Advisory Visit

River Gryfe (Gryffe)

03/07/2018

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Key findings

- The Gryfe is a heavily modified river in terms of both its channel, which is negatively impacted by weirs, and the flows it receives from reservoirs in the upper catchment. However, the river still has the potential to naturally produce viable populations of trout and grayling, as demonstrated by good angler catches of both on the river.
- The long sections with impoundments greatly reduce the availability of high-quality invertebrate and juvenile salmonid habitat.
- Ideally, all of the weirs on the river would be removed to reinstate a more natural geomorphological regime. This should be the long-term aspiration but, in the meantime, there are improvements that can be made to the existing cobble weirs to greatly reduce their impact.
- Additional buffer fencing to exclude livestock from the grazed sections of river would allow a better-vegetated river margin to develop and improve habitat for fish, invertebrates and a range of other wildlife.

1.0 Introduction

This report is the output of a site visit to Bridge of Weir Angling Club's (BOWAC) section of the River Gryfe in Renfrewshire, accompanied by several members of the club. The purpose of the visit was to provide a general habitat assessment and offer recommendations of how the river could be further developed as a wild trout fishery following the club's decision to cease stocking with farm-reared trout.

Normal convention is applied throughout this report with respect to bank identification, i.e. the banks are designated left bank (LB) or right bank (RB) whilst looking downstream. The Ordnance Survey National Grid Reference system is used for identifying specific locations and references to upstream and downstream are often abbreviated to u/s and d/s, respectively, for convenience.

2.0 Catchment and fishery overview

Table 1. Overview of the waterbody details for the section of River Gryfe visited

	Waterbody details
River	Gryfe
Waterbody Name	River Gryfe (Gryfe Reservoirs to Barochan Burn conf)
Waterbody ID	10031
River Basin District	Scotland
Current Ecological Quality 2016	Moderate Potential (as the waterbody is classed as heavily modified owing to the reservoirs and associated altered flows). The river is classed as moderate for fish and invertebrates.
U/S Grid Ref of reach inspected	NS 35893 67763
D/S Grid Ref of reach inspected	NS 38594 65854
Length of river inspected (km)	4

The Scottish Environment Protection Agency (SEPA) catchment summary states: *The River Gryfe (Gryfe Reservoirs to Barochan Burn conf) is a river (ID: 10031), in the River Gryfe catchment of the Scotland river basin district. The main stem is approximately 21.4 kilometres in length. The water body has been designated as a heavily modified water body on account of physical alterations that cannot be addressed without a significant impact on water storage for public drinking water. (https://www.sepa.org.uk/data-visualisation/water-classificationhub/)*

BOWAC is a medium sized club that provides fishing for locals and associate members along with day tickets. The club historically stocked farm-reared brown trout but have now ceased to protect and improve their wild populations of trout and grayling.

3.0 Habitat Assessment

The river was walked from Main Street, Bridge Of Weir, in an u/s direction to the upper limit of the BOWAC water.

Immediately u/s of the bridge are two pipe crossings (Figure 1); the farthest u/s of the two has disintegrated but the other still creates an obstruction to fish movement. Any raised step in the bed will reduce the potential for fish to move up and downstream, interrupting the flow and preventing easy swim-through conditions. Even small steps can create an issue, particularly in low flows, if the water is spread thinly over a wide cross section like a smooth weir or pipe. It is easy to overlook the importance of free movement for all fish at all flows, including small species and juveniles, which may be reliant on passage at lower flows owing to their reduced swimming ability.

Salmonids are subject to density dependent survival, so with plenty of good quality habitat, high survival rates can occur. However, as they become overcrowded, mortality rates greatly increase. Preventing fish from dispersing to find new territories and repopulate under-utilised habitat can therefore greatly reduce the performance of a population, as can delaying other natural movements of fish. Consider that delaying fish may mean that emigrating smolts miss the optimal period for entering saltwater, are more vulnerable to predation (e.g. by birds) or that adult fish are prevented from reaching their spawning grounds in time to spawn successfully.

The habitat in this area is would otherwise be naturally good, with exposed bedrock creating a healthy diversity of shallow water suitable for juvenile fish and deeper pocket water/pools where larger fish can reside. Bankside trees provide a good diversity of light and shade and will support a range of invertebrate life stages for aquatic and terrestrial species.

