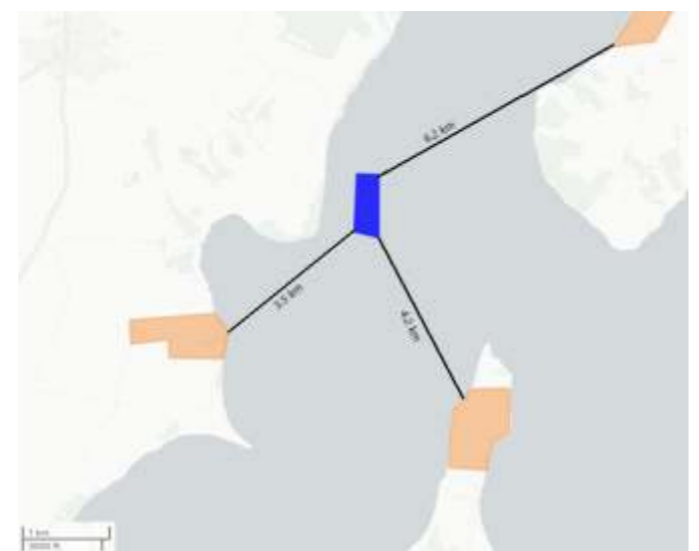


Locations of mussel farms in BONUS OPTIMUS project

LIMFJORDEN (DENMARK)

The Limfjorden is a eutrophic estuary system in northern Denmark where full-scale production modes are being tested to assess yield potentials (i.e. nutrient extraction) and associated operational costs, in order to optimise unit-area production of mitigation mussels. Therefore, optimal materials, production processes and configurations are being tested. Preliminary production results demonstrate considerable differences in yields based on practices and technologies. For example, optimization of longline configurations yielded approx. 1300t of mussels per model farm, while nets demonstrated yields exceeding 3000t per model farm.



Summerhouse area (orange) adjacent to the mussel farm (blue) in Limfjorden

MOLLOSÜND, TJÄRNÖ AND UDDEVALLA (SWEDEN)

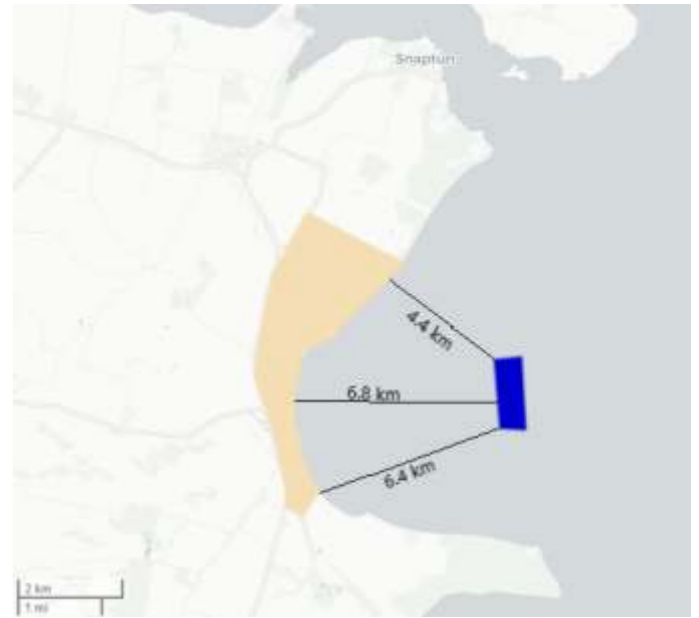
The area represents the most intensively farmed area in Sweden. To help farmers identify the optimal time to deploy their farm lines, a monitoring method for mussel larvae recruitment was developed. Growth data on a high number of sites along the Swedish coast were used to evaluate the potential of predictive modelling to provide spatial data for the use in site selection of mussel farms. Moreover, the environmental impacts of the benthic environment by studying the sediment biogeochemistry and fluxes between sediment and the overlying water using high technological research equipment are investigated. In ongoing studies, the dynamics of eider duck populations and their interaction with existing mussel farms during the last 10-20 years are analysed and new methods (i.e. physical exclusion using nets in combination with boat chasing to prevent predation) are tested to reduce the economic losses due to predation by eider ducks in an ethical sustainable way.

SOUTHERN KATTEGAT NEAR HORSENS FJORD (DENMARK)

An existing offshore mitigation mussel farm in association with fish farms near Horsens Fjord, is used as a test-farm for documentation of the mussel recruitment and biomass yield potential in the area. Preliminary results from the test-farm have shown that the most successful settlement occurs in the autumn, which compared to other areas in Denmark e.g. the Limfjorden, normally occurs in spring. This increases the risk of loss of mussel biomass due to ice cover in sheltered waters, and predation by eider ducks. Harvesting the mitigation mussels before the first post-settlement winter is not possible due to low total mussel biomass and hence, also a low nutrient removal potential. Thus, in areas with autumn spat fall, mitigation mussels will be harvested, at the earliest, in the following spring to ensure sufficient nutrient removal, but at the same time increases the risk of loss of mussels.

