

NRP Endocrine Disruptors

Final Summary

Original project title Estrogenic endocrine disruption in Switzerland: Assessment of fish exposure and modeling of effects on population level (SAFE I & II)
Project leader Prof. Dr. Patricia Holm
Project number 4050-066568

Estrogenic endocrine disruption in Switzerland

Experts assume that endocrine disruption already left their mark on Swiss ecosystems and have contributed to population changes in wildlife. In this project the occurrence of such effects was studied in brown trout in a selected small Swiss river.

Research questions

This project aimed at determining if disturbances of the estrogenic system do occur in wild brown trout in Switzerland and, if yes, if these might affect trout population status. Therefore, we characterized the estrogenicity of Swiss midland rivers that receive effluents from sewage treatment plant (STP). Next, we performed a set of laboratory and field exposure experiments aiming to elucidate how estrogens affect sexual development and reproductive parameters as estrogen-sensitive targets in the life cycle of brown trout. Subsequently, we tried to assess the potential estrogenic impact under actual field conditions, where estrogenic exposure was just one among many parameters potentially influencing the brown trout population. Finally, we integrated the data into a life-cycle model to estimate the potential population-level effects of (xeno)estrogens in brown trout that are detectable under natural conditions of variability and uncertainty.

Results

We characterized the estrogenicity of 18 Swiss midland rivers that receive effluents from sewage treatment plants, which are in general low. The egg yolk precursor protein, vitellogenin (Vtg), is a sensitive biomarker of estrogenic exposure in male fish and we measured this protein. The incidence of induced vitellogenin in male brown trout plasma at some sites indicated that environmental estrogens pose a local problem to brown trout.

In a laboratory experiment, potential disruptive effects of estrogens on gonadal differentiation of brown trout were analyzed. Embryos did not show similar sensitivity to estrogens after hatch and first feeding compared to related salmonid species. Investigating the sensitivity of brown trout reproduction to long-term exposure to environmentally relevant mixtures of estrogens resulted in several effects at the higher dose only. However, VTG synthesis significantly responded at the low dose exposure as well, confirming its use as a very sensitive biomarker, but not necessarily pointing to corresponding reproductive effects.

Characterization of the wild brown trout population, as well as the habitat parameters and confounding factors in the selected river Lützelurg (TG) upstream and downstream of the STP showed that the influence of estrogenic exposure on the biomass and abundance is low compared to other influences in the environment.

Model results showed that the populations in the Lützelurg are likely to be much more sensitive to changes in survival rates in the first winter and beyond than to early life stage survival or reproductive parameters such as fertilization, fecundity, and age of maturity. It is suggested that it may be quite difficult to detect the primarily reproductive effects of endocrine disruptors by monitoring population-level characteristic. This situation is exacerbated by the significant variability of natural populations and our uncertainty in understanding the controls on their dynamics.

Perspectives

Studies are planned to investigate the impact of estrogens on other physiological processes than reproduction (immune system, growth, stress response). The impact of chemical stressors on susceptibility of fish to pathogens/parasites and further environmental stressors, such as temperature elevation and fluctuation is under investigation. It will be investigated how the next generation is affected by the parental exposure to environmental estrogens.