Area-intensive bottom culture production of blue mussels, Mytilus edulis (L.)

The conflict between blue mussel, Mytilus edulis (Linnaeus, 1758), exploitation and other interest groups due to ecological effects of the fishery, was described ten years ago, and still exists today. To reduce the ecological effects and the conflicts between conservation and exploitation it is therefore necessary to focus on area-intensive production methods for mussel exploitation. For that purpose bottom culture production of blue mussels is relevant. Despite a long tradition for bottom culturing in Europe, the method is still dependent on natural conditions, such as recruitment, food availability and predation. The major constraints for development of the production method is lack of recruitment to sustain the seed mussel source, and conflicts with nature conservation interests due to negative effects of dredging. The aim of the present PhD project was, therefore, to study how thorough insights in biological mechanisms can be used as a tool to develop and optimize bottom culture production methods. The study was addressed through the following questions: 1) How can the seed mussel source in bottom culturing be supported? 2) How can survival of mussels in bottom culturing be improved? And 3) How does bottom culture practice support an area-intensive exploitation of blue mussels? To answer the questions four experimental studies were conducted.

Results from a laboratory- and a manipulated field experiment showed that blue mussels collected on suspended long line cultures in the water column have the potential to become an alternative seed source for mussel production in bottom cultures. When compared to mussels collected from natural benthic mussel beds, suspended mussels had an active predator response by developing a significantly stronger attachment to the substrate and having a more pronounced aggregation behaviour. Bottom mussels exhibited a passive strategy by developing a thicker shell and larger relative size of the posterior adductor muscle. When comparing the performance of suspended and bottom seed mussels on complex and smooth substrates, respectively, originally suspended mussels aggregated significantly more than bottom originated mussels on smooth substrates. This indicated that suspended mussels are better in achieving the protection provided by group living compared to bottom mussels, since more aggregated mussels are more protected against predators. Thus, it is concluded that the use of suspended mussels in bottom culture production supplement, and possibly, secure the seed source in future blue mussel production in intensive bottom cultures.

From two manipulated field experiments it was concluded that substrate complexity stabilizes the structure of the mussel bed on micro-scale (<1 m) resulting in an achievement of protection faster than without applying shell substrate to the seabed. On complex substrate, mussels have the protection from predators right after transplantation, due to more spatial refuges, in contrast to on smooth substrate where mussels need to aggregate to achieve the same protection. The stabilization is expressed by increased byssal strength and reduced aggregation activity within the mussels and is resulting in higher survival. However, the increased protection provided by the higher complexity also result in a trade-off between increased survival and reduced growth and lower condition index for the individual mussel. The production output was generally higher on complex substrate than on smooth substrate and it was therefore concluded that an increased substrate complexity has the potential to improve survival of mussels in bottom culture beds. Nevertheless, due to the trade-off between survival and growth, the degree of complexity is important in the planning of culture beds to secure that the reduction in growth and condition index do not eliminate the increased survival of the mussels.

To achieve a smaller impacted area, prerequisites concerning robust bed structures and seeding densities needs to be fulfilled. In a case study it was concluded that production of blue mussels in bottom cultures support an area-intensive exploitation, with offset in Danish production practices. The robust structure and the seeding density of 3.5 kg m-2 support an area-intensive exploitation of blue mussels in the case area. On micro-scale (>100 m) it can be documented that macrostructure of the individual culture bed was similar to the original transplantation tracks established the year before. This indicates that bottom cultures can form robust structures, not affected by wave- or current induced transport. Seeding density of 1.5 and 3.5 kg m-2 and the position of the individual mussel in the culture bed apparently did not adversely affect shell growth, suggesting that there was no detectable food limitation between transplantation tracks. Production of blue mussels in bottom culture beds may impact a smaller area compared to fishery on full-grown mussels from natural mussel beds, and can support an area-intensive production if the biomass/production ratio is higher than 0.5