



By Brook, Ford to Slaughterford, Wiltshire



An Advisory Visit by the Wild Trout Trust August 2016

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Key Findings

- A substantial algal bloom was covering the bed and most macrophytes (aquatic vegetation). This is in part due to the impounded and sluggish nature of **much of the club's water (which will have a concentrating effect on excess nutrients)** but may also be a symptom of point-sources of phosphate originating from domestic septic tanks or other under-performing small-scale sewerage treatment. Diffuse sources of excess phosphate and/or nitrate are also likely to be present as a result of intensive agriculture within the rural catchment of the brook. Although current Environment Agency catchment data classifies water quality (but not overall ecological quality) **as 'good' under the Water Framework Directive (WFD), it is possible that the EA's present water quality monitoring regime is not detecting intermittent nutrient spikes that could be affecting water quality on a local scale.** It is strongly recommended that riverfly monitoring be undertaken by the club to provide a clearer picture of water quality.
- The impounding effect of the numerous weirs on the water are seriously **limiting habitat quality and the brook's ability to support healthy populations of wild brown trout.** Whilst the weirs/sluices do provide some deep holding water, they have the effect of essentially transforming a fast-flowing, gravelly upland **'trout zone' habitat into a sluggish and silty lowland 'bream zone' habitat.** This places severe limitations on the abundance and quality of salmonid spawning habitat and also creates long sections of uniform habitat lacking in the diversity and abundance of habitat required to support a flourishing wild trout population. The structures also impede upstream (adult) and downstream (juvenile) fish passage, **making the club's water extremely vulnerable to potential pollution, predation or other 'fish kill' events.**
- The brook would benefit from a greater abundance of flow-deflecting woody habitat features. Ideally a project to introduce a greater abundance of such features should be undertaken in conjunction with the removal/significant reduction of the aforementioned impoundments.
- Some sections of the brook are in urgent need of additional tree cover.
- Examples of previously installed woody habitat enhancements are a step in the right direction but some additional guidance as to which techniques to use in particular places (and why) might help the club maximise the benefits of employing these techniques. Such guidance is included within this report.
- There is scope for the brook to be transformed into a free-flowing, natural wild trout habitat capable of supporting a greater abundance of wild trout with a healthy age-range represented (including specimen-sized adult fish). The un-impounded sections of the brook that were visited today would serve as a good template for the rest of the water. If such a restoration were undertaken, the club would no longer need to and should not continue to stock farm-bred trout. The club would also no longer need to concern itself with the cost, effort or liability of maintaining the sluices.

Introduction

	Ford Fly Fishers water
River	By Brook
Waterbody Name	By Brook – confluence of Doncombe Brook to confluence with R. Avon
Waterbody ID	GB109053027380
Management Catchment	Bristol Avon
River Basin District	Severn
Current Ecological Quality	Moderate
U/S Grid Ref inspected	ST 84085 74776
D/S Grid Ref inspected	ST 84130 73856
Length of river inspected	~2km in total

This report is the output of a visit undertaken by Mike Blackmore of the Wild Trout Trust on approximately 2km of the By Brook between Ford and Slaughterford, near Bath (national grid reference (NGR) ST 84085 74776 to ST 84130 73856). A walk-over of the site was requested by Mr Robin Donald of Ford Fly Fishers. Mr Donald had reported that the club had had a particularly disappointing fishing season with trout seeming particularly reluctant to rise to even very well presented dry flies. The visit was primarily focussed on assessing habitat for trout (*Salmo trutta*) and biodiversity in general, and also assessing how the conditions in the brook may be influencing the behaviour of the fish.

Comments in this report are based on observations on the day of the site visit and discussions with members of Ford Fly Fishers, the Environment Agency (EA) and the Bristol Avon Rivers Trust (BART). 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.

