Restoring marine landscape and its wildlife back to how H.C. Andersen knew it

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Restoring marine landscape and its wildlife back to how H.C. Andersen knew it

Many fish species are dependent on a healthy seabed. Here, we outline benefits that you may get from restoring habitats at sea.

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Now, don't suppose that there are only bare white sands at the bottom of the sea. No indeed!”

↑ Figure 1: Underwater marine forest. Most seaweed requires hard substrata to grow. This forest is supported by a stone composed substrata. Picture taken by Martin Kielland.

**If you think about a big rock on land,
you probably do not think about a thriving forest.
At sea, rocks often create forests."**

HANS CHRISTIAN ANDERSEN KNEW THE FORESTS AND THE INHABITANTS AT SEA

Back in 1837, the well-known Danish poet, Hans Christian Andersen, published his famous tale "The little mermaid". In the beginning of the tale, H.C. Andersen introduces us to the underwater marine world and the biodiversity that dwells there by saying:

"Now, don't suppose that there are only bare white sands at the bottom of the sea. No indeed! The most marvelous trees and flowers grow down there, with such pliant stalks and leaves that the least stir in the water makes them move about as though they were alive. All sorts of fish, large and small, dart among the branches, just as birds' flit through the trees up here. From the deepest spot in the ocean rises the palace of the sea king."

We have not found the sea king's palace yet, but Andersen's marine life is still thriving down there. At least in some locations.

Unfortunately, in the Baltic Sea, for more than a century, extraction of rocks has been carried out. The activities removed the forests at sea that Andersen referred to, because most seaweed does not make roots as bushes and trees do on land. Instead, seaweed is dependent on attaching to hard substrates, like rocks, and grows from there. If you think about a big rock on land, you probably do not think about a thriving forest on top of the rock. At sea, rocks create amazing forests - if enough sunlight reaches the rocks.

