River Windrush, Barrington, Gloucestershire

An Advisory Visit by the Wild Trout Trust January 2017

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Introduction

This report is the output of a visit undertaken by Mike Blackmore of the Wild Trout Trust on approximately 1.5km of the River Windrush at Barrington near Burford, Gloucestershire (national grid reference (NGR) SP 21264 12995 to SP 22844 13335). A walk-over of the site was requested by Mr. Robert Mills of Barrington Grove. The visit was primarily focussed on assessing habitat for wild trout (*Salmo trutta*) and biodiversity in general.

Comments in this report are based on observations on the day of the site visit. Throughout the report, normal convention is followed with respect to bank identification i.e. banks are designated Left Bank (LB) or Right Bank (RB) whilst looking downstream.

River	River Windrush
Waterbody Name	Windrush and tributaries (Little Rissington to Thames)
Waterbody ID	GB106039030440
Management Catchment	Cotswold
River Basin District	Thames
Current Ecological Quality	Overall status of **Moderate** ecological status (2009 and 2015)
U/S Grid Ref inspected	SP 21264 12995
D/S Grid Ref inspected	SP 22844 13335
Length of river inspected	~1.5km

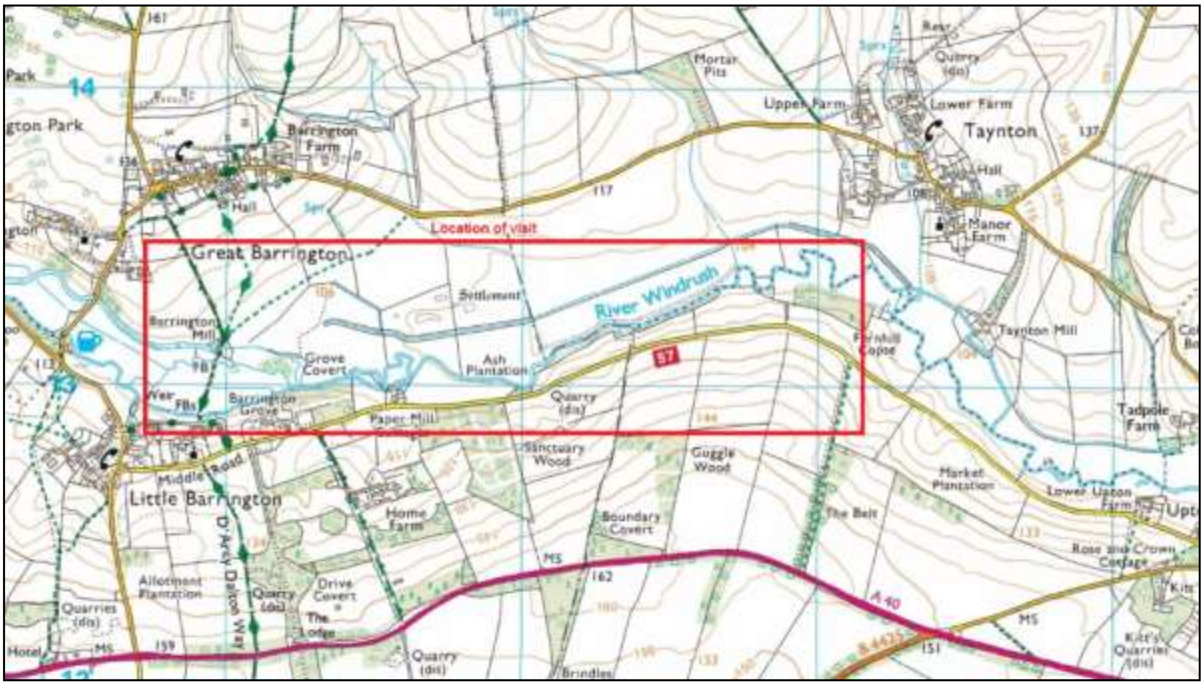

Figure 1: Map showing the location of the water visited

Catchment and Fishery Overview

The River Windrush is a limestone stream that flows from springs at Temple Guiting and Hailes near Winchcombe on the Cotswold Hills. The two headwater streams join near Naunton and flow south east to Bourton-on-the-Water where it is joined by two tributaries, the River Eye and River Dikler. From here the river flows south to Barrington Park, collecting additional flow from Sherborne Brook and Coombe Brook and bending eastward to Burford. The river then meanders towards Witney via Swinbrook and Minster Lovell and flows south east through Ducklington and alongside a number of large lakes (formally gravel pits). The Windrush joins the River Isis (Thames) at Newbridge.

