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WORKSHOP REPORT

Mussel sizes matter: elucidating science facts and finding a way forward together

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Mussel sizes matter: elucidating science facts and finding a way forward together

Date: 15. November 2023 at 09.00-10.30

Moderated by Efthalia Arvaniti SUBMARINER Network

Speakers: Nardine Stybel (EUCC-DE, Germany); Anne Stald Møllmann (Ocean Havhoest, Denmark); Marie Maar & Andreas Holbach (Aarhus University); Peter Krost (Coastal Research & Management, Germany)

How do we use marine space and how do we assess production efficiency in farming? How do we compare social, economic and environmental implications over scale?

Consequently, how can we increase mussel production and meet Mission Ocean targets by 2030, needs clear evidence to enable both proper maritime spatial planning (MSP), increase social license to operate and finally de-risk investments?

Short description:

The aim of the workshop was to analyse state of play in the Western Baltic of mussel farming, a form of low trophic aquaculture, analysing impacts and system capacities to scale up farming, concerning environmental and socio-economic dimensions. During the workshop, we developed relevant targets for Mission Ocean 2030, and suggest concrete actions for mission deployment, including recommendations for R&D needs for mussel production.

Mussels are a known biological marine water cleaning device and also an excellent biomass source of animal protein in food, feed and other product market applications. Farming mussels has a good potential to scale up in the Baltic Sea for food and non-food applications, however the dimensions of both harvested mussels but also the size of farms especially in coastal settings, have been points of discussion and dispute, especially in Denmark. In this workshop **we invited five key experts from Denmark and Germany addressing environmental, economic, market perspectives, and social acceptance perspectives of mussel farming sizing and siting in Western and Central Baltic.**

Background info: To date, commercial mussel farming activities is mature in Northern Denmark in Limfjord area, where local climate and geography have created the right conditions for mussels to grow fast enough and in sizes larger that 4.5 cm, which are then harvested by boats, and sold in supermarkets. However Danish Government, following concerns in aquaculture expansion in the area, they have set a country-wide moratorium for issuing new mussel licenses since 2021. In other regions of Denmark and in the Baltic, mussel farming is practiced in pilot, demo or semi-commercial scales. Germany has licensed one farm so far, while in Sweden there are a few farms both at East, West, and South Sweden.

Session 1: Social acceptance and to how to improve it

Nardine Stybel (EUCC-DE) presented her published paper on "Mussel farm location in the Baltic sea – Community acceptance or distrust"[1].The work presented was on social acceptance of mussel farming, based on interviews with 450 residents in total in two coastal towns in Germany and Denmark, of which more than 200 were aged between 50-69. Results have shown that social acceptance for mussel farming can drop because of visible disturbance of farm facilities to the environment and these are related to site-specific conditions and social attachments to the location. However, it was also found that results of reduced social acceptance for mussel farming was associated mainly with concerns of residents regarding other forms of aquaculture, mainly fish farming, or other forms of industrial developments owned by non-local companies. About 10 years ago, environmental NGOs were positive about mussel farming, but it was criticised that negative attitude started because of coupling of mussel farming to fish farming in multitrophic regimes.

As recommendations, to increase acceptance of mussel farming in an area, firstly it can help if government and industry can raise awareness of mussel farming benefits, also as early as possible they actively communicate with and involve local communities and society, so they all understand socio-cultural particularities of a location, and ideally adapt the design, planning or management of a facility if needed. Farm size was not investigated as a factor for rating social acceptance, although choices, e.g. technology or site selections that reduce visual disturbance of residents, but also means to control and also communicate impacts of mussel farming can improve social acceptance.

Anne Stald Møllmann (Ocean Havhoest, Denmark) presented their ground-breaking work in Denmark in the last 3 years where they are engaging and coordinating dozens of small local coastal communities in Denmark that developing small regenerative farms of mussels and seaweed. In this way, citizens develop a sense of community around mussels, mussel farming, and the coast, and they produce in their community sea gardens and harvest blue food products. With the new Cool Blue Nordic project (EMFAF), Ocean Harvest will develop new business models to expand to more mussel community gardens in Denmark, and transfer good practice to other Scandinavian and Baltic states. Although the prime interest of Ocean Harvest lies in small farming, the definition of a small farm was yet to be defined.

Session 2: Basin scale modelling of ecosystem services and impacts by suspended mussel culture

Marie Maar (Aarhus University) presented their work on ecosystem service benefits from mussel farming along with the trade-offs applied in two sea-basins in Denmark in Limfjord canal and in Horsens Fjord. For this, results from a stakeholder survey showed "no consensus" on stakeholders' perception on nutrient mitigation effects of mussel farming, which is reflecting the confusion on the topic, and also the biggest perceived trade-offs of mussel farming that was 1) competition for space (addressed in first and final session), and also 2) local pollution in sediments. Furthermore, results from 3D ecosystem modelling and remote sensing compared a baseline in which 62 existing mussel farms in Limfjornen with the scenario where farms increased to 82 (so 20 more developed). In this scenario metrics like chlorophyl a (eutrophication factor) and benthic biomass increased, while water clarity but also oxygen would increase. These results are in direct contrast to dominating public opinion that oxygen is depleted under a Baltic farm. Furthermore, models on net Nitrogen nutrient flux were shown as a marker of environmental pollution. Nitrogen flux can

1 https://doi.org/10.1016/j.ocecoaman.2022.106144

decrease because of filtration of particulate nutrients by mussels, which are then removed by the system by mussel harvesting. However, Nitrogen flux can increase as a result of releasing mussel droppings on the benth under the farm. The modelling results showed that the net flux of Nitrogen can increase locally under a farm, and the bigger the farm the higher the net flux increase, which is a fact known and well documented, but when they also analysed fluxes at a sea basin level, the picture is reversed and a net flux decrease of nutrients load is observed. This means that at sea basic macro-level mussel farming removed nitrogen from the eutrophicated system, thus highlighting that we don't see the full picture if we only look below the farm. For now, Marie is trying to communicate their results via meetings with the Danish and European EPA as well as fishery authorities, mainly to restore trust to mussel farming as a positive bioremediation solution to remove the nutrient load from eutrophied marine waters in addition to production of food rich in protein. For future, it was suggested that to improve access to scientific findings to restore misconceptions and enable data-driven decision making, such results should be presented in audio-visual formats suitable to regulators, but also to society.