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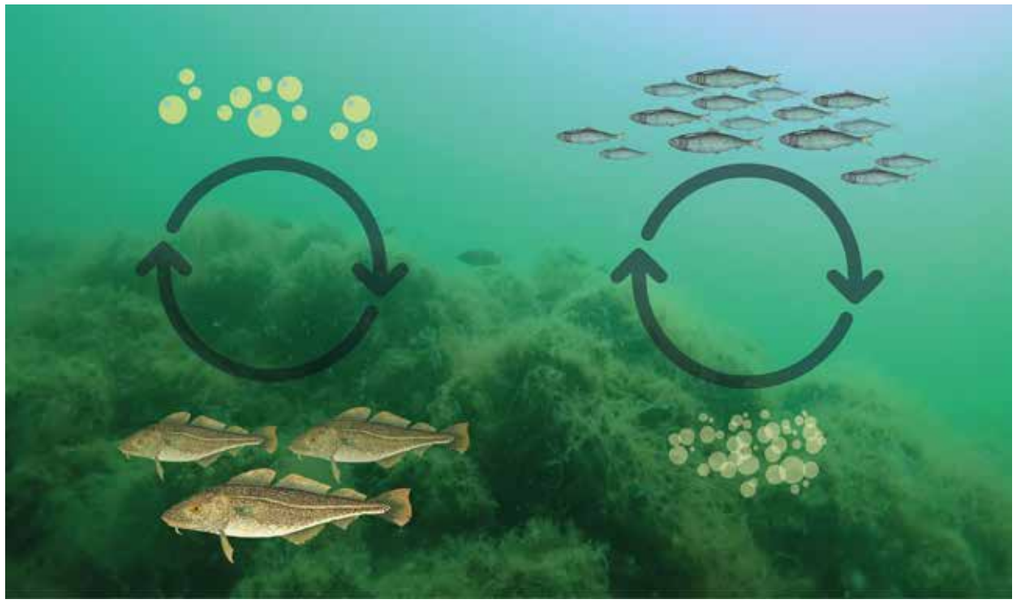
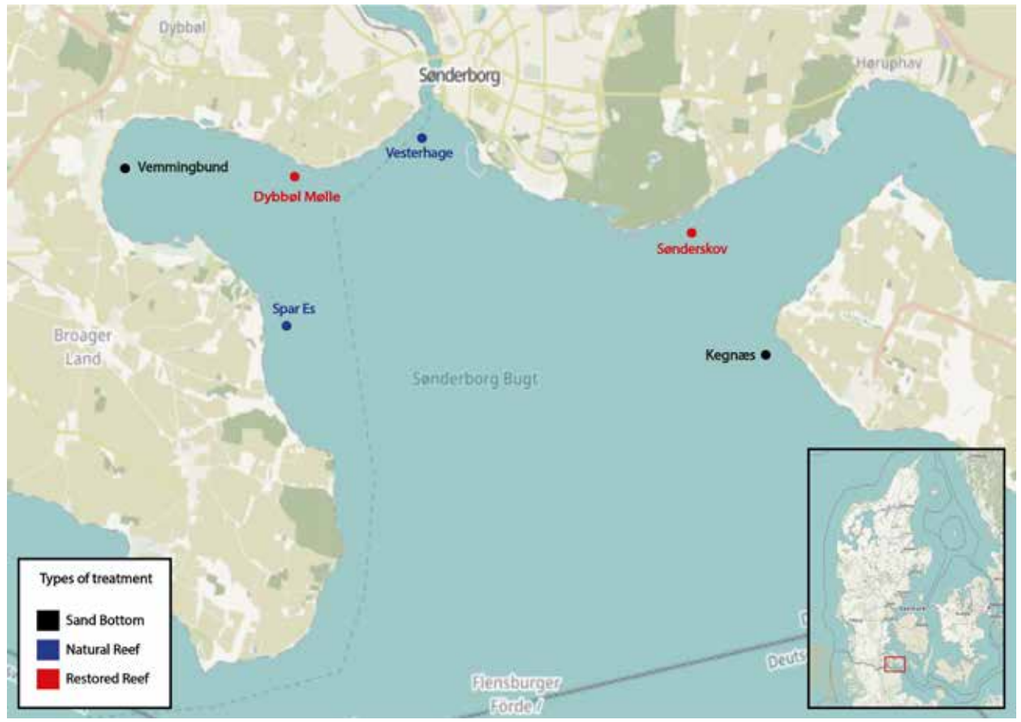
Figure 2: Atlantic cod (*Gadus morhua*) and Atlantic herring (*Clupea harengus*) may use reefs during different stages of their life cycle. Cod inhabit stone reefs as juveniles and adults, while herring may use the hard substrata and seaweed for their eggs. Photo: Bo Mammen Kruse from the organization Als Stenrev.





↑ Figure 3: Map of our sampling area. Each sampling site is color coded to indicate the nature of the seabed.

