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Policy Brief

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Mussel farming in the Baltic Sea

– an uncertain measure against eutrophication

According to current knowledge, blue mussel farming is not an efficient measure against eutrophication in the Baltic Sea. Blue mussels grow slowly in brackish water. Besides, large farms risk harming the marine environment more than they benefit it.

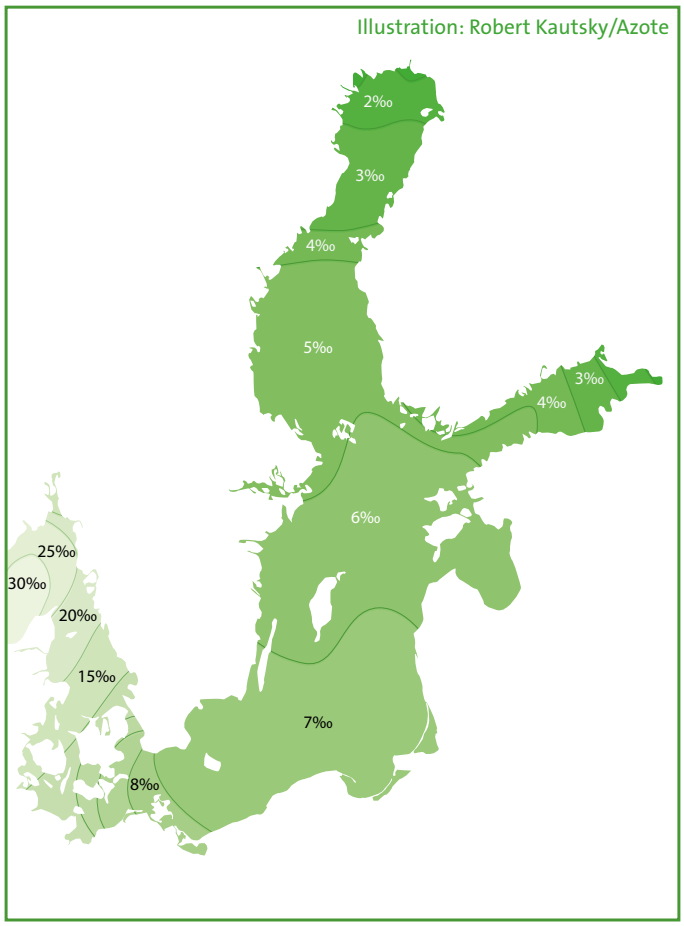
Cultivating mussels for human consumption holds great potential for producing food from the sea, and possibly for producing sustainable feed for agri- and aquaculture. Currently, blue mussels are commercially farmed around the North Atlantic. The EU Baltic Sea Region Strategy for Blue Growth points to mussel farming as a promising opportunity for aquaculture in the Baltic Sea as well.

Recently, mussel farming has also been recommended as a cost-effective measure to reduce eutrophication in coastal areas, including the Baltic Sea. The basic concept of mussel farming as a measure to counter eutrophication is that nutrients are taken up by the mussels and removed from the sea at harvest. However, blue mussels grow at a slower rate in the brackish Baltic Sea and have a lower meat and nitrogen content than mussels from areas with higher salinity. This means that cultivating blue mussels to take up nutrients from the sea has much less potential in the Baltic Sea than in other areas.

There are also still large gaps in knowledge about the environmental impacts of blue mussel farming in the Baltic Sea. The small-scale trial farms that currently exist in the sea have had little negative environmental effect, but at the same time, they have provided no major environmental benefits. The risk of negative effects grows if such farms are scaled up. For instance, we know that intensive mussel farming can lead to reduced oxygen levels in bottom waters and increased release of nutrients.

According to current knowledge, there is no scientific support that mussel farming is an efficient measure against the eutrophication of the Baltic Sea.

Farming mussels for human consumption currently occurs around the North Atlantic. A diver is seen here engaged in mussel cultivation on ropes on the Swedish west coast.



The salinity decreases along a gradient from the Atlantic to the inner parts of the Baltic Sea. This influences the conditions for mussel farming.

