Eider predation mitigation tools for Baltic Sea mussel farming

Observations and experience from eider mitigation tool testing as part of the project “Baltic Blue Growth”.

Maren Moltke Lyngsgaard, Anna Schriver, Per Dolmer (Orbicon)
Anders Lejbach, Torben Wallach (Musholm)

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About

Baltic Blue Growth is a three-year project financed by the European Regional Development Fund. The objective of the project is to remove nutrients from the Baltic Sea by farming and harvesting blue mussels. The farmed mussels will be used for the production of mussel meal, to be used in the feed industry. 18 partners from 7 countries are participating, with representatives from regional and national authorities, research institutions and private companies. The project is coordinated by Region Östergötland (Sweden) and has a total budget of 4,7 M€.

Partners

- *Region Östergötland (SE)*
- *County Administrative Board of Kalmar County (SE)*
- *East regional Aquaculture Centre VCO (SE)*
- *Kalmar municipality (SE)*
- *Kurzeme Planning Region (LV)*
- *Latvian Institute of Aquatic Ecology (LV)*
- *Maritime Institute in Gdańsk (PL)*
- *Ministry of Energy, Agriculture, Environment, Nature and Digitalization of Schleswig-Holstein (DE)*
- *Municipality of Borgholm (DK)*
- *SUBMARINER Network for Blue Growth EEIG (DE)*
- *Swedish University of Agricultural Sciences (SE)*
- *County Administrative Board of Östergötland (SE)*
- *University of Tartu Tartu (EE)*
- *Coastal Research and Management (DE)*
- *Orbicon Ltd. (DK)*
- *Musholm Inc (DK)*
- *Coastal Union Germany EUCC (DE)*
- *RISE Research institutes of Sweden (SE)*

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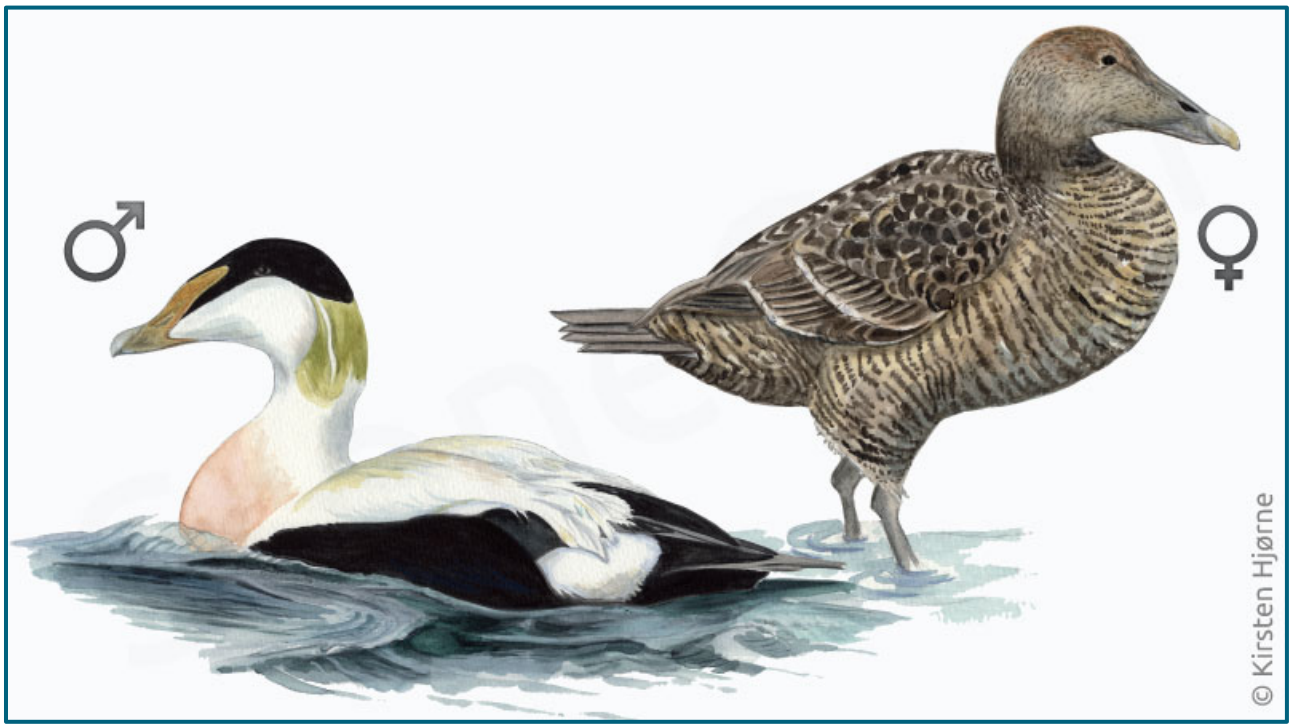