Figure 1. Although relatively low, the vertical step created by an old pipe crossing will inhibit fish passage, potentially preventing fish from migrating u/s or d/s when they need to, particularly in low flows. This may completely prevent the u/s movement of smaller fish if the velocity of higher flows exceeds their swimming ability. The location of the pipe on the edge of a rocky outcrop with little water depth d/s further reduces its passability.

A short distance u/s of the pipe, a small concrete weir creates the next obstruction (Figure 2). This is another relatively small structure but is likely to create a behavioural barrier and will certainly limit the movement of smaller fish. It should also be considered that grayling are very reluctant to ascend obstacles, particularly weirs, so any raised structures within the channel are likely to greatly inhibit their dispersal and habitat utilisation.


Figure 2. A small concrete weir creates another small obstacle. Bedrock at the side of the channel should improve passage somewhat by providing a natural adherent nappe (without a gap or entrained air), rather than the weiring type flow that is occurring along the rest of the vertical step.

Progressing further u/s, the first of many large boulder weirs was encountered. The boulder weirs were apparently installed as part of a well-meaning attempt to improve the habitat of the river. Now, with a greater understanding of the importance of natural river channels and the free movement of fish and sediment, it is unlikely that the installation of such structures would even be permitted. Other less damaging methods can be employed to increase the numbers of fish that a reach can produce and hold.

Figure 3. Looking d/s at the first of the boulder weirs encountered. Note the impounded flow in the foreground and the increased sediment deposition that is gradually filling the pool.

Upstream of the first two boulder weirs, a very much larger and very poorly passable concrete weir impounds the river for several hundred metres (Fig. 4). It appears that this weir was installed to protect a pipe crossing just u/s of it; this is very bad practice. Any service crossing points should be set well below the riverbed level, to protect the crossing and to allow the free movement of flows, sediment and fish past the structure. The weir now creates a major negative impact upon the physical functioning of the river, its habitat and its inhabitants, until it can be removed or altered, at significant expense.

Figure 4. A large, poorly passable weir that appears to have been created to protect a very poorly installed pipe crossing that should have been set below the riverbed level.

Contrary to common belief, weirs are not a positive feature in rivers. They impound the river, reducing flow diversity, and trapping sediment (gravels and silt) that should naturally pass through a reach, greatly degrading habitat u/s and d/s for fish and invertebrates. The deep water created on the u/s side is also only temporary as the impounded reach upstream will continue to trap sediment over time (ultimately filling the pool). This is because the impounded flows do not have the energy to adequately move the bed material supplied – a process that is required to create and maintain naturally occurring pools. Very localised erosion may continue immediately d/s of the weir, both to the bed and banks, but the rest of the pool will become increasingly poorer habitat over time. In low flows, much of the bed u/s of the weir will become smothered by fine sediment which blocks the spaces between the gravels that are required as invertebrate habitat and to supply oxygen rich water to salmonid eggs (should salmonids even manage to find an area suitable for spawning).

Figure 5 is a simplified diagram to depict just some of the major issues created by weirs and other artificial impoundments. Unlike natural scour pools, gravel bars and riffles, which are part of the natural mobile bed of a river, weirs lock the riverbed in place, preventing the natural grading and sorting of the material and greatly degrading the habitat it would otherwise provide. Impoundments therefore create long reaches with little or no spawning potential and poor invertebrate and juvenile salmonid habitat.