The geology of the region is primarily oolitic (forming rounded granular egg-shaped stones) limestone but the northern tributaries (R. Eye and R. Dikler) also drain a partially mudstone catchment. The limestone is permeable but the mudstone less so and often overlain by clay soils.

The Windrush receives relatively stable base flows from the limestone springs of the Cotswolds which are supplemented by surface water during wet weather. As with many other Cotswold streams, the reliable flow of the river made it a prime choice for watermills and much of the river was modified (straightened and deepened) to accommodate milling activities.

The Windrush is presently failing its ecological quality targets under the Water Framework Directive (see Table 1). The failure is driven by biological quality elements, specifically water quality elements measured by surveying nutrient sensitive indicators such as the percentage cover of filamentous algae. Sampling results indicate elevated concentrations of nutrients, most likely phosphate originating from sewage discharges. Fortunately the impact of the nutrient enrichment does not appear to be overly impacting on fish and freshwater invertebrates but it should be noted that localised impacts are not easily identified through the Environment Agency's periodic fixed-point surveys.

The section of the Windrush visited is a single bank, wild trout fishery owned by Mr Mills. The river has not been stocked with farmed trout for approximately 20 years and supports strong populations of wild trout, chub (*Squalius cephalus*) and grayling (*Thymallus thymallus*). Mr Mills is keen to improve wild trout habitat as well as address some erosion problems in the middle beats of the fishery.

Table 1: WFD information for the River Windrush visited

	2009 Cycle 1	2015 Cycle 2	Objectives
Overall Water Body	Moderate	Moderate	Moderate by 2015
Ecological	Moderate	Moderate	Moderate by 2015
Biological quality elements	Moderate	Moderate	Moderate by 2015
Fish	Good	Good	Good by 2015
Invertebrates	High	High	Good by 2015
Macrophytes	Moderate	-	-
Macrophytes and Phytobenthos Combined	-	Moderate	Moderate by 2015
Phytobenthos	-	-	-
Hydromorphological Supporting Elements	Supports good	Supports good	Supports good by 2015
Other Substances	-	-	-
Physico-chemical quality elements	High	Good	Good by 2015
Specific pollutants	High	High	High by 2015
Supporting elements (Surface Water)	-	-	Not Assessed by 2015
Chemical	Good	Good	Good by 2015

Note: Anything classified as less than 'good' is failing quality targets

Habitat Assessment

For the purposes of this report, the water will be described from the upstream to the downstream extent visited.

The visit was undertaken after a period of prolonged rainfall. High water levels and colouration precluded an inspection of the riverbed.

At the top boundary, the river's flow is split between two channels. The river splits upstream at Waterloo Copse near Barrington Park where maps dating back to 1882 (www.old-maps.co.uk) show a boat house was located on the river. The boat house is still present on modern Ordnance Survey maps and is labelled as such on maps as recent as 1982. The northern channel feeds flow to Barrington Mill and the southern channel flows alongside the gardens of Barrington Grove. The southern channel is impounded by a series of small weirs and is artificially deep and straight. This was probably originally undertaken for landscaping purposes and considering the boathouse upstream, possibly for recreational boating or punting. The sluggish flows and uniformity of the channel encourages the encroachment of marginal plants during summer months and the channel requires annual maintenance to prevent it becoming choked. A long-term solution to this issue would be to remove the weirs and reinstate a natural flow regime. This would also improve habitat for wild trout. Downstream of the gardens of Barrington Grove the two channels re-join into a wider single channel flowing through dense woodland. The channel remains relatively straightened but habitat diversity is enhanced by a number of natural flow-deflecting woody features (Figures 2 and 3). Large woody features such as fallen trees deflect flow causing it to accelerate around the fallen wood and also creating a pocket of slack water in the lee of the feature. This creates spate refuge habitat during high flows and also good feeding lies during normal flows where trout and other fish can hold up and conserve energy whilst occasionally darting out into the faster flow to snap up passing prey. Such spots usually make for very good angling opportunities. The submerged wood also makes an excellent habitat for freshwater invertebrates which either feed directly on the decaying wood, or graze algae that grows upon it. Coarse woody material, such as submerged branches, roots and brushwood, also provide cover habitat where fish can evade predators such as piscivorous birds.

