

Environmental influences on the behavioural ecology of juvenile salmonids the importance of rearing density

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Akademisk avhandling

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Dissertation Abstract

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Background and aims: Early environmental conditions are known to influence the phenotypic development of animals, including behavioural alterations. The overall aim of this thesis is to investigate the effects of density, social stability and structural complexity on growth, behaviour, and survival in the wild, using juvenile brown trout (*Salmo trutta*) and Atlantic salmon (*Salmo salar*) as model species. The result can add to the basic knowledge in this research area and can also be used to enhance the welfare and fitness of released hatchery-reared fish.

Methods: In papers II-IV sea-ranched trout and salmon were reared from early life stage in conventional hatchery tanks with modified physical structure and/or density. Hatchery fish were measured for growth, studied for individual and social behaviours, and analysed for fin-erosions and smolt-status. In paper I wild-caught juvenile trout were used for behavioural studies. In papers II-IV fish from different treatment groups were also released in natural streams to investigate treatment effects on survival and growth in the wild.

Results and conclusions: My results collectively show clear positive effects of reduced rearing density, whereas the effects of structure were unclear and harder to interpret. In papers II-IV reduction of conventional hatchery densities generally increased growth rate in the hatchery and post-release survival. Salmonids reared at reduced densities were more dominant in competition for food, consumed more novel prey, escaped faster to refuges after a predator attack and located more food in a maze, compared to fish from higher densities. At time of parr-smolt transformation, salmon reared at reduced densities had less fin erosions and were more fully smolted than salmon reared at higher densities. Taken together, the results presented in this thesis clearly show that reduced rearing densities facilitate the development of adaptive individual and social behaviour in salmonids, resulting in increased growth and survival after release in nature. In paper I wild trout in familiar groups were more vigilant, responded faster to a simulated predator attack and consumed more food compared to trout in unfamiliar groups. These novel results suggest that social stability confer immediate fitness benefits, i.e. higher probability of survival under conditions of high predation risk.

In summary, my results show that conventional rearing methods in supplementary hatcheries do not prepare fish adequately for life in the wild and could be improved considerably, with density reduction as one key factor. Incorporating behavioural aspects in supplementary rearing methods is also important from an ethical point of view. However, there is a limit to what can be accomplished with improving supplementary hatchery rearing methods. Hatchery rearing should therefore be viewed as a complement rather than an alternative to habitat restoration.

Keywords: rearing density, structural complexity, familiarity, antipredator response, limited attention, social status, growth rate, smolt status, fin erosion, post-release performance, hatchery supplementation, brown trout, Atlantic salmon