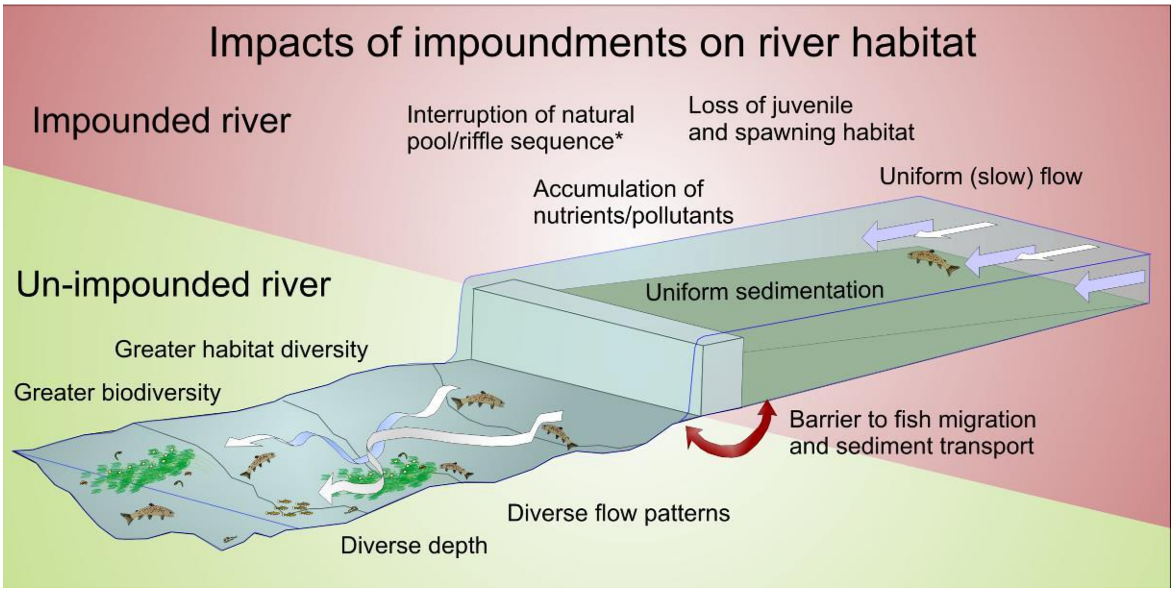

Figure 5. Raised structures such as weirs may temporarily create increased depth but the uniform, low energy flow and increased sediment deposition within the impounded reach ultimately lead to the pool filling in with bed material supplied from u/s.

Ideally, all of the weirs on the river should be removed. However, it may be worth retaining the boulder weirs d/s of the large concrete weir in the short-term, until the raised pipe crossing can be lowered below the bed level (or removed) and the concrete weir can be removed, to avoid lowering the bed d/s and increasing the obstruction. Fish passage could be 'improved' at the weir, but it would be far better to spend the time and money on lowering the pipe and addressing the issue, rather than the symptom.

One of the very few instances when weirs are somewhat beneficial is when they help to improve fish passage at other larger manmade obstacles (weirs or other intrusive structure) that can't be removed (as described above – in the short-term). In such situations, smaller weirs have historically been employed as pre-barrages (effectively a series of smaller, more accessible steps). However, pre-barrages are still a very poor substitute for removal of the offending structure and re-grading the bed with a continuous rock-ramp type easement is usually preferable to installing pre-barrages if an obstruction really cannot be removed.

It is difficult to mitigate the simplified habitat (lack of flow, in-channel structure and impacted channel morphology) within the impoundment u/s of an obstacle, where increased predation rates are likely to occur (Fig. 6). This includes parr and smolts on their d/s migrations while delayed by the impoundment. Low branches along the impounded reach provide some cover and introducing more of that structure would clearly be beneficial, as would planting trees like willows that can be laid into the channel once mature. Livestock access to the banks leads to a loss of vegetation diversity, erosion and fine sediment input and should be prevented.

Figure 6. A typical view of the impounded section u/s of the concrete weir, with very little flow and correspondingly poor habitat diversity. Retaining the low branches and introducing additional structures like trees and branches into the channel will enhance the area, providing some refuge for fish from predators and increasing the number of fish it may support.

The impoundment from the large concrete weir extends for approximately 300m u/s. Another smaller, largely submerged weir located approximately midway through that reach creates no major habitat issues, although it has almost certainly contributed to erosion of the RB d/s (Fig. 7). A slight fall over the next boulder weir further u/s (Fig. 8) signifies the u/s extent of the largest weir's impoundment. The smaller boulder weir poses negligible issues for fish passage, but the issues of sediment retention upstream (and associated infilling of the pool) are clear to see.

Figure 7. Largely submerged weir, which poses no real habitat issues other than potentially contributing to the erosion of the far bank.