Catchment and Fishery Overview

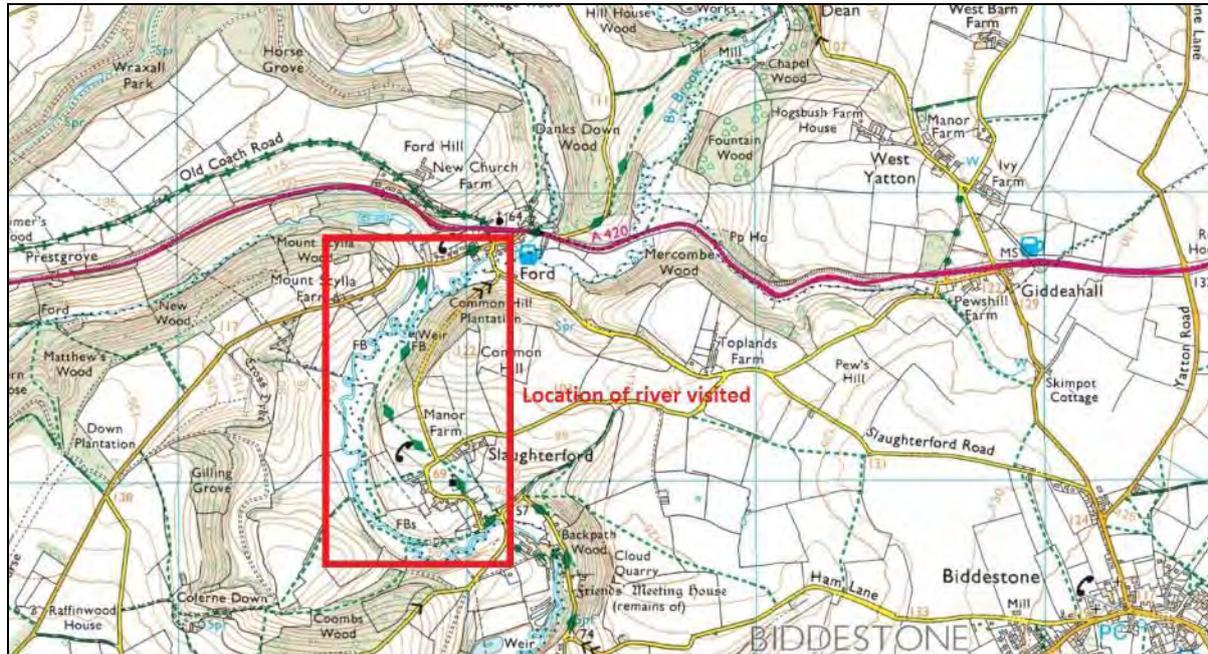


Figure 1: Map showing the location of the water visited

The By Brook rises west of the village of Burton in Wiltshire. The geology of the catchment is predominantly oolitic limestone and occasional outcrops of harder limestone (Bath stone) overlain with clays. From its source the brook flows generally southwards down a gentle gradient, picking up other smaller tributaries such as Doncombe Brook north of Slaughterford. The river then turns southwest and joins the Avon at Batheaston.

The gradient of the By Brook valley is not as steep as some others nearby (such as **St Catherine's** or the **Lam Brook**) but is **nonetheless relatively 'flashy'** due to the impermeable clay soils and abundance of springs within the catchment.

The brook supports healthy populations of native brown trout wherever there is sufficient good quality habitat. However, some sections of the river have been significantly modified for historic milling and land drainage. In particular, weirs and sluices have been installed to impound the river (hold up a ponded head of water). These structures have a significant impact on hydrology, geomorphology, habitat quality and connectivity. The result is a river that, in places, is severely limited in terms of biodiversity and as a habitat for wild salmonids.

Ford Fly Fishers routinely stock the river with farm-reared triploid trout.

Table 1: Water Framework Directive information for the By Brook visited

	2009 Cycle 1	2015 Cycle 2	Objectives
Overall Water Body	Poor	Moderate	Good by 2021
Ecological	Poor	Moderate	Good by 2021
Biological quality elements	Poor	Good	Good by 2015
Fish	Poor	Good	Good by 2015
Invertebrates	-	High	Good by 2015
Macrophytes	-	-	-
Macrophytes and Phytobenthos Combined	-	Good	Good by 2015
Hydromorphological Supporting Elements	Supports good	Supports good	Supports good by 2015
Physico-chemical quality elements	Good	Moderate	Good by 2021
Specific pollutants	High	-	Not Assessed by 2015
Supporting elements (Surface Water)	-	-	Not Assessed by 2015
Chemical	Does not require assessment	Good	Good by 2015

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

A previous Wild Trout Trust advisory visit was undertaken in 2009. The club was advised that the fishery was severely impacted by the series of impounding structures that degrade habitat and inhibit fish passage. Algal blooms were observed which were interpreted as evidence of nutrient enrichment (organic pollution) and bank poaching by cattle was highlighted as a problem. Recommendations were made regarding the introduction of flow-deflecting woody habitat features as well as advice on gravel cleaning, management of marginal plants and the use of triploid (non-breeding) stocked trout (since made mandatory under the EA National Trout and Grayling Fisheries Strategy).

Habitat Assessment

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

At the upstream extent of the water visited, the brook was uniformly deep and slow-flowing, resulting in the deposition of a thick layer of fine sediment over the

bed. As observed in the 2009 visit, the brook was experiencing a significant algal bloom which coated the bed and much of the submerged weeds (Figure 2).



Figure 2: Algae covers the bed and some of the submerged weeds

The land use in the upper parts of the By Brook catchment are fairly typical of many of the Bristol Avon tributaries in this part of Wiltshire/Somerset. There is some relatively intensive arable farming at the very top of the By Brook catchment towards Tormarton but the catchment does not appear to have notably higher levels of intensive arable or dairy agriculture compared to neighbouring catchments (not that neighbouring catchments are necessarily unimpacted). There is a sewage treatment works upstream towards Castle Coombe and although the rural catchment is sparsely populated, there may be a relatively high number of residential properties along the brook with old and poorly-functioning household septic tanks; this has been shown to be the case in other catchments studied e.g. the upper river Itchen. Regardless of the origin of excess phosphate and/or nitrate nutrients, the slow-flowing nature of the brook at this location means that sediments and pollutants will more-readily drop out of suspension and settle on the bed. Dissolved contaminants will also have a longer residence time, increasing their potential toxic impact. Temporary spikes in pollutants that might flush through a more free-flowing section of river, are more likely to accumulate and develop into long-term water quality problems in impounded sections of river. Prolonged periods of low flow and warm temperatures will also contribute to the algal growth.

