COMPLETED PROJECT CASE STUDY

EFFICACY & WELFARE IMPLICATIONS OF THERMAL DELOUSING IN SCOTTISH SALMONID AQUACULTURE

PARTNERS

Mowi Scotland, University of the West of Scotland, Scottish Sea Farms, Bakkafrost Scotland (formerly Scottish Salmon Company), University of Aberdeen

AUTHORS

Prof. Brian Quinn, Dr Josip Barisic, Dr Herve Migaud, Ralph Bickerdike, Prof. Sam Martin, Dave Cockerill

BACKGROUND

Sea lice are native parasites of concern to both farmed and wild Atlantic salmon populations, feeding on skin and blood and potentially leading to disease spread and physical damage. Although sea lice do not directly cause diseases, their presence can exacerbate disease spread and severity by causing stress, immune suppression, and serving as vectors for pathogens. Effective management strategies are essential to mitigate these negative impacts. Traditional methods for controlling sea lice include chemical treatments, moulting inhibitors, and introducing natural predators of sea lice to cohabit with the farmed fish.

Thermal delousing, which involves exposing fish to heated water for a short period to remove sea lice, has gained traction as a non-medicinal, environmentally friendly alternative, effectively reducing lice burdens by 75-100%. The process uses only heated water and does not release therapeutics into the marine environment.

Despite these benefits, concerns about the potential welfare implications of thermal delousing have been raised, primarily based on laboratory studies in Norway that did not reflect commercial farm conditions. This project is the first to investigate the effects of thermal delousing on fish health and welfare under commercial aquaculture conditions for both salmon and cleaner fish.

During this collaboration, the lead commercial partner was Mowi Scotland, with the University of the West of Scotland acting as the lead academic partner. Other participating organisations include Bakkafrost Scotland (formerly Scottish Salmon Company), Scottish Sea Farms, and the University of Aberdeen.

AIMS

The study aimed to address ethical concerns by evaluating the welfare implications of thermal delousing under commercial conditions. The specific objectives were to:

1. Review existing fish welfare considerations and mitigation measures for thermal delousing in comparison with other approaches to controlling sea lice;
2. Evaluate the health and welfare of farmed salmon and cleaner fish at various stages of thermal delousing, identifying relevant improvements;
3. Conduct a welfare benefit analysis for thermal delousing as part of an integrated sea lice management strategy in Scottish aquaculture;
4. Identify the most effective thermal delousing procedures in terms of lice removal and cost efficiency;
5. Provide recommendations and best practice protocols to improve and optimise thermal delousing in Scottish aquaculture.

PROJECT OVERVIEW

The project was divided into four phases, or work packages, each focusing on different aspects of thermal delousing.

WORK PACKAGE 1: DATA MINING

This phase involved analysing anonymised historical data from industry partners between 2018 and 2021. This data included site and pen number, treatment date, mortality rate pre- and post-treatment, gross gill scores for pre-treatment amoebic gill disease (AGD) and proliferative gill disease (PGD), ambient temperature and the change in temperature between ambient and heated seawater used for each pen treatment. The objective was to investigate the effects of different Thermolicer treatments and interventions on salmon health and mortality rates using different Thermolicer instruments. (Currently used in all major salmon-producing countries, the Thermolicer is a technology developed in Norway for non-medicinal treatment to remove sea lice from farmed salmon.)

WORK PACKAGE 2: FIELD SAMPLING AND CLINICAL ASSESSMENT

In total, the consortium partners examined and sampled 1,155 fish from three companies at multiple stages: before crowding, during crowding, pre- and post-thermal immersion, and post-treatment at 24 hours, 48 hours, seven days, and 14 days. The aim was to pinpoint where in the treatment process any potential impact on fish health and welfare occurred. Gill samples were collected for PCR analysis, and histopathology samples were taken from the gills, skin and muscles, liver and kidneys to assess tissue changes. Additionally, the team developed a questionnaire to evaluate environmental, group and individual Operational Welfare Indicators (OWIs) during the procedures to build a view of the general health conditions of the fish population.

WORK PACKAGE 3: ANALYSIS OF SAMPLES

Samples from the second work package were analysed for health and welfare indicators using clinical chemistry, PCR, and histopathology methods. Each blood sample was assessed across 18 biomarkers to interpret the function of various organs and tissues, such as gills, liver, kidneys, and pancreas. Meanwhile, researchers extracted RNA from gill samples to evaluate inflammation markers using quantitative PCR.

WORK PACKAGE 4: STATISTICAL AND WELFARE BENEFIT ANALYSIS

This final phase included statistical and welfare benefit analyses to develop recommendations for improving fish welfare during thermal delousing.

RESULTS

Consortium partners completed the evaluation of fish health at various stages throughout the delousing process, and a welfare benefit analysis.

In the mortality analysis within the first work package, a significant increase in mortality post-treatment was revealed, with a mean 14-day percentage increase of 0.0293%. However, this varied among Thermolicers, with increases ranging from 0.01% to 0.46%. While investigating the relationship between fish weight and post-treatment mortality, Thermolicer #1 (of 6) showed a significant correlation between average fish weight and mortality, indicating that as fish weight decreases, mortality after treatment slightly increases. Conversely, morality decreases between pre- and post-treatment by 0.000006924 units for every 1 gram increase in fish weight. However, this relationship was not present with the other Thermolicers. Across all Thermolicer instruments, there was no significant correlation between fish weight, delta water temperature, and pre-treatment health conditions with mortality rates.

Within the clinical chemistry and biomarker analysis of the second, third and fourth work packages, 18 clinical chemistry biomarkers were measured, showing significant changes in calcium, chlorine, and magnesium levels immediately and 24 hours post-intervention, indicating temporary gill function impairment. These levels returned to normal within seven days. Other indicators, such as albumin and lactate, also showed temporary changes indicating impact to the liver or kidneys. However, recovery was observed within 48 hours to seven days. Despite some muscle tissue irritation and temporary gill function impairment, no long-term adverse effects were found. PCR analysis showed changes in inflammation-related gene expression, but these were not consistent enough to suggest significant gill inflammation. Histopathology indicated minor tissue changes, such as epidermal erosion and scale loss, but no significant long-term damage.

The project team also completed a review of existing mitigating measures in the context of other sea lice controls, which will be included in an upcoming complete peer-reviewed research publication.

IMPACT

This project significantly advanced the understanding of the welfare impacts of thermal delousing in commercial aquaculture. Despite some observed short-term adverse effects, the overall impact on fish welfare was temporary and reversible. The project demonstrated that thermal delousing is an effective method of sea lice removal with manageable welfare implications when properly conducted.

Key recommendations include an integrated sea lice management strategy, development of best practice protocols, continuous monitoring and continued research to refine techniques, considering seasonal variations and pre-treatment health of fish.

Thermal delousing represents a promising non-medicinal approach to managing sea lice in Scottish salmonid aquaculture. The project highlighted its effectiveness and short-term welfare impacts, reinforcing its potential as a valuable tool in sustainable aquaculture practices. While further research is needed to optimise the process, the current findings support the continued use and improvement of thermal delousing to enhance fish welfare and farm productivity.