

Project
Waddensleutels

(Wadden Keys)

Foundations for ecosystem restoration



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Waddensleutels project provides a sound scientific basis for ecosystem restoration

No restoration without knowledge

The need to restore the Dutch Wadden Sea ecosystem is beyond dispute. The question is, how? The Waddensleutels (Wadden Keys) project, which began in 2010 and runs until 2015, is a joint effort by the University of Groningen, the Royal Netherlands Institute for Sea Research (NIOZ), Natuurmonumenten and Staatsbosbeheer (the national forestry and wildlife service). These partners are experimenting with the restoration of mussel beds, compiling a picture of the food web using stable isotopes, and designing guidelines for ecological restoration. The aim is to unravel the key processes driving the Wadden Sea ecosystem for use in restoring it to full health.

Towards a Rich Wadden Sea

By 2030 the Wadden Sea must again become an ecologically rich sea with clean water, extensive shellfish beds and seagrass meadows. This is the goal of the 'Towards a Rich Wadden Sea' programme, in which government agencies and nature conservation organisations have been working together since 2010 to restore the rich diversity of life in the area. But restoring the sea to full health is not a straightforward process. Ecological restoration and management depend on a thorough knowledge of the key processes operating in the ecosystem.

The foundation: ecosystem engineers

Recent scientific studies have shown that shellfish beds and sea meadows play a crucial role in the transition to a rich marine environment. They are the ecosystem engineers: plants and animals that create suitable habitats for themselves and for other species. Ecosystem engineers not only react to environmental conditions, they also strongly modify their physical environment. In the Wadden Sea the ecosystem engineers are mussels and seagrasses, with the Japanese oyster as a newcomer.

Shellfish beds and seagrass meadows

Little is now left of the once rich variety of shellfish beds and seagrass meadows. In 1978 there were about four thousand



hectares of stable intertidal mussel beds in the Wadden Sea. They have now almost all disappeared, along with the plants and animals that depend on them. In the eastern part of the Dutch Wadden Sea a few young, as yet unstable mussel beds are gradually forming, but their development into mature beds is uncertain.

A helping hand?

Some progress has already been made. Water quality has improved, mechanical cockle fishing has ended and the mussel and shrimp fishery is gradually switching to more sustainable rearing and fishing methods. Despite these measures, though, the ecosystem engineers populations have still not recovered, although there are more signs of recovery in the eastern Wadden Sea than in the western part. Why is this? Do we need to give the ecosystem engineers a push in the right direction? If so, what sort of push will be most effective, and where? And how can we measure progress? These are the questions the team of scientists in the Waddensleutels project are trying to answer.

Restoration of mussel beds

The researchers have started testing innovative methods for restoring mussel beds. In March 2011 a large-scale field trial was launched in which experiments are being conducted on 36 test plots of 20 by 20 metres. The plots are on the mudflats near the islands of Terschelling, Ameland and

Schiermonnikoog. For one of the experiments 36 thousand kilos of mussels dredged from the subtidal were deposited on the plots, half on the bare sediment and half on coconut matting, which the mussels can latch onto more easily (see Figure 1). Unfortunately, these mussels did not remain for long. Almost all of them were swept away by storms in the summer of 2011. Interestingly, small experimental plots of intertidal mussels near the large-scale experiment survived the storm, while all subtidal mussels disappeared.

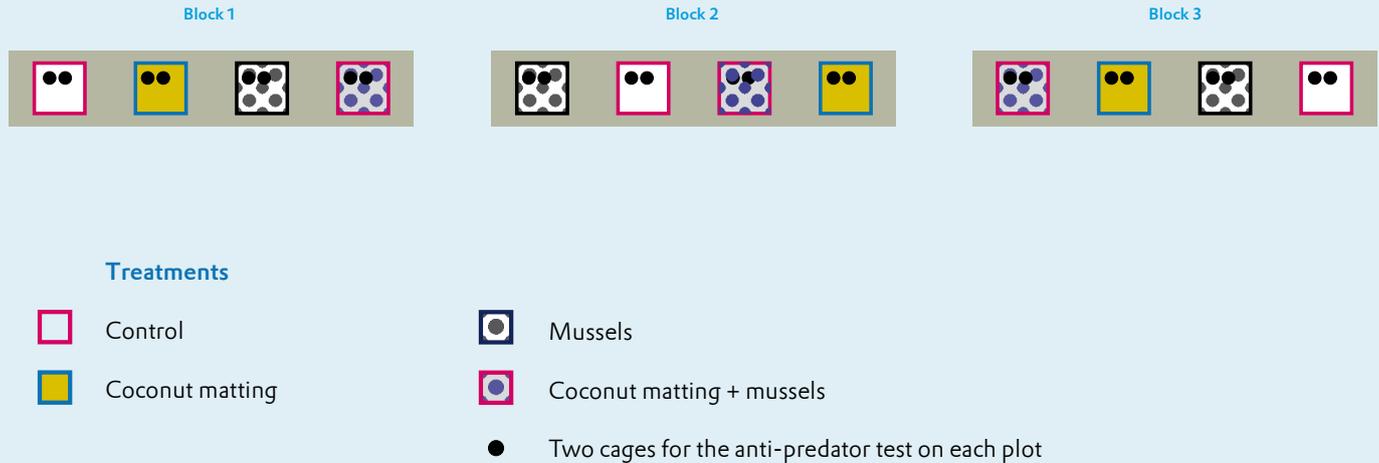


Excluding crabs and shrimps

Predation appears to be a crucial factor in the survival of mussel beds. To measure the effect of predation by crabs and shrimps, the researchers placed 108 wire-gauze cages on the plots to keep out predators. This has proved effective. The cockle and mussel spatfall (settlement of spawn) occurred only in the cages, and in greater numbers on sediment stabilized by coconut matting than on the bare sediment. In April 2012

a new experiment was started, in cooperation with Bureau Waardenburg, in which 18 special mussel crates were placed on the experimental plots. These crates consist of a rectangular block of metal honeycomb mesh. In theory, they not only keep predators out, but also provide a stable substrate for the mussel seed. The initial results are promising. Mussel spat have already been found on the crates.

