000–1 500 million Euros a year

Cost-benefit analyses undertaken by the international research network BalticSTERN show that combating eutrophication in the Baltic Sea would provide large welfare gains to the people living in the Baltic region.

The people in the nine countries bordering the Baltic Sea are willing to pay approximately 3 800 million Euros annually for a less eutrophied Baltic Sea, fulfilling the targets of the HELCOM Baltic Sea Action Plan (BSAP).

The cost of reaching the nutrient reduction targets of the Baltic Sea Action Plan is estimated to 2 300 million Euros annually given a cost-effective allocation of measures. Applying allocations between countries according to the BSAP country quotas would increase the costs by approximately 500 million Euros, leading to total annual costs of 2 800 million Euros.

Thus, benefits exceed costs for reaching the BSAP by 1 000 – 1 500 million Euros annually.

Photo: Marmar Nekoro

Baltic Sea – our common treasure

It is not surprising that citizens in the Baltic Sea region attach high values to an improved health of the Sea.

According to the BalticSTERN study *BalticSurvey* more than 80 per cent of the people living in the region have spent leisure time at the Sea. Common activities are walking along the beach, swimming, fishing, boat excursions and going on cruises.

Many people around the Baltic Sea are worried about the marine environment and mention environmental problems such as marine litter, oil spills, algal blooms, contamination by heavy metals and other hazardous substances, overfishing, lack of oxygen in sea bottoms and damage to flora and fauna.

The most worried are people in Finland, coastal Russia, Estonia and Sweden. Even in Poland and Germany, where the number of worried people was the lowest, more than one third of the population stated that they were worried about the Baltic Sea environment.

The BalticSTERN study *BalticSurvey* is the first coordinated survey of comparable information in all Baltic Sea countries regarding public use of the Baltic Sea and people's attitudes towards the marine environment and towards responsibilities for improving the environment.

It was carried out between April and June 2010 in all nine Baltic Sea countries and included over 9000 interviews.

Photo: Marmar Nekoro

Benefits of the Baltic Sea Action Plan

Eutrophication is one of the major environmental problems in the Baltic Sea. Consequences of eutrophication are: decreasing water clarity, increases in blue-green (and sometimes toxic) algal blooms, spread of hypoxia (areas with low levels of oxygen) and changes in biodiversity, including fish populations.