Figure 1 Eider duck (Somateria mollissima) - Kirsten Hjørne – Naturportalen.dk

Executive summary

The eider mitigation tool testing is part of the technical development on the focus farms, where experiences from tests of laser, nets and drones are described in the following.

The experiences from the Bohus Havsbruk mussel farm shows that, setting up nets around the farms, with no more than 15 m between each production unit, is considered sufficient to keep the eiders out. The largest test area has 30 production units, each 126 m long. Experience from Bohus Havsbruk that uses the eider fence in their mussel production, shows that eiders would rather try to swim into the mussel production area than fly and land inside the eider fence. Hence, the nets have proven efficient in keeping the birds out of the production area and could be implemented in all locations that are protected against high waves and strong currents.

A laser with the same specifications as the shellfish saver laser was tested on a single occasion using a service boat to get near the birds. The laser did not prove useful as a mitigation tool, as the eider ducks showed little to no response to disturbance from the light. As a response to this result, further experiments with laser was not carried out, and focus was aimed at finding other solutions to the problem with eider ducks.

Two additional solutions were proposed and tested, where airborne drones of different sizes were one of them and a boat drone was the other. The expected outcome from test of the effect from a small drone and a medium sized drone, was that the drones would scare the birds away from the mussel farm area through both movement and sound. The tests showed that the small drone had little to no effect on the birds, even when navigated very close to the birds. The bigger drone had an effect on the birds by forcing them to swim away, when flown straight over the mussel lines. However, the same birds returned after intervals of just ten minutes, indicating a minimal and inconsistent effect of the drone on keeping eiders away, especially if not flown constantly.

An equivalent drone boat was tested by Orbicon and proved most efficient as a mitigation tool for scaring eider ducks away from the production site, as the birds did not return to the farm shortly after being scared off by the boat. Preliminary results indicate the drone boat seem promising as a mitigation tool for eider ducks, but this will need further testing before recommendations can be made.

Conclusively, nets have proven efficient in keeping predator birds away from mussel farms. Other solutions such as laser and airborne drones has not shown any indication of reducing the risk of eider duck predation on the farms, whereas the boat drone indicates potential but need to be tested further before recommendations can be made.

