COMPLETED PROJECT CASE STUDY

DEVELOPMENT AND VALIDATION OF WELFARE INDICATORS FOR LUMPFISH IN SCOTTISH SALMON FARMING

PARTNERS

Institute of Aquaculture (University of Stirling) | Fish Vet Group | FAI Aquaculture (now FAI Farms) | Ardtoe Marine Research Facility (then part of FAI Aquaculture) | Bakkafrost Scotland (formerly Scottish Salmon Company) | Scottish Sea Farms | Cooke Aquaculture

PROJECT LEADS

Prof. Sonia Rey Planellas, Dr Bruce McAdam, Beth Appleyard, and Jim Treasurer

BACKGROUND

Lumpfish (*Cyclopterus lumpus*) is a semi-pelagic species known for its distinctive ventral adhesive disc that allows it to cling to surfaces. Lumpfish have often been deployed as cleaner fish in salmon aquaculture to control sea lice, on which they feed. However, key welfare challenges remain to be solved. Survival rates are an ongoing concern, underscoring the need for targeted welfare assessment tools. Ensuring lumpfish health and welfare in salmon farms is vital to enhancing the survival rates and delousing efficiency of this cleaner fish species.

Operational Welfare Indicators (OWIs), such as body condition factor and fin damage scoring, are widely used in salmon farming but have not yet been fully developed or validated for lumpfish. This project aimed to create and validate lumpfish-specific OWIs to improve animal welfare, reduce mortality, and increase the productivity of cleaner fish within Scottish salmon farms. It was one of the first studies to develop welfare indices for lumpfish.

AIMS

The goal of this project was to enhance the survival and welfare of lumpfish in Scottish aquaculture through a detailed evaluation of health and disease challenges across different life stages.

Two primary objectives guided the work:

1. To conduct a 24-month epidemiological study examining trends in significant disease challenges affecting lumpfish, from hatchery through sea pen deployment, including critical phases such as first feeding, transportation, overwintering, and second season;
2. To develop and validate OWIs specific to lumpfish, enabling practical and effective welfare assessments in both hatcheries and sea pens.

OVERVIEW

The project was divided into two work packages linked to the two objectives. The first work package focused on gathering data on the lumpfish in the hatchery and at sea. The project team monitored lumpfish over five months under standard hatchery conditions. Daily and weekly observations included environmental parameters (e.g., dissolved oxygen, temperature, pH, salinity, ammonia, nitrites, nitrates) and performance indicators such as mortality, fin damage (dorsal, caudal, basal), growth, and detailed morphometrics (length, width, height, weight). Behavioural data were recorded and analysed using cameras installed before fish arrival to avoid disturbance.

Fin condition was assessed, and suckers were measured for deformities and attachment ability. Tissue samples from larvae, juveniles, and larger fish (>10g) were collected for histopathology and a healthy tissue bank, stored at the Institute of Aquaculture for future analysis.

During sea cage deployment, a standardised monthly sampling protocol was applied across participating salmon farms. Workshops were held with each farm partner to demonstrate protocols, and training material was developed (e.g. educational videos). Fish were sampled from at least three pens per site and assessed for morphometrics, fin damage, external abnormalities (e.g., malformations, cataracts, infections), and internal condition (liver colour, hepatosomatic index, stomach content). Tissues were also taken for histopathology when necessary.

The second work package focused on analysing and assessing the collected samples against several welfare indicators, such as weight-length relationship (WLR), dorsal and caudal fin damage, lipid content, and fatty acid profile, among others.

RESULTS

The project successfully developed and validated several OWIs for lumpfish:

1. A fin damage key for dorsal and caudal fins;
2. A weight-length relationship (WLR) growth index;
3. A liver colour index (based on Eliassen 2017), validated in multiple studies.

A fin damage index and scoring key were created and validated, enabling consistent assessment of fin condition in both hatchery and sea pen environments. Histological analysis supported the correlation between fin damage and tissue vulnerability to bacterial infection. These findings helped link potentially stress-inducing management procedures – such as grading, transport, and vaccination – to changes in fish condition, growth, and mortality.

Behavioural monitoring, fin scoring, and morphometric data were used to correlate growth patterns with welfare status. A new growth curve was developed to reflect the actual growth dynamics of lumpfish, offering a tool for detecting early deviations that could compromise welfare and production outcomes.

The liver colour index showed potential as a welfare and nutritional status indicator, with correlations observed between liver colour, fin condition, hepatosomatic index, and overall health. Ongoing analysis aims to inform diet development tailored to lumpfish needs, thereby improving survival and sea lice removal efficiency.

Mortality data collected from sea pens indicated seasonal patterns, with higher mortality linked to warmer summer conditions, providing a basis for further environmental risk analysis.

Sampling protocols and training materials were shared with industry partners. OWIs such as the fin damage key are now actively used at the FAI Aquaculture and Aultbea hatcheries (Aultbea was part of FAI Aquaculture at the time of the study) and in sea pens across partner sites.

IMPACT

This project laid the foundation for standardised welfare monitoring in lumpfish aquaculture. Behavioural insights led to improved hatchery enrichment strategies that reduce aggression and increase survival in early life stages. Evaluation of hatchery practices, including grading and vaccination, resulted in best practice recommendations shared with farm staff.

The project also created communication channels between salmon farmers, encouraging knowledge exchange and greater collaboration. The use of shared sampling protocols and OWIs helped unify practices across companies and improved on-farm decision-making.

Dissemination activities included conference presentations, academic publications (a book chapter and review on lumpfish welfare), and presentations by MSc students involved in the project. Engagement with stakeholders such as the RSPCA has opened discussions on integrating OWIs into formal certification schemes.

By developing practical tools, protocols, and training materials, this project has significantly advanced the sustainable integration of lumpfish into salmon farming, with lasting benefits for animal welfare and farm productivity.

FURTHER READING

See also: Establishing a sustainable supply and optimal deployment of lumpsuckers