

Growing and surviving in dynamic floodplains: How does habitat heterogeneity drive young fish in the lower river Rhine

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Many ecologists work to better understand the ecological functioning and complexities of both natural and man-made ecosystems in order to guide restoration efforts. Temporal rivers face unique challenges because of their dynamic, and thus unpredictable, nature, which is influenced by fluctuations in river discharge levels caused by snowmelt, glacier melting, and rainfall. This causes temporal and spatial variability in the availability, quality, and accessibility of habitats for riverine and terrestrial biota, which affects floodplain habitat heterogeneity at any given time. Unlike in many terrestrial systems, changes in river-floodplain habitats can be abrupt, forcing biota to quickly adapt to new environmental conditions and complicating research. Healthy fish populations in rivers have become increasingly important in recent decades, and the restoration of dynamic floodplains has emerged as a top priority in freshwater conservation efforts. Over the last 30 years, many floodplain restoration projects on large lowland rivers such as the Rhine have been completed, including lowering groynes, reopening side channels, connecting floodplains, and relocating dikes. Although the proportion of floodplain nurseries has increased as a result of these restoration efforts, fish populations have yet to reach the desired levels. For the lower river Rhine, almost all of the original fish species are still found, but eurytopic species (less habitat-critical species) continue to dominate the fish fauna, while rheophilic species (specialised river fishes that require flowing water) are underrepresented. To improve recruitment success and restore these sensitive riverine fish populations in the Rhine, we have to first comprehend if and how these restored dynamic floodplains function as nurseries for such species. To assess the ecological efficacy of restored floodplains and dynamic habitat use by young-of-the-year fishes in the lower Rhine (the Netherlands), we collected and analysed a unique data set from over 50 restored floodplains over four growing seasons (March to October 2017-2020). This study shows that restoring floodplains in the Lower Rhine is effective. Each project type provides nursery habitat for different ecological guilds, species, and community characteristics (such as biodiversity or abundance). To increase (sensitive) rheophilic fish populations and overall fish diversity in modified large rivers, we propose that river restoration efforts concentrate on establishing spatially heterogeneous patterns and processes in floodplain restoration projects along the river (as in dynamic natural rivers), with a focus on one-sided and two-sided connected channels of appropriate dimensions that have year-round and long-lasting connectivity to the main channel.