



**INSTITUTIONEN FÖR BIOLOGI OCH MILJÖVETENSKAP**

## **Fish coping with stress**

Physiology and behaviour of salmonids with focus on stress coping styles, rearing conditions and conservational releases

**Malin Rosengren**

Institutionen för biologi och miljövetenskap  
Naturvetenskapliga fakulteten

Akademisk avhandling för filosofie doktorsexamen i naturvetenskap, inriktning biologi, som med tillstånd från Naturvetenskapliga fakulteten kommer att offentligt försvaras 31 Mars, 2017 kl. 10:00 i föreläsningssalen, Institutionen för Biologi och Miljövetenskap, Medicinaregatan 18A (zoologihuset), Göteborg

ISBN: 978-91-629-0137-0 (PDF)

ISBN: 978-91-629-0138-7 (Print)

# DISSERTATION ABSTRACT

When animals are reared for conservational releases it is paramount to avoid reducing genetic and phenotypic variation over time. Therefore, an understanding of how behavioural and physiological traits affect the performance of an individual both within the captive and the wild environment is required. To preserve threatened populations of salmonids, large numbers of hatchery-raised juveniles are released each year. The captive environment do, however, differ in many aspects from the wild, and the standard hatchery practice, using high animal densities and barren tanks, raise questions concerning stress levels, misdirected selection pressures and a naivety of the released fish when coping with the wild environment.

The overall aim of this thesis is therefore to extend the knowledge-base on stress physiology and behaviour of salmonids with special focus on individual variation, stress coping styles and conservational releases. The objectives are to increase the understanding of how behavioural and physiological traits are related to each other, how they are maintained during juvenile development and how they are modulated by environmental factors like the rearing environment.

The results from the present thesis shows that lowering the animal density and adding structural enrichment to the rearing tanks reduces aggression and stress levels while in captivity, as well as have a positive influence on physiological and phenotypic traits important for survival after release. However, fish reared with in-tank shelter at high densities showed a lower post-release survival during smolt migration. These results highlight the importance of thoroughly examining interaction effects of hatchery alterations before implementation.

Furthermore, salmon showing early emergence from the spawning nest as well as a bold behavioural profile had a lower maximum metabolic rate and aerobic capacity prior to release, compared to those with late emergence and a more cautious behavioural profile. While this may have no clear negative implications for the individual in the hatchery, after release it could result in greater risk of predation caused by higher risk-taking and possible impaired swimming capacity and recovery from exhaustion. These results highlight how the selection pressure might differ between different behavioural profiles and environments.

In rainbow trout, individual variation in systemic cortisol output during stress (HPI-axis reactivity) also had an impact on metabolic rate and on the stress sensitive barrier function of the intestine. HPI-axis reactivity was further linked to other stress related neuronal systems in the forebrain and to behavioural traits.

The findings of this thesis broadens the knowledge-base on stress physiology and behaviour of salmonids and how they are interlinked with and modulated by environmental factors.

In conclusion, the rearing environment, behavioural profile and stress reactivity of an individual will affect its ability to cope with challenges both in captivity and in the wild. There is much to gain in continuing the work on finding hatchery alterations, where a reduced rearing density together with structural enrichment is a promising candidate to implement both increased welfare and post-release performance.