Life history types and strategies - DTU Orbit (01/04/2019)

**Life history types and strategies: Case studies on brown trout (Salmo trutta) and alewives (Alosa pseudoharengus), involving physiological differences and interspecific interactions**

This thesis consisted of the following manuscripts:

MS IBoel, M., Aarestrup, K., Baktoft, H., Larsen, T., H. Madsen, Malte, Skov, C., S.S., Svendsen, J.C. and Koed, A. The physiological basis of partial migration in the brown trout (Salmo trutta) (manuscript)

MS II Boel, M., Brodersen, J, Koed, A and Post, D.M. Life history differences in alewives (Alosa pseudoharengus) alter the ontogenetic trajectory of juvenile largemouth (Micropterus salmoides) (manuscript)

MS III Boel, M. & Koed, A. Habitat specific avian predation on brown trout (Salmo trutta) (manuscript)

MS IV Boel, M., Aarestrup, K., Koed, A., Baktoft, H. and Skov, C.. Field based evaluation of the effect of 23 mm passive integrated transponder (PIT) tags on the length-mass relationship in wild juvenile brown trout (Salmo trutta) (submitted manuscript: Fisheries Management and Ecology)

The thesis was focused on the life history strategies and types in migratory freshwater fish, using brown trout and alewife as study organisms. Firstly, we investigated underlying mechanisms of resident and migratory life history strategies of salmonids, using indicators for nutritional status, stress, tissue damage and smoltification. Secondly, avian predation pressure on the groups with different life history strategies was explored in their respective habitats. Thirdly, we demonstrated that the life history type of alewives, through regulation of zooplankton availability, influences the ontogeny of concurrent largemouth bass. Finally, a field study approach was used to evaluate the effect of PIT tagging on body condition of brown trout.

Within a salmonid population several life history strategies can be found, each of which involves variations in migration and residency. Migratory life history strategies are often viewed as an adaptive behaviour to optimise the overall lifetime fitness when resources and predation risk varies between habitats. In salmonids, some individuals migrate to seawater (anadromous), others migrate to freshwater habitats such as lakes (potamodromous), while a others may stay behind in the streams and become residents. In MS I, the physiological status of potamodromous and anadromous fish was examined and it was found that these strategies were generally very similar. It was indicated that both potamodromous and anadromous fish were smoltified and in lower nutritional status relative to resident fish. Moreover, it was found that lipid reserves were lower in the potamodromous trout compared with anadromous trout. Lower lipid reserves in potamodromous trout might provide a mechanistic explanation to why this group cease migration at an earlier point compared with anadromous conspecifics.

The lake dwelling trout population in Lake Hald has undergone a rapid decline in recent years. This has coincided with the arrival of cormorants to the area. It is well known that predation may cause substantial losses in fish populations. However quantitative information on the impact of avian predators is relative scarce. In MS III the minimum predation from cormorants and herons was estimated over a three year period on the brown trout population of Lake Hald. The magnitude of the predation pressure from both bird species were very similar and when summed up, the avian predation accounted for an average minimum of 37.2 % of the annual brown trout mortality in the lake and 10.1 % in the tributaries. This result illustrates that avian predation in the lake can be quite substantial and potentially plays an important role in the population dynamics of brown trout. Cormorants alone were responsible 21.2% in the lake and the arrival of these birds to the area are likely to have an important role in the decline in the lake dwelling trout population in Lake Hald. Further it illustrates that individual predation risk is life history specific, i.e. potamodromous brown trout face higher risk of avian predation than resident individuals. However, the total mortality of the resident trout might be underestimated, i.e. the losses in the tributaries estimated by electrofishing surveys were substantially higher than the avian predation suggested, indicating additional predation losses from ex. mink and otter.

Alewives are specialist planktivore fish that profoundly structure the abundance and size of their zooplankton prey. This can influence the ontogenetic development of concurrent juvenile piscivorous fish, e.g. largemouth bass. The structuring effect of alewives varies according to the life history type, i.e. whether they are landlocked or anadromous. Lakes with landlocked alewife have small-bodied zooplankton year-round; lakes with anadromous alewife have zooplankton communities that cycles between large-bodied zooplankton in the winter and spring and small-bodied zooplankton in the summer months; whereas lakes with no alewives have large-bodied zooplankton year-round. In MS II, we show that this influences the ontogeny of largemouth bass. The ontogenetic development of largemouth bass was compared between lakes with landlocked, anadromous and no alewives. In lakes with alewives young-of-the-year largemouth bass had slower growth and slower transition to feeding at higher trophic position, compared with lakes without alewives. Thus, the alewife presence delayed the transition to piscivory in largemouth bass. Moreover, we found that this slowdown of both growth and progression in trophic level was stronger in lakes with landlocked alewives relative to lakes with anadromous alewives. This shows that the life history type of alewives has significant influence the ontogeny of concurrent largemouth bass through regulation of zooplankton availability.

In MS IV the effect of surgically implanted 23 mm PIT tags on juvenile brown trout was evaluated in a field study. The effect of carrying a PIT tag under natural conditions was evaluated during four time periods ranging from 97-328 days. The length to body mass relationship was compared between tagged and concurrently captured untagged trout of comparable sizes. We found no effect of tagging on the length to body mass relationship. This suggests that tagged and untagged fish had managed equally well in the period leading up to the concurrent capture.

**General information**

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Organisations: National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology

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