BIM EMFAF Work Programme Project Report 2022

BENEFICIARY: Bord Iascaigh Mhara
PROJECT REFERENCE NUMBER: 22/KGS/STS-BG010-BR053
NAME OF PROJECT: **Marine Challenge**
IMPLEMENTATION PERIOD: 1st January to 31st December 2022

Project Scope

The increasing occurrence and threat from phytoplankton and zooplankton have been felt by the Irish aquaculture sector. Harmful plankton can result in symptoms ranging from suboptimal growth through to increased mortalities and present a credible threat in the marine environment. In 2020 and 2021 elevated levels of mortality were recorded from the southwest to the northwest coast of Ireland.

It was established under previous EMFF projects that treatments using desalinated water are effective against gill infections. This project seeks to build on that success and trial other environmentally benign, cost-effective methods that can further enhance fish welfare and support the profitability of the sector.

Using the current method, a desalination treatment is resource intensive, from a financial, equipment and human resource perspective. The reason for this is that large quantities of water need to be moved via well-boat and more recently via tow-bag. This also necessitates having a large pumping capacity onsite along with additional equipment such as dewatering stations. The current process also involves pumping the fish using specially modified pumps. It is accepted that this pumping creates additional stress for fish. To overcome some of these challenges BIM utilising EMFF monies successfully developed a freshwater snorkel that supported a reduced salinity lens, permanently available in the pen. This was based on the principle that lower water volumes can be used to attain this lowered salinity thereby enhancing the cost efficiency and carbon footprint of this technique. The system was successful in a 50m test pen at the Marine Institute test site at Lehenagh Pool. In 2023 this system was trialled on a commercial site. The project was coordinated and supervised by BIM staff both in head office and on-site. One salmon company was involved in the trials.

Phytoplankton and zooplankton can also cause physical damage to fish gills and skin. The integrity of these surface layers are essential for healthy fish and having both surface layers uncompromised will result in improved growth rates, reduced food conversion ratios and reduce the length of time these fish take to reach harvest. In addition, the presence of large numbers of phytoplankton or zooplankton can result in oxygen depletion within the environment of the aquaculture site. This adds further stress, and the results are reduced feeding rates and increased times to harvest.

Currently, the action of logging chlorophyll-a and other water quality parameters such as oxygen and turbidity is not routinely performed on more than a daily basis. Furthermore, in relation to chlorophyll-a there has been no validation of this data using real time samples collected manually or automatically in order to precisely determine the causative organisms should any fish welfare issues arise. The education of site operatives is paramount to current early identification of harmful planktonic species.

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The oceanic environment is changing but the sequences are typically cyclical and many events such as algal blooms can be forecast based on prevailing wind, sea state, temperatures, and season. It is now time to optimise on the sensors being supplied to sites by the BIM sensor array. This will provide advance warning on monitored sites and enable fish welfare decisions to be made in a timely manner.

The freshwater trial sought to establish if a freshwater lens contained within a commercial salmon pen can retain the low salinity levels previously achieved in 50m pens. Pending initial findings regarding the salinity attained we then planned to test if the system could effectively remediate against the signs and symptoms of AGD under commercial conditions. We deployed a flexible, strengthened, impermeable, bottomless structure within a salmon cage to test this approach. To that structure we added desalinated water that remains on the surface due the differences in density. The plan was then to establish any changes in the gill health and whether or not this continuing access to freshwater has an impact on AGD gill scores in a commercial setting.

The phytoplankton project involved the deployment of multiple real time data logging sensors. When thresholds in water quality are exceeded, alarms are activated and email, SMS, text alerts sent.

BIM also sought to develop and refine site specific remediation systems based on new technology and the adaption of existing technology. The remediation systems developed and deployed will utilise knowledge from the real time sensors for activation in order to reduce costs and energy consumption.

The use of non-physical barriers such as bubbles were further validated. These were refined throughout 2022 to deal with the wave and current conditions found in Ireland. These air barriers reduced the abundance and likelihood of harmful algae and zooplankton coming into contact with salmon, damaging gills and skin. Reducing these impacts will improve gill health and reduce exterior infection. This will improve fish welfare and enable better growth rates, reducing time at sea thereby improving profitability.

Objectives

- To maximise the efficacy of biological treatment methods.
- To reduce the costs associated with current freshwater treatments, in relation to boats, generators and staff.
- To reduce the impacts on fish health by reducing the number of times fish are moved by pump.
- To reduce the impacts of AGD by enabling fish to 'self-treat' by the use freshwater that is always available.
- To investigate the effects of this lens of sea lice abundance on Atlantic salmon.
- To develop a network of water quality sensors in order to assist with the early detection of harmful organisms.
- Increase knowledge of water quality around the coast particularly in relation to aquaculture sites.
- To test bubble curtains particularly in relation to commercial effectiveness and running cost.

Outcomes

A commercial scale freshwater snorkel was designed and built. This 38m circumference snorkel was deployed within a 126m circumference salmon pen. The snorkel had a total volume of 678m^3 which represents about 5% of the cage volume. The snorkel was designed to allow the use of fixed flotation or an inflatable collar. The inflatable collar is particularly useful as it allowed the snorkel to be easily transported and deployed. For this trial we used fixed flotation. This fixed flotation is a closed cell foam that provides non-compressible flotation unlike the inflatable collar. The snorkel has a weighted lower outer perimeter to ensure the snorkel maintains the optimum shape and depth.

