Modelling fish recruitment potential of lithophilic fish in restored rivers by means of functional habitat and population dynamics modelling

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ABSTRACT: In hydropower impacted rivers the degradation of suitable habitats due to channelization, lack of sediment supply and interrupted longitudinal connectivity have strongly affected populations of rheophilic and lithophilic fish species, which rely on availability of gravel banks and shallow littoral zones for successful reproduction. The construction of nature-like bypass channels and bank restorations aim to mitigate these deficits by improving longitudinal connectivity and providing key habitats for early ontogeny, in particular for spawning, larval and juvenile development. Predicting and assessing long-term effects on fish populations following measure implementation is however challenging, because of complex recruitment processes acting at various spatial and temporal scales.

We developed an integrated modelling approach that links a functional habitat suitability model with a fish population dynamics model. The approach considers availability, quality and functional connectivity of the most critical habitats during early ontogeny, i.e. spawning and larval nursery habitats. Functional connectivity between suitable spawning sites and nursery habitats is estimated using a larval drift model simulating passive-active larval movement. The recruitment potential is finally assessed using a spatially-explicit fish population dynamics model, in which density-dependent survival rates for spawning and larval development are parametrized based on estimated carrying-capacities for eggs and larvae.

The presented modelling approach allows predicting recruitment potential of lithophilic fish species at existing and planned restoration sites,and can be applied to maximise recruitment potential by identifying habitat bottlenecks and defining optimal spatial shares of essential, functionally connected key habitats.

We tested the approach on a newly restored system at the Ering-Frauenstein Hydropower-Plant in the Inn River (South-East Germany) comprising both nature-like fishpass and restored side-channel downstream of the hydropower dam. Recruitment potential was estimated for four riverine, rheophilic, lithophilic fish species (*Thymallus thymallus; Chondrostoma nasus; Barbus barbus; Squalius cephalus*).