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Adjustment of channel morphology and complexity following restoration of timber-floated rivers

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River restoration is essential to reverse biodiversity decline and improve river resilience to climate change. In northern Sweden, virtually all rivers were historically timber-floated and thus channelized with all complexity elements (e.g., boulders, islands, side channels) removed. In these rivers restoration design is determined in the field by a team leader directing an excavator driver. This efficient methods allows restoration of 100s of river kilometers annually; however, there is little to no monitoring of restoration outcomes. Thus, the influence of restoration on channel morphology and habitat complexity is unknown. Furthermore, response of semi-alluvial rivers constrained by glacial legacy sediment (e.g., boulders) to restoration is poorly understood and expected to differ from their alluvial counterparts. In this study, we followed up eight reaches in the Lögde River catchment (~64° N, DA: ~1600 km^2) restored as part of the EU LIFE project ReBorN. Reaches were equally divided above and below the former-highest coastline (FHC), demarcating different glacial histories and surficial geologies (semi-alluvial vs. alluvial channels). To evaluate the influence of river size on channel response to restoration, half of the reaches were located on tributaries and half of the reaches were on the mainstem of the Lögde River. We surveyed all reaches with a total station or RTK-GPS prior to restoration and 1-year and 3-years post-restoration. Hydromorphologic characteristics and complexity metrics were calculated and compared among years to determine changes during and post-restoration.

As expected due to the nature of the restoration methods, channel size increased, with significant increases in channel width and planform area. Although channel complexity showed increasing trends, few were significant except three metrics describing the longitudinal profile (α= 0.10); one complexity metric showed a significant decrease (thalweg planform sinuosity). In the 3-year period following restoration, channel width, planform area, and depth decreased. Complexity metrics either showed no change or a similar trend of decreasing, with significant decreases in three metrics (width SD, thalweg concavity, and thalweg R^2). There were no significant differences between reaches above and below the FHC or between the mainstem and tributaries.

Overall, these reaches were over-dimensioned during restoration and post-restoration adjustment shows slight narrowing. Inset bankfull channels started forming with vegetation establishing below the designed bankfull channel. An over-dimensioned channel reduces overbank flooding and thus lateral channel-floodplain connectivity, negating a restoration design aim. The decreased post-restoration complexity indicates a smoothening of the longitudinal profile and planform bankfull

profile through sediment settling and preferred areas of erosion/deposition, rather than the artificial complexity created by the excavator. Although eight reaches were too few to reveal many significant changes, many post-restoration studies make conclusions based on a single reach, thus the trends shown here indicate similar processes acting across several reaches. Similarly, three years is a short time period to evaluate post-restoration channel adjustment, particularly in semi-alluvial boulder-bed rivers. Ideally, river restoration should be followed up for at least a decade, allowing the river to experience high flows and potentially varied winter ice conditions.