Figure 8. ~300m u/s of the very large concrete weir, a boulder weir marks the first change in water level, with a small head drop over the weir. Note the large volumes of gravel that have been retained u/s of the weir, now filling in the tail of the pool.

Several similar full-width weirs are present in the reach u/s, creating more impounded, slow flowing pools with limited habitat potential for much of their length (Fig. 9). The uniformity of the flows (dispersed across the full channel width) means that sediment deposition is often quite uniform across the bed. This creates a featureless bed and uniform depth water, rather than allowing gravel bars to form along alternate banks (as would naturally occur) that that would focus flows towards the opposite bank and maintain bed scour and water depth.

If the large concrete weir is not removed, the impounded reach will ultimately fill with substrate and may develop some semblance of a natural bed, but this will take many more years and the lack of gradient (and flow velocity) there mean that it would always be degraded habitat. Removing all of the weirs should therefore be the long-term goal, to allow more natural sediment transport and distribution. However, until that can be achieved, having at least some in-channel structure there could assist with localised substrate retention, providing the structures are not full width weirs that impound the flow and block sediment transport. For this reason, it may be beneficial to notch the first two boulder weirs u/s of the large concrete weir down to bed level at alternating bank sides initially. This would reinstate sediment transport and create a sinuous flow pathway that moves from one bank side to the other between the cobble weirs that are located within the impounded reach of the large concrete weir.

Figure 9. Uniform, low quality habitat created by further weirs and impounded reaches. Notching the weirs down to bed level at alternate bank sides would reinstate sediment transport and provide a more naturally diverse, sinuous flow pathway.

Upstream of the weirs is a short section of natural, un-impounded river and much higher quality habitat for all fish and invertebrates. Aside from the issues already discussed regarding impoundments, drowning out shallower areas of the river also greatly degrades vital habitat that is required to produce invertebrates and juvenile trout. Habitat diversity is the key to healthy, sustainable fish populations and anything that alters the river from the state naturally formed by the flows it receives is likely to be detrimental. Shallower, faster sections are also vital to maintain healthy aquatic vegetation, as was observed in the more naturally flowing reaches.

Figure 10. A naturally shallow section of channel. These are vital nursery areas for juvenile trout and salmon and provide important invertebrate habitat. The shallower areas are also the only places that weed was observed during the visit. Particularly low flows at the time of the visit were facilitating excessive algal growth throughout the river.

Figure 11. A naturally deeper run that has been produced and maintained by bedrock and deposition of cobble substrate on the far bank side.

The man-made weirs begin again a short distance u/s, reinstating the uniform, ponded habitat. Valuable bankside trees provide shade and low cover, but the inhibition of natural flows creates a major negative impact upon the river habitat. As these are well outside the influence of the large concrete weir, the best course of action would be to fully remove them. Habitat enhancements such as tree laying and installation of more natural flow deflectors could also be undertaken if required, but it is anticipated that the habitat would greatly improve naturally. However, owing to the extent of the work required (number of weirs throughout BOWAC waters) an initial step could be to at least create alternating notches in the weirs. Reducing the integrity of the weirs may even lead to further redistribution of the boulders naturally over time. Although not particularly badly grazed, this area would certainly benefit from buffer fencing to allow a more diverse herbaceous river margin to develop.

Figure 13. Another series of impoundments. Ideally, these weirs should be removed, but even notching them down to bed level at alternating bank sides would improve habitat.

Upstream of the weirs is another uniform, straight section. It appears the channel could have been straightened here although it must have occurred over 150 years ago as it already appears straight on modern maps (Fig. 14). The habitat issues here are almost certainly exacerbated by the lowering of the bed and a lack of sediment retention in the straight, structure-less channel. Widening of the ford at the d/s end is increasing deposition on the riffle d/s, which now forms quite a steep gravel bar. Fencing livestock away from the river here (and any other areas where they have access) would be beneficial.

In this section, existing willows could be laid into the channel to increase flow diversity and encourage alternating areas of bed scour and deposition that will help diversify the channel. Additional trees (particularly fast-growing crack willow) could be planted to grow out into the channel and improve the habitat with natural inputs of woody material over time.

Figure 14. Straight, over-capacity channel section that would be improved by buffer fencing and tree planting.

