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Enhancement of mussel culture by artificial upwelling of nutrient-rich deep water in fjords

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Some of the most productive and successful mussel farming areas worldwide are based on nutrient enrichment from natural coastal upwelling. Several simulated or small-scale enrichment experiments using deep water point at the economic potential of developing artificial upwelling for shellfish culture. The project FJORDCULT (1998-2000) analyzed the potential and possible bottlenecks to enhance primary production using artificial upwelling in fjords. Simulation studies showed that primary production in fjords could be enhanced by a 3-4 fold scale, and because of higher silicate content of the deep water, the artificial upwelling tends to stimulate diatom more than flagellate growth. Based on long-term hydro-physical and -chemical studies and model simulations in Lysefjorden, east of Stavanger, the inner part of this fjord was proposed to be suited for a full-scale experiment. In April 2004 artificial upwelling was established using a vertically mounted pipe with an electrical pump to force brackish surface water at a rate of 2 m^3 s-1 down to 30 m depth. The submerged brackish water will mix with the more saline deep water and due to buoyancy it will rice towards the surface at a rate of about 30 m^3 s-1. The intrusion layer is calculated to be between 0 and 10 m depth, and the expected influence area is in a scale of 3 km^2 (5–10% of total fjord area). This paper will present preliminary results from this first attempt to conduct a large-scale experiment using submerged brackish water discharged in a controlled manner to force artificial upwelling.

Keywords: artificial upwelling, nutrients, mussel farming

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Kinetics of depuration of hydrocarbons by mussels (*Mytilus edulis*)

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Shellfish cultivation is vulnerable to the impacts of hydrocarbons from both acute short-term events (accidents/spills) and also longer-term chronic effects of waste discharges. Polycylclic aromatic hydrocarbons (PAH) are particularly important in this context, in that they can be accumulated by shellfish and impart taint to them. Some PAH compounds are also known carcinogens, giving rise to a potential risk to consumers.

Loch Leven, Scotland had received discharges containing PAH compounds from an aluminium smelter for most of the last century. Blue mussels (*Mytilus edulis*) in the loch accumulated relatively high concentrations of a wide range of PAH compounds. A series of experiments have been carried out in which mussels were transferred from a shellfish farm in Loch Leven to a non-impacted sea loch, and also into a laboratory tank system. The kinetics of PAH depuration of in mussel tissues was investigated over a period of three months. The mussels showed a rapid loss of total PAH, such that the concentration decreased from 7564 ng g^{-1} on transfer in February 2000 to 179 ng g^{-1} in May 2000. Comparisons are made of the kinetics of loss of a range of parent and branched PAH (2- to 6-ring) compounds.

The discharge of smelter waste into Loch Leven has subsequently ceased, and concentrations in mussels from the area are not significant risk to consumers.

Keywords: mussels, PAH, depuration.

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