ISSN 2070-1292

danube news

Bulletin of the International Association for Danube Research (IAD)
Informationsblatt der Internationalen Arbeitsgemeinschaft Donauforschung (IAD)

donau aktuell

## Editorial

*Gertrud Haidvogl: Editor DanubeNews, Institute of Hydrobiology and Aquatic Ecosystem Management, University of Natural Resources and Life Sciences Vienna (BOKU), Austria, e-mail: gertrud.haidvogl@boku.ac.at*
*Bernd Cyffka: Editor DanubeNews, Applied Physical Geography, Catholic University of Eichstätt-Ingolstadt and Aueninstitut Neuburg/Donau, Germany, e-mail: bernd.cyffka@ku.de*

Dear readers,

When we started planning this issue of Danube News in January 2020, we assumed that it would be prepared as "business as usual". As you all know, our world was turned upside down in February or at the latest in March 2020. In order to prevent the spread of the SARS-CoV-2 virus, we all had to move to home workplaces, adapt to various restrictions of daily life and at the same time still take over the daily work tasks and often the care of children at home or of elderly relatives.

Under these circumstances, we are especially pleased that Danube News 41 will be published in time and in the same quality as you are used to. In this issue, Tobias Epple and his colleagues provide insights into the effects of fragmentation and subsequent fish pass construction on nase in the Iller, a Bavarian tributary of the Danube. Georg Janauer concentrates on the spread of invasive plants in the Danube and possible management measures to control or restrict them. Michael Neumayer and his colleagues describe their conceptual approach and models for evaluating the effectiveness of natural and decentralised flood protection measures for streams in Bavaria. Finally, Johanna Weidendorfer analysed in her bachelor thesis the application of several macrophyte-based assessment methods for Serbian Danube backwaters.

As some of you may have read or been informed, the 43rd IAS conference will also have to be postponed. We hope to meet you at the currently scheduled date of 26–29 October 2020 at the Aueninstitut Neuburg. Please check for news at iad2020.ku.de.

We would like to thank all authors, our always supportive graphic designer and the printing shop for their efforts and contributions during this challenging time and wish all our readers health and strength for the time ahead.

# The life cycle of nase *(Chondrostoma nasus)* before and after the construction of hydropower plants in the river Iller (Bavaria, Germany) and its migration behavior through fish-bypass channels

*Tobias Epple: Institute of Geography, University of Augsburg, Germany, e-mail: tobias.epple@geo.uni-augsburg.de*

*Arne Friedmann: Institute of Geography, University of Augsburg, Germany, e-mail: friedmann@geo.uni-augsburg.de*

*Karl-Friedrich Wetzel: Institute of Geography, University of Augsburg, Germany, e-mail: wetzel@geo.uni-augsburg.de*

*Oliver Born: Fischereifachberatung des Bezirks Schwaben, e-mail: oliver.born@bezirk-schwaben.de*

### Abstract

The middle section of the river Iller (Bavaria, Germany) is fragmented by weirs since the mid-20th century. At five hydropower plants (Illerstufe 4–8), fish-bypass channels have been constructed between the years 2013 and 2016. The upstream migration of the European fish species nase *(Chondrostoma nasus)* through the fish bypass channels has been studied daily with fish counting pools over 3 years and correlated with abiotic factors. The main abiotic factors that influence the migration patterns of juvenile and adult nase are water temperature and day-length. The highest numbers of migrating adult nase have been documented at water temperatures between 9.0 and 9.9° C and increasing day-lengths between 13:00 and 13:30 hours. Through a literature study, electrofishing and the fish counting pool, the life cycle of the nase has been investigated at the hydropower plant Illerstufe 6. Prior to the fragmentation, nase from the whole river Iller and probably even from the river Danube have migrated to two spawning habitats in the upper river Iller. After the fragmentation, migration has been impossible over a long time and there has been a large reduction of the nase population in the middle section of the river Iller.

After the restoration of the river continuity at the Illerstufe 6, nase are not migrating to their former spawning grounds at the upper river Iller anymore. The great majority of nase is only entering the fish-bypass channel for spawning and is leaving it again instantly after spawning downstream. After hatching, the larvae of nase are also leaving the fish-bypass channel downstream and congregate at a shallow water area in the main stream of the river Iller, which is used as their juvenile habitat. Even after the restoration of the river continuity, there is no automatic return to the same migration and spawning pattern as prior to its fragmentation.

## 1. Introduction

During evolution, fish adjusted to the 'four-dimensional' continuity of rivers (Ward 1989). Therefore, the continuity of rivers has a central importance for the interconnection, spread and resettlement of populations. For many fish species, complex interactions between different habitats are well-known (Jungwirth et al. 2000). Organisms of running waters are losing their possibility to migrate free through waterbodies intersected by dams, which are fragmenting rivers. The wide-spread construction of weirs and dams shows big effects on the biodiversity (Mueller et al. 2011). Thereof, especially long-distance migrating fish and gravel spawners are affected (Schiemer & Spindler 1989). Nowadays, watercourses are considered to be one of the most endangered ecosystems worldwide (Geist 2011). To counteract this situation, the European Union has passed the 'Water Framework Directive' in 2000. Besides other factors, the river continuity is considered paramount. Therefore, interruptions of the continuity must be restored by fish-bypass channels (Marmulla 2001).