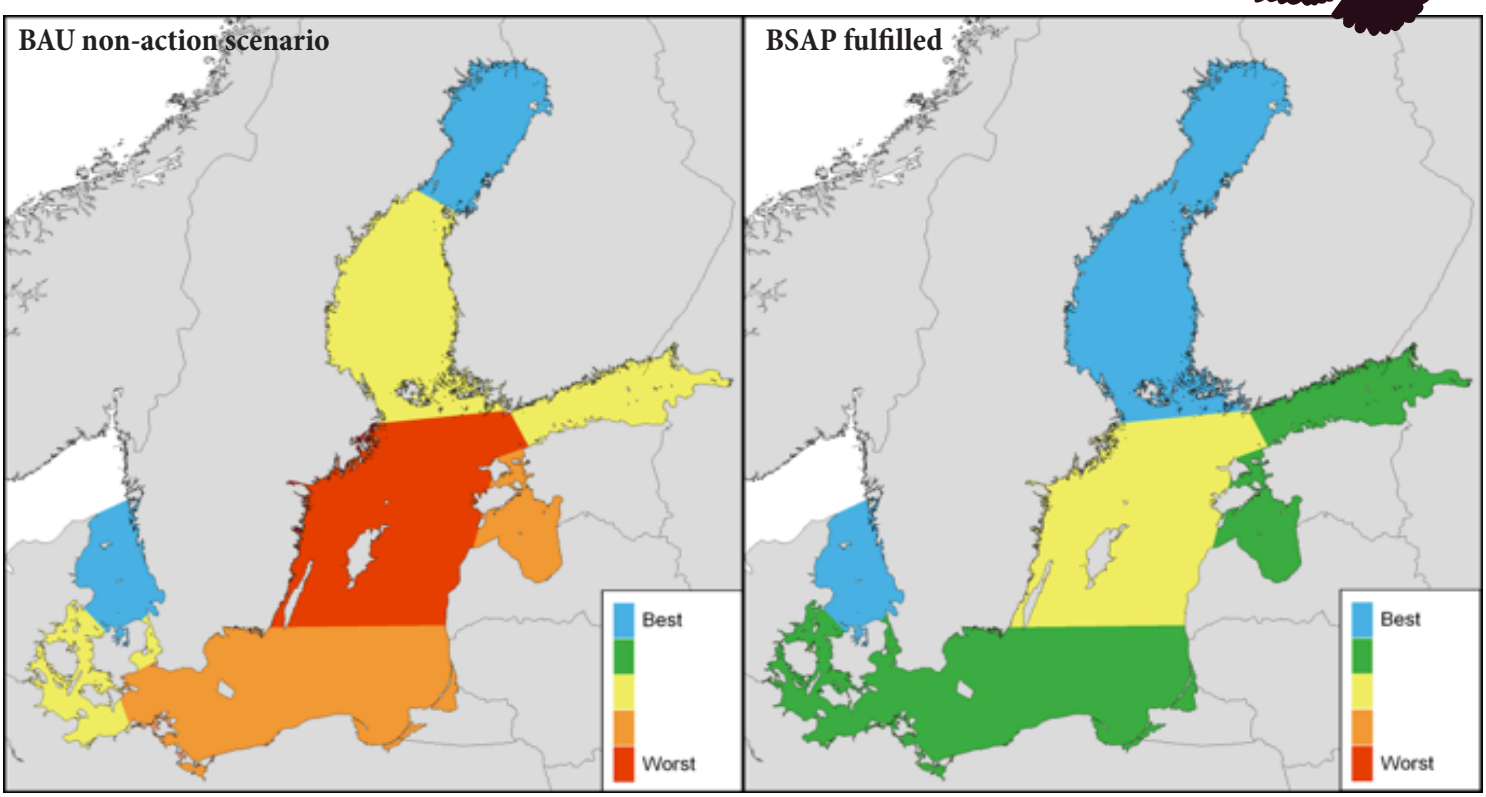
Sea bottoms affected by hypoxia as well as blue-green algal blooms have increased tenfold in the latest century.

Based on the results of the study *BalticSurvey* a study was undertaken to investigate what an improvement of the environmental status of the Sea would be worth to people. The study was called *BalticSUN* and described the state of the Baltic Sea in 2050 if no new measures to reduce eutrophication were undertaken (Business-As-Usual scenario (BAU)), compared to a state where the reduction targets of the Baltic Sea Action Plan (BSAP) were reached.

The respondents to the survey were asked what they were willing to pay to achieve a better environment as illustrated by the map on the right below. The responses were then aggregated to obtain a total value for the whole population.

The HELCOM Baltic Sea Action Plan (BSAP) is a programme to restore the good ecological status of the Baltic Sea marine environment by 2021, and was adopted by all nine Baltic Sea countries in 2007.

The environmental issues addressed in the action plan are eutrophication, biodiversity conservation, hazardous substances, and shipping.



The left map shows the eutrophication scenarios if no further action is taken (Business-As-Usual). All sea basins except two (Bothnian Bay and Kattegat, blue color) will have unacceptable status in 2050. The Baltic Proper has the worst status (red color).

The right map shows the status if the Baltic Sea Action Plan is fulfilled. All sea basins have good (green) or very good (blue) status in 2050, with the exception of the Baltic Proper, which nevertheless become much healthier.

