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Help the Baltic Sea to mitigate climate change

The coastal environment of the Baltic Sea plays an important role as a natural carbon sink. However, the poor environmental status of the coastline risks jeopardising this important function. Measures to protect and restore the vulnerable coastal ecosystems are required to strengthening their ability to store carbon and increase their resilience to climate change.

The Baltic Sea coast - a potential carbon sink

Climate change is one of the greatest challenges of our time.[1] Effective and immediate measures are needed to slow down the ongoing development and achieve the goals Sweden has committed to in the Paris Agreement.[2] An important part of mitigating greenhouse gas emissions is to utilise the natural ability of our ecosystems to capture and store carbon.[3] While much attention has been paid to the forest's function as a carbon sink, the ocean's ability to store carbon, known as blue carbon, has so far not been the focus of Sweden's national climate efforts.[4][5]

The Baltic Sea plays a significant role in Sweden's overall carbon balance, i.e. the relationship between carbon uptake and greenhouse gas emissions within the country›s borders. In the sea, large amounts of carbon dioxide are sequestered in sediments and vegetation that would otherwise have leaked into the atmosphere and contributed to global warming.[6] Compared to forests, marine vegetation areas have greater potential to capture and store large amounts of carbon dioxide per unit area, making them more efficient carbon sinks.[7]

The Baltic Sea is a species-poor sea, but the greatest biodiversity of animals and plants is found along the coast.[8][9] Coastal zones with rich benthic vegetation cover only a small part of the Baltic Sea seafloor but account for a significant amount of the carbon stored in the sediment,[10][11][12] making coastal ecosystems particu-

Recommendations

Create conditions for healthy coastal ecosystems that can effectively sequester carbon and are more resilient to future climate change by:

- Reducing nutrient loads from agriculture and ensuring effective treatment in wastewater treatment plants and private sewers.
- Conserving, restoring and recovering vegetated bottoms that are important for coastal carbon sequestration, such as eelgrass beds and bladderwrack belts.
- Creating conditions for viable predatory fish stocks in the coastal zone by introducing fishing bans, for example in important spawning areas, and reducing fishing pressure in the open sea.
- Increasing the pace of establishing protected areas in coastal areas with high ecological values, to enhance opportunities for plants and animals to thrive and spread.
- Investigating the possibility of establishing protected areas that take into account the capacity of coastal ecosystems to sequester carbon.
- Increasing the knowledge of the interactions between the various components of coastal ecosystems and their abilities to sequester carbon.