Figure 2: Natural woody features increasing flow diversity

Figure 3: A fallen tree deflects flow

There is scope and opportunity to introduce additional woody features to further enhance habitat diversity. Selective tree works aimed at letting more light into the river, particularly over shallow glides and riffles, will improve in-stream productivity and also give rise to woody material that can be secured into the river as flow deflecting woody habitat. Selected limbs already at risk of falling into the river (Figure 4) could be cut and either secured into the river margins with wooden stakes and mild steel fencing wire or tethered to the remaining tree as a 'kicker'. Already fallen features can be left *in situ* or, if considered a problem, winched around to the margin and secured.

Figure 4: Improving habitat by making use of limbs already at risk of falling will be easier than addressing a problem later

There are a variety of options available for arranging and securing woody habitat features but as a general rule of thumb, the more naturalistic the feature, the better the quality of habitat it provides. Ideally, whole trees or large limbs should be used with the branched ends pointing downstream. This is the alignment in which most naturally fallen wood will come to rest and also the best position to withstand spate flows and not be dragged downstream. Details of techniques for creating and securing woody habitat features are outlined in the *Recommendations* section of this report. As the river emerges from the woodland it meanders sharply (Figure 5). Flow diversity is relatively good as flows are naturally accelerated around the outside of the bends. However, flow could be enhanced yet further by again making use of some of the bankside trees to deflect and accentuate the existing pattern of flow. Some signs of light bank poaching were observed here but overall the impact of livestock did not appear to be especially intense. It may be worthwhile reassessing the impacts of grazing on the river margins during the summer when marginal reeds are growing.

Figure 5: The river meanders sharply, increasing flow speed and providing a more varied habitat

A little farther downstream a number of good quality low cover features were observed in the form of shrubby bankside alder saplings (*Alnus glutinosa*) (Figure 6). Trout are naturally photophobic and favour low cover and shade to hide from predators. Such features can sometimes be in short supply as mature bankside trees shade the riverbank, or saplings are browsed by livestock. Many bankside tree species such as alder or willow (*Salix* spp.) can survive heavy pollarding or coppicing and will send out new shoots the following year. Managing sections of bank with a surplus of mature bankside trees in a ten-year rotation (coppicing 10% of the trees every year) will ensure a steady supply of low shrubby cover as well as a good diversity of light conditions. For most rivers, an approximate 50:50 ratio of direct sunlight to dappled shade is recommended to maintain good levels of productivity whilst also keeping the river cool in summer. A good abundance of young bankside alders and willow also gives rise to other opportunities for in-stream habitat enhancement. Whereas mature alders become brittle around the base, young alders can be easily 'hinged' (cut partially through and laid into the river in a similar fashion to hedge laying). If undertaken correctly the trees should survive and continue to grow. Willows are naturally flexible and are normally the easiest species to hinge. Relatively mature willows can be successfully hinged into the river and even if completely felled will normally survive and continue to grow. Hinging over small alders or willows is a quick and effective way of creating dense, complex submerged refuge habitat (see example Figure 7). Such features are particularly important for juvenile trout. As soon as trout emerge from the gravel as fry they are naturally territorial and rarely shoal like other fish species. Complex 'shaggy' habitat where juvenile trout can stay in cover and remain out of line-of-sight from one another is essential in minimising competition and predation at this early life-stage. Rich and diverse beds of marginal plants are also important for the same reason and also for biodiversity. Hinging a series of saplings is a quick, cheap and effective means of reducing rates of bank erosion. Water flowing through dense brashy material experiences a substantial increase in friction and is significantly slowed. The same effect can be created by creating brushwood berms, or low revetments but such structures normally require a great deal more effort and have a lower chance of surviving long-term compared to hinged living trees. If cut and installed during dormant (winter) months, even small willow cuttings (whips) will sprout and grow. Alder however will not re-sprout unless attached to its roots.