Another straight section u/s has been walled/revetted along the LB (Fig. 15). The straightness of the channel will always limit the water depth but scouring alongside the walled bank should help to maintain some pool habitat. Shade and low cover from trees along the walled bank also provide habitat improvement and increase the numbers of fish the reach will hold.

Figure 15. Looking d/s at the straightened, revetted section.

U/s of the straight, walled section another more formal concrete weir was encountered. Again, the ideal solution is to remove the weir completely. If this really cannot be achieved, its passability could be improved by at least removing the wooden boards.

Figure 16. Formal weir with two sets of boards that should be removed.

The section u/s of the road bridge, to the limit of BOWAC waters, is far more natural, without the impact of impoundments (Fig. 17). Correspondingly, far higher quality substrate was observed, with several areas suitable for salmonid spawning (which is limited in other areas owing to the weirs). These areas offer similarly improved habitat quality for invertebrates. The LB field is grazed, and livestock access is creating issues with bank stability and erosion where the animals are entering the river to drink. This issue could be easily rectified with buffer fencing and the provision of pasture pumps along the fence line (N.B. a greater number of pasture pumps than normal are likely to be required because the livestock in the field were sucking cows, which will have a greater water requirement). As it appeared to only be cattle in the field (as opposed to sheep), relatively cheap breast-wire fencing may suffice.

In addition to the general habitat issues, large stands of Japanese knotweed were observed during the visit (Fig. 18). While these seem like a lesser problem, they have the potential to become a very serious issue if left unchecked. All plants should be treated with herbicide by a licensed operative. It would be advisable to tackle the weed at a wider catchment scale, collaborating with other river users and starting at the u/s extent.

Figure 17. Some of the more natural, high quality riffle habitat observed during the visit is found in the upper reaches, well away from the boulder weir impoundments. Grazing is degrading the bankside habitat here and buffer fencing would be beneficial.

Figure 18. A large stand of Japanese knotweed. All plants identified should be treated with herbicide.

4.0 Recommendations

4.1 Weirs

4.1.1 Large concrete Weir

Removal of the large concrete weir and the pipe (suspected to be a sewage pipe) that it protects should be seen as a priority. It appears that the pipe is in active use, so the pipe may possibly have to be lowered. This would be a far better option than any fish passage 'improvements' at the structure (even if it were considerably more difficult and expensive to achieve), as it could solve the problem permanently. If removal or lowering proved to be completely infeasible, fish passage options could be considered as a poor second best.

4.1.2 Boulder weirs d/s of the large concrete weir

In the short term, whilst the concrete weir is intact, it is worthwhile leaving the weirs d/s in place, to avoid the risk of lowering the bed and water level immediately d/s of the large concrete weir and reducing its passability further. If the large concrete weir is removed, or fish passage is improved, the boulder weirs d/s should be removed.

4.1.3 Boulder weirs u/s of the large concrete weir

These weirs should all be removed to allow a natural channel morphology to reinstate, with bankside willows laid into the channel to develop scour and deposition. If removing all of them is too great a task, in the shortterm, some could be removed with others notched down to bed level at alternating sides to at least improve flow diversity and facilitate a more sinuous flow pathway down the channel. Removing the impoundment and allowing sediment transport through the reaches would also allow scour to create and maintain deeper pool areas between the weirs. Planting, tree laying and installing flow deflectors could provide additional surrogate in-channel structure.

If some of the weirs are only notched, it is those at the u/s end of the large weir's impoundment that would suit that treatment best as they may be providing some beneficial sediment retention in the short-term (e.g. before the majorly impounded reach fills with sediment and natural bed raising occurs). Clearly, this concession would not be required if the pipe and weir (and associated impoundment) can be removed. In which case, the other weirs should also be fully removed.

4.1.4 Concrete weir with board slots

As with the other weirs, the best outcome for sediment transport, fish movement and river habitat is to completely remove the weir. If this is absolutely unachievable, the weir boards should be removed as a bare minimum.

4.1.5 Buffer fencing

Livestock access to the banks and the associated erosion and fine sediment input are a moderate issue on the Gryfe. The problems are not as acute as encountered on many watercourses, but installation of buffer fencing would greatly improve bankside habitat, particularly in the upper section. Fencing would facilitate greater diversity of bankside vegetation and tree/shrub regeneration and prevent over-widening of the channel through erosion. Ultimately, suitable trees that become established could then be laid into the channel to provide valuable additional structure.

