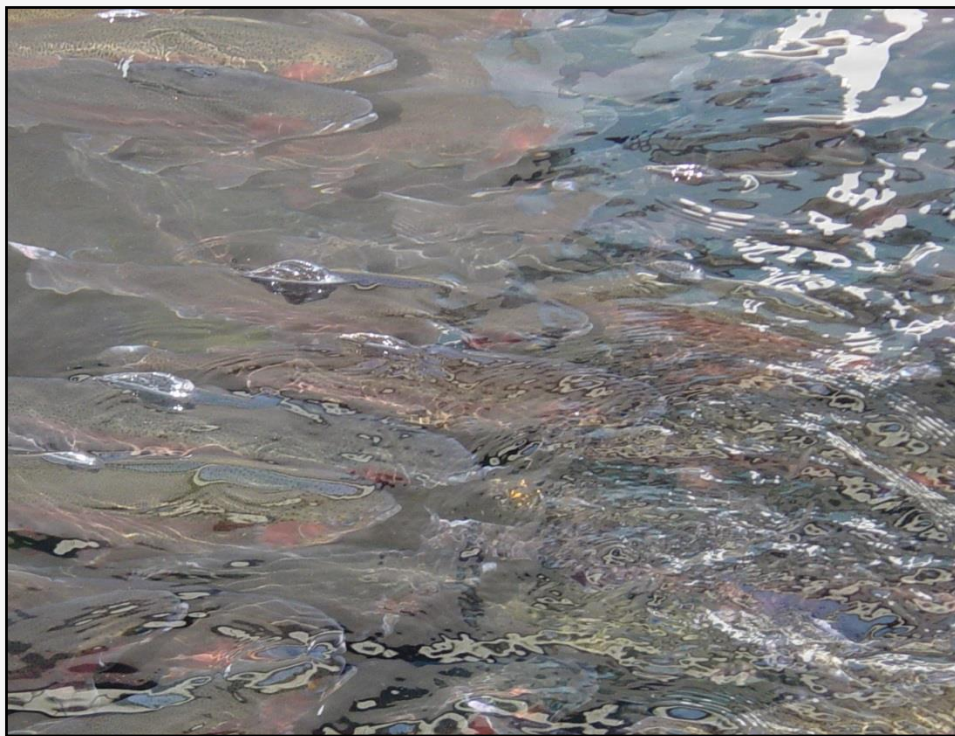


# FISHWELL welfare indicator toolboxes for farmed salmon and rainbow trout

The recently completed FISHWELL project has produced two handbooks which synthesise the scientific information on the welfare of farmed Atlantic salmon and rainbow trout. The information is then used to assemble a toolbox of welfare indicators for various production systems and husbandry operations.



*Farmed rainbow trout © J. F. Turnbull*

Atlantic salmon and rainbow trout dominate farm animal production in Norway and are key aquaculture species in many other countries. There is increasing interest in their health and welfare from a wide range of stakeholders including the R&D community.

The objectives of fish welfare research are to understand what good and bad fish welfare is and to find practical ways to protect it. This involves discovering what the fish needs, how it experiences its environment and how we can improve farming practices to give fish a life worth living.

A key research area in recent years has been identifying and quantifying the tools that stakeholders can use to measure and assess fish welfare, which are termed Welfare Indicators. These indicators can be measured on the farm (Operational Welfare Indicators, OWIs) or require samples to be taken at the farm and sent to a laboratory for further analysis (Laboratory-based Welfare Indicators, LABWIs). A huge number of OWIs and LABWIs have been developed over the years and this number is rapidly expanding as we increase our knowledge of fish welfare and also embrace the benefits of digitalization the measurement and analysis of OWIs and LABWIs.

However, no single indicator is good enough to tell you whether all the welfare needs of the fish have been met, and there is no “one-size-fits-all” answer. We therefore need welfare indicator ‘toolboxes’ to assess fish welfare. These toolboxes need to be refined and adapted to the species, farming system, husbandry processes and life stage of the fish.

Assembling OWI toolboxes for each farmed species can be challenging, even when we have a wide range of scientific literature to utilise. In late 2015, scientists from Nofima, the Institute of Marine Research (IMR), the Norwegian Veterinary Institute (NVI), Nord University (NU) in Norway and the University of Stirling in the UK started a project, FISHWELL to address this challenge. The project aimed to collate our knowledge of the welfare of Atlantic salmon and rainbow trout in aquaculture and use this knowledge to develop fit-for-purpose OWI toolboxes for differing rearing systems and farming operations. The project was financed by the Norwegian Seafood Research Fund (FHF) and received just over 9 million NOK in research funding.

Handbooks outlining the latest knowledge on the welfare of Atlantic salmon and tailor made OWI toolboxes for assessing their welfare were first released in 2017 and 2018 (Norwegian and English language versions, with an updated Norwegian version released in 2018). Corresponding handbooks for farmed rainbow trout have now been released in both languages (see [www.nofima.no/fishwell/english](http://www.nofima.no/fishwell/english) for salmon and <https://nofima.no/fishwell/trout/> for trout).