Figure 6: Low and submerged branches provide excellent cover and refuge habitat

Figure 7: An example of hinged alder being used to deflect flow and provide cover

Downstream of the sharply meandering reach, tree cover becomes sparser and the abundance of marginal plants increases. The time of year made it difficult to make an accurate assessment of marginal plant diversity but it is probably fair to conclude that during summer months there is a good abundance of shaggy marginal cover (Figure 8).

Figure 8: Tree cover becomes sparser. Note the bed of marginal plants on the far bank

The river is straighter than the meandering section upstream but not without a few gentle bends. Accentuating the existing bends by strategically installing some large flow deflectors would help to increase the rate of natural morphological change, aiding the development of key habitat features such as pools, runs and glides. As mentioned above, the increased diversity of flow conditions would also provide additional lies and interesting angling opportunities. A number of small bankside trees are good candidates for hinging into the river but care should be taken to ensure that the bank does not become denuded of cover. Leaving lone trees (such as shown in Figure 8) to mature and hinging a few trees from a cluster (such as shown in Figure 9) will help maintain a good balance.

Figure 9: A line of small alders provides an opportunity to introduce more cover

Fast-growing crack willows (*Salix fragilis*) can sometimes be difficult to manage if allowed to grow across the channel. Although providing valuable habitat, the partially fallen crack willow in Figure 10 is likely to become a management problem in the future. Hinging the leaning limbs into the margin and pulling (possibly winching) the protruding limbs back toward the bank will retain valuable cover but keep the tree manageable. Acting sooner rather than later can prevent such features becoming problems (trapping excessive amounts of debris or impeding angling) and instead be turned into assets for the fishery.

Bankside trees with low trailing limbs (Figure 11) can also provide very good cover habitat. Ideally these features should be retained, or at the very least, if deemed an impediment to casting, pruned back as lightly as possible.

Figure 10: A sprawling crack willow makes for good habitat but may require managing sooner rather than later

Figure 11: Low, trailing branches (far bank) will make good trout lies. Management should be a light as possible.

In the middle reach of the fishery the RB is experiencing an accelerated rate of erosion and is denuded of a marginal fringe compared to the LB. Grazing up to the bank edge has reduced the depth and complexity of root structure in the bank but burrowing American signal crayfish and the lack of trees (compared to the LB) may also be contributing issues (Figure 12). Livestock are excluded from a short section of bank downstream which despite being on the outside of a relatively sharp bend (and therefore receiving greater erosive forces), appeared to be relatively stable. Abundance of tree, grass and marginal plant roots have a significant influence on the banks resistance to erosion.

Figure 12: Erosion on the RB caused by grazing up to the bank edge and probably other factors

A short distance downstream the excessive rate of erosion is apparent where the bank has retreated back except where resisted by the roots of bankside trees (Figure 13).

From this point downstream through the lower third quarter of the fishery, the river has been artificially straightened and a raised bund on the LB appears to be spoil piled up from historic dredging works. The RB is protected from grazing livestock by a wide fenced buffer but excessive erosion remains a problem in places. As it appears the river was dredged from the LB, it is possible that the work has given the channel an even cross-sectional profile. If the action of dredging the river has resulted in the RB being given a more vertical profile and the LB a gentle, sloping profile (as for example, an excavator bucket was dragged from the RB to LB), this could have left the steeper RB more vulnerable to erosion. The abundance of tree cover on the LB compared to the RB is also notable.

Where woody material has collected, or been placed in the rivers margins, the resulting deposition in the lee of the feature has resulted in an increased rate of deposition and establishment of marginal reed beds (mostly unbranched bur reed (*Sparganium erectum*) (Figure 14). This illustrates the potential for the river to 'heal' itself and hints at the solution to the erosion problem. The trees on the LB are mostly multi-trunked alders and woody material could be won from them without making a significant change to the amount of tree cover on that side. Introducing a variety of woody structures on the RB with the aim of deflecting flow away from problem areas and increasing friction with a series of small brushwood berms would change conditions from erosive to depositional. The woody features would protect the bank in the short-medium term and once fine sediment (loaded with a natural seed bank) has accumulated, marginal reed beds will establish and provide long-term erosion protection.