Lower production, fewer harvests, poorer efficiency

The salinity of the water decreases along a gradient from the Atlantic into the inner Baltic Sea. This gradual decrease in salinity is mirrored in the size and growth of blue mussels in these regions.

Blue mussels are adapted to live in sea water with high salinity. Life in the low salinity of the Baltic Sea, therefore, becomes a physiological challenge for them. Much of the energy of the mussels is used to maintain proper water content in their cells. As a consequence, mussels grow at a slower rate and are significantly smaller than blue mussels in other areas. The growth, measured as increase in weight, is approximately 10 times slower in 7 ‰ salinity than in 25-30 ‰.

Based on this, several scientific reports question the efficiency of blue mussel farming as a method against eutrophication in the Baltic Sea in areas with salinity less than 13 ‰. The slow growth means that it takes more time before it is possible to harvest the Baltic Sea farms, which makes these farms up to 10 times less efficient compared to farms in high salinity.

The longer period between harvests also carries a major financial risk, because of the probability of costly disturbances due to extreme weather and unforeseen incidents.

The mussels take up less nutrients

Not only do the blue mussels grow more slowly in the Baltic Sea, but there are also indications that they contain less nutrients per unit weight compared to blue mussels living in high salinity. This has not been acknowledged in evaluations of cost-efficency of blue mussel farming in the Baltic Sea. Instead, these evaluations build on old measurements of nutrient content from the US and the west coast of Sweden. The few measurements that exist on nutrients in mussels from the Baltic Sea indicate a significantly lower proportion of nitrogen – just half as much compared to mussels in marine waters. This is due to the fact that the meat of blue mussels living in the Baltic Sea contains more water.

The importance of calculating correctly

Available estimates for cost of nutrient uptake in mussel farming in the Baltic Sea vary between approximately 30 - 60 € per kilo of nitrogen and 400 - 900 € per kilo of phosphorous in the northern Baltic Sea and between approximately 15 – 25 € kilo of nitrogen and 225 - 350 € per kilo of phosphorous in the southern Baltic Sea. However, these estimates build on unrealistic production estimates and overestimates of nutrient content in the mussels. In order not to overvalue mussel farming as an environmental measure in the Baltic Sea, calculations of efficiency of measures and cost effectiveness must take into account the special conditions of the sea.

Large farms could cause environmental problems

For small-scale trial farms in the areas of the Baltic Sea that have good water circulation, no major negative environmental effects of mussel farming have been observed. At the same time, such small farms carry limited potential for removing nitrogen and phosphorus, as well as for increasing water clarity.

More research is needed to be able to predict if, and to what extent, these trials can be scaled up without damaging the environment. Several previous studies have shown that intensive mussel farming can have negative environmental effects. This is partly because mussels excrete faeces and other organic material that sinks to the seabed during cultivation and reduces oxygen con-

tent, which in turn harms other animals and plants inhabiting the area. In addition, mussels release dissolved nutrients, which can alter the nutrient balance and increase the amount of accessible nutrients in the water, and can even cause algal blooms.

When farming mussels has the primary aim to improve the environment, it is very important to take into account the risk of negative side effects that counteract the positive environmental effects. This risk increases as farms grow larger or denser. The potential negative environmental effects also need to be internalized in the farming costs.

Cannot replace measures on land

Since the small blue mussels in the Baltic Sea have a low market value, the current motivation for starting blue mussel farms is often to remove nutrients from the sea to reduce eutrophication.

Researchers in the project Baltic Blue Growth have a target of annually cultivating 25 tonnes of mussels per hectare in their farms, but have until now reached only 12 tonnes of mussels per hectare and year, which is equivalent to approximately 7 kilos of phosphorus and 100 kilos of nitrogen per hectare and year. It is estimated that the northern part of Baltic Proper holds the potential for approximately 400 hectares of mussel farms.

If successful in cultivating 25 tonnes per hectare per year, such large cultivation would be able to produce 10,000 tonnes of mussels per year at the most, and would therefore absorb approximately 6 tonnes of phosphorus and 85 tonnes of nitrogen. These calculations are based on a number of assumptions and do not take into account any potential losses due to unforeseen incidents, which means that they are optimistic.

