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DEGREE: Philosophiae Doctor
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DEPARTMENT: Department of Biosciences
AREA OF EXPERTISE: Marine Biology
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DATE OF DISPUTATION: 19th of June 2019

DISSERTATION TITLE: *Effects of fish farm effluents on kelp forest ecosystems: kelp performance, associated species, and habitats*

SUMMARY:

Production of salmonid fish in open sea cages results in the release of waste products to the marine environment. These waste products include nutrients and chemicals. Both could impact the health status of kelp forests along our coastline, as Barbro Taraldset Haugland's PhD thesis has shown. She has studied two of the most common kelp species in Norway, the sugar kelp and the cuvie kelp.

In a laboratory experiment, Barbro found that low doses of the debated sea lice therapeutant hydrogen peroxide resulted in the disintegration of small sugar kelp plants. A dilution down to 5% of the dose that is commonly used in the salmon cages – the treatment dose – and emitted to the environment, proved to be deadly. The treatment dose will dilute fast in the sea, but an unfortunate combination of wind- and current directions could result in harmful hydrogen peroxide concentrations reaching nearby sugar kelp forests.

The nutrients emitted from fish cages could be an extra resource of food for marine plants and animals. Barbro's thesis indicates that kelp cannot benefit from these extra nutrients. By collecting monthly measurements over one year, she found that the growth of young sugar kelp plants did not change when growing next to fish farms.

The cuvie kelp thrives where there are strong waves and currents. Here, it forms dense underwater forests which are an important part of the coastal ecosystem. The fouling (epiphytic) community on cuvie kelp is an important part of the forest, and a large variation in the amount of epiphytes can be found from plant to plant. Both the cuvie kelp and the

epiphytic community is used as shelter by small fish and amphipods, and as hunting grounds by cod, saithe and sea birds.

Kelp are perennial plants, for example, the cuvie kelp can reach more than 18 years of age. In nature, it is often the fastest growing organisms with short life spans that are best at benefitting from extra food, such as the epiphytic community on kelp. By collecting cuvie kelp from several places around the islands Frøya and Smøla, Barbro showed that cuvie plants growing nearby salmon farms had a different and less varied epiphytic community. Though these changes were small, they could have an impact on the animals living in the kelp forest.

Other parts of the kelp forest showed no obvious changes due to the release of waste products from fish farming. This is good news for the kelp forest, and suggests that the cuvie kelp is resilient to the current production of farmed fish in this area.

The work was carried out at the Institute of Marine Research in Bergen.