DOES RIVER RESTORATION WORK?

By Dr Katie Whitlock

A controversial question perhaps, and one which at first glance may seem to have an obvious answer: of course it does. Featureless, straight, over-deepened channels can be re-meandered, narrowed and restored to introduce a variety of flow and habitat types. River restoration projects are generally carried out on the assumption that if these more natural hydrological and morphological conditions of a watercourse are restored, ecological recovery will follow. But is this the case? Does river restoration actually deliver the ecological improvements that we assume it will?

I first considered the evidence for whether river restoration actions benefit salmonid populations over a decade ago. It proved difficult to answer then and even now it seems that many of the challenges to reaching a definitive answer still remain. Why, after decades of undertaking river restoration projects across the globe, with billions of pounds invested on an annual basis, is an answer so hard to come by?

Lack of objectives/success criteria: The first challenge in answering the question lies in the question itself: does restoration 'work'? The objectives of river restoration projects are often poorly defined, making success difficult to assess. In these situations, there is a tendency for success to be judged using abstract criteria. For example, the majority of published studies consider their restoration projects to be successful, but only a small percentage support this with a measurable ecological outcome. The situation can be further confused by the potential for different stakeholder expectations/ requirements. Although many advocate that, by definition, the outcome of river restoration should be ecological, there is increasing recognition of the potential benefits of community engagement and the provision of wider ecosystem services.

Poor/insufficient monitoring: Where objectives and outcomes are poorly defined, monitoring is not designed to measure a specific outcome. Monitoring is frequently focused on the physical habitat change, rather than biological change. This is perhaps because of the challenges associated with monitoring biota, especially fish populations. Detecting significant changes in fish populations, particularly salmonids with their multi-year life histories and migratory behaviour, requires extensive monitoring both before and after restoration works. The minimum recommended post-project monitoring period is 10 years but most published studies include only a couple. The short-term nature of most monitoring is considered insufficient for outcomes to fully develop and there is the potential for temporary deterioration in habitat conditions during construction, generally associated with loss of macrophyte cover.

Monitoring may also need to include different life-stages to ensure that changes in juvenile salmonid abundance are genuinely linked to restoration actions, rather than a simple increase in migratory adult abundance - a situation encountered during restoration work on North American streams.

Even when outcomes are clearly defined, it may also be hard to deliver the desired monitoring due to constraints on funding. There is often a lack of long-term

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Above and below: River Bulbourne in Hertfordshire before and after restoration

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commitment for funding this aspect of projects and therefore vital opportunities are missed to capture important information on the effectiveness of actions being implemented.

Establishing cause and effect: Linked to the challenges of monitoring is the issue of establishing cause and effect, ie that any observed changes in fish abundance or survival is due to the restoration action(s) and not linked to other factors. There are a number of environmental variables that can influence the natural variability in salmonid abundance, such as temperature, flow, food availability, competition, etc., which may be difficult and/or costly to effectively monitor. To address this, some studies incorporate reference sites where no restoration work is undertaken, but this often raises challenges around true comparability. Questions can also remain over whether changes in abundance represent an increase in production or reflect a redistribution of fish within the watercourse, although some studies try to address this by including mark-recapture assessments.

Action not addressing limiting factor: For in-stream/riparian habitat river restoration to be effective, habitat quality should be the limiting factor for the population. River restoration actions are frequently carried out opportunistically with projects often conducted to address the symptoms rather than the wider-scale processes that may be affecting the observed environmental degradation. This happens with good reason and good intention: local river restoration projects represent an achievable action to contribute to environmental improvement. However, if another limiting factor/pressure (such as water quality, water quantity or non-native species) is having an ►

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over-riding influence on the fish population, limited benefits will be achieved by improving habitat alone.

Where actions are undertaken that have been directly linked to addressing a known population bottleneck, positive outcomes are generally observed. This has been demonstrated in multiple restoration projects for Pacific salmonids in North American streams where improving over-wintering habitat has been found to increase juvenile survival.

This is also the case for river restoration projects incorporating improvements to fish passage. The evidence base for the success of this type of restoration is more established as many of the identified pitfalls of project design are avoided. The issue is known (fish movement is restricted), the objective/outcome is clear (providing access to upstream habitat) and monitoring the effectiveness is relatively easy to achieve, potentially over quite short time-scales (for example by monitoring an installed fish pass, microtagging or upstream redd surveying/juvenile monitoring).

Works not at a scale to influence change: Many restoration projects conclude that a lack of observed ecological response may be due to the works not being at a scale relevant to the species. This is similar to the issue of not addressing the factor(s) limiting the population but also incorporates the consideration of habitat degradation and the action, or actions, required to restore conditions for a specific species. Having an understanding of the relationship between deteriorating habitat quality and a given ecological response variable may be key to delivering the most appropriate restoration action(s). Theory predicts that largely undisturbed catchments are predominantly influenced by local factors, with the relative importance of catchment factors increasing with disturbance level. Consequently, in-stream and riparian habitat improvements are likely to be most effective in undisturbed catchments, whereas catchment scale land-use management is more beneficial in degraded catchments.

The conclusion of such studies is that management must look beyond the river and the riparian zone to realise change on a scale that will benefit most salmonid populations.

And it is this final aspect that has changed the most in the decade since I first considered the available evidence on the effectiveness of river restoration. With limited ecological response frequently observed, approaches to river restoration have shifted from being habitat focused to seeking to restore the physical processes and functioning of whole river systems. Or, in some cases, seeking to remove the anthropogenic disruption of natural processes. River restoration actions are increasingly considered more holistically taking a Catchment Based Approach (CaBA), working collaboratively with multiple partners to identify and address pressures impacting a healthy water environment from source to sea.

More recently a 'stage zero' approach to river restoration is being trialled, removing even more of the human influence in deciding the form of the restored channel. Instead, the stage zero approach seeks to reconnect with the floodplain and allow the watercourse to decide its own new course. This has the potential to create multiple, braided channels likely to be more typical of those found in the UK before human disturbance. Benefits of the stage zero approach also include the potential to improve water quality through the creation of wetland habitat. Working in this way to restore natural processes also helps allow

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Above and below: River Meon in Hampshire before and after restoration

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systems to respond and evolve to future pressures, such as climate change, by improving water storage potential.

Such approaches may be more likely to address the fundamental causes of declines in salmonid populations and deliver restoration at the scale required to elicit a biological response. Practitioners are now well equipped with information to ensure ecological outcomes are considered and appropriately monitored to determine the biological response associated with physical recovery. For salmonids, this will always remain a challenging and potentially expensive task and it is likely to be some time before sufficient data are available in the published literature to determine effectiveness even if best practice is followed.

In the meantime, where does this leave us? Does this mean river restoration doesn't work? That's certainly not what I take from the evidence but it is harder to reach a definitive answer than we might hope. The right action carried out in the right place can clearly deliver the desired outcome. Restoration actions have also been found to be critical in preventing substantial worsening of the status of some salmonid populations. There are additional benefits for riverine terrestrial ecology, flood risk, aesthetics and from public engagement generating interest in local river environments. But without addressing the issues identified, there is the risk that the ecological response to the restoration of physical habitat, features and process will remain an assumption or expectation. Further evaluation of river restoration projects will improve confidence in the evidence base and help to inform future approaches which maximise the ecological benefit provided. ❐

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