Riparian habitat was excellent both in terms of abundance and diversity of marginal (Figures 3) and upper bank (Figure 4) wetland plant species. A dense, **'shaggy' margin provides valuable refuge habitat** for fish (particularly juvenile trout) where they can more-easily evade predators. The vegetated river margins and wetland fen in the adjacent floodplain provide excellent habitat for a wide

range of invertebrate species. This will help boost biodiversity and provide a broad diet for trout that includes both true riverfly species (to which the fen provides excellent habitat for adult life-stages) and other flies and terrestrial bugs that will occasionally drop into the water and become prey for trout.



Figure 3: Marginal plant diversity and abundance is excellent



Figure 4: A rich and diverse wetland fen habitat has developed in the adjacent floodplain.

A few woody habitat features have been installed which are providing some additional cover habitat and probably provide some good lies for adult fish (Figure 5). However, the low energy flows, which characterise the brook throughout the vast majority of the year, significantly limit the ability of such

features to function as flow deflectors (limiting their influence on the morphology of the channel). It may be worthwhile introducing some additional woody habitat features in positions and orientations that will maximise their potential to deflect flow and influence habitat beyond their immediate location. However, even the most pronounced of features will have a limited effect whilst the brook remains impounded.



Figure 5: Woody habitat features provide additional lies but provide limited flow deflection in impounded flows

The sluggishness of flow through the reach is further compounded by the channel being significantly over-wide and deep for the mean discharge of water the brook carries (Figure 6). The presence of pondweeds (Figure 7 - species not identified), that would normally be found in stillwater or extremely slow-flowing waterbodies, highlights the extent to which the brook has diverged from its natural state. It is advisable to check if the pondweed is an alien invasive such as Canadian pondweed (*Elodea Canadensis*) or Curly waterweed (*Lagarosiphon major*) and eradicating if required.



Figure 6: The overwide channel further compounds the sluggishness of flows and uniformity of habitat



Figure 7: Partially obscured by the reflection of bankside trees, pondweed (circled in red) is indicative of extremely slow flows

At NGR ST 83805 74520, a large weir impounds the river and presents as a complete barrier to fish passage (Figure 8). This structure is severely reducing habitat quality upstream (as illustrated Figure 9) as well as having other impacts on the river downstream (as illustrated Figure 10).



Figure 8: An upstream view of the uppermost impoundment

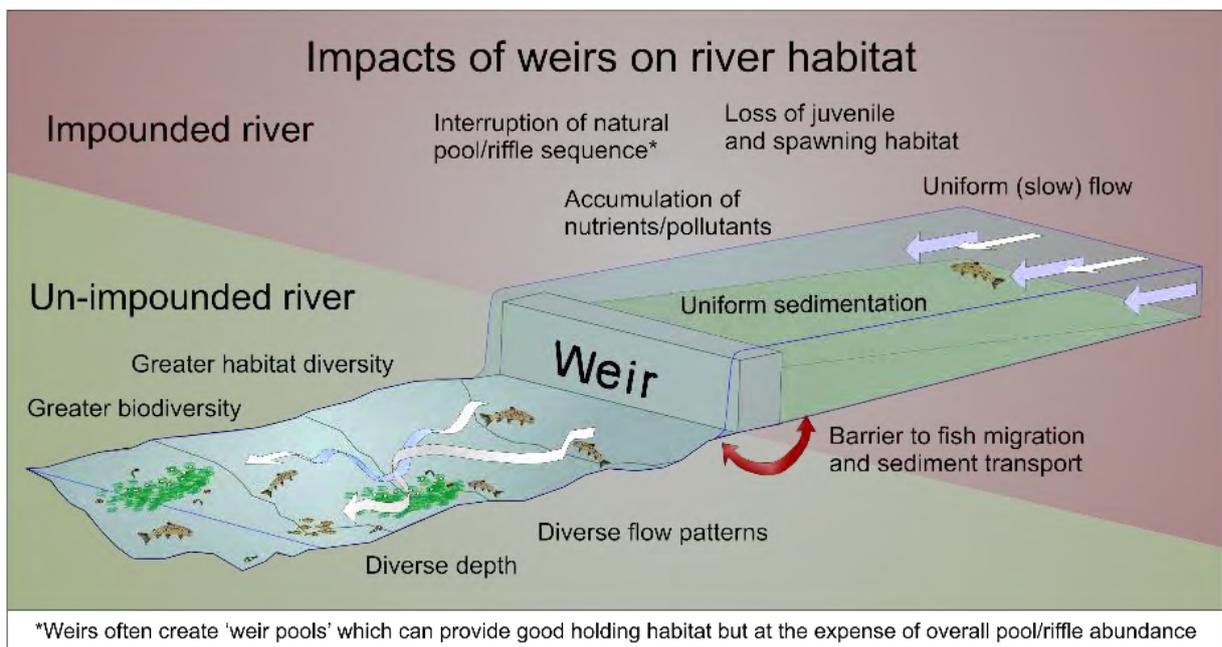


Figure 9: An illustration highlighting the impact of impoundments on river ecology