larly important for carbon storage in the Baltic Sea

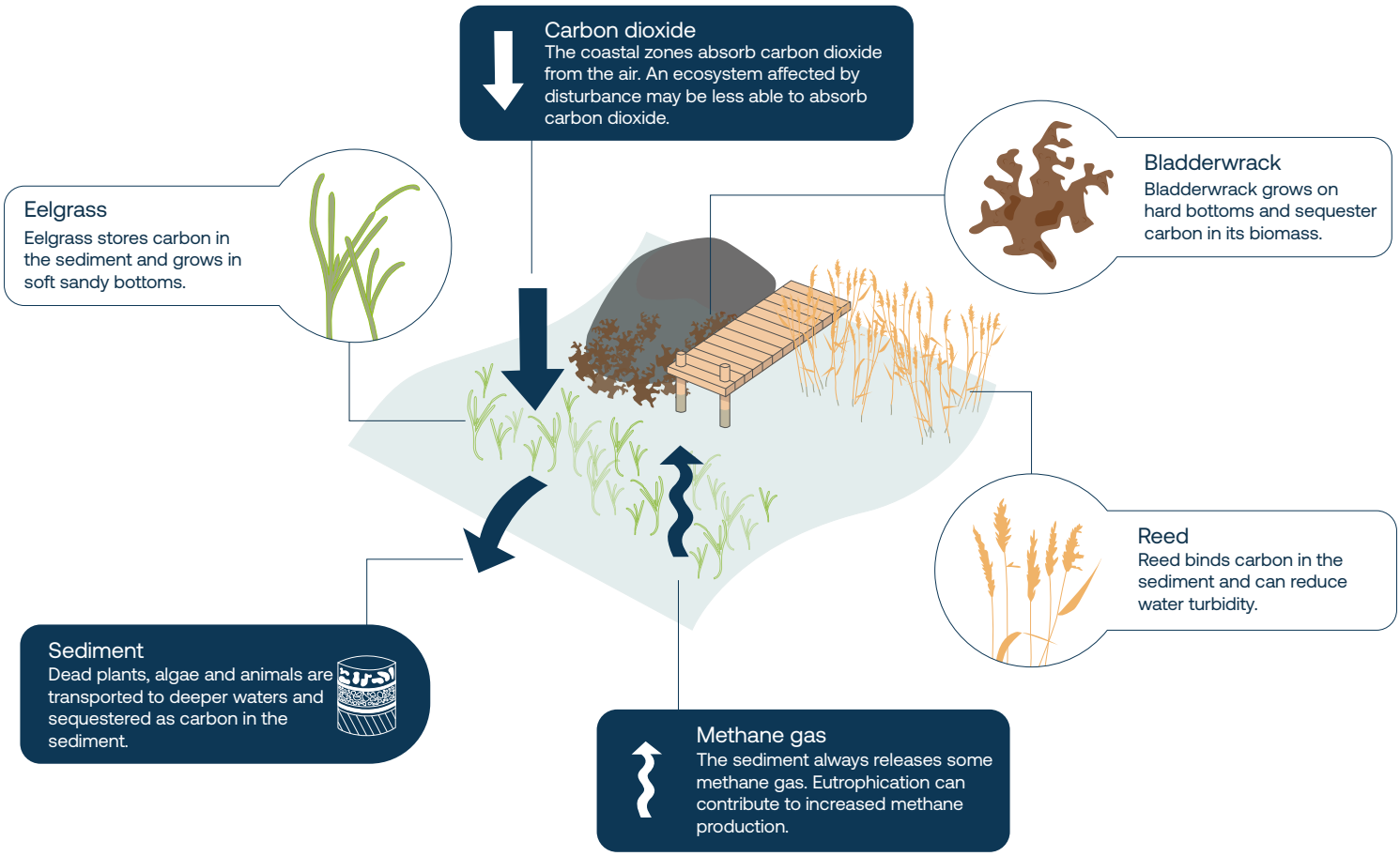
Healthy ecosystems are better for carbon storage

Coasts are home to a large number of species that fulfil important roles in the ecosystem, from bacteria to predatory fish and seabirds. Several research projects are underway to understand how different species contribute to carbon storage in coastal zones,[13][14] but most evidence suggests that healthy ecosystems have greater potential to act as effective carbon sinks.[15][16][17] A healthy coastal ecosystem is characterised by high biodiversity with viable fish populations such as pike and perch, clear water, and rich bottom vegetation.[18][19]