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In previous trials we found a 5% ratio of snorkel to pen adequate to derive positive operational welfare indicators. We opted to deploy similar ratio flow rates as derived from our test trials in previous years and successfully achieved low salinity at an input rate of 9 litres per second. This resulted in the establishment of a salinity of less than 5 parts per thousand at a depth of 4m. This depth is equal to 66% of the snorkel volume.

It was found that the use of fixed flotation resulted in a rugged flotation system that could easily be moved by crane without puncturing. It also allowed the snorkel to be positioned at any location within the pen and fixed there whilst the flotation collar needed topped up. As a result, the flotation needed to be placed near the walkway to allow access to the inflation valves. The snorkel was also built with lifting rings along its outside, this enabled the snorkel depth to range from 1m to 6m by using rope tied onto the lower perimeter edge. This allowed the snorkel to be raised in the event that water quality or fish welfare parameters necessitated.

The snorkel worked very effectively in this trial. However, we failed to take account of the increased buoyancy differential in the much larger commercial snorkel. At a volume of 678m^3, we estimated this lift to be in the region on 2000kg. This buoyancy combined with the inadequacy of the lower perimeter weight resulted in the snorkel lower edge and walls being up ended and exposed to wind 4 weeks after deployment. The design specification did not account for these forces and as such the snorkel was damaged. The snorkel has now been amended to ensure those events described above can no longer take place. The unseasonably dry summer prevented the snorkel from being deployed in June and July after its redesign. As such, we were unable to obtain sufficient information in respect of gill health, operational welfare indicators and lice abundance.

A bubble curtain was successfully deployed under Irish environmental conditions. A suitable site was selected. Examples of the selection criteria included the presence of fish onsite over the trial period (April until November 2022), the presence of a strong tidal stream, access to the test site on a daily basis and the presence of a remote data sensor offshore. The bubble curtain required many assets to be in action over the course of the trial. These included generators, air compressors, dryers and receivers. The above assets enable the required ISO standard compressed air to be delivered to a custom designed bubble tubing network placed around the farm. Peak airflow produced by the system was approximately 2000m^3/hour. In this trial deployment the system was designed to be placed 24.5m outside the perimeter of the farm grid, however, due to the size of the pens (90m circumference vs 126m circumference), the system was redesigned by the deployment team in communication with the commercial trial partner and deployed directly below the grid at a depth of 17m.

The bubble curtain was assembled and deployed in April with plant commissioning and testing also taking place. In respect of the plant, we concluded that the generator needed to be run for approximately 15 minutes prior to the compressors being switch on. We also established that there needed to be a 15-minute interval between each compressor being activated. This resulted in a total activation time of 60 minutes.

During initial equipment tests we started up the generator and all three compressors in a short time window. This often resulted in connections being blown and sections of the curtain not working. This was particularly apparent if the equipment has been off for a period of 2 or more days. We ascertained that during this 48-hour period the bubble tubing and associated pipework would fill with water. When all compressors were activated the force of the air combined with the reduced volume (as a result of the water ingress) would create areas of very high pressure resulting in clamps coming loose. By activating the compressors sequentially, we purged all the water from the bubble tubing without blowing any connections.

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The cost of running a bubble curtain for 6 months continuously would render the project unfeasible from a commercial perspective. A critical component determining the future commercial success of the project was the real time data sensor situated approximately 1 nautical mile from the test site. The sensor array allowed us to monitor water quality variables such as chlorophyll a, oxygen and temperature in order to determine when the bubble curtain should be activated. The sensor system was alarmed, and email alerts were sent to the project participants as an advanced warning system. The alarm thresholds were set based on local information relating to past activity in the area and known acceptable limits for Atlantic Salmon.

Data sensor readings were calibrated with physical sample collection at the sensor, full speciation and enumeration took place. In addition, there were 4 plankton sampling locations at the bubble curtain, 2 inside the curtain and 2 outside. Discrete sampling for quantitative analysis took place at 2 depths (2m and 7m) using a Van dorn water sampler. Vertical hauls using a 53micron and 200micron mesh were also obtained at each sample location. Sampling took place every three days during bubble curtain operation.

The effectiveness of the bubble curtain was largely contingent on current speed and direction. These findings are site specific and can be used to define better operational parameters for other sites in future. At the end of a strong ebb tide we found that the bubble curtain removed between 20 and 40% of the target species at 2m. This reduction was less pronounced at 7m where the difference was generally less than 20%. When the tide was flooding, we found the bubble curtain to work much more effectively with 80 to 95% reductions in target species of phytoplankton at 2m. We found very similar results at 7m indicating that the bubble curtain was having a significant impact on the phytoplankton community.

In relation to large zooplankton such as jellyfish, we learned from operation welfare indicator collection that the trapping of compass jellyfish within the bubble curtain did not result in damage to the salmon skin or gills as would have been expected if the nematocysts had come into contact with these organs.

Project findings are invaluable in the design and implementation of future bubble curtain deployments as we recognised that the air feed lines were prone to kinking, even when the curtain was activated. This resulted in reduced airflow to bubble curtain segments and in some cases, no flow at all. Our monitoring revealed that when one or more segment was down, results indicated no reduction in phytoplankton community or their abundance. The use of flexible pipe as the air feed line resulted in significant effort from the commercial partner. A rigid pipe feeding air to the segments should greatly reduce this requirement and permit greater operational efficiency of the bubble curtain and the staff on site.

Veterinary reports in addition to operational welfare indicator reporting and phytoplankton reports are available separately.

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Summary of Project Spend

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Total Approved Costs	€575,000
Total Eligible Expenditure	€573,787
EMFAF Eligible Expenditure	€286,893
Exchequer	€286,893

Report by: Geoff Robinson

Date: February 2023