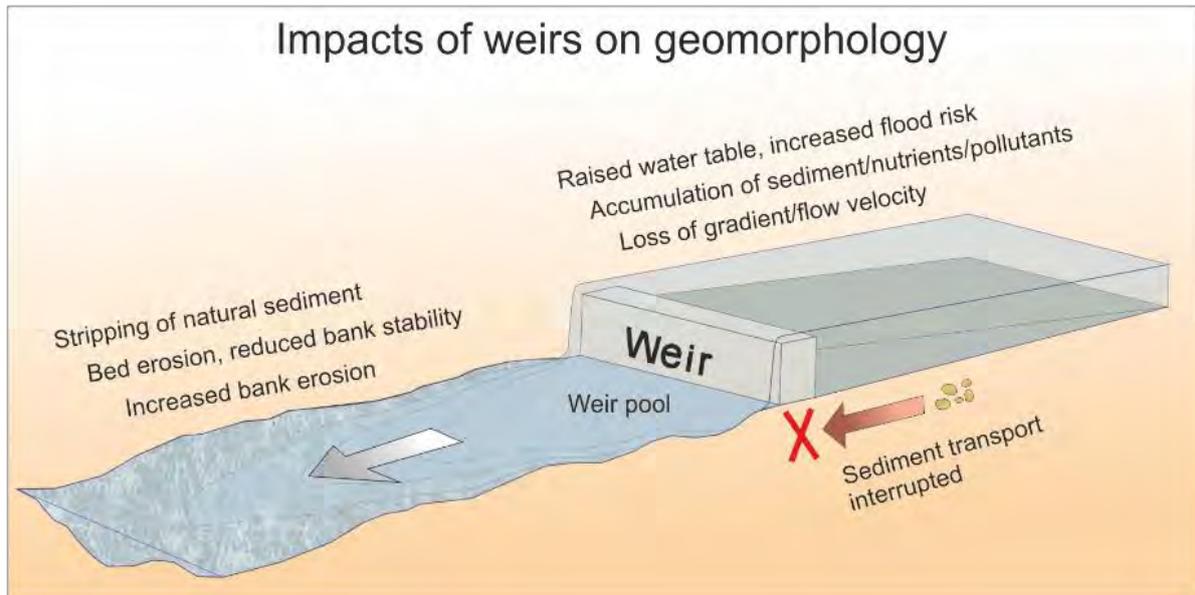


Figure 10: An illustration highlighting the impact of impoundments on geomorphology

Below the weir the river abruptly widens (Figure 11). There are probably several factors contributing to the rate of bank erosion at this location. Dogs and grazing livestock have accelerated the rate of erosion but the interruption of natural sediment transport caused by the weir, along with eddying flows around the pool, are probably significant factors. A cursory inspection of the riverbed highlighted a general lack of any stony substrate (Figure 12).



Figure 11: The widened channel below the uppermost impoundment



Figure 12:

A short distance downstream, a sluice forms another impoundment and barrier to fish passage (Figure 13). Whilst the deeper water created by impounding the river may be considered by some to provide good holding water for larger, stocked trout, the slow flows may also be altering the behaviour of trout and impacting on the quality of angling. Adult trout in naturally free-flowing rivers often seek out lies where they can hold up on the edge a fast run of water **(sometimes referred to as a 'feeding lane')** and **take passing prey from the surface or mid-water**. In sluggish flows, the lack of distinct feeding lanes is likely to impact on trout feeding behaviour, so that they cruise, looking for food and feed more opportunistically. Dry fly fishing for cruising fish is a difficult undertaking and very few anglers enjoy much success in such circumstances. Furthermore, slow-flowing water is also warmed more quickly by the sun (especially if the riverbed is covered in dark silt); warmer water retains less dissolved oxygen and this can reduce trout activity, making them less inclined to take a fly. Temperatures above 20 degrees C will put trout under severe stress and can sometimes prove fatal. As well as degrading habitat quality, impassable impoundments prevent trout from accessing potential spawning habitat upstream. They also prevent sections of river from naturally repopulating following pollution incidents or other fish kill events.



Figure 13:

As a general rule of thumb, rivers can be divided into different *zones* where particular fish species will be dominant. In reality, different populations co-exist and overlap and the change in species down through a catchment is a gradual trend as opposed to a distinct *zonation*. However, for the purposes of describing habitat suitability for a particular fish community, the division of a river into specific zones is a generally good description of species distribution. Generally, rivers can be divided as follows:

- Trout Zone – River headwaters. High energy systems, steep gradient rivers with mobile gravel/cobble substrates, cold water with high levels of dissolved oxygen and low nutrient levels. Brown/sea trout are dominant and sometimes virtually the only fish species present.
- Grayling Zone*– Upper river. Medium-high energy systems, steep-medium gradient, clean gravel substrate, cold water with medium-low nutrient levels. Trout, grayling (*Thymallus thymallus*), bullhead (*Cottus gobio*), minnow (*Phoxinus phoxinus*), salmon (*Salmo salar*), eel (*Anguilla anguilla*) etc.
- Barbel Zone – Mid-catchment. Slow-medium energy, meandering systems with medium nutrient levels, higher levels of fine sediment and significant vegetation growth. Barbel (*Barbus barbus*), chub (*Squalius cephalus*), dace (*Leuciscus leuciscus*), roach (*Rutilus rutilus*), perch (*Perca fluviatilis*), pike (*Esox Lucius*) etc.
- Bream Zone – Lowland river. Low energy, slow-flowing and warm, with silted bed, high nutrient levels, lower oxygen levels and abundant vegetation. Bream (*Abramis brama*), tench (*Tinca tinca*), common carp (*Cyprinus carpio*) as well as roach, perch, pike etc.

- Flounder Zone – Brackish, estuary or otherwise tidal river. Fluctuating salinity, very high levels of fine sediment, often poor mixing of dissolved oxygen. Flounder (*Platichthys flesus*), grey mullet (*Mugil cephalus*), bass (*Dicentrarchus labrax*) etc.