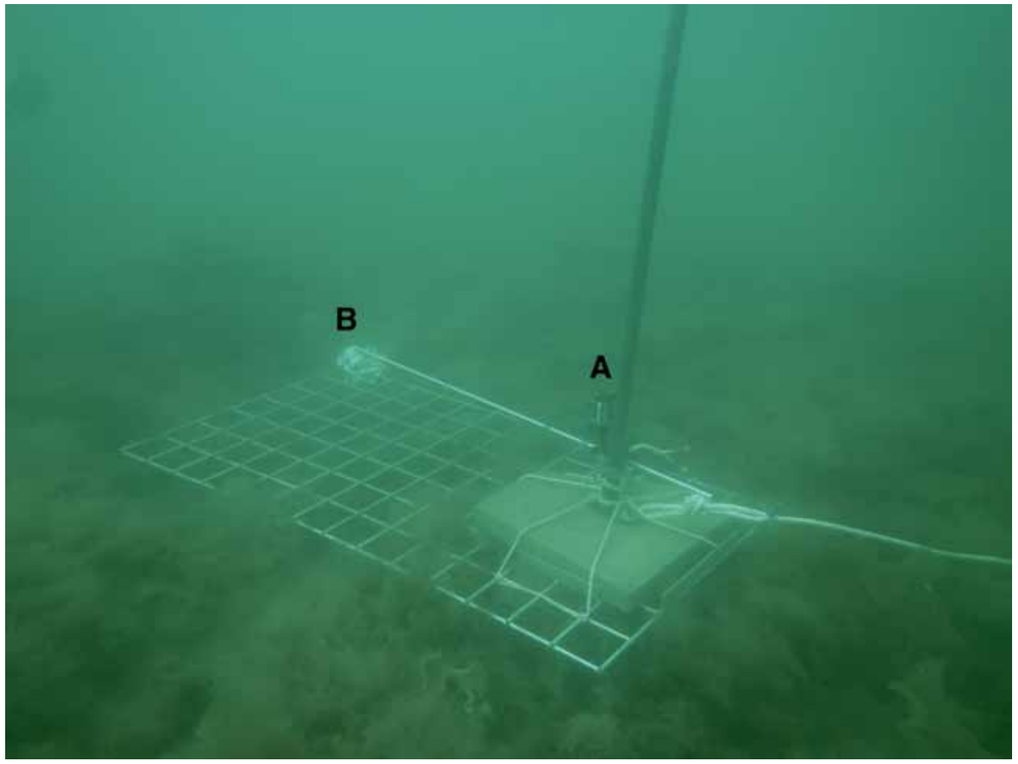
ROCKS AT SEA ARE IMPORTANT FOR MANY SPECIES

A stone (or rocky) reef is a structurally complex habitat that rises from the seafloor. A stone reef involves hard substrata, going from cobble to boulder rocks. Structurally complex habitats provide shelter for many fish species, especially in their juvenile phases. Boulder and cobble provide a favorable surface for seaweed to attach and grow, creating an even more 3D structurally complex habitat. The seaweed creates a marine forest that increases food availability for many species and provides a larger surface area to shelter or lay eggs on. Seaweed is also producing oxygen for other organisms to breathe.

Stone reefs are considered an essential fish habitat, because stone reefs are areas that support key life stages during the life history of many species. For example, Atlantic cod (*Gadus morhua*) use stone reefs in their juvenile and adult stages to hide from predators, whereas Atlantic herring (*Clupea harengus*) may use stone reefs as spawning sites where fish eggs are attached to the vegetation. So stone reefs can act as shelter and spawning site simultaneously.

RESTORING COBBLE REEFS TO SUPPORT FISH

To determine the effects of restoring these habitats, a project from DTU Aqua has restored cobble reefs in Sønderborg Bay. These reefs consist of two rows of 11 mounts of cobble (each rock is up to about 30 cm in diameter) located in two different spots in the Sønderborg Bay: Dybbøl Mølle and Sønderskov. The restoration of the reefs was completed in January 2018. In total, three sampling campaigns have been carried out



↑ Figure 4: Baited Underwater Video Systems (BRUVS) used in our sampling campaigns. The camera (A) is attached to the vertical pole and the bait bag (B) is attached at the end of the horizontal pole.

to assess how the reefs affect fish abundance and biodiversity; one sampling campaign in Spring 2017 before the restoration, another campaign in Spring 2018 about four months after restoring the reefs, and lastly the most recent campaign in Spring 2021.

SUBMERGIBLE CAMERAS – OUR EYES IN THE SEA

We used a special kind of underwater cameras known as Baited Remote Underwater Video Systems (BRUVS). BRUVS consist of a structure that supports both a camera and a bait bag. In our case, GoPro HERO® 3, 3+ and 4 cameras were used. A mesh net containing 500 g of Atlantic herring was used as a bait. The use of bait increases the number of fish seen in one recording as it attracts fish to the field of view, decreasing the needed sampling effort (Figure 4). Lastly, BRUVS have a very limited impact on the surveyed habitat, because BRUVS only record fishes rather than capture them to count them later.

