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Editorial: Challenges and benefits of restoring river connectivity

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Editorial on the Research Topic
Challenges and benefits of restoring river connectivity

Rivers rank among the most threatened ecosystems in the world, but also the most valuable to society. Conflict over water is not only one of the most widespread global stressors, but also the one most likely to impact humans and nature. People have dammed rivers for centuries to divert water, transport goods, catch fish, and generate power. Despite the continued worldwide increase in dam construction, many barriers are obsolete or abandoned. This opens opportunities for river restoration through dam removal, the re-establishment of environmental flows, and the reconnection of organisms with habitats, nutrients, and sediments. This is explored in the six articles of this Research Topic, contributed by projects of the European Regional Center for Ecohydrology (ERCE) of the Polish Academy of Sciences, the EC-funded Horizon 2020 Projects AMBER (www.amber.international), FIThydro (https://www.fithydro.wiki/index.php/Main_Page; https://www.lestudium-ias.com/consortium/ecohydraulics-and-dam-removal), and the LeStudium consortium on Ecohydraulics and Dam Removal. One example of the complexities of managing river barriers is demonstrated by the review of Jones et al. which examines the use of artificial instream barriers to contain the spread of aquatic invasive species (AIS) without impacting on native fauna. Jones et al. concluded that the jury "is still out" as few studies have assessed the impacts of "exclusion barriers" on native species, and those which have were either too short or employed an inadequate study design. AIS are major threat to freshwater biodiversity, but so is river fragmentation. Two wrongs don't make a right and before exclusion barriers can be widely recommended their design and operation must be refined to allow unimpeded passage of native fauna and exclusion of unwanted species.

Assessing the impacts of dams, and the benefits of dam removal, is not easy but new technological advances provide some help at hand for the river restoration manager. One powerful addition to the river restoration toolkit is the use of environmental DNA (eDNA) retrieved from water samples. Muha et al. used a before-after-downstream-upstream (BADU) approach to monitor changes in fish community composition following the removal of a 1.85 m high weir. No change in fish diversity or relative abundance were detected, most likely because the time line was too short as only 9 months elapsed between the removal of the weir and the collection of samples. The use of eDNA made it possible to detect the endangered European eel, which had been overlooked by traditional sampling technique, showing the potential of this technique for assessing river fragmentation caused by instream barriers and its value for both assessing barrier impacts and monitoring the effects of barrier removal. However, absence of evidence is not evidence of absence, and to document the benefits of dam removal it is essential that adequate temporal scales and proper study designs are adhered to.

One challenge to make dam removal more widely accepted as a restoration tool is to develop appropriate narratives. The study of Arboleya et al. examined awareness of environmental impacts of river fragmentation and the benefits of dam removal among university students taking different degrees. Clear differences in awareness and willingness to pay were found between students enrolled in different disciplines (education, natural science, engineering), most likely reflecting different backgrounds and values assigned to natural capital. This suggests that to maximize the value of restoring connectivity in the conservation of freshwater biodiversity, convincing narratives need to be developed and this can only be achieved if stakeholder diversity and differences in stakeholder perceptions are taken into account.

The study of Bubb et al. examined the short-term effects of removing 22 low-head weirs (<3 m) in England and Denmark using a before-after approach. As expected, weir removal restored the former habitats upstream of the weirs, making the former ponded waters faster and shallower, and reducing the proportion of fine sediments. No change in fish species richness and diversity were detected, most likely because of the short duration of the study (1–2 years), although an increase in the density of juvenile Atlantic salmon and brown trout was detected in one third of removals. Taken together, the interventions monitored in this study show that weir removal can be very effective in restoring lotic habitats quickly, but the response of fish communities may take longer to become apparent and may be more context specific.

The removal of two large dams in the Elwha River (USA) has attracted of lot of attention in recent years and has served to showcase the benefits of dam removal for migratory fish. Duda et al. assessed the spatial distribution of anadromous (migratory) and potadromous (resident) fish following the Elwha removals. Before the dams were removed in 2014, the Pacific lamprey and seven anadromous salmonids were restricted to the lowermost 8 km of the river and had been extirpated from their historical spawning grounds in the headwaters for over 100 years. Within 5 years of the removals, all but one of migratory species had colonized the upper reaches, extending their range by 50–60 km in some cases. This was accompanied by a large increase in fish densities, suggesting that restoring access to the former spawning habitats of migratory fish can result in higher survival and, ultimately, in more abundant and resilient populations.

Dam removal is not the only way that streams can be reconnected. This is particularly true in the case of urban rivers that tend to be the ones that have been most heavily modified. The study of Wantzen et al. examined how stream "daylighting" (i.e., the resurfacing of buried streams) can be used to reconnect rivers with people, turning urban rivers into valuable blue-green "socio-ecosystems." More people live now in cities than ever before, and the benefit of urban rivers is becoming increasingly important in the face of climate change as many cities have turned into dangerous heat traps. However, not all urban rivers can be easily "resurrected" and Wantzen et al. provide practical advice on how to prioritize such rivers for daylighting, drawing on case studies across Europe and Asia.

Fragmentation is not the only problem rivers face, but defragmenting them is a necessary condition for effective river restoration. Healthy rivers are flowing rivers that generate, transport, and sort sediments. This is how dam removal outperforms other river restoration solutions: it rehabilitates sediment processes that allow habitat creation and channel adjustments, which make rivers more resilient against the impacts of climate change. Dam removal delivers ecological benefits beyond fish and fisheries, which are commonly underestimated by fish-focused investigations. The papers in this Research Topic identify some of the challenges for restoring river connectivity and offer some practical solutions for turning broken rivers into free-flowing rivers, based on hands-on experience drawn from real case studies.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

RT is employed by RiverFutures Ltd.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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