

[Integrating and extending ecological river assessment: concept and test with two restoration projects \(Paillex et al. 2017\) \[1\]](#)

While the number of river restoration projects is increasing, studies on their success or failure relative to expectations are still rare. Only a few decision support methodologies and integrative methods for evaluating the ecological status of rivers are used in river restoration projects, thereby limiting informed management decisions in restoration planning as well as success control. Moreover, studies quantifying river restoration effects are often based on the assessment of a single organism group, and the effects on terrestrial communities are often neglected. In addition, potential effects of water quality or hydrological degradation are often not considered for the evaluation of restoration projects.

We used multi-attribute value theory to re-formulate an existing river assessment protocol and extend it to a more comprehensive, integrated ecological assessment program. We considered habitat conditions, water quality regarding nutrients, micropollutants and heavy metals, and five instream and terrestrial organism groups (fish, benthic invertebrates, aquatic vegetation, ground beetles and riparian vegetation). The physical, chemical and biological states of the rivers were assessed separately and combined to value the overall ecological state.

The assessment procedure was then applied to restored and unrestored sites at two Swiss rivers to test its feasibility in quantifying the effect of river restoration. Uncertainty in observations was taken into account and propagated through the assessment framework to evaluate the significance of differences between the ecological states of restored and unrestored reaches. In the restored sites, we measured a higher width variability of the river, as well as a higher width of the riparian zone and a higher richness of organism groups. According to the ecological assessment, the river morphology and the biological states were significantly better at the restored sites, with the largest differences detected for ground beetles and fish communities, followed by benthic invertebrates and riparian vegetation. The state of the aquatic vegetation was slightly lower at the restored sites. According to our assessment, the presence of invasive plant species counteracted the potential ecological gain. Water quality could be a causal factor contributing to the absence of larger improvements.

Overall, we found significantly better biological and physical states, and integrated ecological states at the restored sites. Even in the absence of comprehensive before-after data, based on the similarity of the reaches before restoration and mechanistic biological knowledge, this can be safely interpreted as a causal consequence of restoration. An integrative perspective across aquatic and riparian organism groups was important to assess the biological effects, because organism groups responded differently to restoration. In addition, the potential deteriorating effect of water quality demonstrates the importance of integrated planning for the reduction of morphological, water quality and hydrological degradation.

Keywords

Aquatic macroinvertebrates; Aquatic vegetation; Ecological state; Fish; Ground beetles; Multi-criteria decision analysis; Multi-attribute value theory; Thur and Töss rivers; Riparian vegetation; River restoration; Uncertainty

Publication Date:

Saturday, 13 August 2016

Full reference:

Paillex, A., N. Schuwirth, A.W. Lorenz, K. Januschke, A. Peter, P. Reichert (2017) Integrating and extending ecological river assessment: Concept and test with two restoration projects. *Ecological Indicators* 72: 131-141.

Link to DOI:

<http://dx.doi.org/10.1016/j.ecolind.2016.07.048> [2]

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