NOTVASK

Biofouling is a challenge for salmon aquaculture worldwide. The unwanted growth of marine organisms such as mussels, algae, and hydroids on nets and other structures can impact hydrodynamics in and around the cage, increase risk of diseases, and lead to behavioural impacts to cleaner fish (used as biological control against salmon lice). Biofouling is commonly controlled by a combination of antifouling coatings on nets and in-situ high-pressure cleaning of nets. However, high -pressure net cleaning can negatively impact fish health and welfare and leads to abrasion of the net coating, reducing its efficacy. To support the sustainable growth of salmon aquaculture, novel net cleaning technology is needed.

Figure 1: Setup for the conduction of net cleaning experiments where biofouling cleaning waste was collected.

AIM

To develop new knowledge, technology and operational methods for the cleaning of biofouled nets. Novel cleaning technology should improve the cleaning efficacy while reducing the cleaning frequency, abrasion of the coating, energy and time consumption, and the release of particles.

The project was conducted by a consortium consisting of Brynsløkken AS, PSO AS, Lerow AS, Mowi ASA, Sperre AS, and SINTEF Ocean.

Data collected in a survey among 51 Mowi site managers provided a good overview of the biofouling situation in Norway, indicating similar biofouling related challenges for most sites. The main driver for biofouling management was the use of cleaner fish. Furthermore, many sites

reported that net cleaning does impact the fish and that feeding regimes are often adjusted in response, confirming the need to improve cleaning practices.

As potential alternative technologies for net cleaning, low-pressure, cavitation-, and suction-based cleaning were assessed in field tests and compared to high-pressure cleaning. Cavitation cleaning reduced the damage to the antifouling coating to a maximum of 10% - a nine-fold improvement over high-pressure cleaning while having similar (and at times higher) efficacy as high -pressure cleaning. In comparison, low-pressure cleaning had a significantly lower cleaning efficacy while still having a considerable impact on coating integrity. Suction cleaning was not able to remove sufficient biofouling from the test samples. Thus, this study identifies cavitation cleaning as promising technology for biofouling control on aquaculture nets that has the potential to provide efficient net cleaning while considerably reducing damage to antifouling coatings and subsequent contamination of the environment.

The feasibility of cavitation cleaning as alternative to high-pressure cleaning was assessed in a cost-benefit analysis, taking into account the performance results from the field tests as well as information regarding energy consumption, technical requirements and potential impacts on the fish and other organisms in the surrounding area. The results indicate that cavitation cleaning has the potential to reduce energy consumption by 50% while offering similar cleaning performance as high-pressure cleaners. Since reduced abrasiveness will protect the coating's longevity and likely reduce cleaning frequency, cavitation cleaning could make net cleaning more sustainable. Further assessments of this technology, including tests of larger prototypes, should be conducted.

Based on the collected information, the project identified three future biofouling management strategies.

- **Strategy 1** is based on an efficient biocidal antifouling product that eliminates the need for all net cleaning. Thus, negative impacts on fish health and potential environmental pollution associated with the release of cleaning waste are prevented. A coating for this strategy should be a highly efficient yet environmentally benign biocide that allows good leaching control.
- **Strategy 2** acknowledges the difficulty of developing an omnipotent biocide and therefore combines a good antifouling product with intermittent net cleaning. By relying on a robust antifouling material combined with gentle net cleaning, the abrasion of the antifouling surface can be reduced, keeping its functionality intact and enabling long intervals between cleaning events. Ideally, cleaning waste should be collected to further prevent impacts on the fish and the environment.
- **Strategy 3** is based on regular grooming of the net without the use of antifouling. By cleaning the net at an interval shorter than the growth cycle of biofouling organisms, the build-up of a mature biofouling community is prevented, and the released cleaning waste should be limited to harmless particles. Using nets with protective coatings that facilitate biofouling removal may further support the success of this strategy.

While these strategies are partly applicable today, a focused research and development effort is needed to implement the strategies with their individual benefits to their full extent.

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