Nevertheless, there are still open questions: e.g. how fish are using fish-bypass channels and whether there are abiotic factors, which affect the migration through fish-bypass channels. Another question is, whether the life cycle of river fish species is comparable to the time before the fragmentation of the river once the river is restored with fish-bypass channels. These points will be addressed by the example of a nase *(Chondrostoma nasus)* population in the middle river Iller (Bavaria, Germany).

## 2. General Situation

### 2.1 Study area

The study took place at the river Iller in southern Bavaria, Germany. The river Iller has a catchment area of 2154 km² and a mean discharge of 53.9 m³/s (GKD Bayern 2019). It flows into the river Danube near the city of Ulm *(fig. 1)*. Between Altusried and Lautrach *(fig. 2)*, five run-off river hydropower plants have been built in the first half of the 20th century. It has not been possible for fish to migrate upstream over them. Also, at the hydropower plant 'Illerstufe 6' *(coordinates: N 47.869845° E 10.181145°, fig. 2, fig. 3)* which has been built until 1951 near Legau, the river continuity has been interrupted over many decades.

Between 2012 and 2016, all five run-off-river hydropower plants in the study area have been made passable with fish-bypass channels. Most of them have been constructed

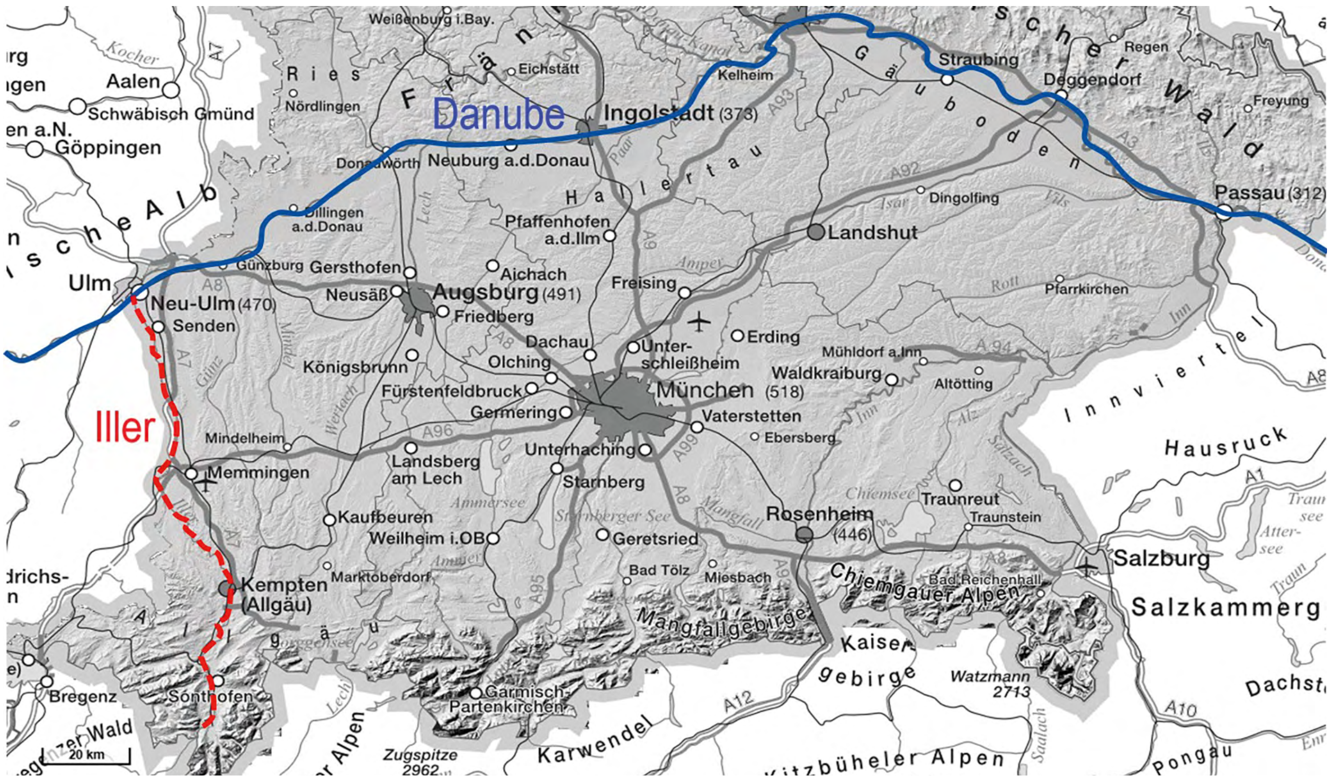


*Figure 1: An overview of southern Germany, with the river Iller and the river Danube. Credit: Tobias Epple, modified from Bayerische Vermessungsverwaltung.*

