

# How Weirs Affect Fish Communities



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River restoration describes a set of activities that help improve the environmental health of a river or stream. These activities aim to restore the natural state and functionality of the river system to promote improved fish populations, biodiversity, recreation, flood management and development. Restoration to improve fisheries tends to focus on increasing habitat quality and diversity, and a popular method of achieving this is by addressing barriers such as weirs.

Humans have adapted rivers for our own use, modifying them to facilitate land use for agriculture and development, navigation, water supply, power generation and other priorities. Fish evolved in rivers before humans had this influence and are therefore not adapted to the modifications we have made, such as dredged sections, straight uniform channels and weirs.

However, weirs and their associated downstream pools and upstream slow deep reaches are valuable and popular fishing spots as they provide habitats and daytime refuge areas for large adult fishes. So a balance needs to be struck between improving the river ecologically (more fish!) and providing areas where fish are likely to congregate in the daytime when anglers are on the banks (hot pegs!)

Weirs impact rivers in two main ways;

1. Habitat fragmentation is frequently caused by human activities which disrupt the continuity of habitats used by wildlife and is a terrestrial conservation issue as well as an aquatic one. Habitats which were once continuous become divided into separate fragments, restricting the movements of organisms (*e.g.* fish) and separating them from habitats / resources / other fish required for their survival / the completion of their life-cycle. Fragmented habitats are also less resilient, preventing re-colonisation after pollution incidents and lowering genetic variability, due to the restricted effective population size, potentially placing populations at an evolutionary disadvantage.
2. River habitat is degraded by the creation of an impounded reach upstream (river-like habitats become lake-like) drowning out natural features like riffles, causing important spawning and nursery habitats for river fishes to be lost, thus lowering recruitment and breeding success. Also, natural processes such as sediment transport are prevented. Rivers are naturally dynamic with erosion and deposition occurring in balance, creating a highly varied mosaic of micro-habitats for all life-stages of fishes. Weirs arrest this natural tendency for change, creating a uniform static environment. Upstream an over deep river channel akin to a lowland river is formed in the impounded reach which may be inappropriate for the fish community (for instance, barbel habitat may become bream habitat). Impoundments also alter the temperature regime, oxygen content and cause siltation in the upstream reach.

Removal of the weir should always be considered as the preferred option, which solves both the main issues described above. However, total removal is often not possible due to the way the landscape has developed since the weir was built, and there is also a need to take account of the wishes of the land owners and river users, like anglers, who may value the weir and its effect on the river channel. Dependant on this, the next best option may be a partial removal (lowering of the weir) and/or the implementation of a fish passage solution, which solves part of one problem (reducing the impounded reach) and all of the other (connecting the upstream and downstream habitats). Fish passage solutions include natural bypass channels (preferred as these create additional habitat), rock ramps and technical fish passes *e.g.* Larinier.

The design of a fish passage solution (e.g. a natural bypass channel) needs to take into account the wishes of other river users (e.g. anglers), provide free passage and attraction flow for a range of sizes of the species of fish present through a wide range of flow conditions, and be deliverable for the usually tight budgets available for such works. Modelling, using an existing locally specific Environment Agency flood model (a computer simulation of the rivers flow at a specific location), can be used to satisfy these needs and to ensure no increase in flood risk for any nearby residential properties. This approach is best practice and gives all concerned (residents, deliverer and the regulator) the confidence to implement schemes with the simplest, most cost effective design.



*Photo 1 - Harpers Weir on the River Teise (Medway catchment, Kent), which was recently removed revealing thirteen new gravel riffles, additional spawning habitat for the native brown trout.*



*Photo 2 - A newly constructed nature like bypass channel around an impassable weir (visible to the left) on the River Darent, Kent.*

So, just to reiterate, weirs affect fish communities by causing two main impacts. The first is habitat fragmentation, which prevents fish migration and separates fish from habitats and resources that they need to survive and reproduce. If fish do not have access to appropriate spawning habitat, successful recruitment will be reduced. The second is habitat degradation, as a barrier impounds or backs up a river, producing a lake-like habitat in the upstream section instead of a free flowing river; drowning out natural features like gravel riffles, that are important spawning and nursery areas.

It is often thought that such problems only affect 'migratory' species such as salmon, sea / brown trout and eels, as their migrations are relatively easy to observe and for many centuries man has been exploiting these behaviours to harvest these fishes from our rivers with fixed traps like eel racks and fishing weirs. However, all fish migrate to some extent, and all fish have life stage specific habitat requirements. Salmonid species are not the only fish that spawn on gravel riffles: coarse species such as barbel, chub and dace are also affected by fragmentation and habitat degradation caused by impoundments. As with all fish species, recruitment success is dependent on the most limiting habitat requirement, potentially causing a population bottleneck. If a section of river can only support 100 juveniles of one year class as a result of the poor quantity or quality of juvenile habitat, this will limit the adult population size, as the adult population cannot be more than 100 of each year class.

Riffles provide cover in the form of weed growth, and are difficult places for predatory fish to hunt due to the fast current. They provide an abundant food supply of invertebrates, and overhead cover from a heavily rippled surface that hides them from predatory birds and other animals. Riffles are a good place to live if you are a baby trout or young salmon. They are also the preferred habitat for juvenile barbel. Riffles hidden under lake-like habitat upstream of a weir, lack the characteristics that make them great juvenile barbel habitats. If there are low numbers of small barbel, then there will be small numbers of big barbel and eventually no barbel at all.