*Spring-fed, lower energy systems such as chalkstreams often support trout and grayling populations lower in the catchment thanks to relatively stable (cold) temperatures and high abundance of freshwater invertebrates.

Impounding a river high up in the catchment reduces its gradient and significantly alters its character. The By Brook between Ford and Slaughterford should be a relatively narrow, steep-gradient river with an abundance of trout spawning and nursery habitat interspersed with occasional deep pools and fast-flowing 'runs' holding adult fish. However, where the river is impounded, it has essentially been transformed from trout/grayling zone habitat to bream zone habitat. Were the club managed as a coarse fishery this may not necessarily be considered a problem. However, the sluggish, almost stillwater habitat is fundamentally incongruous to a trout river.

Downstream of the sluice the river is more free-flowing. It was encouraging to see that a small weir identified in the 2009 advisory report had been modified as recommended (Figure 14).



Figure 14: Left: The small weir in 2009. Right: The weir with centre third removed 2016

Through the free-flowing, un-impounded reach, a number of good natural habitat features have developed. The channel form and dimensions are reminiscent of other celebrated trout streams within the wider Avon catchment such as Wellow Brook south of Bath. Avon and Tributaries Angling Association (ATAA) and Wellow Fly Fishers (WFF) both manage their sections of Wellow Brook as wild trout fisheries and have overcome some of the typical issues that local Avon tributaries face (such as low summer flows) by impoundment removal, judicious introduction of flow-deflecting woody features and working with natural processes.



Figure 15: An ATAA work party introduces woody habitat and loosens gravel on Wellow Brook



Figure 16: Wellow Fly Fishers pin logs to the bed under the supervision of WTT and BART



Figure 17: A hinged (cut partially through and laid downstream) alder helps a deep run to scour on Wellow Brook.

Creating opportunities for the river to scour deep pools during high flows will provide much better holding habitat than can be created by holding back water above weirs. A series of natural small pools and runs provides a range of micro-territories that trout will keenly defend. A strong wild trout will generally hold and defend a particular territory until it either dies or is displaced by a more-dominant fish. This ensures maximum habitat utilisation and maximises the number of fish present. Uniform habitat such as that found upstream of a weir significantly reduces the number of micro-habitats available and therefore reduces the holding capacity of a river. Stocking farmed fish into the river only serves to further disrupt fish/habitat interactions and to limit the number of wild fish a river can support. This means that when stocked fish die, are removed or washed out, the river is left with fewer fish than would have been present if the fishery was not stocked to begin with.

A good example of natural processes forming good quality trout habitat was observed within the un-impounded reach where a concrete structure (possibly remnant of an old sluice) protrudes only part-way across the channel (Figure 18). This feature has acted as a flow deflector and scoured a deep pool, emphasising an excellent (albeit short) pool-riffle sequence. This feature **demonstrates the By Brook's ability to develop** good holding habitat for trout if **provided with the right 'toolbox' of in-channel** structure and lack of impoundment. Securing simple log deflectors to the bed in sections of free-flowing river (Figure 19) can have equally impressive results but with the additional benefit of providing good quality habitat for fish and invertebrates in their own right.



Figure 18: The remnants of an old concrete structure (not impounding) deflects flow and has scoured a deep pool



Figure 19: An example of a simple log deflector in shallow water starting to scour a new pool

Channel width through the un-impounded reach varies, providing both wide, shallow riffles (Figure 20) and narrow fast-flowing runs (Figure 21). A good diversity of depths is also present **providing both large pools and small 'pots'** where trout are likely to lie up and feed. Improving access to these sections of river will provide anglers with some excellent sport. It would be worthwhile securing some woody flow-deflectors to enhance existing small pools/lies. Techniques for doing this are explored in the *Recommendations* section.



Figure 20: A shallow riffle would benefit from some simple flow deflecting woody habitat features



Figure 21: A narrow pinch point creates a fast-flowing run. A great feeding lie for trout.

In the next field downstream, the brook deepens and flows slow (Figure 22). Intensive grazing has denuded the upper bank of root structure and accelerated bank erosion. Reduced bank stability and increased soil compaction will significantly increase the volume of fine sediment entering the brook at this location. After a short distance the bed rises up into a shallow glide (Figure 23). Although the brook is relatively shallow at this location, flow is nonetheless influenced (slowed) by another impoundment downstream.



Figure 22: Flow slows down again and becomes laminar



Figure 23: A shallow glide provides some variation in depth but flow is slowed by an impoundment

Through the downstream half of the field, the character of the brook changes dramatically: it becomes canalised in an artificially straight and uniformly deep channel and flow is extremely slow and laminar. The slow flows, uniform habitat and total lack of tree cover has resulted in bur reed (*Sparganium erectum*) encroaching across the channel. In a natural river, marginal plant species are only able to encroach as far as flow, depth and light conditions will allow. However, in impounded and uniform channels there can be very little difference between the conditions at the river margins and the centre of the stream. A lack of any shade from bankside trees further compounds the problem resulting in a

channel that will require a substantial amount of expensive annual maintenance to remain functional.



Figure 24: The straightened and impounded channel is lacking tree cover. Perfect conditions for uncontrolled marginal encroachment.