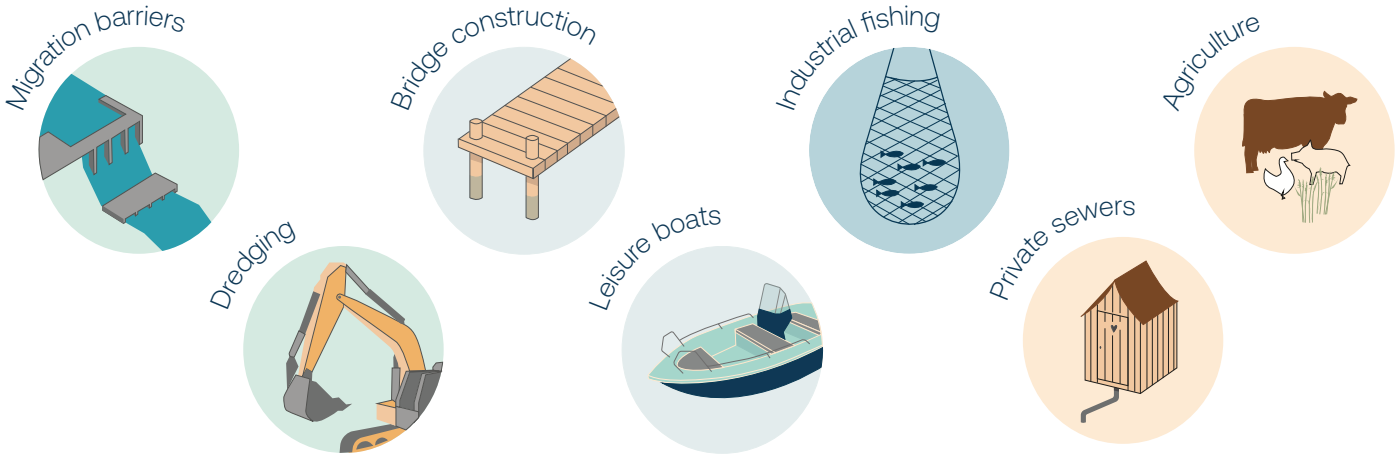
Unfortunately, the Baltic Sea is far from being a healthy sea today. As an inland sea, the Baltic Sea ecosystem is particularly vulnerable to climate change and other human impacts.[20] DThe coastal ecosystems are severely affected by disturbances such as eutrophication, overfishing and exploitation.[21] The coast has great potential to act as a carbon sink, but scientists warn that the poor environmental status of ecosystems means that these areas may instead contribute to increased greenhouse gas emissions.[22][23]

Healthy ecosystems are also more resilient to climate change

While healthy ecosystems are better able to sequester carbon, they are also more resilient to climate change. High biodiversity increases the ability of species to compensate for each other when ecosystems are disturbed. Dispersal between species, populations and ecosystems is important for the ecosystem's capacity to recover.[24] Given the unique conditions in the Baltic Sea, resilient ecosystems are particularly important as the risk of permanent ecosystem change is high.[25] The importance of resilient ecosystems is growing with global warming,[26][27] and new research shows, among other things, that microscopic life in the Baltic Sea may have problems to adapt to higher sea temperatures, which will affect the entire ecosystem.[28][29] As sea levels rise and extreme weather becomes more frequent, bottom vegetation is also important to counteract the increased risk of shore line erosion, as it binds sediment through its roots.[30][31][32]



The environmental status of the Baltic Sea's coastal environments is crucial to the sea's ability to sequester and store carbon. In healthy ecosystems, here exemplified by eelgrass, reeds and bladderwrack, carbon is stored in sediments and bottom vegetation. When the environmental status is poor, however, carbon storage may decrease and methane production may increase, counteracting the coast's function as a carbon sink. Illustration: Louisa Juvall Molin.



The coastal environment of the Baltic Sea is severely exposed to human disturbance. To strengthen the carbon storage capacity of coastal ecosystems and limit methane emissions, we need to reduce eutrophication, overfishing and physical exploitation in coastal zones. Illustration: Louisa Juvall Molin.

Eutrophication - one of the biggest threats to coastal zones

Eutrophication is a serious threat to the sensitive waters of the Baltic Sea.[33] Inputs of nutrients from agriculture, forestry, and sewage, among others, promote the growth of fast-growing algae near the surface. These algae prevent sunlight from reaching the slower-growing benthic species. As a result, eutrophication risks disadvantaging larger aquatic plants and macroalgae, such as bladderwrack and eelgrass, which account for a significant proportion of carbon sequestration in biomass and sediments.[34][35]

Eutrophication has also contributed to the spread of anoxic bottoms in the Baltic Sea.[36] When organic matter breaks down in anoxic environments, methane is formed, a powerful greenhouse gas with a warming potential 45 times higher than carbon dioxide.[37] The release of methane from the Baltic Sea is a natural part of the carbon cycle. However, it is worrying that methane emissions seem to be linked to the poor environmental status of the Baltic Sea. Researchers believe that eutrophication and the continued spread of oxygen-free bottoms are a major cause of increased methane production.[38] Rising water temperatures may also play a significant role.[39]

Measures to reduce eutrophication in the Baltic Sea are necessary to restore coastal ecosystems, increase carbon storage and limit methane production in coastal areas.[40] The single most important measure is to limit nutrient inputs, especially from agriculture,[41][42] and research also shows that the effects of eutrophication and weakened predatory fish stocks can reinforce each other.[43] Therefore, measures that favour predatory fish stocks are also important for the work against eutrophication.