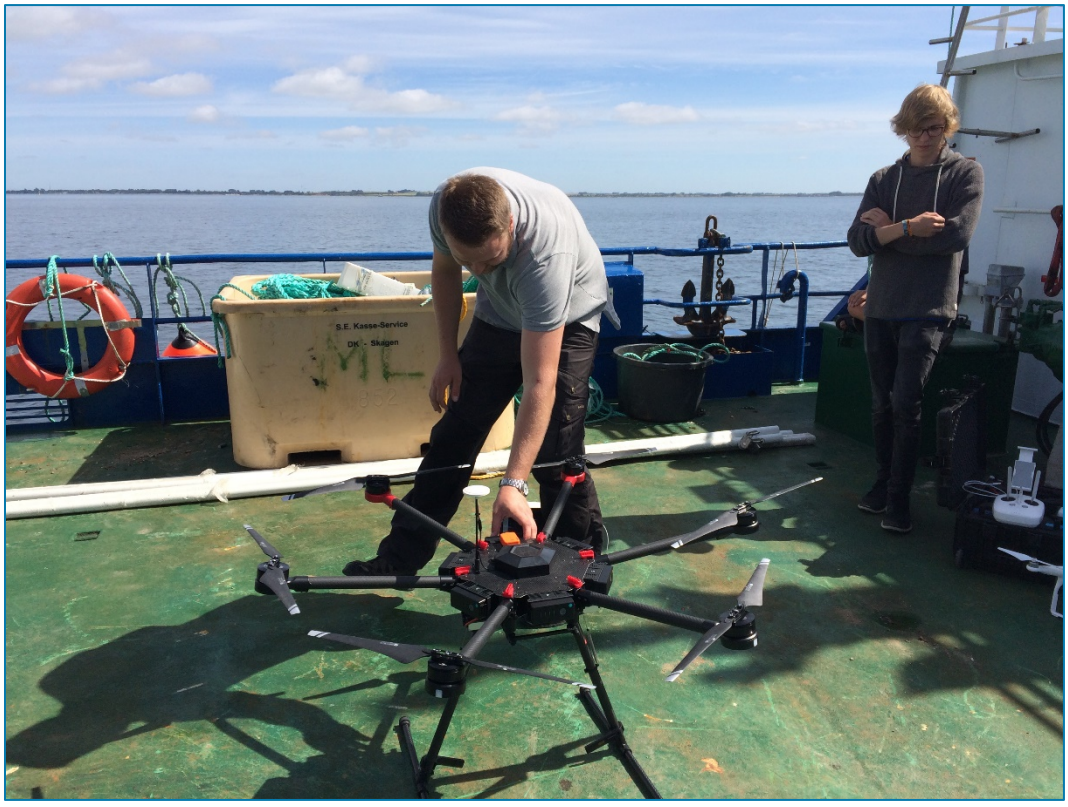
Introduction

Mussel (*Mytilus edulis*) production has been demonstrated in Denmark, Sweden, Germany, and Latvia as a part of the Baltic Blue Growth project. Focus has been on production techniques, harvest amount, growth rates and substrates. This report will focus on one of the major obstacles being predation by eider ducks (*Somateria mollissima*), that occurs on the mussel farms in the southern part of the Baltic Sea.

The different areas have been facing different obstacles. In the Swedish archipelago, where the Sct. Anna farm is situated, they have had no predators. Other molluscs, such as the olive green cockle (*Cerastoderma glaucum*), has been settling on the production ropes and thereby introducing a threat to the production of mussels. The cockles were, however, pushed off the ropes by the blue mussels, and were therefore no threat to the mussel production.

In another area, Kalmarsound, where the other Swedish farm is situated, there are small populations of eider ducks that breed and spent the whole summer in the area. These populations have been eating small amounts of mussels from the nets and not shown any severe effects on the farm yet. There are also migrating populations of eider ducks in the area. These have not been foraging on the farm yet.

In Latvia, where the UTARTU farm is situated, the main predator is the round goby (*Neogobius melanostomus*). Overall, a massive depletion of small mussels has been observed in the coastal area of Kurzeme. At the farm site the lower part of the farm, up to 2-2,5m from the bottom, contains very few mussels compared to the higher parts of the farm, where the mussels are larger and much more abundant. Natural predators of mussels are flounders, which are becoming increasingly scarce since the invasion of the round goby, as the gobies are eating the juvenile flounders and competing for food sources with adults.



Picture 1. Using airborne drones as a mitigation tool against eider duck predation

In Kiel, Germany, there has been a heavy predation on the mussel farm by eider ducks once, during the cold winter 2010/2011. During that year, the eider probably could not feed on their natural feeding grounds in the Baltic Sea because of ice coverage and thus went into Kiel Fjord in search for food. In the subsequent years eider ducks were seen regularly, however only in low abundances (approx. 5 – 10) and do not cause any major loss. Overall, the biggest threat to the business of mussel production in Kiel, are heavy storms, high concentrations of harmful bacteria and harmful algae.

At Musholm in Denmark, there is a foraging colony of eider ducks. In 2017, the farm experienced a complete loss of mussels on the production units due to eiders feeding on the farm. Therefore, the aim of the technical study was focused on preventing this occurrence on - and nearby - the mussel farm. The tests did not include techniques for decreasing other mussel predators, such as starfish, which were not a threat to the mussel production during the time of the Baltic Blue growth project.

In this context, Orbicon has identified predation by eider ducks to be the primary threat to mussel production in the Southern Baltic Sea. Several technical solutions have been tested, and the best preventive practice identified for actions associated with mussel farming on long lines and SmartFarm systems. After testing several predator mitigation tools the results have been summarised in a short report from the Musholm mussel farm.

