Nature-like fish passes as migration routes and compensative habitats

Les passes à poissons dites naturelles comme voies de migration et comme habitats compensatoires

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RÉSUMÉ

Les passes à poissons dites naturelles ont prouvé leur efficacité pour des poissons à faible capacité de nage. Elles offrent aussi des habitats de croissance de juvéniles et de reproduction notamment utiles pour compenser la perte des habitats due à la présence de zone de remous résultant des centrales hydro-électriques. Au Canada il y a un long historique de construction de canaux de reproduction, d'alevinage et de croissance pour les saumons. En Europe les meilleurs exemples de centrales hydroélectriques allient passes à poissons et création d'habitats de reproduction.

En Finlande le ruisseau urbain de Imatra, planifié comme habitat pour la reproduction de la truite, a une grande densité d' alevins de truite. Dans cette communication, la morphologie du ruisseau est présentée comme la base pour les bons résultats. Une productivité élevée semble possible en dépit de débits relativement faibles, ce qui est encourageant pour des projets similaires. Le ruisseau a aussi une valeur pour le paysage et pour le tourisme.

ABSTRACT

Nature-like fish passes have proved to be efficient for weak swimming species, thus creating an opportunity for ecological continuity. Also juvenile production can be possible. New compensative reproduction habitats are needed in rivers with hydro power plants, especially if original habitats are deteriorated by drying or impoundment of river sections. In Canada there is a long history of constructing special spawning and rearing channels for salmonid fish. In Europe the best new cases of hydropower have combinations of fish passes and constructed reproduction habitats.

In Finland the Imatra urban brook, which was aimed as reproduction habitat for brown trout, has a high density of trout juveniles. In this paper channel morphology and hydraulics of the brook are presented as a basis for the good monitoring results. High productivity seems to be possible even with relatively small discharges, which is encouraging for further similar projects. The brook has also value for landscape and tourism.

KEYWORDS

Bypass channel, compensative habitat, environmental flow, fish pass, reproduction

1 INTRODUCTION

Removal of dams is not always possible for reasons like hydro power, cultural history and needs to preserve water levels upstream. By gentle sloped nature-like weirs and rock ramps water levels can be maintained and they serve also as instream fish passage facilities. They enable migration and in many cases also reproduction of fish like natural rapids. One option is to construct a fish pass around the obstacle. The best way is to construct a nature-like fish pass which resembles a natural brook or small stream. The performance of nature-like fish passes has proved to be good for all kind of species, also weak swimmers, as heterogeneous bottom substrates provide diverse vortexes and swimming possibilities. The location of the entrance and water intake and the amount of discharge are essential for the attraction of fish up and downstream. Even spawning and rearing of fish juveniles has been noticed in nature-like channels which were mostly planned for migration.

Special spawning and rearing channels have been constructed in Canada from 1950'ies, already. The first spawning channels were meant for spawning of some salmon species and they were technically operated like hatcheries. The later rearing channels from the 2000's are more nature-like and they provide natural but specially planned circumstances for the reproduction of several Pacific salmon species and also Atlantic salmon. The channels are like small side channels of the main river, with an even discharge to avoid limiting circumstances during floods. The juvenile production of such channels has been good.

Reproduction channels have been lately constructed also in Europe. The legislation and permitting in many countries, like Germany and Switzerland require compensative habitats in renewal of hydropower permits, if natural reproduction areas will be deteriorated. The reproduction channels have been often designed as a combined system with fish passes, to ensure good location of the entrance near to the dam. Promising results have been gained and there is a need to get more experience of their possibilities. Examples of dam modifications, fish passes and constructed reproduction channels are presented as backround for the case study in Finland.

1.1 Mitigating the impact of dams

The removal of the Koskenkylä dam was one of the first removals of dams in Finland in 1993. The middle part of the 2 metres high dam was removed and the sides were left as memory of the history. The remnants also serve as platform for viewing the rapid. The rapid with about 50 m width was restored for reproduction of sea trout. The original water level of the dam was maintained by a nature-like submerged weir.