Figure 13: Trees denote the historic position of the bank and the rate of erosion. Note the raised bund on the far bank.

Figure 14: Woody material in the channel creates an area of slacker water where reeds colonise fine sediment deposits.

The straightness of the channel is limits the diversity and quality of trout habitat in this reach. Although the riverbed could not be directly observed on the day of the visit, laminar (flat) flows strongly suggest an overly uniform depth profile (Figure 16). Installing flow deflecting woody habitat features such as secured tree limbs, log flow deflectors and brushwood berms along both banks would introduce some much needed diversity. Structures should be installed at approximately 20m-30m intervals alternating from bank to bank. This will create a meandering flow within the straightened channel and allow a more sinuous channel form to develop over time. Where possible, these features should be installed to accentuate existing depositional features and reed beds. Installing a large limb or wedge-shaped brushwood berm at the upstream edge of an existing reed bed (such as shown in Figures 17 and 18) will accelerate its development and help consolidate fine sediment.

Figure 15: A straight channel and laminar flows make for a uniform and limited habitat

At the bottom of the fishery the river meanders sharply again and benefits from an abundance of low trailing branches providing excellent cover for fish (Figure 19). As mentioned above, these features should be retained wherever possible and only receive the lightest of management if they prevent casting.

Figure 16: More low trailing branches. These should be retained as far as is practical for the fishery

Figure 17: A deflector or small brushwood berm could be positioned on the upstream edge of the emergent reed bed on the far bank.

Figure 18: A small brushwood berm or deflector on the upstream edge (left of image) of this reed bed would help consolidate fine sediment. Pinching the channel and creating a faster flowing run that will make a great trout lie..

Recommendations:

In order for the River Windrush at Barrington to achieve its full potential for biodiversity and good quality habitat, capable of supporting healthy, self-sustaining populations of wild brown trout, the following actions are recommended:

Explore opportunities to introduce a greater number of flow deflecting woody habitat features into the channel. In already sinuous reaches these should be secured in locations where they will accentuate existing flow patterns. For example, a flow deflector secured into the margins on the inside of a bend will increase the rate of deposition on that bank and increase flow speed along the outside of the bend. A flow deflector secured at the tail end of an outside bend will amplify flow speeds across the river to the next bend. In combination these features will increase flow speeds through the 'thalweg' (the trench that forms the lowest part of the bed) and maximise bed scour, helping to increase in the formation and diversity of pools, runs and riffles.

In straightened sections of river, flow deflectors should be secured in an alternating pattern to bounce flow from bank to bank, helping to mitigate against channel uniformity, increasing the rate of morphological change and the number of good fishing lies.

There are a number of techniques for installing flow deflectors but there are four tried and tested techniques that should be applicable to the Windrush:

1. Whole small tree/large limb deflectors.

   - This technique simply involves securing a small tree or large limb in the river margin with the butt keyed into the bank and the branches facing downstream. The limb can then be tied to wooden stakes (ideally untreated hardwood such as sweet-chestnut) with small loop of mild steel fencing wire and a couple of fencing staples.

Figure 19: A whole tree secured into the margins of the River Nadder, Wiltshire

   - If possible, an attempt should be made to hinge cut the tree/limb and keep it attached to its roots. This will help keep it secure and also give it a better chance of surviving. Even if successfully hinged it may be advisable to secure the tree with stakes and wire.

Figure 20: A hinged willow on the same river

Figure 21: Sweet chestnut stakes and fencing wire used to add extra security to a hinged willow.

- If a tree/limb is not successfully hinged it can be installed with stakes as shown in Figures 19 and 21 or tethered back to its stump as a 'kicker'. This technique allows the limb some movement, ensuring good flow deflection during normal flows but also allowing the limb to be pushed against the bank in higher flows. A kicker can be secured with rope but this will need to be monitored and replaced when it shows signs of wear. Alternatively, cable (wire rope) can be used. This technique can withstand very high flows such as in upland spate rivers.