Description of circumstances

MUSHOLM MUSSELS

Musholm mussel farm is located in The Great Belt between Zealand and Funen in Denmark. The area experiences a large bloom of mussel larvae each year, resulting in complete coverage on any natural substrate available, including old anchors, marine constructions and, with great success, the substrates deployed for mussel farming. Consequently, a low food availability causes the abundance of newly settled small mussels to grow very slow throughout the summer, compared to, for example, the Danish fjords. However, by early autumn the mussels have grown large enough in size, making them a preferred and easily accessible food source for eider ducks. Thus, Musholm mussel farm is an obvious area for testing different predator mitigation tools.

EIDER DUCKS

Eiders are, to this day, one of the biggest threats to the mussel farming industry in Denmark. Eiders natural food source are mussels, because of this, they have the ability to swim and dive to deep-sea bottoms to obtain their food and sustain colonies. Eider duck males grow to about 2,3 kg, and females 1,9 kg, both of which may reach 20 years of age, producing offspring all its life from the age of 3.

A population of 100 eider ducks are able to consume up to 260 kg of mussels per day, making them a serious predator for the mussel industry. Eiders are able to dive down to 42 m below the surface, in pursuit of mussels, making them difficult to control from boat or land. Eider ducks can eat all sizes of mussels.

EIDERS AT MUSHOLM

At the Musholm farm, a constant abundance of eider ducks has been registered. Although fluctuating, the area has hosted a minimum of at least 200 individuals since 1995, with an annual registration of bird numbers being undertaken in early May. In 2006, Musholm experienced its highest abundance of Eiders, with at least 1400 individuals – see Figure 2. Eiders were observed continuously on the mussel farm during summer time from May to July 2017 (Figure 3).