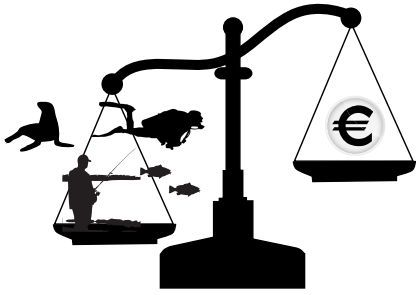
The results show that every second person has personally experienced the consequences of eutrophication, and that a majority is willing to pay for improving the Baltic Sea environment. In total people are prepared to pay 3 800 million Euros annually for a healthier Sea with clearer water, less frequent algal blooms, underwater meadows (seagrasses) in good condition, recovered cod stocks and less oxygen deficiency in deep sea bottoms. These would be the results if reaching the BSAP nutrient targets.

As expected, the average willingness to pay varies significantly between countries: Swedes are willing to pay the most, on average 110 Euros per person annually, followed by Finns and Danes, on average 56 and 52 Euros respectively. The lowest average willingness to pay was found in Russia, Lithuania and Latvia.

Aggregated to the total adult population, Germans are willing to pay the most, 1 870 million Euros, reflecting the large population size, followed by Swedes who are willing to pay 840 million Euros annually.

The *BalticSUN* study also shows that most people care not only about their local areas, but place a value on having the entire Baltic Sea in a healthier state. Moreover, the study also points to that distance to the Sea is generally not decisive for whether people are willing to pay.

Together, this indicates significant non-use values. That is, those who do not use the Sea may also attach a value to having a healthy Sea to pass on to future generations, or may merely take satisfaction from knowing that it will recover from its environmental problems.



In the BalticSTERN valuation study *BalticSUN* people in all nine countries surrounding the Baltic Sea were for the first time asked how much they would be willing to pay for a healthier Baltic Sea.

More than 10 000 people were interviewed (through the Internet or in face-to-face interviews) in the survey, making it one of the most extensive international WTP studies to date. The interviews were conducted simultaneously in the autumn of 2011.

Country	Adult population (in millions)	Annual mean WTP per person for BSAP (€)	National WTP per year for BSAP (million €)
Denmark	3.958	52	205
Estonia	0.989	18	17
Finland	3.617	56	201
Germany	68.321	27	1870
Latvia	1.690	4	7
Lithuania	2.516	6	16
Poland	24.624	9	211
Russia	81.476*	6	473
Sweden	7.564	110	838
Total	194.746		3838

*Includes the Central, Southern, North-western and Volga Federal Districts in Russia.

Willingness-To-Pay for reducing eutrophication in the Baltic Sea by fulfilling the HELCOM Baltic Sea Action Plan.

Young, unique and vulnerable

The relatively young Baltic Sea is the largest body of brackish water in the world, containing a mixture of saline seawater from the North Sea and freshwater from rainfall and rivers in the catchment area. It is connected to the Atlantic through the North Sea only via the narrow and shallow Danish Straits, making water exchange very limited and residence times of bottom waters very long.

With its special geographic, oceanographic and climatologic characteristics, the Baltic Sea is not only ecologically unique, but also vulnerable to the environmental impacts of human activities. For example, Baltic Sea food webs have relatively low biodiversity, although certain species (e.g. blue mussels) can be quite abundant.

