

## Mapping the natural values and ecological rehabilitation potential of Sweden's bypassed river reaches

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**ABSTRACT:** One of the primary impacts of dams and regulation on river systems is the loss of rapids and water falls, as the fall height is used for electricity production in hydropower stations. What is the ecological state of such reaches, and what can be done to improve their ecological conditions? To address these questions, we created a database of all bypassed reaches in Sweden, that is, river sections where discharge has been diverted to hydropower stations, which leaves the original river channel dry or with reduced discharge. There were 972 bypassed reaches meeting our criteria, and the majority of these lack any mandates on minimum flow release: Out of 622 reaches with flow data, 481 lacked mandated minimum flow release. The 137 bypassed reaches with minimum flows had an annual flow averaging only 3.6% of their pristine mean annual discharge.

The mean slope of the channels of the bypassed reaches was relatively high (3.6%), and they generally correspond to runs and rapids in terms of flow velocity. The average length of bypassed reaches was 1,317 m, with a median length of 319 m, the distribution being skewed with many short and fewer long ones. The majority of them were positioned in the lower reaches of catchments, in stream order 1 and 2 counting from the mouth. The bypassed reaches had a lower proportion of rheophilic fish species and lower fish abundance compared to reference sites in free-flowing rivers, according to electrofishing data. Bypassed reaches with minimum flow release had fish communities with higher proportion of rheophilic fish species, higher abundance of fish, and more fish species per site compared to bypassed reaches with no minimum flow release. Furthermore, the proportion of rheophilic over lentic fish species, fish abundance as well as species richness of fish increased with increasing magnitude of minimum flow release, with diminishing returns at higher flow levels.

Collaboration among stakeholders (including hydropower managers, authorities, consultants and NGOs) is key to be able to select which bypassed reaches to be targets of ecological rehabilitation, and to implement ecological rehabilitation measures. We present a framework to facilitate the process, and discuss the competences needed for a successful process, as well as a methodology going from mapping, to analyses of impacts and needs, and projection of potential benefits of ecological rehabilitation options. To facilitate making decisions on the magnitude of minimum flow release, we present a list of ecosystem states or functions, and the aspect of the flow regime needed to maintain them. This can help determining the flow needed to obtain specific ecosystem functions or states, or conversely, given flow, what ecosystem functions and states are realistic to achieve.