The poor conditions observed in the brook are due to both the artificial shape and form of the channel itself and also to the fact that flows are so heavily impounded. The structure impounding the flow is a redundant and non-functional (permanently closed) sluice gate owned by the Environment Agency (Slaughterford Gate) (Figure 25).

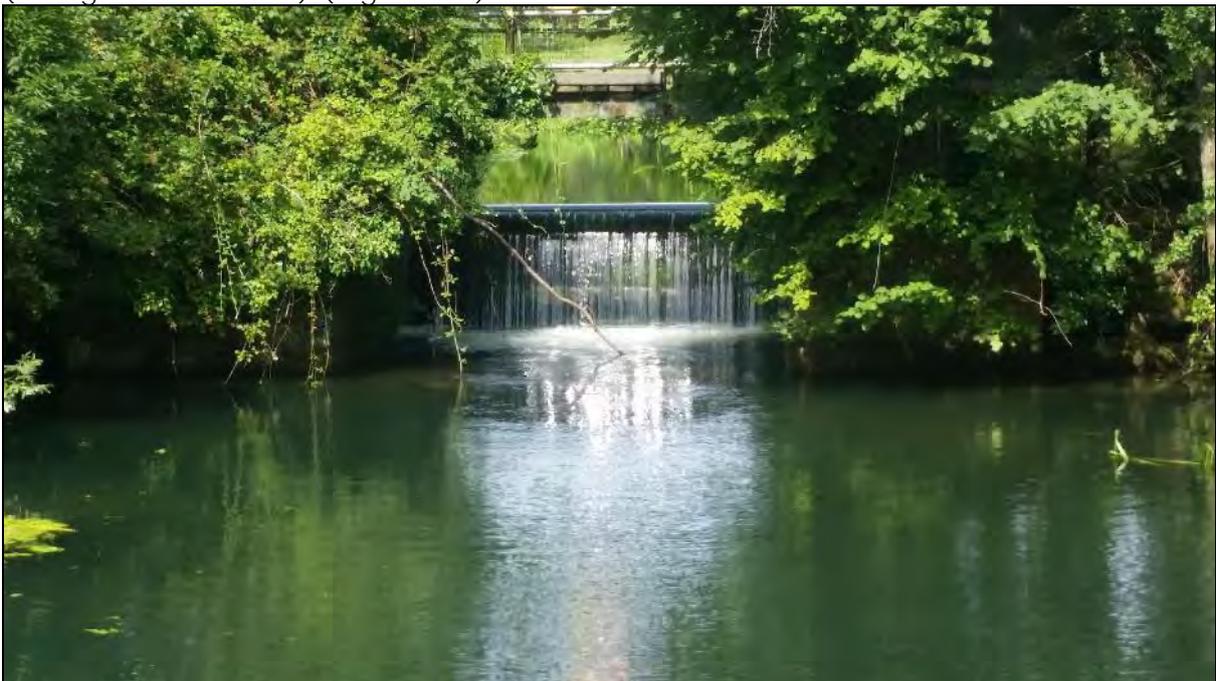


Figure 25: Slaughterford Gate seriously degrades habitat quality upstream and is a complete barrier to fish passage.

It is understood that discussions have been ongoing between the fishing club, land owner, farmer and EA with regards to the future of the gate. BART has

worked hard to broker a solution that is agreeable to all stakeholders but the process has been fraught with compromise and delay. Originally installed as part of flood defences for Bath but now redundant, Slaughterford Gate is a structure that serves no useful purpose and causes substantial harm to river ecology. It both acts as a complete barrier to fish passage under all but the highest flow conditions and significantly degrades habitat quality. Although a great deal of work has already been undertaken in scoping options for the sluice, it is of the utmost importance that the best possible outcome for the ecology of the river and the health of the fishery be achieved. For this reason, options for Slaughterford Gate are further explored in the *Recommendations* section of this report.

Downstream the river is briefly free-flowing before once again becoming impounded by another structure near the old rag mill (Figure 26). As outlined in the 2009 report this structure is in a state of disrepair and at risk of collapse (evidenced by water piping through the brickwork). This is a potential health and safety concern as a footbridge for a public footpath is situated on the structure. Lowering the water level upstream by removing the stoplog from the weir would help but ideally the structure should be removed and replaced with a clear-span footbridge.



Figure 26: Another impoundment further fragments habitat and the wild trout population.

In the free-flowing conditions below Rag Mill Weir, wild trout were observed in abundance and exhibiting a range of natural behaviours including holding in feeding lanes, feeding from the surface and darting to cover. As with the unimpounded reaches observed upstream, the brook here had a good diversity of flows and depths and should provide both good habitat for trout and opportunities for angling (Figure 27).



Figure 27: Free-flowing again the river exhibits some excellent natural features.

Continuing downstream, the floodplain narrows and becomes more densely wooded. Flows once again become sluggish but in this case not due to the impounding effects of a weir or sluice but to the channel being, in many places, significantly over-wide (Figures 28 and 19). In places the riverbanks have been poached by livestock and this has almost-certainly contributed to the widening of the channel (Figures 29 and 30).



Figure 28: Overwide and over-shaded, habitat becomes uniform through the wooded reach.



Figure 29: The over-wide channel causes slow, laminar flows. Note the reflection on the flat water surface.



Figure 30: Bank poaching is eroding the banks and contributing to the widening of the channel.



Figure 31: Bank poaching is often more acute under heavy shade where banks struggle to re-vegetate.