4.2 Tree management

4.2.1 Planting

In any existing fenced areas lacking trees, and where any future fencing is undertaken, planting with locally native, deciduous tree species is recommended. Saplings could be purchased but the quickest and easiest way of establishing trees is by pushing short sections of freshly cut willow whip into areas of wet ground, ideally close to the waterline. Whip planting can be undertaken at any time of the year but will have the greatest success during the dormant season, shortly before spring growth begins (ideally late Jan-March). This kind of planting should be undertaken sparingly to avoid a proliferation of willows alone.

Whips should be planted into the ground so that there is a greater length ($^{2}/_{3}$) within the ground, to minimise the distance that water has to be transported up the stem. Planting them on a shallow d/s angle will also ease water transport within the developing shrub and reduce the potential for it catching debris and being ripped out. Leaving 300-400mm of whip protruding from the ground is often sufficient, providing this reaches past the surrounding vegetation (to allow access to light). Whips of 5mm-25mm diameter tend to take best, but even large branches can be used. If undertaken during the growing season, care should be taken not to leave excessive amounts of foliage on the whips as these greatly increase the rate of transpiration and can lead to their dehydration.

The species of willow whip used will depend upon the required result and what is native locally. Small shrub willow / sallow species, particularly grey willow and goat willow (*Salix cinerea and S. caprea*) tend to be best for creating low, dense fish holding cover, with larger individual trees eventually growing out into the channel, which can also be ideal for laying into the river margin. The larger tree species like crack willow (*Salix fragilis*) tend to grow fast and collapse under their own weight, so creating a great method of naturally introducing woody material and structure into a channel over time. The desired outcome and array of species naturally present should dictate what are used.

4.2.2 Tree Laying

The laying method involves cutting part way through the branch, quickly through the first two thirds, then continuing until it collapses down over the river (Fig. 19). The depth of the cut should be limited to only that which is required to bend the limb over, as this will maintain maximum size and strength of the hinge and the health of the tree/shrub. Being fast growing, willow can even be strategically planted in areas lacking low/trailing cover in anticipation of employing this technique once they become established.

Figure 19. Willow hinged into the river margin to increase cover and structure

4.3 Invasive species management

All Japanese knotweed plants should be treated with herbicide by a licensed operative. It would be advisable to tackle the weed at a wider catchment scale, collaborating with other river users and starting at the u/s extent.

5.0 Making it Happen

WTT may be able to offer further assistance such as:

- WTT Project Proposal
    - WTT can devise a more detailed project proposal (PP) report. This would usually detail the next steps to take in initiating improvements, highlighting specific areas for work, what

exactly is required and how it can be undertaken. The PP report could then form part of any required consent applications.

- WTT Practical Visit
    - Where recipients are in need of assistance to carry out the improvements highlighted in an advisory visit report, there is the possibility of WTT staff conducting a practical visit. This would consist of 1-3 days' work, with a WTT Conservation Officer(s) teaming up with interested parties to demonstrate habitat enhancement methods (e.g. tree kickers and willow laying etc.).
- WTT presentation/Q&A session
    - Where recipients are unsure about the issues raised in the AV report, it is possible that your local conservation officer may be able to attend a meeting to explain the concepts in more detail.

In these examples, the recipient would be asked to contribute to the reasonable travel and subsistence costs of the WTT Officer.

In addition, the WTT website library has a wide range of free materials in video and PDF format on habitat management and improvement:

www.wildtrout.org/content/wtt-publications

We have also produced a 70 minute DVD called 'Rivers: Working for Wild Trout' which graphically illustrates the challenges of managing river habitat for wild trout, with examples of good and poor habitat and practical demonstrations of habitat improvement. Additional sections of film cover key topics in greater depth, such as woody debris, enhancing fish populations and managing invasive species.

The DVD is available to buy for £10.00 from our website shop https://www.wildtrout.org/shop/products/rivers-working-for-wild-trout-dvd or by calling the WTT office on 02392 570985.

6.0 Disclaimer

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