We surveyed three different types of habitats: restored reefs, natural reefs and sand bottom sites (Figure 5).

HOW DID ATLANTIC COD AND HERRING REACT TO THE RESTORATION?

We compared recorded data from 2017, before the reef restoration, and from 2018, after the reef restoration. The abundance of both Atlantic cod (*G. morhua*) and herring (*C. harengus*) was analyzed to document the reef restoration effects. We expected increased fish abundance after the restoration, because both species may rely on the reef habitats to complete their life cycle (Figure 2 + 6).

Our results showed increases in abundance, however, the changes were not statistically significant. The abundance of herring increased in all three investigated habitats (i.e. restored reefs, natural reefs and sand bottom sites). The abundance of Atlantic cod increased in restored reef sites and decreased in sand bottom sites. However, none of the changes were statistically significant.

”Nowadays, stone reefs are listed as a protected habitat for many marine species in the Natura 2000 network and rock extraction is not allowed anymore.”

As both Atlantic cod and herring may use cobble reefs during their life cycle, we expected significant increases in the abundances. The lacking effects of the restored cobble reefs are probably explained by the absent seaweed communities on the reefs when we investigated the reefs in 2018. During the data collecting, the reefs were just four months old and there was no diverse seaweed community growing on the reefs (Figure 7).

WE COLLECTED NEW DATA IN 2021 TO FURTHER TEST THE EFFECTS OF THE COBBLE REEFS

This year 2021, we carried out a new sampling campaign. From the 2021 underwater videos, it is clear that the seaweed community is more developed now, as even large sugar kelp

↓ Figure 5: Camera setup used for sampling in Sønderborg Bay in Spring 2021. Fieldwork activities include changing camera SD cards and the batteries every day at sea.

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**Marine life is threatened, and we need to act now.
We cannot let another 180 years go by.”**

↑ Figure 6: Atlantic Cod (*Gadus morhua*) being recorded on a reef. Atlantic cod is a schooling species.

Figure 7: Habitat restoration. Pictures of how the seabed changed across four years. In 2017, the seabed mainly consisted of sand and no rocks or stones. In January 2018, the cobble reef restoration was carried out. In Spring 2018, seaweed colonization slowly started. In Spring 2021, a marine forest was developing.

If we take action and reverse recent changes, the marine life that H.C. Andersen observed may recover and continue to thrive."

(*Saccharina latissima*) was observed. With this encouraging evidence of the reef status, we expect to see greater effects of the restored cobble reefs in terms of fish abundance and biodiversity. We are now analyzing hundreds of underwater video recordings from Spring 2021.

A long time ago, H.C. Andersen noticed life at sea and he described abundant life in marine forests. Since then, marine ecosystems have been exposed to serious stressors including overfishing, bottom trawling, eutrophication and rock extraction. Unfortunately, it took decades until we realized the importance of stone reefs. Nowadays, stone reefs are listed as a protected habitat for many marine species in the Natura 2000 network and rock extraction is not allowed anymore.

We know that many human activities are detrimental to life at sea, and we are increasingly realizing that we can reverse the negative impacts. By protecting marine areas, eliminating serious stressors, and restoring marine habitats, we can recover the thriving and diverse marine wildlife. Marine life is threatened, and we need to act now. We cannot let another 180 years go by. If we take action and reverse recent changes, the marine life that H.C. Andersen observed may recover and continue to thrive.

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LINKS

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https://www.youtube.com/watch?v=CizuF4fN1C0&ab_channel=CoastalEcology

https://www.youtube.com/watch?v=7Tj2zVboQyA&ab_channel=DTUAquaBroadcast