Figure 22: A cabled 'kicker' in a tributary of the River Exe

A video outlining the kicker technique is available on the WTT website: http://www.wildtrout.org/content/how-videos#tree kicker.

2. Log flow deflectors

- This is the simplest technique and involves securing a log in the channel in such a position that it deflects flow across the channel. Logs should be keyed into the bank to prevent the river cutting behind them and ideally be of a diameter that they sit just below the surface. This will cause water rolling over the log to be deflected at 90 degrees (perpendicular from the long axis of the log). They should also slope down into the river from the bank so that the deflector works over a wide range of flows.
- The log should be orientated at approximately 45 degrees from the bank in an upstream direction. This ensures that flow rolling over the log is deflected across the river and not towards the bank.
- The log is secured in place with a pair of stakes at each end. Once the stakes are driven firmly into the bed, secure a loop of wire between them over the log and drive them in a few inches deeper to tension the wire and hold the log against the bed.
- Finally, cut the stakes off as low as possible to prevent them snagging debris.

Figure 23: A simple log flow deflector introduces flow diversity.

3. Brushwood berms

- Increase channel sinuosity and the abundance of marginal refuge habitat by installing low brushwood (branch) berms. These instantly create a depositional zone where fine sediment will accumulate and if positioned to receive sufficient sunlight, should be colonised by marginal plants.
- The easiest way of installing a brushwood berm is to mark out the shape of the outer (riverside) edge with stakes driven into the bed every 1-2 meters the back-fill with branches keeping the butt ends towards the upstream bank edge and the finer branches pointing downstream towards the outer edges. Once the structure is densely packed, place some long, straight limbs across the structure as 'cross braces' and tie to stakes on the outer and inner (bankside) edges. Finally, drive the stakes in a little deeper to tightly compact the brushwood and trim off any excess.

Figure 24: A brushwood berm with cross braces

- Brushwood can also be used to protect banks from erosion. A narrow revetment of brushwood can be secured behind a line of stakes in method similar to that described above. Once vegetated it will provide good long-term protection from erosion (Figure 26)

Figure 25: A newly installed brushwood bank protection revetment

Figure 26: The same structure one year later colonised by marginal plants.

Engage with land owners/tenant farmers on both banks and seek to protect the river with stock fencing. Even in areas where bank erosion does not appear to be particularly exacerbated by grazing, a fenced buffer strip will allow a more diverse marginal fringe to develop which will improve biodiversity, boosting fly life and potentially providing better periods of dry fly fishing.

Making It Happen

The creation of any structures within most rivers or within 8m of the channel boundary (which may be the top of the flood-plain in some cases) normally require a formal Environmental Permit from the Environment Agency. This enables the EA to assess possible flood risk, and also any possible ecological impacts. Contacting the EA early and informally discussing any proposed works is recommended as a means of efficiently processing an application.

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

http://www.wildtrout.org/content/index

The Wild Trout Trust has 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 stocks and managing invasive species.

The DVD is available to buy for £10.00 from our website shop http://www.wildtrout.org/product/rivers-working-wild-trout-dvd-0 or by calling the WTT office on 02392 570985.

There is also the possibility that the WTT could help via a Practical Visit (PV). PV's typically comprise a 1-3 day visit where WTT Conservation Officers will complete a demonstration plot on the site to be restored.

This enables recipients to obtain on the ground training regarding the appropriate use of conservation techniques and materials, including Health & Safety, equipment and requirements. This will then give projects the strongest possible start leading to successful completion of aims and objectives.

Recipients will be expected to cover travel and accommodation (if required) expenses of the WTT attendees.

There is currently a big demand for practical assistance and the WTT has to prioritise exactly where it can deploy its limited resources. The Trust is always available to provide free advice and help to organisations and landowners through guidance and linking them up with others that have had experience in improving river habitat.

Disclaimer

This report is produced for guidance; no liability or responsibility for any loss or damage can be accepted by the Wild Trout Trust as a result of any other person, company or organisation acting, or refraining from acting, upon guidance made in this report.