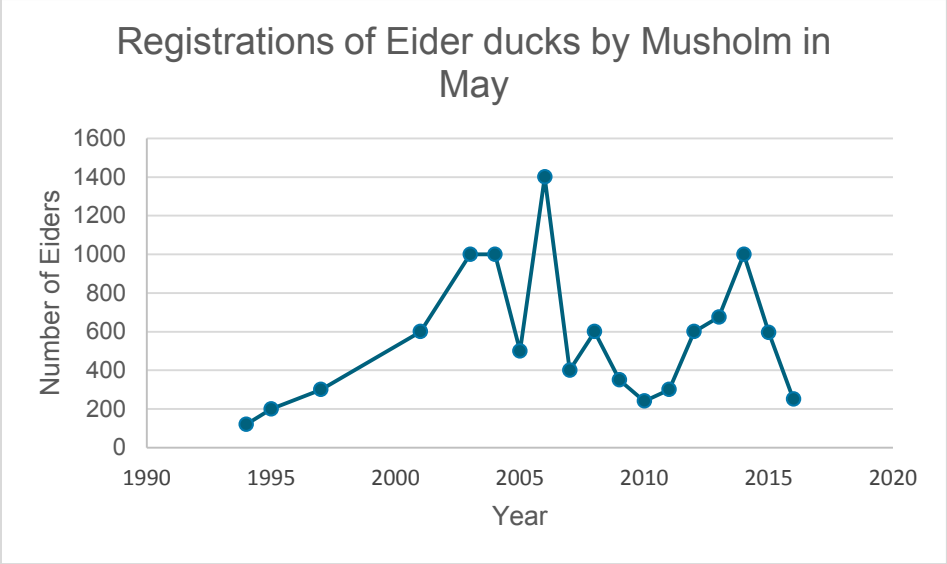


Figure 2 Annual registrations of eider ducks by Musholm from 1993 to 2016

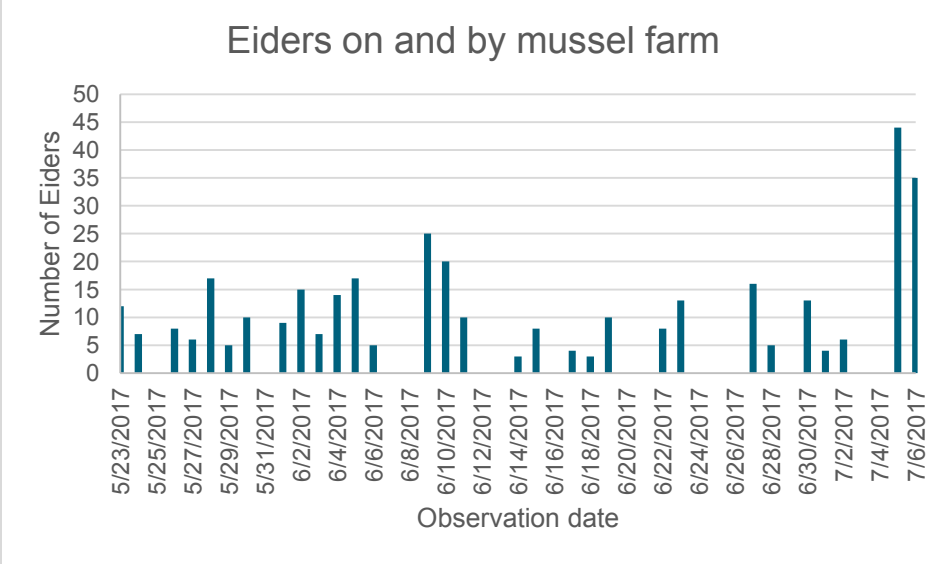


Figure 3 Eiders on mussel farm in early summer 2017. Observations were carried out around noon.

Tested predator mitigation tools

In collaboration with Musholm A/S, Orbicon has tested three different mitigation tools for preventing eider foraging on mussel farms. The results of each equipment test will be included in the combined results of the Interreg BBG project. Furthermore, experience with nets from Bohus Havsbruk on the westcoast of sweden is included, as this has been used on a full-scale mussel farm with positive results.

CARAPAX EIDER NETS

The most efficient way to keep eiders from consuming the mussels before harvest is to place nets all around the farming area. The eiders are talented divers, but the nets do not need to go very deep. Also leaving too much room inside the farm area will make landing within the farm area possible, making it possible for eiders to avoid the surrounding netting. Therefore, the netting will need to be extensive, making an investment expensive and resource demanding in start-up establishment and maintenance. Furthermore, the netting will decrease mobility around the farm, making harvest and maintenance more difficult.

The Swedish company Carapax (**Carapax Marine Group AB, Lysekil, Sweden)** has developed an eider fence system, which is easy to work with on the mussel farm and relatively easy to clean for biofouling. The eider fence is composed of a series of units of vertical buoys of 4,8 m with a bottom weight attached to it – see Figure 4. It is recommended that units are set up for every 10 meters, to ensure efficient prevention of eider ducks foraging. Half of the buoys are submerged in the water and the netting can be lifted and flipped, when biofouling begins to weigh them down. After a few days above water, the biofouling dries off and by shaking the nets; they are cleaned and can be left until the next flipping and drying is necessary. The nets are symmetrical so that they do not need to be flipped back.

Net mesh size of 60 mm x 60 mm will help ensure keeping the birds out of the farm area, with minimal amounts of birds getting caught in the nets. However, it is advised that the nets be checked regularly to make sure no animals are harmed.

The behaviour of eider ducks is associated with their poor flying skills, as they need considerable space for taking off and landing. Therefore, setting up nets around the farms, with no more than 15 m between each production unit, is considered sufficient to keep the eiders out. The largest test area has 30 production units, each 126 m long. Experience from Bohus Havsbruk that uses the eider fence in their mussel production in the area of Bohuslän, Sweden, shows that eiders would rather try to swim into the mussel production area than fly and land inside the eider fence. Therefore, Bohus Havsbruk has learned that they optimally need to check the nets every day during the most active months to prevent birds getting stuck in the nets.

The eider fence is designed with a click-on click-off solution so that it is easy for workers to enter the mussel farm inside the nets. The eider fence from Carapax is relatively new, and its durability (expected lifetime) has not been tested fully yet. Carapax can help set up the system, which is usually done within one day. For now, the nets have a minimum expected lifetime of 2 years and the system itself a minimum of 10 years. The price of the eider fence is approx. 330 € for every 10 m of eider fence, excluding anchors which will depend on the specific conditions of the different sites.

The Musholm area in the Great Belt is a production site with strong currents and at time strong wind as well. Therefore, will take a considerably amount of resources to keep the nets in place, which may in the end be too costly compared to the outcome of the mussel production.

