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Assessing Impacts of Hydropower Regulation on Salmonid Habitat Connectivity to Guide River Restoration

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Anthropogenic activity in riverine ecosystems has led to a substantial divergence from the natural state of many rivers globally. Many of Scotland's rivers have been regulated for hydropower with increasing intensity since the 1890s. At the same time they sustain substantial populations of Atlantic Salmon (Salmo salar L.), which have a range of requirements in terms of flow and access to habitat, depending on the different life-stages. River barriers for hydropower regulation can change the spatial and temporal connectivity within river networks, the impacts of which on salmon habitat are not fully understood. Insight into such changes in connectivity, and the link with the distribution and accessibility of suitable habitat and areas of high productivity, are essential to aid restoration and/or conservation efforts. This is because they indicate where such efforts might have a higher chance of being successful in terms of providing suitable habitat and increasing river productivity.

In this study we applied a graph theory approach to assess historic (natural) and contemporary (regulated) in-stream habitat connectivity of the River Lyon, an important UK salmon river that is moderately regulated for hydropower. Historic maps and GIS techniques were used to construct the two contrasting river networks (i.e. natural vs. regulated). Subsequently, connectivity metrics were used to assess the impacts of hydropower infrastructure on upstream and downstream migration possibilities for adults and juveniles, respectively. A national juvenile salmon production model was used to weight the importance of reaches for juvenile salmon production.

Results indicate that the impact of barriers in the Lyon on the connectivity indices depends on the type of barrier and its location within the network, but is generally low for both adults and juveniles, and that compared to the historic river network the reduction in the amount of suitable habitat and juvenile production is most marked in the upper reaches of the river.

This study represents an improved approach over more commonly applied assessments that focus on the impact of impoundment on wetted area or river length. Simpler approaches often lack ecological and hydrological detail leading to over- or underestimation of the impacts of river regulation on connectivity depending on the relative quality of available habitat.

Our work aims to integrate hydrological and ecological aspects into a spatially explicit connectivity framework. Such an approach can help to better identify those areas most important to the conservation of fish habitat, inform sustainable management of hydropower schemes, and aid cost-efficient river restoration and management efforts.