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EXPERIENCE WITH ON-BOTTOM MUSSEL CULTURE IN LOW TIDAL AREAS: THE LIMFJORDEN CASE STUDY

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Introduction

On-bottom culture of blue mussels (*Mytilus edulis*) is the dominant aquaculture of mussels in North European countries like the Netherlands, Germany, Ireland and the UK (Capelle 2017). Areas allocated to mussel production in these countries are characterized by high tidal amplitude creating strong horizontal water velocity, thus ensuring advection of food to the production areas, and benthic conditions suited for mussel production. Mussel production areas in Danish coastal waters are characterized by low tidal amplitude, i.e. <0.3 m, but are on the other hand heavily eutrofied with often muddy bottoms. Fisheries on wild stocks or long-line off-bottom farming accordingly dominate mussel production in Danish waters. There is, however, a wish to increase on-bottom mussel production for several reasons: 1) Due to predicted increased productivity of relayed mussels, it is assumed that on-bottom culture will result in less area affected by the mussel dredge and is thus from a management point of view important; 2) By relaying mussels from areas affected by oxygen depletion, resources that would otherwise have been lost are utilized; 3) Relay of mussels for on-bottom culture can secure a stable source of biomass for the fishing fleet and 4) as a potential mitigation tool for removing nutrients back to land from the eutrophied system. It is the purpose of this study to evaluate possibilities and problems for an increased on-bottom mussel aquaculture production of blue mussels in Danish coastal waters.

Materials and methods

The study took place in the Limfjorden, which is the main mussel production area in Denmark. Basis of the investigations are analysis of data sampled in relation to relay carried out by the mussel fishery industry association "Foreningen MuslingeErhvervet (FME)" using their mussel relay vessel "Limfjorden". Ordinary relay activities carried out by FME in the period 2005-15 were analysed for efficiency by comparing relayed biomass with fished biomass from culture plots in the sub-basin Kaas Bredning. In order to explain results of the overall analysis of efficiency of the FME relay activities, a number of experiments were carried out in two other sub-basins. In Løgstør Bredning and Venø Bugt, the relay areas were surveyed before relay, after relay and prior to the fisheries using sidescan sonar mapping and benthic sampling by diver. The mussel biomass variation and size distribution were analysed accordingly. Finally, a dedicated experiment was conducted with the aim to test the effects of relay on survival and growth of mussels transferred from areas potentially affected by oxygen depletion. Mussels from another sub-basin Thisted Bredning were dredged at deeper waters exposed to emerging oxygen depletion and relayed at shallow waters with no signs of oxygen depletion. Samples were taken both before and after relay and analysed for mussel biomass and size distribution.

Results and discussion

The results from the various experiments data analyses indicate that the ratio of gross biomass of relayed to harvested mussels on the relay plots varied from 1:0.1 to 1:4 but was in general close to 1:1 for net biomass, indicating no clear increase in biomass, thus not so promising. In some on-bottom culture beds, density dependence effects could be observed, but the main issue remains the starfish predation. In some plots, while there was a net increase in mussel biomass over time, none was left at harvesting time due to the predation pressure. In other plots where mussels had been transferred from zones of potential mass mortality due to oxygen depletion to shallower areas in the same basin, starfish predation also reduced the final harvested biomass. The mussels survived well the transfer from deep to shallow areas and grew individually, however, frequent monitoring of the relay plots is important in order to exploit mussel biomass prior to starfish predation.

The key challenges to develop an efficient on-bottom culture production in Danish coastal areas is to: a) reduce/avoid starfish predation, b) secure relay before oxygen depletion events during the summer period, c) limit costs associated to relay, d) avoid density dependence effects. Net biomass from on-bottom culture do not seem encouraging, although, with new relaying plots outside zone with high starfish predation pressure, more information regarding environmental conditions and mussel biomass ratio might bring a new representation. More, on-bottom culture might not bring a net biomass increase and thus not be an efficient mitigation tool, but it might be seen as a management strategy to a) reduce the impact of mussel dredge while searching for fishing on commercial size mussel beds, b) save the mussel seeds from zones with predation pressure or with frequent oxygen depletion events and c) keep a safe mussel plot for the fishermen when commercial size mussel beds are scarce.