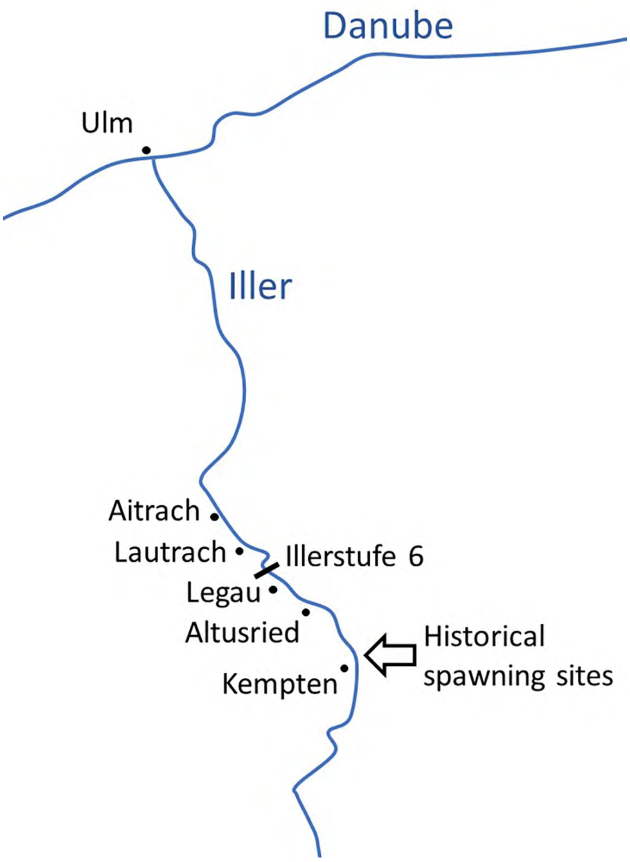


*Figure 2: Detailed map of the river Iller. 'Historical spawning sites' depicts the location of the historical spawning sites of nase (Chondrostoma nasus) described in Kreisfischereiverein (county fishing association) für Neuburg und Donau (1895) and Sarrazin (1992). The spawning site mentioned in Kreisfischereiverein für Neuburg und Donau (1895) is around 2,4 km downstream of the spawning site described in Sarrazin (1992). Credit: Tobias Epple.*

as a nature like pond pass. The length of the fish-bypass channel at the Illerstufe 6 is 473 m, its mean flow is 0.9 m³/s. During the construction of the fish-bypass channel, it was paid attention to the fact, that it is not only a pure migration corridor, but also a compensatory habitat for rheophilic fish species. Hence, there has been an aim to construct structures in the fish-bypass channel, which enable gravel spawning fish species to spawn there (Epple et al. 2018). Otherwise, also shallow and slow flowing shore areas have been integrated in the fish-bypass channel, which are suitable as larvae- and juvenile habitats. There have also been fish-bypass channels built at the other hydropower plants in the middle river Iller, so that the river continuity of the river Iller is now restored from its source until Aitrach *(fig. 2)*.

The downstream area of the hydropower plant Illerstufe 6 is free flowing over a length of round 1.5 km and starts to merge into the head of the reservoir of the next hydropower plant then. There is no gravel over wide areas in the downstream water section. The riverbed is mainly flat rock *(fig. 3)*. This leads to a lack of suitable spawning grounds for gravel spawners. Therefore, gravel has been added between 2017 and 2018 in the downstream area of the Illerstufe 6 *(fig. 3;* Epple et al. 2019; Stojakowits et al. 2019).

### 2.2. The nase *(Chondrostoma nasus)*

The nase *(Chondrostoma nasus)* is a schooling fish of the *Leuciscidae* family and populates the mid-courses of middle-European rivers *(fig. 4)*. It reaches a size up to 60 cm and a weight of 2.5 kg. In spring, nase migrate up to 100 km upstream to their spawning grounds (Penaz 1996). The

*Figure 3: The hydropower plant 'Illerstufe 6' near Legau. The fish-bypass channel at the left shoreline is clearly visible. There have been bed load additions at the right shoreline and shore levelling at the left shoreline. At the midstream of the main riverbed, flat rock is visible as light ground. Credit: Olav König.*

*Figure 4: The nase (Chondrostoma nasus) is a common fish in middle Europe. In spring it migrates up to 100 km upstream to their spawning grounds. Credit: Patrick Türk/Landesfischereiverband Bayern e.V.*

spawning itself takes place between mid-March and late April at water temperatures from 9.6 to 10.8° C (Huber & Kirchhofer 1998; Melcher & Schmutz 2010). Suitable spawning habitats are shallow, fast flowing and gravelly stream areas (Keckeis 2001). The larvae and juveniles have different habitat requirements than the adult nase and need shallow and slow flowing habitats along the river shore (Keckeis et al. 1997).

## 3. Material & Methods

At the inlet area of all five fish-bypass channels of the project area, a fish counting pool has been installed, in which all fish that are migrating upstream through the fish-bypass channels are registered in species and size daily from 15.08.2016 to 15.08.2019 (Epple et al. 2019). The fish-counting pools have a size of 4.6 m x 2.0 m, the bar racks at the inlet and outlet have a bar rack distance of 15 mm. Due to a fish trap, fish cannot leave the counting pools anymore after they have swum in. The numbers of nase in the counting pools have been matched with water temperature and daylength.

The historical situation of nase in the river Iller has been reconstructed through a literature study, as well as historical spawning sites. The present population of nase and its spawning and migrating situation at the Illerstufe 6 has been established with electrical fishing, a fish counting pool in the fish-bypass channel and optical observations of spawning processes.

Electro-fishing has been realized in the downstream water area of the Illerstufe 6 once in spring 2017, autumn 2017 and autumn 2018 on a length of over 1.5 km. At every fishing day, both shorelines have been fished once against the flow and the midstream once with the flow. All caught nase have been measured to the nearest cm. The fish-bypass channel around Illerstufe 6 has been fished electrically in spring 2017 and spring 2018 upstream against the flow. During the spawning season, the fish-bypass channel has been searched daily visually for spawning nase in 2016, 2017 and 2018.

