



The role of sediment supply on fish habitat dynamics in river widenings

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Flow and sediment regimes are key to aquatic and floodplain habitats. Natural hydro-morphological processes are essential in creating such habitats and sustaining their ecological functions. River morphological changes are known to influence aquatic species by affecting availability and accessibility of habitats, energy expenditure, and behaviour. Climate change and human activities, for example damming and channelization, have altered these regimes, intensifying flooding and droughts and causing sediment starvation issues in these river systems. Sediment starvation has led to river narrowing and disconnection from floodplains, reducing habitat heterogeneity and consequently causing a loss of freshwater biodiversity. River restorations such as river widenings have recently been proposed to favour morphological processes and restore physical heterogeneity.

The morphological trajectories of river widenings depend on the level of sediment supply. Although some evidence supports the role of sediment supply in the evolution of widening morphologies, the linkage to fish habitat remains poorly understood. Therefore, we explored the following research questions: (i) What trade-offs exist among sediment supply, flow discharge, and habitat availability in river widenings? (ii) What morphological processes are associated with habitat dynamics, and how do these processes vary under different sediment supply levels? (iii) How can flood events alter these relationships?

Starting from experimental widening morphologies formed under various sediment supply levels and hydraulic conditions, we delineated the habitat availability of brown trout (*Salmo trutta*) under multiple discharge conditions using 2D hydrodynamic models and habitat suitability curves. We analyzed the habitat change and stability spatially between the evolution phases of the widening morphologies and investigated closely the underlying morphodynamic processes driving these habitat dynamics.

Our results reveal that widening morphologies formed with near-natural sediment supply showed a significant increase in habitat availability at all discharge conditions—especially drought and flood discharges—compared to the initial channelized state. Notably, the flood event further enhanced habitat availability at low flow conditions in these scenarios. Conversely, widening morphologies with reduced sediment supply did not show an improvement in habitat quantity

during the widening formation phase or after a flood event. Furthermore, sediment supply levels clearly influenced the morphological processes responsible for habitat loss, gain, and persistence. This study advances our understanding of riverscapes by disentangling the role of sediment supply and flood events on fish habitat dynamics. Ultimately, these insights can guide us toward more effective restoration practices that promote resilient river ecosystems.