“Our aims when we started the project were to review, evaluate and clarify the suitability of differing existing and emerging welfare indicators for assessing the welfare of farmed salmon and trout. We wanted to link welfare indicators to what we know regarding the welfare needs of each species, including how these needs change with the fish’s life stage. We then evaluated whether the indicators were suitable for use on the farm, and could be termed OWIs, before assembling tailor made OWI toolboxes for the wide range of production systems and operations that the fish are subjected to throughout their life. This work resulted in the Atlantic salmon handbook that we released in 2018 and the recently completed rainbow trout handbook that we released this month” says Chris Noble, a Senior Scientist

at Nofima who led the project. "The project was wide-ranging, ambitious and detailed, and we ultimately split the work into two, rather than combining it into one large handbook. Each book follows the same format but is species specific, collating knowledge on the welfare of each species and adapting each OWI toolbox accordingly".

Each handbook is split into three parts: Part A addresses the latest state of the art knowledge regarding the welfare of each species, Part B outlines fit-for-purpose OWI toolboxes for differing rearing systems and Part C adapts the same approach for differing husbandry procedures and operations.

### **Updated scientific state of the art for each species**

Part A builds the scientific foundation for the rest of the handbook. For the Atlantic salmon handbook, the work was led by Jonatan Nilsson, Lars H. Stien (IMR) and Martin Iversen (Nord University). For the rainbow trout handbook, Jimmy F. Turnbull (University of Stirling) joined the lead writing team to help refine and adapt the handbook to rainbow trout.

"Part A gives an overview of what we know about fish welfare, outlines what we know about the welfare needs of each species, and conditions that may affect the fulfilment of these needs. As the requirements for fulfilment of needs may vary through life, we have specified the needs for different life stages, where this is suitable" says Jonatan Nilsson, a Scientist at Institute of Marine Research in Norway.

It then breaks down the array of welfare indicators into i) animal-based, direct indicators (outcome-based indicators) that can be applied at the individual or group level, and ii) environment-based indirect indicators (input-based indicators) that are applicable to the environment or resources the fish are subjected to.

It outlines whether these indicators are OWIs or LABWIs, highlights important factors or thresholds to pay attention to and also draws attention to any knowledge gaps that may exist regarding each welfare indicator.

"Whilst there are many similarities between Atlantic salmon and rainbow trout in terms of their welfare needs, there are also many differences in their e.g. responses and behaviour that needed to be addressed in each book" says Associate Professor Martin Iversen at Nord University, Norway.

"Many researchers have worked on farmed fish welfare over the last 3 decades, but this is the first time all of that information has been brought together in an accessible form for farmers, regulators and other stakeholders" says Professor Jimmy F. Turnbull at the University of Stirling, UK.

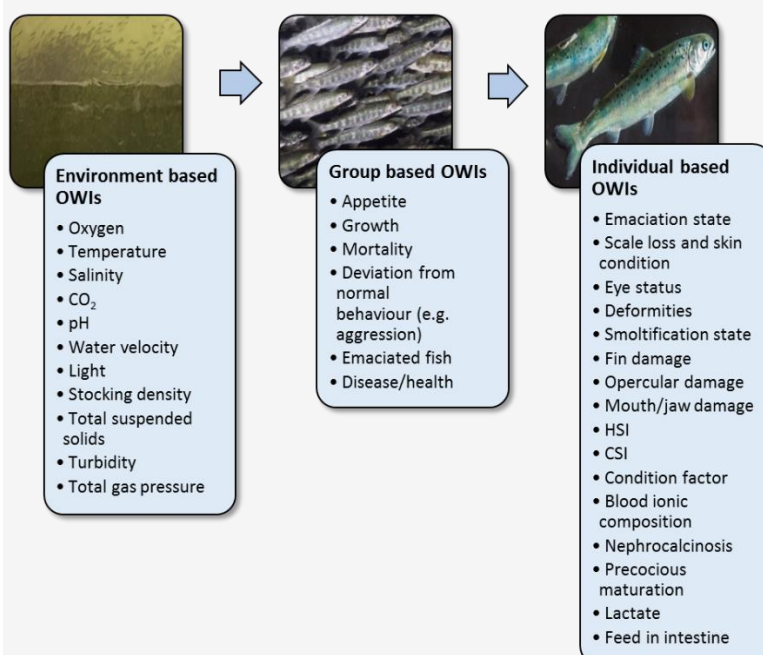
## Fit-for-purpose OWI toolboxes for different rearing systems

The in-depth foundational work of Part A is then used in Part B of each handbook to develop fit-for-purpose OWI toolboxes for differing rearing systems. In the Atlantic salmon handbook, Part B addresses seven different production systems including flow-through, RAS, open net cages, submerged cages, snorkel cages, semi-closed containment systems in the sea (S-CCS) and cages fitted with lice skirts. In the rainbow trout handbook, we outline OWI toolboxes for flow through and net cage production systems as these systems currently dominate trout production in Norway.