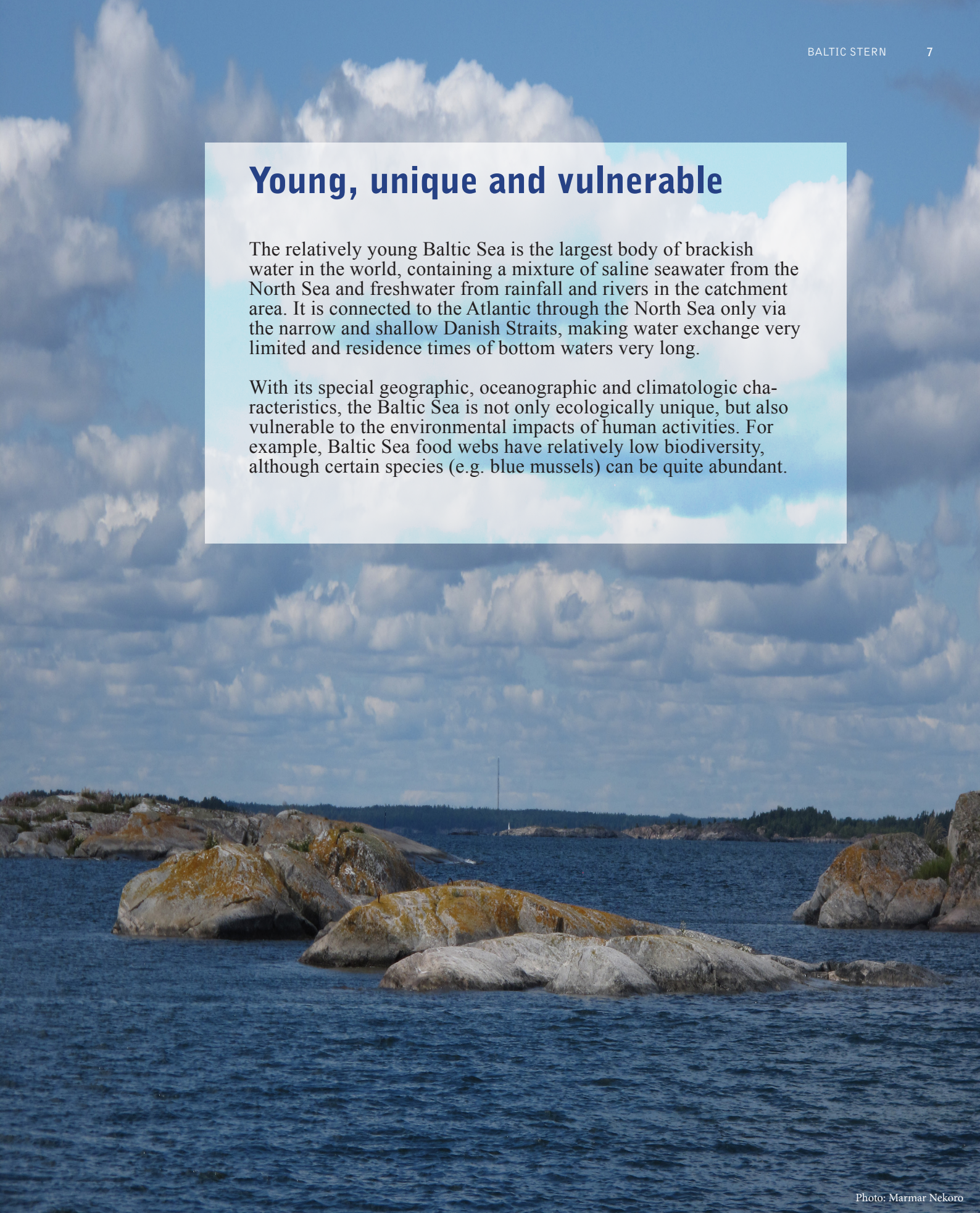


Photo: Marmar Nekoro

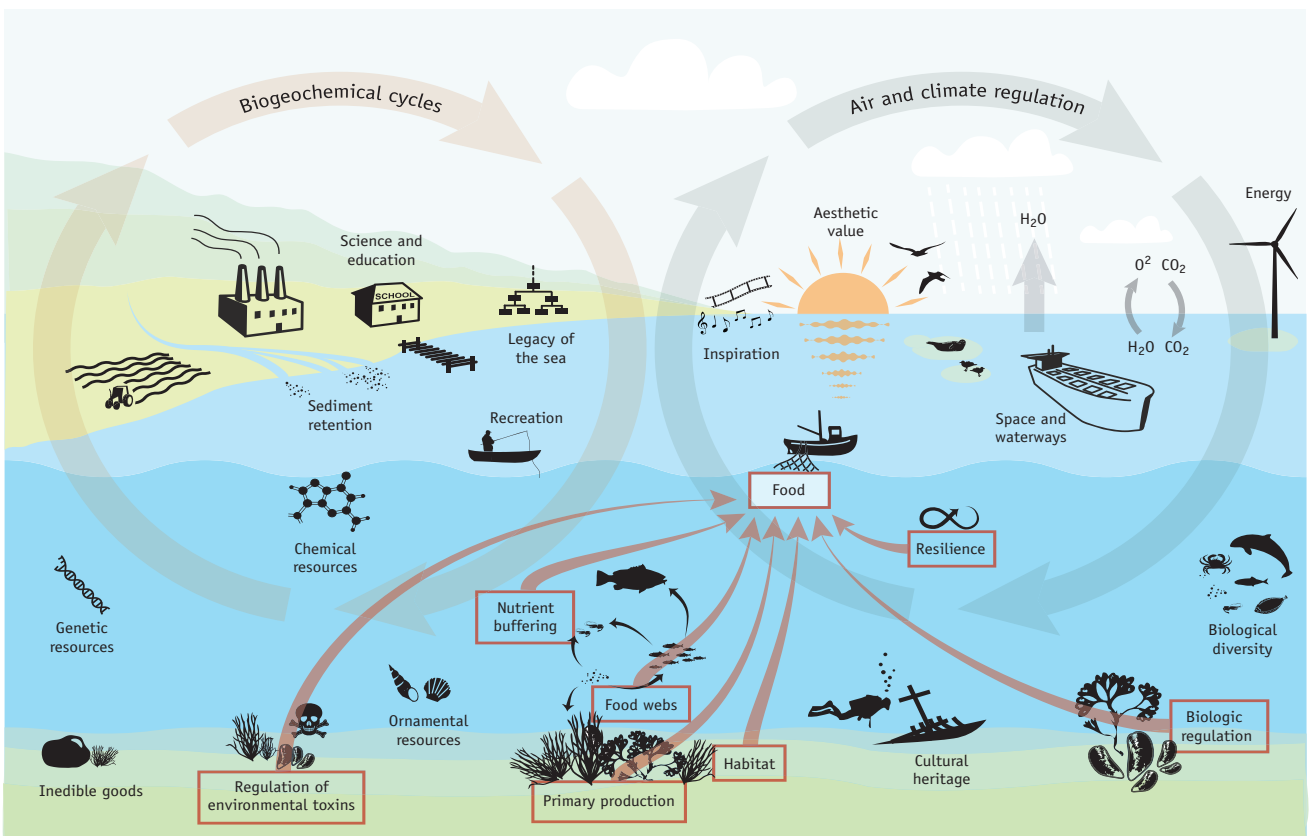
Benefits depend on ecosystem services

Benefits to human societies, such as food, recreation and inspiration, depend on a multitude of ecosystem services provided by the Sea.

Fish, an important part of human diets, depends on viable fish stocks, which in turn depends on ecosystem services, such as primary production and habitats, nutrient buffering, regulation of environmental toxins and resilience of the ecosystem.

It is thus crucial that all ecosystem functions and processes are in good condition.


Photo: Marmar Nekoro



Ecosystem services provided by the Baltic Sea, also illustrating (orange arrows) how one ecosystem service (food) is dependent on other ecosystem services. (Illustration: J. Lokrantz/Azote)

Recovery costly, but worth achieving

As measures are costly there is naturally a lot of interest in identifying cost-effective solutions, that is the allocation of measures that reach the target at lowest possible cost. In order to estimate the costs of meeting the BSAP nutrient reduction targets, the BalticSTERN cost-benefit analysis used seven measures targeting the nutrient loads from agriculture and two measures aimed at the loads from wastewater treatment plants.

The total cost for reaching the BSAP country quotas by investing in the nine measures was estimated to 2 800 million Euros annually. However, applying the most cost-effective allocation of measures would reduce the costs by 500 million Euros annually. All countries except Denmark and Estonia would experience lower costs under such an allocation, compared to an allocation in accordance with the country quotas.

