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The FRESH project: Animal welfare in modern production systems for fish

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Highly stressful events such as crowding, netting, sorting and transports are common practice in commercial fish farms. In our project FRESH ('Fish REaring and Stress Hazards') we used an integrative approach in order to identify the mechanisms of specific physiological responses which commonly cause detrimental tertiary stress responses (i.e. decreased growth, diseases resistance, and swimming capacity) in farmed fish. We focused on rainbow trout (*Oncorhynchus mykiss*) and Arctic char (*Salvelinus alpinus*), the two main aquaculture species in Sweden. By a combination of studies using novel implantable bio-loggers and biotelemetry systems in commercial fish farm settings, and studies using traditional physiological methodology in the lab, we investigated how the cardiovascular and gastrointestinal system are affected by different stressors induced by common farming practices. The studies included; stress hormones, blood chemistry, gut microbiota, primary barrier functions, metabolism, nutrient uptake, heart disease, circulatory and respiratory effects. Our results demonstrate that the use of implantable bio-loggers opens up a broad range of possible applications that will allow researchers to investigate the effects of environmental and/or anthropogenic stressors on the welfare of fish in scenarios more realistic to the aquaculture industry. Furthermore, our results also clearly show how stress is an integrative physiological response affecting the animal on a range of different ways and how little we know of the complexity of the stress response in fish. With all different studies associated with this project we have only started to unravel the roles of e.g., changes in stress hormones, blood chemistry, gut microbiota, primary barrier functions, metabolism, nutrient uptake, osmoregulation, circulation, heart disease, in the welfare of farmed fish. To complement our results, additional studies are needed to fully understand the importance of all these factors, how they interact and how they are affected by other biotic and abiotic factors in an aquaculture environment.

Keywords: Welfare, bio-loggers, stress, physiology