This section of the brook could be enhanced via the introduction of some flow-deflecting woody habitat features. The abundance of tree cover gives rise to several opportunities to hinge live trees into the river margins or otherwise secure felled trees with sweet-chestnut stakes. These would provide both refuge habitat for fish and also a greater diversity of flow speeds and directions, creating new opportunities for trout to feed and anglers to test their skill. Making use of existing bankside **trees would also help to open 'skylights' (gaps in the canopy)** and allow more light into more heavily-shaded sections. This could help increase the abundance of marginal plants and help protect banks from erosion. **Introducing coarse woody 'brushwood shelves' into areas with sufficient light,** would provide additional marginal plant habitat as well as provide excellent refuge habitat for juvenile fish. These techniques are explored in greater detail in the *Recommendations* section.

Conclusions:

The By Brook from Ford to Slaughterford is a stream with a number of issues affecting habitat quality. In its present condition and management regime, the brook is neither achieving its full potential as a biodiverse and flourishing trout habitat, nor as an easily-managed and high-functioning game fishery. Both the resident wild trout population and the fish stocked into the river by the club are at risk from potential water quality issues (as identified by the observed algal blooms). Poor habitat connectivity (caused by the impassable impoundments) will prevent fish from escaping threats such as pollution incidents, temperature spikes or predation. It will also inhibit repopulation by wild fish from downstream following any fish kill events. Measures taken to mitigate against low flows (such as retaining or raising water levels at the weirs/sluices) are counter-productive and actually *reduce* the resilience of the fishery to such events. Habitat uniformity, poor fish passage, run-away marginal encroachment, sedimentation and algal blooms are all mostly due to the presence of these impoundments.

Despite these issues, the Ford Fly Fishers water has enormous potential as a trout fishery. It is entirely possible that with sufficient ambition and confidence, the river could be transformed back to a natural, healthy and diverse stream that provides both an excellent habitat for wild trout and excellent opportunities for angling. A restored By Brook would generally be narrower but faster-flowing with an abundance of different pools, pots and runs that will hold fish. Clean gravel glides and riffles would provide good spawning opportunities as well as habitat for flow-loving invertebrates, resulting in a greater diversity of fly life and potentially longer periods of good dry-fly fishing. Simple habitat enhancement techniques as outlined in this report and practised in other Avon tributaries (such as Wellow Brook) will enable the club to maximise both opportunities for angling and also the resilience of the river to fluctuations in flow.

The restored fishery would be more cost-effective (not requiring any stocking), more interesting, (with a range of different features to hold fish and cast at) and easier to manage (not having uncontrollable marginal encroachment).

Recommendations:

In order for the By Brook from Ford to Slaughterford 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:

1. Continue to work with the Environment Agency, BART and other stakeholders to develop solutions to eliminate (or reduce as far as possible) impoundments and barriers to fish passage.

There are a number of ways of addressing these structures. However, in terms of ecological and geomorphological outcomes, the available options can be organised into a distinct hierarchy:

Plan A: Remove. In terms of fish passage, upstream habitat quality and sediment transport, removal is always the best option. All possible options for removal should be exhausted before other compromises are considered. Removing an impoundment that has been present for several decades or more, or is at the tail of a straightened channel, will result in a significant morphological change as a new equilibrium between channel length, sediment load and gradient is achieved. This can result in sudden and potentially alarming head-cut bed erosion and reduced bank stability. In such situations, it may be necessary to undertake restoration works (often requiring some re-meandering of the rivers course) on the channel upstream so that an appropriate balance is attained. This is often a superb opportunity to deliver multiple benefits to river ecology as well as to local stakeholders (by improving the aesthetics, function and stability of the river).

Plan B: Bypass. If complete removal is definitely not a feasible option, if for example there is a risk that the geomorphological change (resulting from the river adapting to a new gradient-sediment equilibrium) was almost certain to damage property, infrastructure or livelihoods (and could not be mitigated by suitable soft revetment work), a bypass is the next best option. A bypass involves creating a new section of channel connecting the habitat below the impoundment with the habitat above. Ideally, such a bypass channel would be long enough to provide an appropriate gradient for the river. A well-designed and constructed bypass channel should be almost indistinguishable from a natural channel and should provide all the same valuable habitat features.

Plan C: Lower and create nature-like fish pass. If a barrier/impoundment cannot be removed or bypassed, the next best option is to lower the impoundment as far as feasible and/or improve habitat **connectivity with a 'nature-like' fish pass. This is essentially** a fish pass that closely resembles naturally occurring rises in channel elevation (such as rocky cascades) that fish are well-adapted to overcome. Rocky cascades baffle flow and create a complex network of **different flow conditions. This offers a variety of different 'pathways'** for fish of different species (including eels) and different sizes to follow in order to pass upstream. A nature-like pass can consist of a short cascade or a series of rock ramps depending on the head drop required and space available. The reduced vertical head-loss also provides at least some additional energy to upstream flows (though much less than removal would).

Plan D: Technical fish pass. A technical fish pass is usually a hard engineered structure consisting of a baffled slope (e.g. Larinier style) or series of pools and small jumps (pool and traverse). This is a more traditional style of fish pass that has been installed in rivers across the globe. However, technical passes can be less effective in providing passage for multiple species and usually require an additional eel pass. Technical passes improve habitat connectivity but do not have any inherent habitat value as features in the channel.

