WETLAND NURSERIES

Photo: Tom Buijse

FLOODPLAINS ARE ESSENTIAL FOR GROWTH AND SURVIVAL OF JUVENILE RIVER FISH

Floodplains are important for a healthy fish community in lowland rivers. This is the reason that, since the 1990's, much time and money has been invested in restoring the ecological quality of floodplain areas and thereby of the entire river system in the Netherlands.

The implementation of various river rehabilitation projects has led to the improvement in water quality and an increase in natural habitats in the lower river Rhine, but did not result in the expected increase in numbers and diversity of rheophilic (flow-loving) fishes. Why the recovery of especially these specialised fish species is lagging behind, is being studied by Twan Stoffers, PhD candidate at the Aquaculture and Fisheries Group of Wageningen University. His research is commissioned by Rijkswaterstaat, which is part of the Dutch Ministry of Infrastructure and Water Management.

Important function

Floodplains fulfil an important function as spawning and nursery areas for many river fish species. In the past, most floodplain areas along the lower river Rhine were (almost) annually flooded by rain and melt water, before the water was eventually being discharged in the North Sea. When flooded, floodplains turn into shallow, slow-flowing water bodies with a variety of different habitat types, which is ideal for functioning as spawning and nursery area for river fishes. Nursery areas are generally lacking in the main channel and many of the eggs and larvae of fish species that spawn there, flow with the current and finally also end up in the floodplain. During their first life stages, foraging for food and finding shelter against predation is of paramount importance for fish, and floodplains meet these needs. Due to high levels of nutrient exchange between land and water, a relatively long residence time of the water, and rapidly warming, shallow spots, high levels of food production in the form of zooplankton (especially water fleas and copepods) and macrofauna (insect larvae, shrimp and water lice) take place in floodplains. Furthermore, riparian vegetation, submerged aquatic plants, boulders, and dead wood provide structures where small fish can hide from predators. These structures also serve as a habitat for benthic algae and coexisting or-

Many different rheophilic fish species were collected during the intensive sampling programme, led by Twan Stoffers (photo) and Leo Nagelkerke.

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ganisms, which can be used as a source of food by various fish species.

A tamed river

Originally, the Dutch part of the river Rhine used to be a dynamic, meandering river with a robust system of gullies, river arms, embankments and shallow floodplains with a variegated pattern of clay, sand, and gravel substrates. In this natural state, changing river discharges and flow velocities resulted in a wide variety of natural habitats that constantly changed and switched places. Nowadays the natural dynamics of the river Rhine are highly regulated because of the requirements for flood risk reduction, shipping, and agriculture. As a result, the natural alternation of habitats has been replaced by narrow, deep and, above all, fast-flowing stream. This created a uniform habitat, 'tamed' by summer and winter dikes, groynes and weirs, and with limited connection to the floodplains. In addition, shipping causes a lot of turbulence, noise, suction and wave action, creating a harsh environment for river fish.

Room for the River

The extremely high flood levels in the Dutch Great rivers in 1993 and 1995 prompted the 'Room for the River' programme, with the main aim to reduce the risk of flooding. Fortunately, this implementation of the programme often turned out to go hand-in-hand with improving the ecological quality of the entire river system. One of the measures that gave the river more space, and also was intended to improve the ecology, was the reconnection of many (former) floodplains with the main channel. Despite many such restoration measures, the densities of rheophilic fishes in the main channel did so far not increase to a desired level. In particular the densities of Nase (*Chondrostoma nasus*), Dace (*Leuciscus leuciscus*), Chub (*Squalius cephalus*), and Barbel (*Barbus barbus*) remain low. A possible explanation for the slow recovery of these fishes is the way floodplains are designed and managed. Many rehabilitated floodplains were laid out to initially have a monotonous habitat and not to be permanently connected to the

A 20-m seine net was used to sample the juvenile fish community in habitats without a lot of structural complexity.

the main channel. It was envisaged that through a process of natural habitat succession floodplains should then develop into a system with a wide range of habitats, which is the prerequisite for high ecological quality. However, requirements for safety, shipping, and other uses impose restrictions on river management in the Netherlands. In practice this means that there is little room for a dynamic floodplain system that is directly connected to the river, let alone that this system can function optimally as a nurse-ry area for rheophilic fishes. If the landscape planning and management of floodplains would take the ecological requirements of these target species directly into account, the rheophilic fish community in the river Rhine may be able to recover faster than it has done so far.

A large comparative study

To study floodplain function as nursery area for river fish, Rijkswaterstaat started a large-scale comparative study of rehabilitated floodplains in 2017. In this study the ecological consultancy firms ATKB and Bureau Waardenburg carried out fish community and habitat surveys in more than 60 floodplains and groyne fields along the river Rhine during four years (2017-2020). At each study site juvenile fish communities were sampled yearly in July.

