Fish diversity documented in Switzerland's rivers

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Chubs (Squalius cephalus), also called European chub, on their spawning ground in the Trême, a tributary of the Saane, Canton Fribourg, Switzerland. Credit: Michel Roggo

In a major survey of Swiss rivers and streams, more than 50 different fish species were recorded. For the first time, more than one species was also found in the case of smaller types of fish such as the bullhead. In Progetto Fiumi, riverine fish were surveyed using standardized methods

and both morphological and genetic characteristics were analyzed. Particularly high diversity was seen in large lowland rivers—where, however, near-natural reaches are rare.

The smallest fish recorded by the Progetto Fiumi biologists was a stickleback measuring 2 centimeters, while the largest—70 times longer—was a 140-centimeter catfish caught in the Rhine. In terms of weight, the span was even wider, with the lightest—a 0.01-gram carp larva—weighing 5 million times less than the almost 50-kilogram catfish. The sheer variety of sizes is emblematic of the enormous diversity of fish harbored by Switzerland's rivers and streams.

Over a period of five years, Eawag scientists—aided by fishery inspectors, leaseholders, environmental consultancies and volunteers—collected samples of fish from rivers and streams at 324 sites, at altitudes ranging from around 200 to more than 2,200 meters above sea level. More than 20,000 specimens from over 50 species were caught, with 12,000 DNA and over 5000 scale samples being archived for further analysis. All the data collected was stored in a publicly accessible reference database. Following Projet Lac for perialpine lakes, Progetto Fiumi now for the first time provides an overview of fish diversity in Switzerland's rivers and streams. Today, the Final Report on this project was published online.

Just a few species in numerous rivers, large numbers in a few

In many of the reaches studied, just a few species were recorded, with no more than one—mostly Atlantic trout (Salmo trutta)—found at 158 sites. Only 16 sites showed high diversity (10 or more species). These are mainly located on larger rivers in the Central Plateau or close to lakes. The highest numbers of species were recorded in large

impoundments.

As project leader Jakob Brodersen explains, "This doesn't mean that impounded river habitats are especially valuable for fish diversity, since here you mainly find species that are common in lakes. Threatened species, such as grayling or nase, which require larger, non-fragmented river habitats with a stronger current, are underrepresented or wholly absent." According to Brodersen, large lowland rivers are particularly affected not just by impoundments but more generally by artificial interventions and remain largely unstudied.

He says, "We should therefore look for ways in which the few remaining near-natural habitats of these acutely threatened species can be better protected. The high water temperatures and prolonged dry spells associated with climate change, as in 2022, and the current energy policy situation with pressure to produce more electricity from hydropower, show just how urgent this is."

Unknown species disappear unnoticed

For anyone wondering why the researchers went to all this trouble, Jakob Brodersen has a clear answer: "If the diversity of nature is not documented and understood, we can't effectively protect it. Species or regional diversity will disappear unnoticed. That can lead to the loss of ecosystem services, also creating new challenges for humans." As he also emphasizes, if species diversity is to be fully recorded and changes detected at an early stage, it is not enough for species to be identified "in the field." What is required are experts with in-depth species knowledge, using a combination of determination by morphological characteristics and analysis by genetic methods.

Often, genetic analyses are essential in revealing how a high degree of diversity has developed even within individual species—for instance

through adaptation to different habitats. Brodersen mentions the example of the Bioleyre, a small stream in the canton of Vaud where two different phenotypes of trout are found in the upper and lower reaches. In the middle reaches, they even occur together, while mostly remaining reproductively isolated from each other. Whether this is due to dietary specialization or to other factors now needs to be further investigated.

Like the recently updated Red List of fishes and cyclostomes of Switzerland (available in French/German/Italian), Progetto Fiumi also shows the extent to which Switzerland's known trout species are under pressure. The only exception is the Atlantic trout : originally only native to the Aare/Rhine and Lake Geneva catchments, this species was introduced in many other places and is now found throughout Switzerland. In contrast, the Northern Italian brook trout is critically endangered.

While the trout species from five distinct evolutionary lineages were already known, the Progetto Fiumi scientists found more species than had been expected in other genera, including bullheads, loaches and minnows. More time will, however, be needed to classify these precisely.

As part of Progetto Fiumi, populations of fish and aquatic macroinvertebrates were also investigated in eight residual-flow reaches and compared with those in waters up- and downstream of the hydropower plants. Densities of sensitive organisms such as mayflies, stoneflies and caddis flies were lower in the residual-flow reaches. While trout numbers did not differ systematically, the specimens caught in the residual-flow reaches weighed less in relation to body length, i.e. these fish were thinner.

More information: Jakob Brodersen et al, Erhebung der Fischbiodiversität in Schweizer Fliessgewässern. Progetto Fiumi Schlussbericht (2023). DOI: 10.55408/eawag:30020 [pdf file, in

German, with summaries in English, French and Italian]

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