Local physical disturbances can also pose a threat to coastal zones

Physical activities in coastal areas can severely disrupt local ecosystems and reduce carbon sequestration. Dredging in shallow bays can negatively affect the habitat of many species.[44]. Dredging stirs up sediment and increases the turbidity of the water, preventing sunlight from reaching the bottom.[45] Bridge construction and mooring boats can also shade or damage the seabed, reducing living conditions for the animals and plants that live there.[46][47] Eelgrass beds in soft bottoms act as nurseries for many fish species living along the coasts and provide for example both shelter and food for cod during their first critical period of life. When these areas are disturbed, fishes have problems to survive, affecting the whole ecosystem.[48]

Dredging and clogging of coastal wetlands and waterways can also disrupt coastal ecosystems. These areas are important for fish spawning and when access to them is lost, many fish species find it difficult to reproduce. [49] Industrial fishing in the open sea also affects species living near the coast. For example, herring stocks have declined significantly due to high fishing pressure over many years.[50] This has a major impact on coastal ecosystems as herring juveniles are important food for coastal predatory fish.[51]

Fact box

Ecosystem services of the Baltic Sea coast

Healthy ecosystems fulfil several important functions by sequestering carbon and increasing resilience to climate change. But measures to protect and restore coastal areas with poor environmental status also provide a range of other environmental, social, and economic benefits - known as ecosystem services.[52][53][54]

In addition to carbon sequestration, healthy coastal ecosystems contribute to:

- Food security as the coast is a source of many commercially important fish species
- Natural protection from storms and erosion by stabilising the seabed
- Improved water quality as coastal vegetation and marine wetlands filter water and absorb nutrients
- Slowing down ocean acidification as coastal vegetation can counteract low pH values
- Attractive environments for recreation and tourism

Physical disturbance in coastal areas can also lead to increased shoreline erosion. Erosion is a natural process,[55] but the risks increase when an area is exploited. Natural habitats can be damaged or lost, negatively affecting entire coastal ecosystems.[56]

Preventive measures are cost-effective

Sweden has committed to protect 30 % of its land and sea areas by 2030.[57] Today, 15 % of Sweden's area is protected, which means that additional efforts are needed to reach the target.[58] To strengthen the coast›s function as a carbon sink, particularly important coastal areas need to be protected. This means protecting ecologically and biologically significant areas where positive spillover effects on neighbouring ecosystems are possible.[59][60] By protecting these ecosystems now, it is possible to avoid restoration costs later. Prevention is always much cheaper and easier than restoration. In the long term, when we have more knowledge about what makes an area a good carbon sink, it may be possible to include an area's carbon storage capacity as a criterion in the establishment of marine protected areas[61]

Restorative measures are also needed

In addition to preventive measures, we also need to restore coastal environments with poor environmental status to allow coastal ecosystems to recover.[62] Under a new EU law, Sweden and other EU countries should aim to restore and rehabilitate 20% of the EU's land and water areas by 2030.[63] By restoring ecosystems in line with the new EU rules, Sweden can increase the ability to sequester and store carbon in its coastal areas.

Conclusions

How we manage our coastal zones can determine whether they become carbon sinks or carbon sources. To achieve the goals that Sweden has committed to in the Paris Agreement, we need to work to increase carbon storage and reduce methane emissions in coastal zones. Healthy coastal ecosystems bind carbon and are more resilient to climate change. Therefore, measures are needed to protect and restore the Baltic Sea's important coastal ecosystems. Limiting human impacts from eutrophication, overfishing and physical disturbance of habitats are important steps towards a healthy coast. By protecting important coastal areas today, we can allow ecosystems to recover and increase their ability to store carbon, while avoiding high restoration costs in the future.

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