Effects of fish farm effluents on epiphytic algae and faunal community associated with *Laminaria hyperborea*

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Production of fin-fish is a major industry in Norway, with more than 1.3 million tons produced in 2017, a 3-fold increase over the last 15 years. This rapid expansion has resulted in a significant restructuring of the industry, including increased farm sizes (from 3-5000 tons up to 14 000 tons) and relocation of farms from quiescent fjords to dynamic and exposed areas along the coast. It is well known that discharges (i.e. particulate and dissolved effluents) from intensive fish farming in net cages alters the structure and functioning of benthic communities, although this knowledge is restricted to soft bottom habitats. Impacts to other habitats (i.e. hard-bottom habitats) along the Norwegian coast have been poorly studied.

Laminaria hyperborea is the dominating kelp species at exposed hard-bottom sites along the Norwegian coast, forming forests that are estimated to cover an area larger than 10 000 km^2. Kelp forests are biodiversity hotspots much due to their structural complexity, and serve key functions in the ecosystem by providing refuge, habitat, nursery grounds and feeding grounds for more than a hundred marine faunal species, including seabirds and economically important fish such as Atlantic cod (*Gadus morhua*) and saithe (*Pollachius virens*).

It is hypothesized that increased loading of available nutrients could stimulate the growth of fast-growing epiphytic macroalgae and bryozoans on the lamina, which could negatively influence the kelp through decreasing total surface area available for nutrient uptake and light interception necessary to conduct photosynthesis. Stimulation of fast-growing macroalgae species on the stipe may lead to changes in the epiphytic community structure and reduce the habitat complexity. The holdfasts of *L. hyperborea* have been proposed as a eutrophication-indicator, as excess nutrients may motivate the presence of opportunistic species, and alter the faunal composition.

To assess the potential effects of fish farm effluents on *L. hyperborea* forests, 6 different fish farms were chosen: 3 at the beginning of the production cycle (had a low fish biomass and therefore low effluent load), and 3 at the end of the production cycle (high fish biomass and high effluent load), in addition to 6 reference locations. Lamina and stipe data were collected from 10 individual plants from each location, while holdfast data was collected from 3 individual plants from each location. Total epiphytic biomass of algae and % cover of bryozoans were assessed for the lamina, while epiphytic algae growing on the stipe were identified and weighed to assess changes in community structure. Holdfast macrofauna (>500 μm) was identified and counted to assess shifts in community composition and to evaluate the potential as an indicator-unit. Several parameters were modelled or sampled, and used to explain observed patterns, including wave exposure, current velocity, plant age, kelp density along transect, amount of fish feed used at fish farm sites and distance to nearest farm.

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