## 4. Results

The majority of the nase that have been documented in the fish-counting pools had a total length from 47 to 54 cm and are assigned to the age group of adults. Furthermore, numerous juvenile nase with a total length between 5 and 20 cm have been registered in the fish-counting pools. In contrast, nase with a total length between 20 and 46 cm have only been documented sporadically, with few individuals *(fig. 5)*.

Adult nase have been primarily recorded at water temperatures between 8.0 and 12.9° C in the fish-counting pools, with a peak at water temperatures between 9.0 and 9.9° C. At water temperatures below 5.9 and over 17.0° C, no adult nase have been registered in the fish-counting pools. Juvenile nase show a different migrating behavior subject to the water temperature, in contrasts to the adults there are two peaks at very warm water temperatures from 21.0 to 21.9° C and above 23.0° C *(fig. 6)*.

Depending on the daylength, the number of adult nase in the fish-counting pools shows a strong peak at increasing daylengths from 12:30 to 13:59 hours. Beside this daylength, only a few adult nase have been documented in the fish-counting pools. The relation of the mean daily number of juvenile nase to the daylength is not as closely

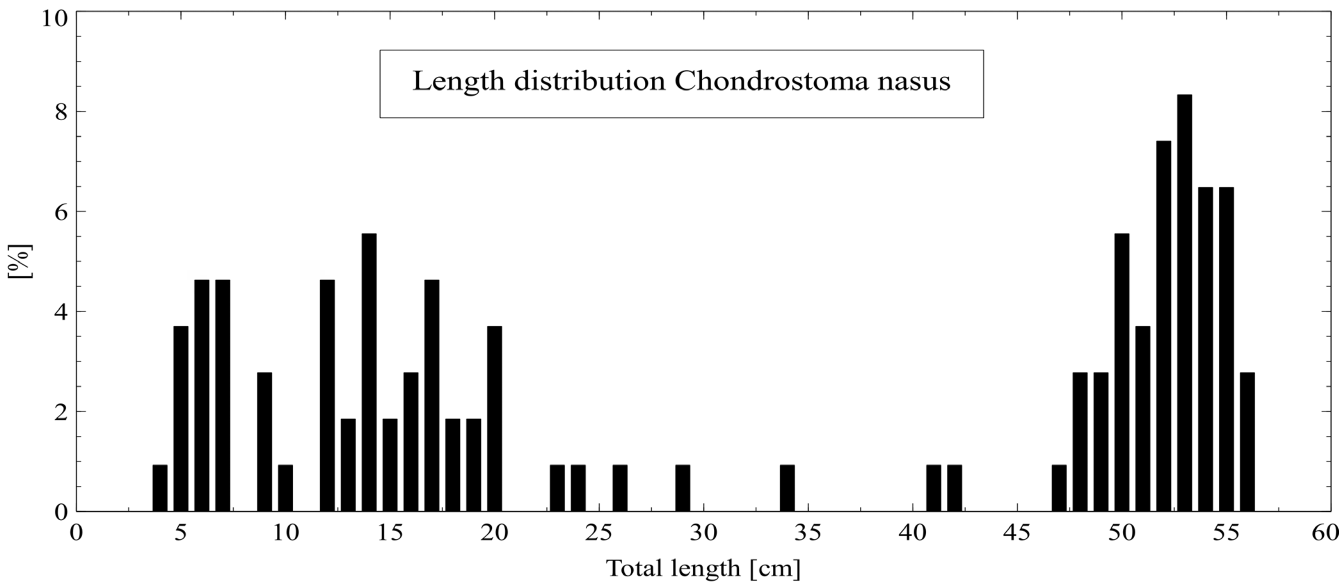


*Figure 5:* The length distribution of nase (Chondrostoma nasus) recorded in the fish counting pools of the five fish-bypass channels in the study area. Credit: Tobias Epple