Figure 4 Carapax eider net

LASERS

Previous tests have included a trial of lasers as a mitigation tool for predators on the farms. John Bonardelli from Shellfish solutions advised Orbicon to test the effects of lasers, which has proved to work as a tool to scare off birds in relation to aquaculture. In August 2016, Orbicon talked to a Norwegian mussel producer (Snadder og Snaskum AS), which states that they had used the handheld ShellFish Saver system by SaveWave successfully. The mussel producer stated that the system has a low power when there is much sunlight. In more dim conditions, the system is efficient and has a lasting effect. The mussel farmer reported good experience of fighting eider birds across fjord, using the laser from the top of a slope at a height of 30-40 meters and at a distance of 1.5 km from mussel farming. The company had tested cheaper Chinese laser that had lower power and had trouble getting rid of heat.

Musholm did not end up testing the Shellfish saver but purchased a small edition with the same specifications as the shellfish saver laser – see Figure 5.

Figure 5 Handheld laser, pocketsize

The price of the laser was, at the time, € 95,02.

The Danish department for Agriculture and Fisheries gave written permission on the 4th of October 2016 for the use of lasers at Musholm. The permission was granted for a two-month period. Within this period, the laser was tested on a single occasion using a service boat to get near the birds. The laser did not prove useful as a mitigation tool, as the eider ducks showed little to no response to disturbance from the light. John Bonardelli has explained how the shellfish saver system is most effect full when there is little light such as early mornings or evenings or during night-time. The test of the laser was carried out during morning-midday, therefore with plenty of light.

DRONES

Over the past few years, drones have become increasingly popular and more versatile, securing a fast technological development. Today drones can be purchased for a relatively small amount of money, making them an easily accessible tool.

Orbicon tested the effects of two different types of aircraft drones, one small and one medium sized – see Table 1. The expected outcome was that the drones would scare the birds away from the mussel farm area through both movement and sound. The assumption was that, through continuous flights over time, the birds would not want to return to the area for foraging.

The tests showed that the small drone had little to no effect on the birds, even when navigated very close to the birds. The bigger drone had an effect on the birds by forcing them to swim away, when flown straight over the mussel lines. However, the same birds returned after intervals of just ten minutes, indicating a minimal and inconsistent effect of the drone on keeping eiders away, especially if not flown constantly.

Table 1 Technical specifications for two types of drones used in the mitigation tests

Drone 1	Drone 2
Type: Phantom 3 Pro **Weight:** ca. 1,3 kg **Category:** 1B **Dimensions (diagonal):** 350 mm	**Type:** Matrice 600 **Weight:** 9,6 kg **Category:** 2 **Dimensions (BxHxL):** 1668 mm, 759 mm, 1518 mm.

Continuously flying drones around production sites would both require having personnel on a mussel farm at all times and thus large financial resources. Therefore, the drone most suitable for mitigation measures would be a self-flying drone that does not require remote controlling. These drones can be deployed from a docking station charged by solar power, and can be put on a timed schedule for fly outs.

An equivalent drone boat was tested by Orbicon and proved most efficient as a mitigation tool for scaring eider ducks away from the production site, as the birds were unable to swim to nearby water and return to the farm shortly after. It is possible that eiders register flying drones as predator birds, and since eider ducks have poor flying ability they tend to seek refuge in the water until a threat from the air has disappeared. Mitigation techniques focused on airborne tools may therefore be less efficient than waterborne equipment. Preliminary results indicate the drone boat seem promising as a mitigation tool for eider ducks, but this will need further testing before a complete recommendation can be made.

Conclusion

As part of the BBG project Musholm has been looking for an efficient mitigation tool against eiders over the past 2 years. So far, no perfect cost-efficient mitigation tool against eiders has been found, but several of the tested techniques look promising. However, they do require further site-specific testing, which is costly and therefore in need of financial support.

It is Orbicons assessment that the use of either eider Nets or Drone boats will prove to be efficient as a mitigation tool for preventing foraging of eider ducks. Economically, the drone boat will require investment, but if financially possible, a combination of both nets and drone boats is recommended for an optimal outcome.

In late 2017, Orbicon applied for funds to further investigate the possibilities and outcomes of using eider nets and drone boats. The application was sent to the European ocean and fisheries fond (EHFF) and a decision is expected in early spring 2019. The application was made in collaboration with Musholm and Hjarnoe Havbrug, and if financial aid is given, Orbicon hopes to successfully prove that the use of eider nets in protected bays and drone boats in more open areas will minimise or eliminate the well-known production losses of mussels due to the negative effects of eiders ducks.

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