Here, the trout and salmon fraternity are ahead of the game. The economic value of salmon (commercial and recreational) and the large declines in salmon populations since the 1980s have caused scientists and anglers alike to research and understand what the habitat requirements are for all life stages of these fishes. They have used this information to minimise potential population bottlenecks or limiting factors, due to available habitat. There are many things impacting our fish populations, but in-river habitat is the one thing that is relatively easy to address and benefits all wildlife. Organisations like the Wild Trout Trust have been encouraging progressive thinking and educating game anglers in fisheries management and river restoration. Lots of great work is going on out there, which is having a real positive effect on stocks. Coarse anglers need to take heed and follow this successful model, if we are to continue to enjoy high quality river fishing.

Coarse fish migrate and need to move around a river system to locate specialised habitats required at certain times and during certain conditions. Adult coarse fish such as chub, barbel, bream and roach migrate to spawn, often upstream, but also searching out the highest quality spawning habitat available to increase the survival of their eggs. Coarse fish lay their eggs on gravel (chub and barbel) and weed (bream and roach). The eggs take a few days to hatch into larvae and these larvae are then free-drifting with the flow of the river, until they find a suitable slack.

Modern telemetry tracking studies using implanted radio or acoustic tags have revealed these migrations. For example, in 2010 Dr Karen Twine, of the Environment Agency, radio tracked 20 adult barbel (6-15lb) in an 8.2 km reach (between two impassable weirs) of the Great Ouse for a year and a half. She demonstrated that the barbel utilised most of the river length available to them and made seasonal movements to spawning and over wintering habitats. Similarly, in 1993 Dr Martyn Lucas, of

Durham University, radio tracked 31 adult barbel (2-6lb) over 15 months in a 7.2 km reach of the River Nidd, a tributary of the Yorkshire Ouse, with open access to the Ouse. Again these fish were highly mobile, ranging over sections of river from 2-20 km in length, and their movements were associated with seasonal shifts in habitat, upstream spawning migrations and downstream migrations to over wintering habitats in the lower reaches and main River Ouse. Fish will basically move as far as they are able, to fully exploit the best available habitat / resources: the more limited those resources, the further they will go.

Other studies on less fragmented rivers with more limited essential habitats have shown that fish have the potential to move over very long distances, where they are able to, due to absence of weirs that would otherwise restrict their movements. During my PhD in 2006, I tracked the movements of 80+ adult common bream (4-7lb) over four years in a long 40 km reach of the Lower River Witham, a very uniform fenland river in Lincolnshire. My bream were tightly shoaled and relatively immobile in a deep tributary off the main river at the upstream extent of the reach during the winter, moving short distances of, on average, about <5 km a month, up and downstream. In the spring, they became highly mobile moving on average 30 km a month utilising the entire length of the river available to them, with one individual moving over 120 km in a single month! At this time they were visiting shallow tributaries off the main river, before using these for spawning in late May / early June. Once they had spawned, they spread out and spent the rest of the summer in the main river foraging, again moving on average 20-30 km a month up and downstream. In the autumn they moved back upstream to the deep tributary for the winter. This same yearly pattern was observed throughout the study.

These studies demonstrate that adult fishes use different habitats at different times of the year and require free passage between them. Habitat requirements are different for adult and juvenile fishes, so during its life a fish will have many different habitat requirements. These requirements will be more crucial for juvenile fishes, due to their vulnerability to predators and therefore their need to find safe cover. If any one habitat type is lacking, limiting or inaccessible, there will be consequences for individual survival and therefore the population as a whole. Weirs often restrict populations to those reaches that have sufficient connectivity to enable life-cycle completion, with the availability of the most limiting habitat type being the controlling factor or bottleneck for the population.

During my PhD I re-captured three of my bream that I'd been tracking for over a year and moved them 35 km downstream. They returned to their original point of capture within, on average, two weeks. Other fish species have also been shown to have this homing instinct and are therefore very aware of their surroundings. Floods often displace fish downstream, where there are no barriers to their movements, fish will follow their homing instinct to return to their previous area of residence once the flood has subsided. However, if the flood pushes them over an impassable weir they cannot return and as such fish can work their way further and further downstream.

One concern anglers and fishing clubs may sometimes have about weir removal is that club waters often only stretch for a few hundred yards, and anglers will want to keep 'their' fish in 'their' water. Weir removal presents a risk that fish may move to another section of river, free range fish! However, addressing degraded and fragmented habitats will improve the environment and lead to a healthier ecosystem with more fish in the longer term for all.

The impacts caused by weirs are problems for coarse fish as well as salmon and trout: the principles may not be as well understood or as popular, but they are real. We as anglers need to address this and other factors that are limiting fish populations if our rivers are to return to their former glory.



*Photo 3. Juvenile barbel have similar habitat requirements to salmon and trout parr: riffles provide cover from weed growth, an abundant food supply of nymphs dislodged by the fast current and overhead cover, due to the heavily rippled surface, that hides them from predators.*



*Photo 4. Male bream guarding marginal spawning sites in a shallow tributary off the main River Witham, Lincolnshire, in late May. Bream utilise oxbow lakes as spawning sites in natural 'unmodified' rivers: these shallow fen drain tributaries provide a surrogate habitat that allows them to reproduce. If these were unavailable or inaccessible due to impassable weirs, the bream population would suffer.*