Many of the floodplains consist of different habitat types, such as fast-flowing channels, submerged shoreline vegetation, and areas with dead wood or boulders, and therefore as many habitats as possible were sampled. Furthermore, water quality and habitat characteristics such as physical structures, substratum type, and water flow were accurately measured and mapped out for each study location. Depending on habitat type, seine netting or electro-fishing was chosen to sample the juvenile fish community. With the data obtained from this large-scale research project, patterns in the distribution of juvenile fish in relation to environmental characteristics was studied, and differences between different floodplains as well as within individual floodplain areas were examined. Within this study it is assumed that the more juvenile fish and the more different rheophilic fish species were found, the higher the quality of the floodplain as a nursery area was. The results can then be used to improve floodplain areas for the rheophilic fish community in the river Rhine.

A complex system

Studying the occurrence of rheophilic juvenile fishes and its relation with environmental characteristics sounds reasonably straightforward, but there are a number of aspects that make it quite complex. Almost

The secondary channel of Hurwenen (on the right) along the river Waal (left), one of the study locations within this research

"This study increases our understanding of habitat variation preferences of rheophilic fish in their first life stages"

all fish species show a shift in habitat use in their first year of life. This is mainly because different life stages have different demands in habitat types related to food sources, hiding places and environmental conditions. For instance, a 2-cm ide larva will eat smaller food in spring, such as small water fleas, than a juvenile ide in August with a size of 12cm, which then feeds on insect larvae. On the other hand, the juvenile ide itself may become a prey for fish-eating birds, something that fish in the larval stage are not subject to. These major changes in the development of young fish take place over a period of a few months within an ever-changing environment: the water gets warmer, water plants grow, and the river discharge levels gradually decrease from March to September. Meanwhile, in the course of summer, juvenile fish increase in size and can therefore swim farther and faster from one habitat to another, provided that these habitats are still present and accessible with the decreasing water levels. Since the large-scale study described above is not suitable to cover this level of complexity, additional sampling took place in June and September (2018-2020) in 26 floodplains along the river Rhine. This additional survey aims at studying small-scale habitat use patterns in juvenile fishes throughout the growing season, which is important because changing habitat uses indicate which habitat types are important at what time and also which floodplain habitats are potentially limiting for the survival of river fishes.

Seasonal differences

Three sampling moments during the growing season are still not enough to thoroughly understand what drives the success of juvenile fish recruitment. Due to their limited size and hence mobility, processes affecting juvenile fish take place at smaller spatial scales than the entire floodplain. Furthermore, because of the rapid growth of juvenile fish, it is important to consider habitat use not only at a small spatial, but also at a short time scale. By studying smaller scales, an attempt is made to disentangle (habitat) processes and influences that remain below the radar on the scale of the floodplain as a whole. For this detailed research three rehabilitated floodplains and associated groyne fields were selected. Here larvae were sampled weekly at a very fine spatial resolution from March to October 2018-2019, during the two growing seasons. From June onwards juveniles were sampled bi-weekly. Furthermore, for each sampling event the environment was characterized, and potential food items such as zooplankton and macroinvertebrates, were sampled. For this detailed fieldwork, the analyses in the laboratory, and the first data analyses, a small army of students was engaged, both from Wageningen University and the HAS University of Applied Sciences in Den Bosch.

Habitat mosaic

The analysis of the large amount of data collected in this study will increase the understanding of the variation of habitat preferences of (rheophilic) fish species in their first life stages. The main aim of this study is to clarify how different habitats must be present and accessible, in both time and space, for the successful development and survival of juvenile fish, not only in terms of the amount of available habitat, but also in their interconnection: the habitat mosaic. Ultimately, this information will be used to improve the ecological quality of Dutch floodplains and hereby contribute to the recovery of native fish populations in the river Rhine.

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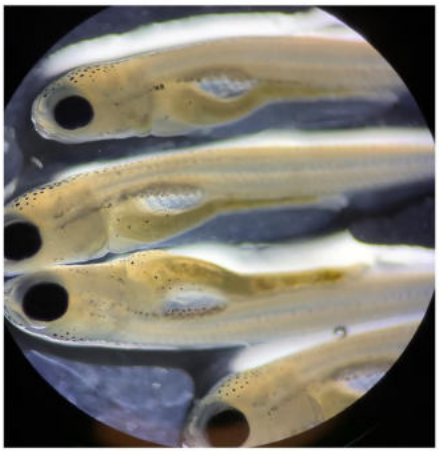

The collected fish larvae were brought back to the lab for identification and measurements.

The macroinvertebrate community was sampled with a standardised method using a 40-40cm box. Samples were taken back to the lab for species identification.