BalticSTERN results indicate that some of the most cost-effective measures are reduced nutrient loads from wastewater treatment plants, reduced application of fertilizers, ponds serving as sinks for phosphorus, ban on phosphorus in detergents, and investments in wetlands to reduce nitrogen leakage.

The location of measures is important because of retention. In general this means that measures implemented close to the coasts, where retention is low, will be more cost-effective.

It is likely that in reality the total costs could be lower than estimated, as there are more low cost measures available than could be included in the models used. Furthermore, the benefits are most likely underestimated, as the measures would generate ancillary benefits, for example in lakes and waters upstream, which were not accounted for in *BalticSUN*.

Thus it is likely that the welfare gain of fulfilling the BSAP nutrient reduction targets would be even larger than the annual surplus of 1 000 – 1 500 million Euros indicated by this study.

> *"This exceeds the costs for reaching the targets with 1 000 – 1 500 million Euros annually."*

Retention is the collective term for all processes that mean that only a certain proportion of the total quantity of phosphorus or nitrogen discharged from a particular source reaches the final receiving water body due to denitrification, uptake in biota or sedimentation.

Agriculture stands for a major part of the nutrient loads causing eutrophication of the Baltic Sea, followed by wastewater. The rest comes mainly from sea and land traffic, but also from industry and energy combustion.

The *BalticSurvey* study revealed that a majority of people in all Baltic Sea countries see it as necessary that polluters, such as waste water treatment plants, industries, maritime transports, ports, farmers and professional fishermen, take actions to improve the Baltic Sea environment.

Photo: European Parliament - Audovisual Unit

Threatened by a multitude of pressures

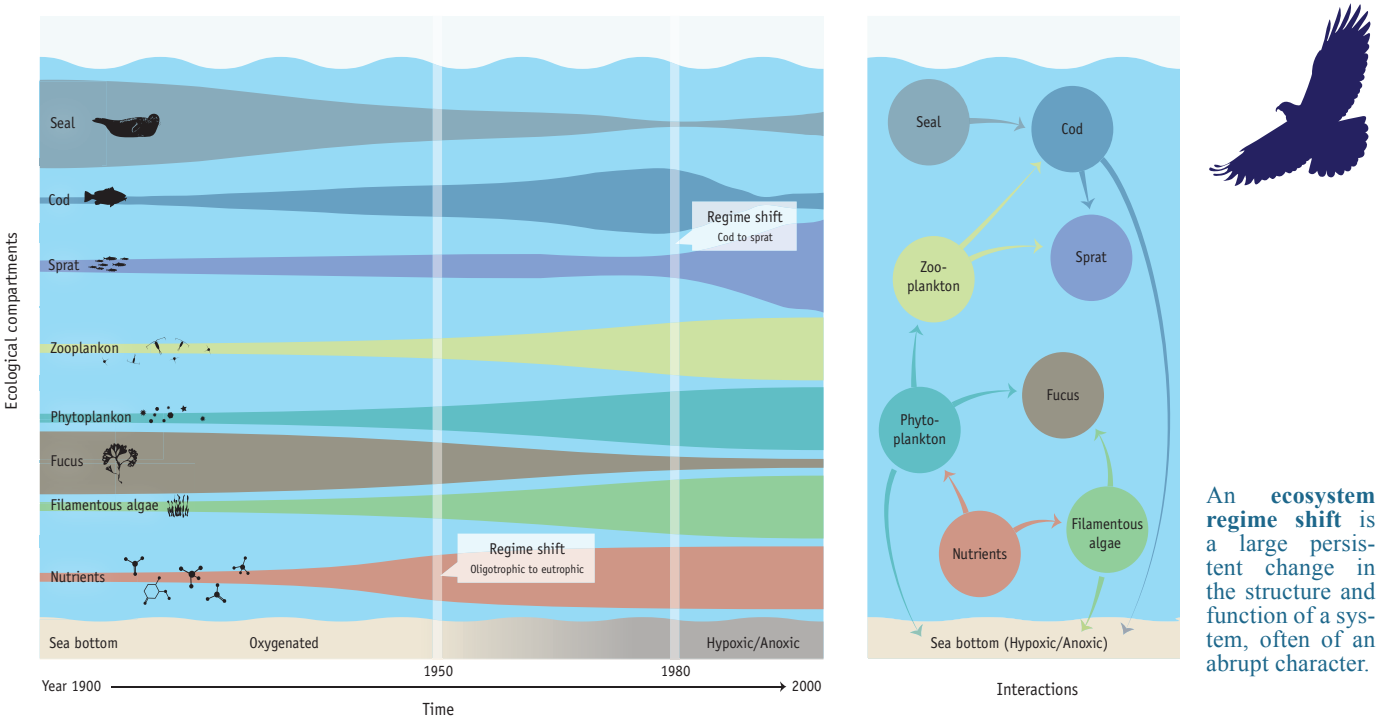
A number of drivers have affected the Baltic Sea ecosystem over the course of previous centuries. These drivers include: An increasing population in the catchment area, the establishment of industry and trade and the resultant economic growth, changes in consumption patterns (i.e. a shift toward diets with a higher proportion of animal protein), intensified agriculture, as well as increases in energy use and traffic.