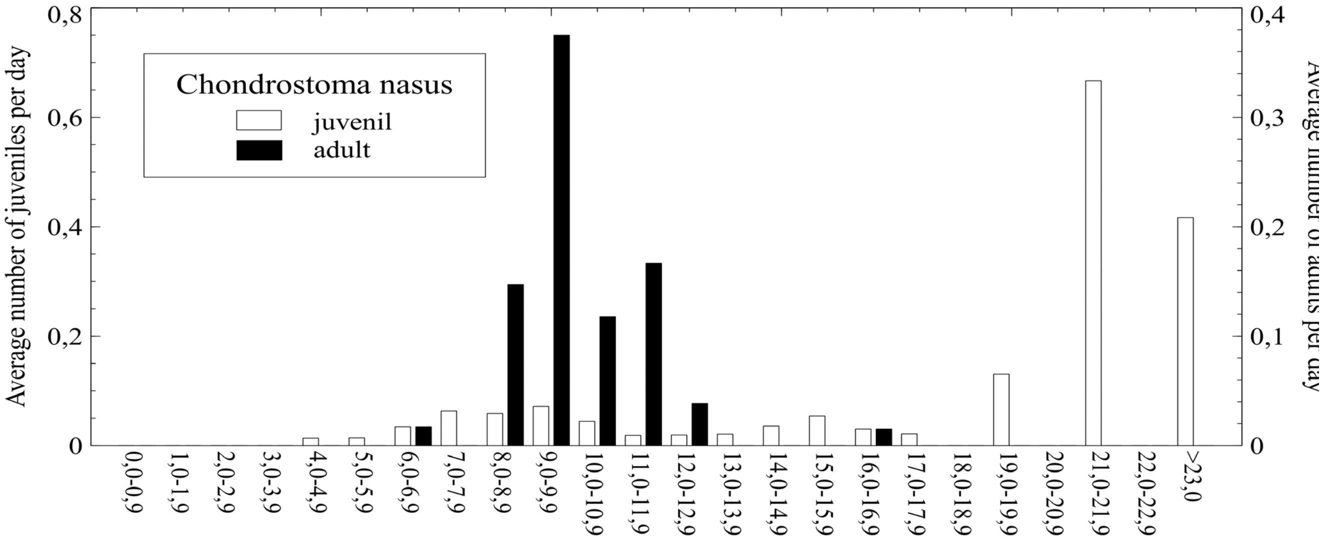


*Figure 6:* The average daily numbers of juvenile and adult nase (Chondrostoma nasus) recorded in the fish counting pools of the five fish-bypass channels in the study area, in relation to the water temperature. Credit: Tobias Epple

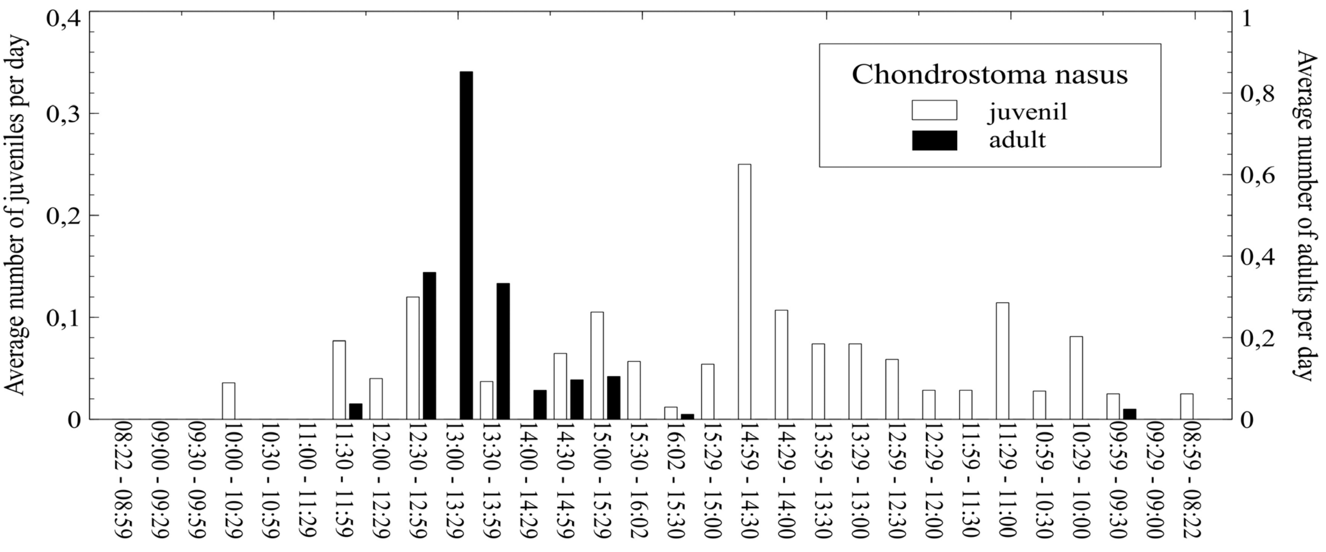


*Figure 7:* The average daily numbers of juvenile and adult nase (Chondrostoma nasus) recorded in the fish counting pools of the five fish-bypass channels in the study area, in relation to the daylenght. Credit: Tobias Epple

linked as for the adults. The highest mean daily numbers of juvenile nase have been registered at decreasing daylengths between 14:59 and 14:30 hours *(fig. 7)*.

Two sources have been identified which are describing the historical situation of nase in the river Iller before its fragmentation (Kreisfischereiverein für Schwaben und Neuburg 1895; Sarrazin 1992). The Kreisfischereiverein für Schwaben und Neuburg (1895) names a spawning site at the mouth of a creek called “Mühlbach” into the river Iller (coordinates: 47°47’02.1”N 10°17’24.3”E). Further in this text, there is no other description of the population of nase, although the fish stock of the river Iller is outlined in detail. It is described, that the barbel (Barbus barbus) and all other fish of the barbel region are frequent downstream from the city of Lautrach *(fig. 2)*. Whether this also includes nase can only be suspected.

Sarrazin (1992) documents that the river Iller has been historically well-known for its spawning migrations of thousands of nase, which have migrated until the upstream area of the city of Kempten *(fig. 1, fig. 2)*, coming from the river Danube *(fig. 1)*. An exact spawning site is not indicated. Furthermore, Sarrazin (1992) depicts that in the beginning of the 1990s some nase were still present between the hydropower plants, but that they cannot migrate anymore because of the fragmentation.