Session 3: On the feasibility of mussel meal production for pet feed in the Baltic Sea

Peter Krost (Coastal Research & Management, Germany) presented their work under Baltic MUPPETS project, where the entrepreneurs perspective was scoped, by assessing the socio-economic and market needs in regard to mussels for pet-food markets and ecosystem service applications. In his presentation Peter presented business models with cost break down & prices for both Western and Central Baltic, where harvest and down-stream market applications differ. It is roughly estimated that in Western Baltic conditions, 67% of harvested mussels (tonnage) are >4.5 cm in size and they can be easily sold to food market applications, while 33% of harvest is undersized (<4.5 cm), mussels cannot be sold easily as food, but these mussels could be used in feed applications, e.g. petfood (dog and cat). For the reference, meat vs. shell does not change with size. From interviews with pet food industry customers, the minimum annual tonnage of small mussel meal was estimated to be 200T per year mussel meal (dry weight) that is equivalent to 4kT small mussel wet weight (i.e. harvest of meat plus shells). While this mussel harvest is relatively large for a single farm, several neighbouring farms could potentially cooperate annual to supply a single buyer contract. In conclusion, preliminary economic and market analysis showed a new potential business model scenario for use of undersized mussels in pet food applications in Western Baltic conditions, and provide to the farm some extra income, yet depending on price of fish meal, which is the price reference point.

The scenario for Central Baltic was also analysed for 100% undersized mussels aimed for use, in pet food applications and not for human consumption, but it was less not economic sustainable, especially because of high production and harvesting costs. As conclusion, if neighbouring farms get organised, they can share the harvesting costs, e.g. one logistics company harvests multiple farms, then the farm could get profitable, due to less staff and no boat. Finally, to date there is no income associated for nutrient mitigation services (bioremediation) of mussel farms, similar to agriculture, since there are no any nutrient mitigation accounting system leading to verification of green claims and compensation measures.

Session 4: Mussel mitigation farming: scalability and nutrient removal capacity under different placement scenarios

Andreas Holbach (Aarhus University) presented their published results from MUMIPRO and BONUS OPTIMUS on optimal siting and scaling up of mussel "mitigation" farms, considering environmental and technical and social capacities. A mussel mitigation farm is

as a specific type of farm, designed mainly for reducing the nutrient load in the Western Baltic, and not for production of food for human consumption. Environmental and planning authorities, entrepreneurs (farmers, other users), and local society often have interest perspectives, e.g. success indicators and impact factors, that they do not share, as for example how we define area efficiency; if we ask local society and environmental NGOs, they wish to spread the farms (less intensive activity), while mussel farmers prioritise economy and technical efficiency, thud focusing on production capacities. As a result, both environmental and technical, and socio-economic factors play an important role in decision making in optimal farm siting and sizing, and overlaying such perspectives is often a complex and time-consuming task to find optimal solution. As a good practice, Andreas presented the MYTIGATE online modelling tool for optimal site selection in Western Baltic area, that develops customised scenarios considering farm setup, site selection, and stakeholder conflicts, that are accessible to everybody. In one such a customised scenario, they demonstrated that to extract the target nitrogen loads for good ecological status, then small areas as low as 3.6% of areas with high mitigation potential can host mitigation farms (of 18.8 ha with 90 km collector substrate in loops with 2m depth-range). In this way, decision makers can prioritize areas (e.g. by mitigation requirement) and criteria (e.g. area usage) to identify a suitable set of different setups of mitigation farms, other mitigation measures, and enough space left for additional utilization of marine areas.

Targets and recommendations:

Current state of play and targets for 2030

Mussel Farms	Danish farms (Western Baltic)	German farms (Western Baltic)	Swedish farms in Western Baltic	Swedish farms in Central Baltic
Current situation 2023	45 mussel farms (ca. 8kT)	1 mussel farm	xxx farms in West Sweden	6 mussel farms in the Baltic; 2 new farms in South Sweden
Expected by 2030 (target)	100-120 mussel farms (100kT)	3 mussel farms (more if faster licensing)	Xx Future farms	2 new farms in the Baltic with together 2,000t/y

Recommendations for future action points:

- to increase acceptance of mussel farming in an area,
  - government and industry should raise awareness of mussel farming benefits, AND
  - involve also local communities and society, in the design, planning or management of a facility.
  - choose technologies or site selections that reduce visual disturbance of residents.
  - improve access to scientific findings to restore misconceptions and enable data-driven decision making, such results should be presented in audio-visual formats suitable to regulators, but also to society.

- to meet market demand without creating large size farms, several neighbouring farms could potentially cooperate annual to supply a single buyer contract. In this way, neighbouring farms can also get organised, and share the harvesting costs, e.g. one logistics company harvests multiple farms, then the farm could get profitable, due to less staff and no boat.
- to increase mitigation potential of mussel farming and manage competition for marine space, decision makers could prioritize the use of marine areas and set criteria to identify suitable setups for mussel mitigation farms, other mitigation measures, and also leave enough space for additional utilization of marine areas.