As a result, the Baltic Sea is under severe stress. In addition to eutrophication there are other environmental problems, such as: overfishing, hazardous substances and marine litter, oil spills and invasive species. These problems and subsequent changes in flora and fauna, threaten the ecosystem services provided by the Baltic Sea.

Climate change has caused sea surface temperatures to increase by 0.7 °C during the 20th century. In combination with overfishing and eutrophication, these changes have resulted in several regime shifts during the 20th century.

As illustrated below, the Sea changed from nutrient poor (oligotrophic) to nutrient rich (eutrophic) in the middle of the 20th century. The food web has undergone shifts from being dominated by seals in the first half of the 20th century to being dominated by cod until the end of the 1980s. A drastic decline of cod then paved the way for a shift to sprat domination.

There are complex inter-linkages between the various ecosystem services that the Sea provides and the environmental problems facing the Baltic Sea. Eutrophication, for example, entails a range of documented effects on food webs and individual fish species, while the composition and state of the food web in turn influences internal processes of eutrophication mitigation.



An **ecosystem regime shift** is a large persistent change in the structure and function of a system, often of an abrupt character.

Changes in the Baltic Sea ecosystem during the 20th century. The illustration shows changes in major ecological compartments and their interactions, as well as regime shifts in the Baltic Sea ecosystem. (Illustration: J. Lokrantz/Azote)

BalticSTERN Case Studies

BalticSTERN researchers have made case studies regarding some problems besides eutrophication.

• **FishSTERN**, a case study on fishery management in the Baltic Proper, indicated that there is overcapacity in the fishing fleets and that reduced fishing effort would be favourable for job opportunities and profits, as well as for ecosystem health.

• **Oil spill effects** were studied for the Gulf of Finland, and showed that action needs to be taken by all surrounding countries to ensure an effective response in the event of an oil spill.

• **Invasive marine species.** Optimal strategies to manage the risk of invasive species were investigated through a case study in a local area outside the coast of Finland. The results emphasize the need for careful implementation and enforcement of ballast water treatment, an effective preventive action to reduce the risk of new invasions.

These case studies illustrate the need to address all environmental problems simultaneously. Benefits obtained by mitigating eutrophication may be jeopardized by a large oil spill, an influx of invasive species or a decline in fish stocks.

Photo: T. Dahlin/Azote

Photo: European Parliament - Audovisual Unit

Photo: N.Wijkmark/Azote

... allow this treasure to recover so that people can swim in clear water, stroll along clean beaches and eat fish that is healthy.

Photo: Marmar Nekoro

Future risks and options

BalticSTERN scenarios indicate that if no further measures are implemented, most of the basins that make up the Baltic Sea would be in a degraded state in 2050. The Baltic Proper would be in a really bad condition with very turbid water, blue-green algal blooms in large areas every summer and with constant oxygen shortages in sea bottoms over large areas.