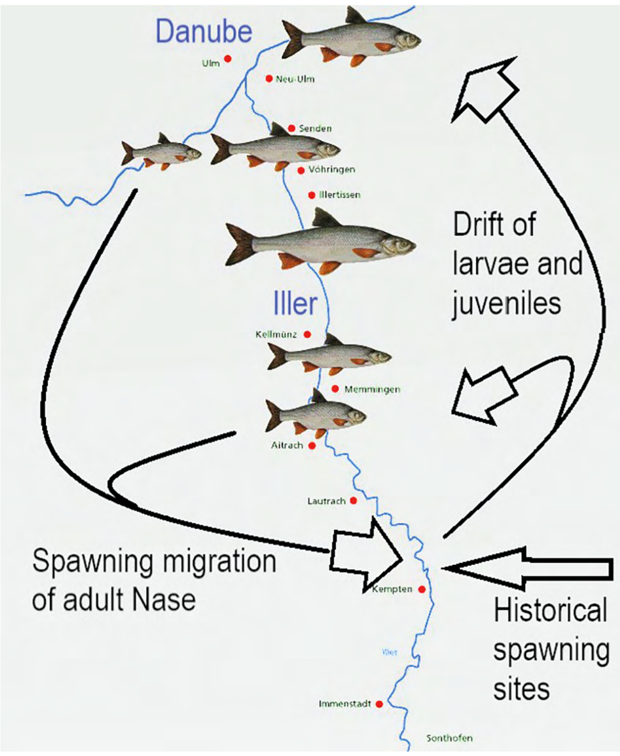


***Figure 8:*** *Reconstructed historical life cycle of nase (Chondrostoma nasus) in the river Iller. nase from the whole river Iller and probably even from the river Danube migrated to the historical spawning grounds in the north of the city of Kempten, to spawn there with many ten thousand individuals. Subsequently, the larvae and juveniles were drifted away from the spawning ground and spread out in the mid and lower river Iller and river Danube again. Credit: Tobias Epple, modified from www.fahrrad-tour.de, 21.12.2018.*

In Sarrazin (1992) also a spawning site at the mouth of the river Leubas into the river Iller *(fig. 2)* is mentioned. Thus, this spawning site is located around 2.4 km upstream of the spawning site that Kreisfischereiverein für Neuburg und Donau (1895) records. Sarrazin (1992) further describes, that during their spawning 10 000 to 13 000 nase are caught at the spawning site at the mouth of the river Leubas every year.

During electro-fishing in spring 2017 (26. May 2017), three nase have been caught in the downstream area of Illerstufe 6, two adults with a total length of 54 cm and 58 cm and one juvenile with a total length of 6 cm. In autumn 2017 (29. September 2017), 15 nase have been captured by electrical fishing. Three of them have been adults with a total length of 38 cm, 52 cm and 56 cm, 12 of them juveniles with a total length from 4 cm to 7 cm. In autumn 2018 (12. October 2018), 10 adult nase with a total length from 51 cm to 54 cm and 1441 juvenile nase with a total length from 6 cm to 10 cm have been caught. All juveniles have been documented in a cut-off meander around 1.5 km downstream of the Illerstufe 6 (coordinates: 47°52’26.6”N 10°10’26.5”E).

During electrical fishing in the fish-bypass channel around Illerstufe 6, no nase have been caught.

In 2016, 2017 and 2018, 100 to 150 spawning nase have been documented in the fish-bypass channel in spring. The spawning nase had an estimated total length of 35 cm to 55 cm.

In spring 2017, seven nase with a total length between 48 cm and 54 cm migrated into the fish-counting pool of the fish-bypass channel around Illerstufe 6 between 01.04.2017 and 18.08.2017. Four of them have been documented before the spawning in the fish-bypass channel and three of them after it. In spring 2018, 13 nase have migrated into the fish counting pool between 09.04.2018 and 19.04.2018. Two of them had a total length of 18 cm and 20 cm and eleven between 50 cm and 56 cm. Of the eleven sexually mature nase, nine have been documented before the spawning in the fish-bypass channel and two after it.

## 5. Discussion

The peaks of adult nase in the fish-counting pools are strongly related to their spawning migration. Besides the spawning migration, nearly no adult nase have been documented in the fish-counting pools. The increasing daylengths from 12:30 to 13:59 hours corresponded to the period from ca. March 26 to April 22. The peak of juvenile nase at decreasing daylength between 14:59 and 14:30 hours corresponded to the period from ca. August 01 to August 11 and fits subsequently to the peaks in high water temperatures. The motivation of this migration cannot be easily interpreted. It could be a migration to find suitable feeding grounds, as this is described by Prchalová et al. (2006) for other cyprinids.

Based on the literature study, it was possible to establish, that before the fragmentation of the river Iller, nase from the whole river Iller and probably even from the river Danube (Sarrazin 1992) migrated to the two spawning grounds in the upper river Iller *(fig 8)*. The fact that 10 000 to 13 000 nase have been caught at the mouth of the river Leubas during spawning every year, without endangering the population, obviously shows, that many thousand nase must have spawned there. This indicates a large nase population in the river Iller prior to its fragmentation. The literature study shows also that the nase have been migrating over long distances, before the fragmentation of the river Iller. The distance from the mouth of the river Iller to the Danube into the spawning ground described by Sarrazin 1992 is around 95 km.

The total length of the observed spawning nase, the nase documented in the fish counting pool and the nase caught while electrical fishing, leads to the conclusion, that the nase population at the downstream area of Illerstufe 6 is strongly overaged, due to a lack of medium sized fish between 20 and 45cm total length. It is assumed, that successful spawning of nase at the downstream area of Illerstufe 6 only took place on a very limited basis in recent years before the restauration measures, mainly because of the lack of spawning habitats. Therefore, only a small relict population of nase could persist.

