

# Stone reefs in Denmark show promise in promoting marine biodiversity

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Credit: Wolfgang Kunther/DTU

Just six months after DTU Aqua and local organizations established new reefs at Bredgrund near Sønderborg, researchers recorded 100 times as many cod as usual. That was good news.

There is a need to re-establish Danish stone reefs. The original reefs have been reduced following decades of human activities. In the past

100 years alone, 8.3 million cubic meters of stone have been removed to expand Danish harbors and produce concrete. According to a study from DTU Aqua, this corresponds to the removal of at least 55 square kilometers of habitats for plants and animals—an area about the size of Fanø island.

The disappearance of the stones results in a lack of hiding places for [marine animals](#) and places where seaweed and mussels can attach themselves. And if the seaweed disappears, there are often fewer small marine creatures and fish, such as cod. The absence of stone reefs and [kelp forests](#) means cod have fewer places to hide from predators such as cormorants and seals.

So far, only a small percentage of the stone reefs that have been removed have been restored. DTU, together with local actors, has therefore initiated a number of projects investigating reefs consisting of rocks, mussels, concrete, etc. For example, one of the projects is looking at whether reefs can both protect coastline and create more [marine life](#). It can help increase biodiversity, improve spawning and growth areas for fish, and create value for sports fishermen and divers.

"We are in the midst of a biodiversity crisis, where species are dying at about the same rate as when the dinosaurs went extinct. That is why I am pleased with the results from Sønderborg Bugt. These tell me that cod seem to thrive around stone reefs, and have a better chance of hiding and feeding than before."

"We are currently in a pilot phase, developing and testing various reefs and documenting how they function. We are moving in the right direction, but progress is slow, because building stone reefs is expensive and complicated," says Senior Researcher Jon C. Svendsen, DTU Aqua.

## **Stone reefs that protect coastline**

Establishment of stone reefs began in Denmark 15 years ago. There is greater focus on stone reefs today—in part because Denmark is obligated to protect and restore the reefs that have disappeared under the EU Habitats Directive, which protects stone reefs in Natura 2000 areas.

There are two types of reefs in Denmark. One type is "geogenic," consisting of rocks. To recreate these reefs, rock is collected from quarries and transported by ship from Norway to Denmark. The other type is "biogenic." These consist of living organisms, such as oysters or mussels, and provide important habitats for a variety of fish species.

A new initiative is to determine whether stone reefs can be used to both protect coastline and promote biodiversity. The stone reefs can end up being multipurpose if so. DTU is currently testing the first Danish coastal protection [reef](#) along the coast of Samsø. The project is called BARREEF, and is being supported by Velux Fonden and the Vattenfall energy company.

One of the partners is Samsø Municipality. From here, Head of Department Bjarne Manstrup is following the project closely. He hopes that the reef will create new habitats for a number of marine plants and animals, thereby increasing biodiversity in the nearby area.

"It is my clear expectation that the reef will have a stabilizing and restorative effect on the coastline. In the larger perspective, BARREEF can provide knowledge and experience that can be valuable in similar coastal protection initiatives—locally and elsewhere in Denmark," says Bjarne Manstrup.

## **Climate and biodiversity crisis**

The project has received a lot of attention from Danish and foreign

media, such as the BBC, which produced a program on the feasibility studies for the project earlier this year. BARREEF is a good example of a project that incorporates two sustainability principles, "nature-inclusive design" and "nature-based solutions." This means that you set out to give nature a helping hand—and at the same time develop solutions that benefit people.

"In light of these two principles, it would be good in future to build stone reefs which also serve as coastal protection. Then we can promote biodiversity around the reefs, while also being better prepared to subdue waves next time a storm like Bodil hits us. In this way, stone reefs may become an additional tool for protecting the coastline."

"In the future, we will need more coastal protection as sea levels rise due to climate change. This is especially true for a low-lying country like Denmark with a lot of coastal infrastructure. However, it is important to note that the BARREEF project is still ongoing, so we still do not know whether stone reefs can serve as a supplementary tool for coastal protection," says Jon C. Svendsen.

As on Samsø, the climate and biodiversity crises are also at the core of the Coastal Life project, launched by the Limfjord Council together with municipalities, universities, state agencies, and private actors. The project aims to restore several hundred hectares of Danish coastal areas, with everything from salt marshes and islets to eelgrass, stone reefs, and biogenic reefs. DTU Aqua is part of the project, and will re-establish biogenic reefs composed of mussels and oysters in the part of the Limfjord called Løgstør Bredning.

## **Artificial concrete reef**

A different direction has been chosen in Copenhagen's Inderhavn. DTU is testing an artificial reef here made of newly developed concrete,

together with the Superflex artist group and CPH City & Port Development.

The project functions as a home for marine creatures, as a scientific experiment, and as a work of art. The purpose is to understand how seawater affects the reef installation and whether concrete reefs promote biodiversity. The project will run for several years. This is in part because it is necessary to monitor the reef several times, at the same time of year, in order to understand how conditions vary over a number of years.

"I hope that the surface on the concrete reef will create a natural breeding ground for marine creatures, because it is similar to coral reefs and seashells. We are also investigating the service life for concrete reefs. In the vast majority of concrete structures used for maritime infrastructure projects, concrete is used together with steel reinforcement."

"But with the type of concrete structure we're testing, we don't expect it to be necessary to use steel. This means that the service life will be longer than for conventional concrete structures in seawater. This has a great environmental benefit," says Wolfgang Kunther, a materials scientist at DTU Sustain.

The expectation is that the [construction industry](#) can draw on the experience gained in future coastal protection projects, bridges, tunnels, and [offshore wind farms](#), which can perhaps be optimally designed to offer new habitats for fish, mussels, seaweed, etc. The aim is to help create more marine life. Because it is necessary to act now, according to Jon C. Svendsen:

"In the past, we viewed the sea as an inexhaustible chamber, where we caught the fish we wanted and dumped a lot of wastewater. We have also

removed key living conditions, in the form of [stone](#) reefs, which fish and small marine creatures use as habitats. Every year, we cause oxygen depletion in the sea and extract sand from the seabed for coastal protection and construction. We have now reached the point where we cannot keep taking from the sea. We need to give back, acquire better knowledge, and be more careful. Otherwise we could end up with an ocean devoid of life."

Provided by Technical University of Denmark

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