Abstract

Over the past few decades the availability of spawning grounds for anadromous populations of northern pike (*Esox lucius* Linnaeus, 1758) in the Baltic Sea region has been reduced significantly by the effects of anthropogenic factors such as river regulation, drainage works, and pumping station construction. Additionally, pike that spawn in marine waters no longer occur in some geographic areas, which has led to drastic declines in pike populations in them. The pike population in the Puck Lagoon is currently mostly maintained by stocking with fry produced in hatcheries using "freshwater" spawners. Consequently, developing plans to improve the situation of northern pike requires a better understanding of the ecology of this species particularly in the early developmental stages and of the processes that occur during embryonic, larval, and juvenile development that can lead to local mortality rates as high as 100%.

The results presented in this article are those obtained during two experiments conducted in recirculating aquaculture systems: experiment 1 focused on the influence of salinity on pike larval development, and experiment 2 focused on the influence of water temperature on larval growth rates, the intensification of cannibalism, and otolith growth in pike juveniles in the first month of life. The occurrence of otolith fluctuating asymmetry was also analyzed. During experiment 1, the developmental stages of 3,500 eggs was identified, while during experiment 2,810 specimens and 71 cannibalistic pairs were analyzed. The size of 1,440 otoliths was measured (sagittae and lapilli lengths and widths) to analyze their growth rates, and 284 otoliths (sagittae surface areas, lengths, and widths) to analyze fluctuating asymmetry in otolith samples from cannibalistic pairs.

The studies revealed the following:

1. Larval development depends on the prevailing salinity conditions during fertilization, and hatching success was 89.7% at 0 PSU, 19.7% at 4 PSU, and 0% at 7 PSU. However, if fertilization occurred in freshwater, one hour after fertilization salinities of 4 and 7 PSU did not negatively influence further embryonic development or hatching success.

2. Water temperatures within the range of 10 to 22°C had a positive influence on pike larval and early fry growth rates; thus the optimum temperature for growth was 22°C or higher.

3. Water temperature significantly influenced the occurrence of cannibalism during the larval and early juvenile stages. At higher temperatures, cannibalistic attacks occurred sooner (five days following hatching at 22°C) and their frequency was greater. Water temperature did not influence the ratio of victim size to cannibal size. The smallest size difference between victims and cannibals was barely 0.2 mm, which indicates that the size of the victims and cannibals was practically the same.

4. Differences in the fluctuating asymmetry (FA) of otolith sizes did not occur between cannibals and their victims, and this pertained to both sagittae and lapilli. Even if belonging to the victim group within populations was associated with stress, this was not reflected in FA.

5. Otolith growth rates, and thus the widths of daily growth increments, was strictly linked with pike larval and fry growth rates.

The basic way to rebuild the pike population in the Puck Bay is to restore its spawning grounds. Considering the results described above, restoration work should focus on ensuring food availability for foraging pike fry and providing them with adequate space to minimize cannibalism. This is especially important since pike larval and fry growth rates are fast at the high temperatures of shallow wetland waters, and large size differences among individuals from the same hatch date appear very quickly, which can lead to intense cannibalism. Eggs deposited in fresh coastal wetland waters are safe because the influx of salt water should not cause damage as long as the eggs have been fertilized and embryonic development has already begun. When planning future studies on early developmental pike stages in natural conditions, it would be worth considering the possibility of obtaining some of the data from the analyses of the microstructures and sizes of otoliths since they fulfill basic methodological assumptions and could be sources of knowledge regarding pike larval and fry ages and growth rates.