It is concluded from the present results that the majority of nase at the downstream area of Illerstufe 6 is not migrating over long distances anymore, even though this would be possible again due to fish-bypass channels. Only a small part out of the 100 to 150 nase that have spawned in the fish bypass-channel migrated through the whole fish-bypass channel. The main part of nase is only entering the fish-bypass channel to spawn there and not to migrate through it *(fig. 9)*. After spawning the nase are leaving again the fish-bypass channel downstream. After hatching, the nase-larvae are drifted out of the fish-bypass channel downstream. They are growing up in a small cut-off meander around 1,5 km downstream of the Illerstufe 6 *(fig. 9)*.

From the results of electrical fishing in autumn 2018 it is assumed, that the nase population of the Illerstufe 6 is now recovering slowly. The main reason for this is seen in the presence of suitable spawning habitats in the fish bypass-channel, since there have not been suitable spawning habitats in the downstream area of Illerstufe 6 itself over a long time.

Before the fragmentation nase have done long spawning migrations through the river Iller *(fig. 8)*. After the successful restoration of the river continuity, the nase of the downstream water section of Illerstufe 6 are no longer performing long spawning migrations anymore. They migrate only a few 100 meters from the downstream water area of Illerstufe 6 to the spawning habitats of the fish-bypass channel *(fig. 9)*. The downstream area is used as an adult and feeding habitat by the sexually mature nase. The fish-bypass channel is only used as a temporary habitat by adult nase for spawning. Only a small part of the nase population uses the fish-bypass channel as a migration corridor. Nase larvae are drifted out of the fish-bypass channel downstream and are also not using the fish-bypass channel as a long-term habitat. They are congregated in a shallow water area at the main river, which they use as their juvenile habitat.

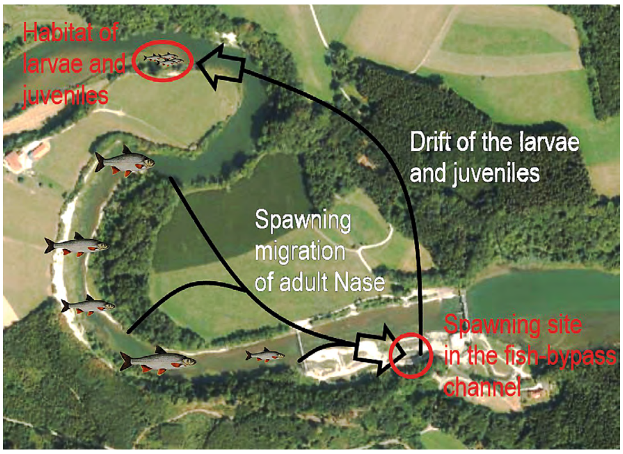


*Figure 9: The life cycle of nase (Chondrostoma nasus) at the hydropower plant Illerstufe 6 in the middle river Iller after the restoration of the river continuity with a fish-bypass channel. The main part of the nase population moves in the fish-bypass channels only for spawning and leaves it after spawning downstream again. Only a small part of the nase population uses the fish-bypass channel for upstream migration. The fish-bypass channel is used by nase primarily as a spawning habitat and not as a migration corridor. After the hatching, larvae of nase drift out of the fish-bypass channel downstream and congregate at a shallow water area round 1,5 km downstream of the Illerstufe 6, which they use as their larvae and juvenile habitat.*
*Credit: Tobias Epple, modified from Bayerische Vermessungsverwaltung.*

## 6. Conclusions

Even after the successful restoration of the river continuity, the spawning and migration behavior of nase will not be automatically be the same as before the fragmentation. The life cycle of nase can, if the relevant habitats are available, take place along relatively few river kilometers. There are complex interactions between fish-bypass channels and the main river, emphasizing why the presence of suitable key habitats is essential in both water compartments. Therefore, restauration efforts must concentrate on both areas.

## Data Availability Statement

The datasets generated and analyzed during the current study are not publicly available but are available from the corresponding author on reasonable request.

## Acknowledgements

This paper has been written within the project 'Geschiebemanagement an der Iller' (2015-2016) which has been funded by the LEW Wasserkraft GmbH and the EU LIFE Project ISOBEL (Integrated Solutions for BEd Load management, LIFE15 ENV/DE/000162, 2016–2019).

## References

Bayrle, H. (2007). Süßwasserfische, Muscheln, Krebse. Heintges Lehr- und Lernsysteme GmbH, D-95615 Marktredwitz

Epple, T., Friedmann, A., & Wetzel, K. F. (2019). Illerstrategie 2020 und EU-Projekt ISOBEL schließen Lücken zwischen Forschung und Praxis. WasserWirtschaft, 2–3/2019. 68–74.

Epple, T., Wetzel, K.-F., Friedmann, A. (2018): Einbau und Pflege von Kieslaichplätzen in naturnah gebauten Fischaufstiegsanlagen. WasserWirtschaft 9/2018, 63–68.

Geist, J. (2011). Integrative freshwater ecology and biodiversity conservation. Ecological Indicators, 11(6), 1507–1516.

