Mussel Farming to combat eutrophication in the Baltic Sea

Statement of the German Federal Environment Agency

Blue mussels *Mytilus edulis* (photo Wera Leujak)

The role of bivalves in ecosystem

Filter-feeding mussels can be regarded as keystone species in aquatic ecosystems since they fulfil a number of key functions. Firstly, they are powerful biofilters and can regulate phytoplankton populations by grazing. Secondly, they play an important role in nutrient recycling by coupling the water column to the benthos ("benthic-pelagic coupling"). Thirdly, mussels are an important component of the structural matrix (mussel beds). Given these key roles in ecosystems any biomanipulation of bivalve populations must be exercised with great care.

Culturing mussels for nutrient removal

Mussel farming has positive impacts on marine ecosystems through nutrient removal, but also negative impacts through the concentration and accumulation of organic matter (faeces, pseudofaeces, dead mussels) on the bottom that decomposes under oxygen consumption. Well-oxygenated sediments can be regarded as a prerequisite for positive ecosystem effects of bivalves. Anoxic sediments recycle and release nitrogen and phosphorous as well as NOx as a potent greenhouse gas. They lead to impacts on the benthic fauna and in cases where hazardous substances are stored in the sediments these can be released under anoxia. To avoid anoxic sediments mussel stocking densities should not exceed the carrying capacity of the local ecosystem. Well-flushed sites have higher carrying capacities but are at the same time not the sites with most severe eutrophication problems. Furthermore, in order to combat eutrophication mussels must be cultivated at eutrophication hotspots. These hotspots are very often already characterised by anoxic sediments and mussel cultivation at such sites will exacerbate anoxia.

Given the above described negative environmental effects of mussel farming and based on the current state of knowledge the Federal Environment Agency is against using large-scale mussel farming to combat eutrophication problems in the Baltic Sea. Following the precautionary principle, nutrient inputs must be remediated at source or as close to the source as possible. Mussel farming to combat eutrophication is an "end-of-pipe" solution that sets the wrong incentives. In addition, large-scale mussel farming constitutes an ecosystem manipulation whose impacts on marine ecosystems are currently difficult to judge.

Nutrient trading
Advocators of mussel farming often call for nutrient trading regimes as an incentive to promote mussel farming. The Federal Environment Agency is against nutrient trading since there is the danger that it exacerbates or creates localised eutrophication hotspots (due to the fact that nutrients are not uniformly mixed and measures will be carried out where they are cheapest and conditions for cultivation are most favourable and not where eutrophication hotspots are situated). Nutrient trading thereby contravenes the Water Framework Directive and the Marine Strategy Framework Directive that both demand that a "good status" of surface / coastal waters is achieved or maintained and that deterioration is prevented.

Integrated aquaculture
While the Federal Environment Agency is against using mussel cultivation to combat coastal eutrophication it promotes using bivalve biofilters in integrated aquaculture, since there locally introduced nutrients are also locally mediated. Integrated aquaculture could be supported by certification (e.g. Aquaculture Stewardship Council) and by voluntary codes of good practice.

Outlook
With respect to research on mussel cultivation to combat eutrophication the Federal Environment Agency points to the fact that most field studies have not sufficiently considered negative ecosystem effects. Future research should in particular aim at gaining an understanding whether ecosystem benefits of mussel farming potentially outweigh localised negative effects and what the prerequisites (farming techniques, site conditions etc.) for ecosystem benefits are.

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