Figure 1: Experimental design of mussel bed restoration plots

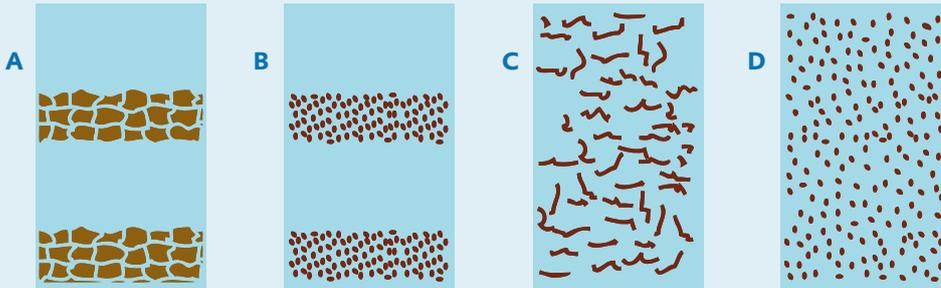


The ideal pattern

In the experimental plots the researchers are monitoring many factors, such as foraging birds, the presence of bottom-dwelling animals and the density and growth of the mussels. They are also measuring the depth of the mud and the pattern of mussel distribution with a 3D laser scanner and underwater cameras. To determine the most favourable pattern for

mussel growth and survival, researchers seeded mussels on experimental plots in different patterns in the spring and autumn of 2012. In some plots the mussels were laid out in bands of mussel strings or in bands of individual mussels; other plots were covered with randomly distributed mussel strings or individual mussels (see Figure 2). The results are expected in the spring of 2013.

Figure 2: Experimental mussel seeding patterns



Treatments

- A: Bands of mussel strings
- B: Bands of individual mussels
- C: Random distribution of mussel strings
- D: Random distribution of individual mussels





Piecing together the food web

To understand the importance of ecosystem engineers for other species, Waddenseutels is investigating the food web in the Wadden Sea. Traditional monitoring of parameters like water quality, birds and marine mammals does not provide sufficient information to determine the shifts in the richness and complexity of the food web. Better indicators can be obtained by using stable isotopes of carbon, nitrogen and hydrogen as molecular markers. Small differences in the isotope signatures can provide valuable information. For example, the ratio of nitrogen isotopes reveals how high up in the food web an animal is, while the ratio of different carbon isotopes makes it possible to distinguish between food from marine and terrestrial origins. The researchers are also developing new methods, including the use of hydrogen isotopes to identify whether a sample comes from seawater, brackish water or fresh water.

Thousands of samples

An isotope-ratio mass spectrometer (IRMS) has been purchased to measure the stable isotope markers. Each year this device is used to analyse thousands of samples from fish, crabs, worms, shellfish and birds. Most of these samples come from four survey ships of the Ministry of Economic Affairs, Agriculture and Innovation, and the NIOZ Synthoptic Intertidal Benthic Survey that is mapping the distribution of the bottom-dwelling life. The researchers are using the results of the isotope studies to develop a set of process indicators to measure the damage to the food web and the degree of recovery, not only for mussel beds but also for other systems, such as saltmarshes. The isotope markers make it possible to quantify sediment trapping by saltmarsh communities. The accumulation of sediment on saltmarsh and mudflats can provide additional protection against coastal flooding as sea levels rise.

Opportunity map

Ecosystem engineers do not grow everywhere. They have specific requirements, such as the properties of the sediment, depth of water and current strength. The researchers are compiling a restoration opportunity map of the whole Wadden Sea showing the locations with the greatest potential. The map can be used by conservation organisations and governments to confidently identify where they have the best chance of restoring mussel beds. In compiling the map the researchers are drawing on all the knowledge acquired during the Waddensleutels project, as well as information from other relevant projects. One of the researchers is working on ground truthing of satellite images as part of the 'Intertidal ecosystem engineers in a Changing Climate' project. He is comparing the images from space with the situation on the ground to map the mussel and oyster beds and the surrounding nutrient-rich environment.

Guidelines for ecological restoration

The Waddensleutels project is building a sound scientific basis for restoring the Wadden Sea ecosystem, and the experiments and new monitoring methods are providing valuable initial experience and concrete guidelines for conservation. Under the 'Towards a Rich Wadden Sea' programme the conservation strategy for the area has shifted from preservation to restoration of the wet ecosystems. The Waddensleutels project is now providing the information and know-how needed for the practical ecological restoration work and management of the Wadden Sea.



Broad consortium

Waddensleutels is a joint project in which research institutes and nature conservation organisations work closely together. The project team consists of researchers from:

- Natuurmonumenten
- Staatsbosbeheer
- University of Groningen
- Royal Netherlands Institute for Sea Research (NIOZ)

Funding

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For more information: waddensleutels.nl