In comparison, the Baltic Sea receives more than 30,000 tonnes of phosphorus and almost a million tonnes of nitrogen every year. In this example, extensive mussel farming under optimal conditions would remove less than 0.02 percent of the annual supply of nutrients to the Baltic Sea. There are other measures against eutrophication that are both cheaper and more efficient.

While blue mussels in a salinity of over 25 ‰ can grow to approximately 5 centimetres and reach a weight of 13 grams in only 18 months, a mussel in the Baltic Sea, in a salinity of 7 ‰, can only grow to 2.5 centimetres and weigh only 2 grams after almost double as long cultivation time. This is one reason why mussel farms in the Baltic Sea are up to 10 times less efficient than those in areas with high salinity.

Uncertain measure in the Baltic sea

Combating eutrophcation is a high priority for the countries around the Baltic Sea, in order to fulfil the obligations of the EU Water Framework Directive (WFD), the EU Marine Strategy Framework Directive (MSFD) and the Baltic Sea Action plan (BSAP). Some of the countries have included development of mussel farming and other so-called "blue catch crops" in their Programmes of Measures under the MSFD. For instance, Sweden has set aside 3 million € for blue catch crops in order to reduce eutrophication.

But with the current state of knowledge, blue mussel farms in the Baltic Sea are not very efficient in removing nutrients. There are ongoing projects working to improve farming technology, for instance the EU-funded project Baltic Blue Growth that is evaluating the potential for eutrophication mitigation farms in the Baltic Sea. However, the Baltic Sea environment provides unique challenges that may not be easy to overcome. Therefore, investments in mussel farming in the sea risk being costly and having little impact on the eutrophication problem.

The blue mussel is a common species on hard seabeds, both in the Baltic Sea and in adjacent sea areas. This is a mussel bed in the archipelago of Lysekil.

BLUE MUSSEL, *Mytilus edulis trossulus*

Illustration: Camilla Bollner/Azote

Blue mussels are able to survive in a salinity as low as 4.5 parts per thousand and they are one of the relatively few species that can live in the brackish Baltic Sea. It is a common species in most coastal areas of the Baltic Sea, as well as adjacent sea areas, and fills an important function for biodiversity and for nutrient cycling.

Blue mussels in the Baltic Sea grow to no more than approximately 3 centimetres in length due to low salinity, while blue mussels in the Atlantic can grow up to 10 centimetres. They are filter feeders, consuming plankton by filtering water.

During the breeding season in the spring, eggs and sperm are excreted into the water and fertilisation occurs. Mussel larvae swim freely in the water for a few weeks until they attach themselves with threads to a hard surface, where they start growing.

Blue mussels are farmed commercially around the North Atlantic, often on long ropes where the mussels larvae attach themselves.

RECOMMENDATIONS

- **Delay large investments in blue mussel farming as a measure against eutrophication in the Baltic Sea.** Blue mussels in the Baltic Sea grow at a slower rate, are smaller, and have lower nutrient content than mussels living in waters with higher salinity. According to data from farming trials, a mussel farm in the Baltic Sea can be up to 10 times less efficient in absorbing nutrients, per unit of area. It is still uncertain if blue mussel farming in the Baltic Sea can become an efficient measure against eutrophication.
- **Account for the unique environmental conditions of the Baltic Sea.** The special conditions of the Baltic Sea must be taken into account when valuing both the cost effectiveness and nutrient removal efficiency of mussel farming. Potential benefits should use realistic growth rates and nutrient content values, as well as take into account unforeseen incidents.
- **Do not start any large mussel farms in the Baltic Sea until more is known about negative side effects.** Larger and denser farms have been suggested to compensate for the lower growth rate; however this can increase the risk that negative environmental effects exceed the environmental benefits. A thorough evaluation of the potential negative environmental effects of blue mussel farms in the Baltic Sea is needed.

Photo:Robert Kautsky/Azote

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