Do block ramps improve river connectivity for fish?

The innumerable sills and weirs found along Switzerland's rivers fragment the habitats of aquatic organisms and impede the migration of fish. These artificial barriers are therefore increasingly being replaced by block ramps. Whether such measures are effective in restoring connectivity, however, depends on the type of ramp and the fish species concerned. *Text: Andres Jordi*

Armin Peter

Fig. 1: Artificial falls – as here in the Aabach at Uster (Canton Zurich) – represent barriers to fish migration.

In the 19th and early 20th century, most of Switzerland's rivers were straightened and channelized. As streamflows increased, processes of erosion and bed deepening were intensified. Artificial sills and weirs were then constructed so as to reduce flow velocities and stabilize riverbeds. For many aquatic organisms, however, these measures created impassable barriers (Fig. 1). The river-engineering structures fragmented habitats and impeded the migration of fish to their spawning grounds. For certain species, even small obstacles can make migration impossible. Today, Switzerland's 65,000 kilometre river network is fragmented by over 100,000 artificial barriers at least 0.5 metres high.

Loss of biodiversity due to habitat fragmentation

As fish ecologist Armin Peter of Eawag explains, "Connectivity between the various habitats required by fish for foraging, reproduction and wintering is essential for the survival of populations." Barrier free confluences of side and main channels are especially important in allowing fish to access spawning sites and refuges upstream. If such movements are prevented, Peter adds, demographic conditions in fish communities are adversely affected, with a loss of genetic diversity and a reduction in species richness. Long-distance (e.g. salmon) and medium-distance migrants (e.g. lake trout, nase) are particularly susceptible to habitat fragmentation.
As part of ongoing rehabilitation efforts, the longitudinal connectivity of rivers is to be re-established by replacing sills and weirs with so-called block ramps. A block ramp is a river engineering structure consisting of boulders, which is designed to stabilize a riverbed while permitting the passage of fish. The difference in bed level is overcome by a shallow slope rather than by a step, as in traditional barriers (see Fig. 2). On behalf of the Federal Office for the Environment, Armin Peter and fellow researcher Denise Weibel studied the effectiveness of various types of block ramp in several Swiss rivers. Their study involved translocation experiments, in which fish were captured upstream and then released downstream of a block ramp. These experiments took advantage of the natural tendency of fish to swim back to their home site after translocation.

Fig. 2a: Different block ramp designs: classical block ramp

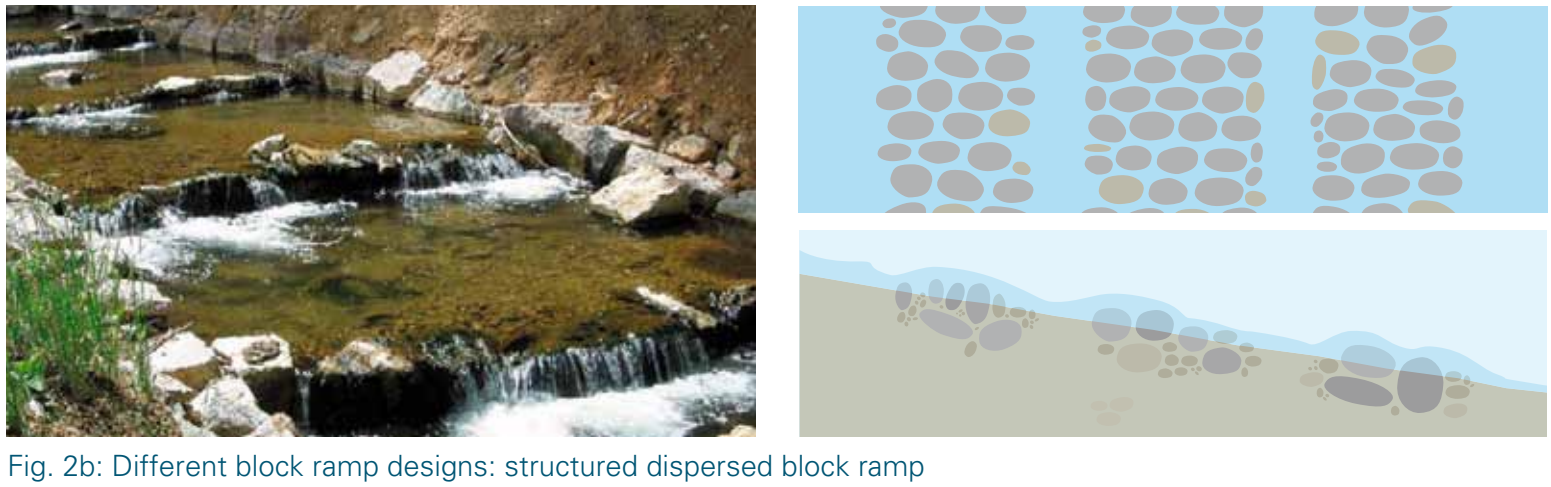

Fig. 2b: Different block ramp designs: structured dispersed block ramp

Fig. 2c: Different block ramp designs: unstructured dispersed block ramp

Effectiveness dependent on ramp type and fish species

Summarizing the findings, Peter says: "The passage efficiency of block ramps varies according to the type of ramp and depends on the fish species and body size." Dispersed block ramps (block clusters) would appear to be more suitable than block carpets (classical uniform ramps with closely embedded boulders) . Dispersed ramps of the structured type (step-pool-step), in turn, offer the advantage of providing pools with low current velocity after each of the transversal sills, where fish can rest to avoid exhaustion. However, under low discharge conditions, the vertical drops associated with these sills can only be cleared by leaping. For the bullhead – a species with a limited leaping capacity – drops of only 15 centimetres proved to be insurmountable.

Upstream passage is much easier for larger than for smaller fish: in the case of brown trout, up to 80 per cent of individuals more than 20 centimetres long passed the block ramps successfully, while this was only possible, at best, for just over 30 per cent of the smaller specimens. In addition, ramps with a slope of more than 6 per cent often represented an impassable barrier for smaller brown trout. Slopes of more than 5 per cent posed difficulties for cyprinid species with lower swimming capacities. At a maximum flow velocity of 2 metres per second, upstream passage was also found to be impossible for small fish such as the gudgeon or vairone.

In view of the varying demands of individual fish species, the researchers recommend that monitoring should be carried out prior to the construction of a block ramp, so that the target species can be determined and their particular requirements taken into account. They also stress the necessity of monitoring during the post-construction phase, so that the ecological functioning of block ramps can be evaluated and appropriate adjustments made to the design of future structures.

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Further information:

>> Original publication in Aquatic Sciences

>> www.rivermanagement.ch

>> Federal Office for the Environment information sheet no. 6 on passability of block ramps (available in French/German/Italian)

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