GKD Bayern (2019). Aktuelle Messwerte Wieblingen / Iller. https://www.gkd.bayern.de/de/fluesse/abfluss/iller_lech/wiblingen-11405000/messwerte. 13.05.2019

Huber, M., & Kirchhofer, A. (1998). Radio telemetry as a tool to study habitat use of nase *(Chondrostoma nasus* L.) in medium-sized rivers. Hydrobiologia, 371, 309–319.

Jungwirth, M., Muhar, S., & Schmutz, S. (2000). Fundamentals of fish ecological integrity and their relation to the extended serial discontinuity concept. In: Assessing the Ecological Integrity of Running Waters. Springer, Dordrecht. 85–97.

Keckeis, H. (2001). Influence of river morphology and current velocity conditions on spawning site selection of *Chondrostoma nasus* (L.). Archiv für Hydrobiologie. Supplementband. Large rivers, 12(2–4), 341–356.

Keckeis, H., Winkler, G., Flore, L., Reckendorfer, W., & Schiemer, F. (1997). Spatial and seasonal characteristics of 0+ fish nursery habitats of nase, *Chondrostoma nasus* in the River Danube, Austria. Folia Zoologica-Praha, 46, 133–150.

Kreisfischereiverein für Schwaben und Neuburg (1895). Fischbuch für Schwaben und Neuburg. 5–8

Marmulla, G. (2001). Dams, fish and fisheries: opportunities, challenges and conflict resolution (No. 419). Food & Agriculture.

Melcher, A. H., & Schmutz, S. (2010). The importance of structural features for spawning habitat of nase *Chondrostoma nasus* (L.) and barbel *Barbus barbus* (L.) in a pre-Alpine river. River Systems, 19(1), 33–42.

Mueller, M., Pander, J., & Geist, J. (2011). The effects of weirs on structural stream habitat and biological communities. Journal of Applied Ecology, 48(6), 1450–1461.

Penàz, M. (1996). *Chondrostoma nasus*-its reproduction strategy and possible reasons for a widely observed population decline-a review. In Conservation of endangered freshwater fish in Europe. Birkhäuser Basel. 279–285.

Prchalová, M., Vetesník, L., & Slavík, O. (2006). Migrations of juvenile and subadult fish through a fishpass during late summer and fall. Folia Zoologica, 55(2), 162.

Sarrazin J. (1992): Fischerei auf der Iller. – In: Kettemann, O & U. Winkler (Hrsg.): Die Iller. Geschichten am Wasser von Noth und Kraft. Druckerzeugnisse des Schwäbischen Bauernhofmuseums Illerbeuren 5, 100–110.

Schiemer, F., & Spindler, T. (1989). Endangered fish species of the Danube River in Austria. Regulated Rivers: Research & Management, 4(4), 397–407.

Stojakowits, P., Epple, T., Merkel, W., Friedmann, A., Wetzel K.-F. (2019). Wege zur Zielerreichung des guten ökologischen Potenzials am Beispiel der Iller zwischen Krugzell und Lautrach. Hydrologie & Wasserbewirtschaftung, 63, (5), 262–277.

Ward, J. V. (1989). "The 4-dimensional nature of lotic ecosystems." Journal of the North American Benthological Society 8(1): 2–8.

# Neophytes – what will be the future for present Aquatic Floodplain Vegetation?

*Georg A. Janauer: Department of Functional and Evolutionary Ecology, University of Vienna, Austria, email: georg.janauer@univie.ac.at*

## The river corridor environment and its aquatic plants

Floodplains are part of river corridors, which – in preregulation times – extended significantly in lateral dimension of the river course wherever landscape conditions had allowed. Today most river corridors are constrained by human intervention, especially by systems of levees, mainly serving flood protection. Therefore, waterbodies between the levees, still connected to, or already disconnected from the main channel, are part of the 'active floodplain' environment and undergo periods of high to extreme discharge, but the active floodplain area is usually much reduced as compared to historical conditions. Beyond the levees former river channels and meanders still are present in many locations, but their waterbodies are relicts, which depend on groundwater connection with the active floodplain and on precipitation. Most of these waterbodies have negligible flow, close to still conditions.

The term 'Aquatic Macrophytes' comprises aquatic plant species, even some bryophytes (mosses and liverworts), but usually no algae species. Aquatic plants live submersed (pondweed), with floating leaves (water lily), or free floating (duckweed), but some can live either submersed and/or in very shallow water, and/or on wet substrate, too (moneywort). All plant species which are rooted in shallow water and reach up the shore of still waters or up on river banks, with most of their structures above the water, are 'helophytes' (reed, cattail). Despite the fact that all these plants produce oxygen during light hours, most essentially they contribute to providing structure in the open water (hideout for young fish, cover for predatory fish), serving for food (waterfowl, invertebrates) and offering much space on the surface of their stems and leaves (algae, fungi, protozoa, invertebrates, etc.). This makes them an essential group of organisms in aquatic environments. Non-native aquatic plants, which show 'invasive character', can be called 'Aquatic Neophytes'.

## Neobiota – their 'legal environment' defined by EU-Regulation

Aspects regarding invasive species are dealt with the 'Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 23 October 2014 on the prevention and management of the introduction and spread of invasive alien species' (Official Journal of the European Union / L317, EU IAS 2014). Alien species of animals, plants, fungi and micro-organisms are subject of this Regulation, but only where they 'become invasive', show 'adverse impact' on native biodiversity and ecosystem functions, or on social, respectively economic, conditions. EU Member States