The restoration of the Mattilankoski dam in 2015 is an example of reconstructing a fish ramp into a dam and preserving the possibility of water intake to an old sawmill. The fish ramp is gentle sloped and can serve as habitat for sea trout.

The use of the small Sågarsfors powerplant in the river Siuntionjoki was stopped by buying it by private people. The dam was opened in 2006 and the impounded area was restored for trout. A bypass channel with discharges from one to two m2/s was constructed to enable migration and to create habitats.

1.2 Perfomance of nature-like fish passes

The nature-like fish pass in Biron at the river Gave the Pau, France has proved to be 100 % succesful for upstream migration of salmon in a telemetry monitoring. The fish pass has a discharge of 5 m3/s and it is also used for canoeing. The only problem at the power plant is downstream migration of eel.

The nature-like fish pass at Kissakoski power plant in Finland, constructed in 2012 has been monitored by video calculator in 2017. Altogether 17 000 fish were detected, most of them weak swimming species. The power company wants to modify the fish pass for trout juvenile production.

1.3 Spawning and rearing channels in Canada

The rearing channel at Seton river, British Columbia was originally constructed for the spawning channel and it was modified for rearing of king salmon, silver salmon and steelhead in 2003. The length is 3,8 km and discharge 1,12 m3/s and depth 0,38 m. The gradient is only 0,1%, in some sections 0,7 %.

The rearing channel at the Granite Canal power plant in Newfoundland was constructed in 2003 to compensate the loss of 4,5 hectares habitats with equal new area. The channel is 2 km long and

discharge 1,25 to 5,5 m3/s. A lake salmon stock of Atlantic salmon uses the channel and 55 to 150 juveniles per 100 m2 have been monitored, which exceeds densities in natural rivers.

1.4 Combinations of fish passes and reproduction areas in Europe

Combinations of long reproduction channels with diversion into a fish pass have been constructed in the basin of the river Rhine in Switzerland and Germany. The rearing channel at the Rheinfelden power plant, constructed in 2012, is 1 km long and 50 m wide and has discharge 10 to 25 m3/s. (Gebler 2013). In a monitoring 34 500 fish individuals from 33 species were caught.

2 CASE STUDY: IMATRA URBAN BROOK, FINLAND

2.1 Design and construction

The Imatra urban brook was constructed in 2014 at the biggest waterpower plant in Finland. The aim was to create a spawning habitat for the local trout in the river Vuoksi and also to design an attractive element in the touristic landscape. The channel is 1 km long and has discharges 0,3 m3/s in summer and 0,15 m3/s in winter. The habitat section was designed gentle sloped to create habitats. In the planning flow and habitat modelling was used to evaluate performance in advance. (Jormola et al.2016, Koljonen et al.2016). The finalization of the channel was done according to principles of rive restoration, adding diverse substrates and large woody debris.

2.2 Monitoring of hydraulics, invertebrates and fish

After construction velocities and depths were measured and they showed good values for habitats. Macro invertebrates have been monitored to evaluate colonization and nourishment for fish. In electro fishing best densities for brown trout were 50 juveniles/100 m2 in 2016 and 150 juveniles/100 m2 in 2017.

2.3 Discussion

The Imatra urban brook has shown a very rapid colonization of brown trout and increasing densities of juveniles. The design and construction was successful, despite some need for reparations. Slush events during frost and lack of planned discharges have not impacted the juvenile production severely. The diversity and amount of macro invertebrates has been increasing, giving nourishment. Further monitoring will show the limits of juvenile production.

3 CONCLUSIONS

3.1 Advantages of compensative habitats

Compensative reproduction habitats are a promising option to increase natural reproduction of migrative fish in constructed rivers. Possibility to construct them should be always considered when planning fish passes and migration routes. Nature-like channels which resemble natural streams and rapids create also values for recreation in sites where natural rapids have vanished.

3.2 Discharges as environmental flows

The relatively small amount of discharge which is needed for functioning reproduction channels shows that there is no reason for power companies to choose a technical solution with closing of discharge for winter. The even discharges of reproduction channels seem to provide much higher densities and juvenile productivity than in natural rivers with floods. Thus they represent the most efficient form of environmental flows and they can often be used as a part of discharges needed also into dry river sections.

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