Location	Coordinates	Size	Type	Owner	Intended for	Kind of business	Harvest yield
Mollösund, Tjärnö and Uddevalla (Sweden)	58,07458 11,491925	0.0224 km ²	Long line	Scanfjord Mollösund AB	Human consumption	Full business	About 150 tonnes
Southern Kattegat near Horsens Fjord (Denmark)	55,778966 10,077974	0.2439 km ²	Smart farm	Hjarnø Havbrug	Nutrient remediation	Additional business	Low/no harvest since eiders have eaten the mussels
Limfjorden (Denmark)	56,670742 9,127841	0.2187 km ²	Smart farm + Long line	Wittrup Seafood A/S	Human consumption	Full business	About 400-500 tonnes
Hagensche Wiek and Wieker Bodden (Germany)	54,318124 13,625936	0.0025 km ²	Long line	Leibniz Institute for Baltic Sea Research Warnemünde (IOW)	Nutrient remediation	Research farm	About 1 tonnes

Details about the used mussel farms in BONUS OPTIMUS project



Summerhouse area (orange) adjacent to the mussel farm (blue) near Horsens Fjord



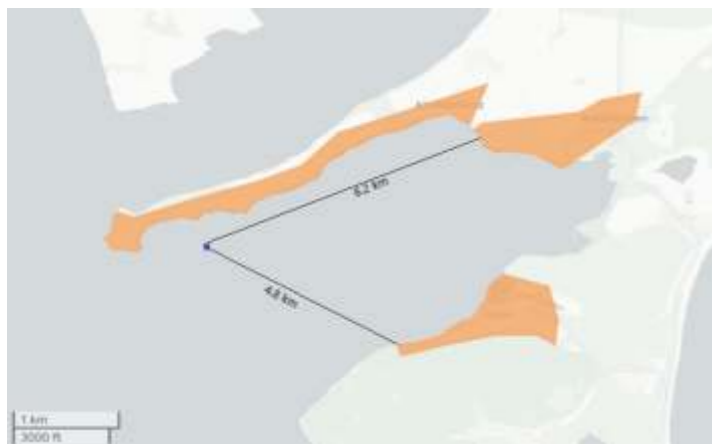
RESEARCH AT MUSSEL MITIGATION FARMS IN THE BALTIC SEA

ABOUT BONUS OPTIMUS: OPTIMIZATION OF MUSSEL MITIGATION CULTURES FOR FISH FEED IN THE BALTIC SEA

The BONUS OPTIMUS project aims to provide robust evidence-based documentation (ecological, social, and economic) on optimized use of farmed mussel. The mussels are used as a mitigation tool for eutrophication that in turn can be a sustainable protein-rich feedstuff for fish. The project has partners from Denmark, Germany, Poland and Sweden and is supported financially by the BONUS programme and national funds. The project runs from 2017 to 2020.

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Summerhouse area (orange) adjacent to the mussel farm (blue) in Hagensche Wiek

HAGENSCHÉ WIEK AND WIEKER BODDEN (GERMANY)

Two small scale mussel farms were established in low salinity waters (6-10 PSU) in 2017 to analyse the mussel growth and mitigation potential. During the study period, larvae occurrence, settling densities, mussel growth and environmental parameters such as salinity, temperature and chlorophyll concentration are being recorded. Additionally, biannual sediment samples show impacts of the mussel accumulation on organic content and life underneath the farm. The mussel settlement was successful at both sites with no significant negative effect been visible below the farm so far.



MUSSEL FARMING POTENTIAL IN THE BALTIC SEA

Due to low salinity, harsh weather conditions with ice cover during winter together with low regional interest for mussel products, the development of mussel farming has so far been prevented.

To unlock this potential, the ecosystem services of mussel mitigation farming have to be documented and efficient farming practices have to be developed for Baltic conditions. Equally important is the need for spatial planning tools which take all interests from within the coastal zone into account. They shall include predictions of optimal sites for both mussel production and the need for nutrient removal as well as indicators for where mussel farming can be integrated into the coastal zone with local acceptance.

A major challenge facing the Baltic coastal zone is the effect of excess nutrient loads from land causing undesired phenomena such as oxygen depletion, algal blooms and degeneration of the coastal environment. Despite many efforts from the Baltic countries and the implementation of the EU Water Framework Directive, Baltic coastal waters have generally not yet reached good ecological status.

MUSSEL FARMING FOR MITIGATION OF NUTRIENT LOADING

Blue mussel aquaculture is an example of a blue growth potential that will not add to the pressure on the Baltic ecosystem but in contrast has the potential to mitigate some of the effects of excess nutrient loads. Nutrients lost from land and incorporated into microalgae are ingested by the mussels through filtration of the water. When the mussels are harvested, nutrients are brought back to land. In addition, mussel filtration increases water transparency. Combined with an increasing demand for the valuable protein source, blue mussels can be used for both human consumption and as a feed ingredient.

BONUS OPTIMUS aims at contributing to solutions in order for mussel farming to become an important activity in the Baltic.