Underwater meadows (seagrasses) would be almost lost and no longer suitable for fish spawning. The cod stock would be close to extinction, sprat and herring stocks would have decreased but there would be an abundance of roach, carp and bream.

Furthermore, there is reason to believe that in a 'non-action' scenario the environmental degradation of the Baltic Sea could become even more severe. Drivers and pressures may increase more than presumed and climate change is predicted to contribute to warmer and less saline waters. The combined effects may push the ecosystem into an even worse state. Experience shows that such regime shifts may be difficult to reverse. There is even risk for collapse of parts of the ecosystem.

To be able to foresee and avoid such risks there is need for an integrated management strategy that is ecosystem based, with a holistic perspective of the problems and solutions. Flexible management is important since the actions required are likely to change over time due to changes in the drivers and the dynamics of the ecosystem.

A shared vision for the Baltic Sea would help guide actions to safeguard ecosystem services and the benefits they provide to human societies.


Photo: European Parliament - Audovisual Unit


Photo: Marnar Nekoro

Action is needed

All in all, the BalticSTERN studies show that large values are at stake and that action is needed and would generate substantial welfare gains.

The coming years will be crucial. According to the EU Marine Strategy Framework Directive, plans for actions should be decided and reported by 2015 in order to reach a 'Good Environmental Status' in all European seas by 2020.

The Baltic Sea Action Plan targets are to be revised at the HELCOM Ministerial Meeting to be held in autumn 2013. It is then up to the different countries to decide on policy instruments that can generate incentives for the required measures to be implemented.

At the UN Conference on Sustainable Development in Rio de Janeiro in June 2012 (Rio +20) it was agreed to undertake measures to reach better environmental status of the Earth's seas by 2025 based on scientific results. The Baltic Sea is one of the most polluted seas on Earth, surrounded by some of the richest countries. If a good status is achieved in the Baltic Sea it could serve as a positive example to the rest of the world. In contrast, if we do not succeed this would set a bad example and could pose as an excuse for other, less wealthy countries not to take action.

BalticSTERN research has clearly shown that the Baltic Sea is a common treasure. It is also evident that action is needed in order to avoid further degradation and instead allow this treasure to recover, so that people can swim in clear water, stroll along clean beaches and eat fish that is healthy.

Photo: Marnar Nekoro

Swedish Agency for Marine and Water Management

BalticSTERN

BalticSTERN

The BalticSTERN research network has partners in all countries around the Baltic Sea. STERN is an acronym for *System Tools and Ecological-economic evaluation – a Research Network*, inspired by the report "The Economics of Climate Change – The Stern Review". The study is also a response to the calls by Nordic Ministers for Environment in 2008 and 2009 that Stern-like analyses should be made for the Nordic Seas.

BalticSTERN combines socioeconomic and ecological models to make cost-benefit analyses and to identify cost-effective measures needed to meet the targets of the Baltic Sea Action Plan. BalticSTERN is the first large-scale international cost-benefit analysis for an environmental policy target (i.e. the BSAP), in which both costs and benefits have been estimated for all Baltic Sea countries.

BalticSTERN Secreteriat

The BalticSTERN Secreteriat at the Stockholm Resilience Centre, Stockholm University, is financed by the Swedish Agency for Marine and Water Management (SWAM), and has been responsible for overarching coordination, communication and for writing the synthesizing reports.

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Photo: T. Jarnetun/Azote

The full report, **THE BALTIC SEA – OUR COMMON TREASURE Economics of Saving the Sea** and the corresponding background papers, as well as other reports and material from the BalticSTERN can be found on our website:

www.stockholmresilience.org/balticstern
as well as on www.havochvatten.se/balticstern

BalticSTERN SWAM

Layout and production: BalticSTERN Secretariat - Marmar Nekoro
Photos: Marmar Nekoro • Azote • European Parliament - Audovisul Unit • Cover Photo: F. Wulff/Azote
Published: US-AB Stockholm, March 2013