Each chapter outlines appropriate environment, group or individual based OWIs for each system, and also highlights knowledge gaps that need to be addressed in relation to e.g. welfare needs at different life stages, or whether we have enough information on appropriate thresholds or key factors to look for in relation to each OWI.

Work on Part B for Atlantic salmon was led by Jelena Kolarevic (Nofima) and Lars H. Stien (IMR). For the rainbow trout handbook, both Jimmy F. Turnbull (University of Stirling) and Chris Noble joined the lead writing team.

“We tried to make Part B very practical and user friendly. As Chris already mentioned, the aim was to provide the industry and other interested stakeholders with appropriate tools for measuring fish welfare out on the farm. Farmers are often very busy, and we wanted them to get a detailed yet effective overview of the relevant OWIs and LABWIs for their relevant production systems, allowing them to use the handbook more efficiently.” says Jelena Kolarevic, a Nofima scientist.



*Overview of OWIs suitable for flow-through land-based systems, reproduced with permission from the FISHWELL Atlantic salmon handbook.*

## **Fit-for-purpose OWI toolboxes for different husbandry routines and operations**

The final part of the handbook, Part C outlines science based OWI toolboxes for differing husbandry routines and operations, in a similar format to Part B. It includes numerous existing and emerging husbandry operations such as crowding, pumping, grading and mechanical de-licing to name but a few. Each section again outlines the array environment, group or individual based OWIs for each operation, again highlighting any potential knowledge gaps.

Work on Part C for Atlantic salmon was led by Kristine Gismervik (NVI). For the rainbow trout handbook, both Jimmy F. Turnbull (University of Stirling) and Chris Noble again joined the lead writing team.

“Aquaculture is a new industry and highly innovative, in Part C we attempted, not only to provide welfare indicators for existing husbandry practices, but also to provide approaches for new or developing practices.” says Jimmy Turnbull.

## **Reception of the work so far**

The FISHWELL Atlantic salmon handbook has been well received by a wide range of stakeholders both within the aquaculture industry and beyond. It has been published as a free hard copy in Norwegian (1700 copies) and is also available as a free PDF in both Norwegian and English.

“We have developed the OWI toolboxes to primarily help those who regularly handle the fish, such as the farm staff who work with the fish on a daily basis. The toolboxes will hopefully give them a good overview on how to assess the welfare of their fish and help them use the right welfare tools in the right situation. We also hope it is of value for the wider farming community including fish health professionals” says Chris. “These toolboxes are just the start of the process, at this stage all we have done is outline what OWIs are suitable for each rearing system or routine, without saying which indicators are most appropriate or important, or weighing the indicators in terms of the impact upon fish welfare”.

“This has been a very large undertaking and it has provided the foundation for better fish welfare in the aquaculture industry.” says Jimmy.


“The FISHWELL handbooks have also been utilised in the scientific community and are the basis of a new study program at Nord University” says Martin.

“In a follow up project (LAKSVEL), also funded by FHF, we use FISHWELL as a basis to develop a standard protocol for how to assess the welfare of caged salmon. In order to make a rapid but robust welfare evaluation, we need to select the most relevant and operational welfare indicators, and define sample sizes, sampling methods etc. A standard protocol will make it much easier to compare the welfare situation between cages, and also over time within cages” says Jonatan at IMR.

"Already FISHWELL is being used in many if not all parts of the world where salmonids are farmed. However, this is only the start, the foundation laid by FISHWELL has to be built on by industry-academic partnerships to improve the way we farm fish." says Jimmy.

The FISHWELL rainbow trout handbook is out now. See [www.nofima.no/fishwell/english](http://www.nofima.no/fishwell/english) for the salmon handbook and <https://nofima.no/fishwell/trout/> for the trout.

## Welfare Indicators for farmed Atlantic salmon: tools for assessing fish welfare



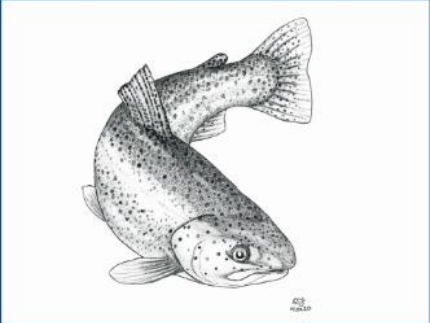
Even in a school, there are individuals. Photo: Lars H. Stien

Edited by Chris Noble, Kristine Gismervik, Martin H. Iversen, Jelena Kolarevic, Jonatan Nilsson, Lars H. Stien and James F. Turnbull

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