Plan E: Fish passage easement. Fish passage easements are structures that improve fish passage but do not necessarily function as well as a technical pass over all flow conditions. An easement might **consist of one or more 'pre-barrage' structures that raise water level** downstream of an obstacle and reduce the overall head-drop, combined with lowering or notching of the obstacle itself. An easement might also consist of a series of baffles secured to a sloping weir to reduce the effort required for fish to overcome it. Whilst fish passage easements are an effective tool for improving fish passage, they are not ideal solutions and often fail to provide adequate passage for small/juvenile fish and/or eels.

It should be noted that although any improvement is better than the *status quo* in terms of fish passage, compromising too far on an

impoundment/fish passage solution in the short term could reduce the likelihood of funding a more effective solution in the medium term. As Slaughterford Gate is presently an Environment Agency owned asset, every effort should be made to ensure that the best possible solution is delivered. Once a project to improve fish passage has been delivered at the structure, it may not necessarily be a priority to fund any further improvements for some time. Similarly, if the ownership of the structure changes before an optimal solution has been delivered, the handover of responsibility may also reduce its priority.

In terms of habitat connectivity, sediment transport (particularly important considering the nutrient load on the river) and overall habitat quality, it is vital to consider all of the impounding structures together and develop a joined-up plan of action that addresses them all. There is little gain in improving fish passage up into a poor quality habitat or if another barrier is only a few hundred metres upstream.

2. Continue to engage with land owners/tenant farmers with regards to protecting the river margins from grazing livestock. Even relatively short sections of temporary electric fencing could heavily poached sections recover, improve biodiversity and reduce the input of fine sediment.
3. In the un-impounded reaches (hopefully one day to include the whole of the water visited), install some simple log flow deflectors to amplify the existing natural processes scouring small pools and runs (Figures 32 and 33). Also consider introducing some marginal brushwood structures alongside potential spawning sites to provide refuge habitat for juvenile trout (Figure 34).



Figure 32: Log deflectors positioned in an 'upstream V' formation focus scour and accentuate a pool



Figure 33: A log deflector scours the bed and also kicks flow around a bend

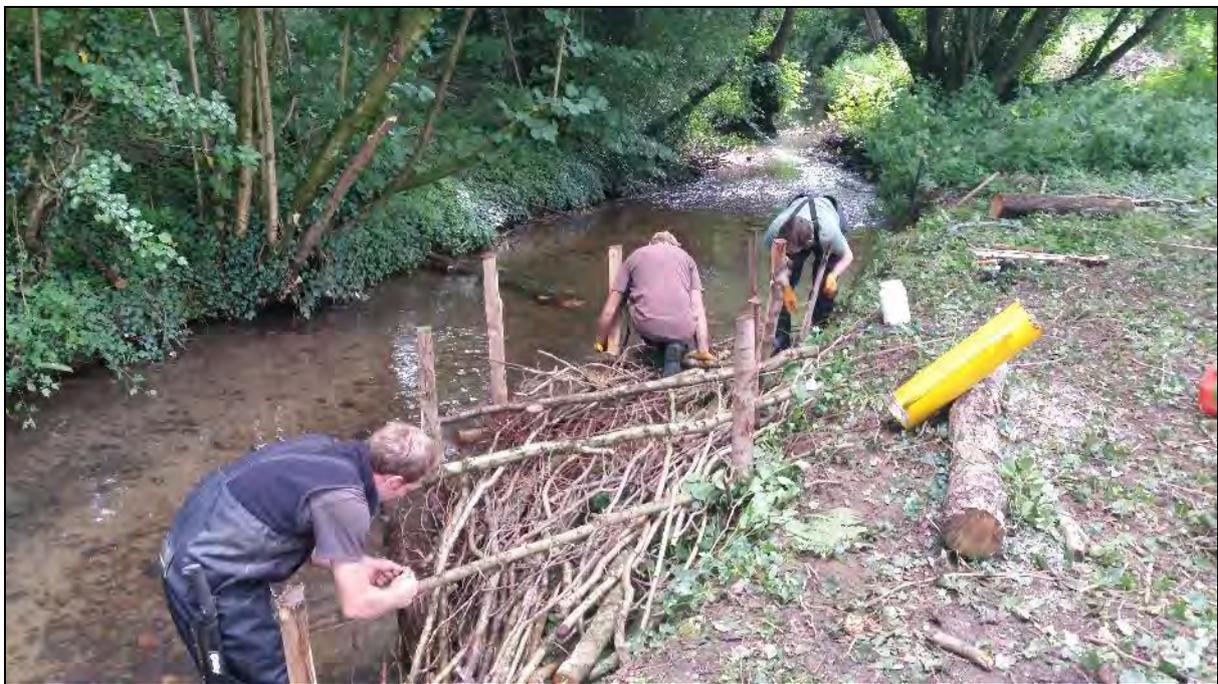


Figure 34: Volunteers introduce marginal brushwood habitat alongside a known trout spawning site.

4. Through the wooded reach below Rag Mill, consider opening up sections of tree canopy and introducing flow deflection and cover by hinging or felling trees into the channel and securing with sweet-chestnut stakes (Figures 35 and 36). These features are the best means of safely reproducing the fallen tree habitat that trout (along with countless other fish and freshwater invertebrates) have evolved to utilise.



Figure 35: Live willow hinged along the bank downstream

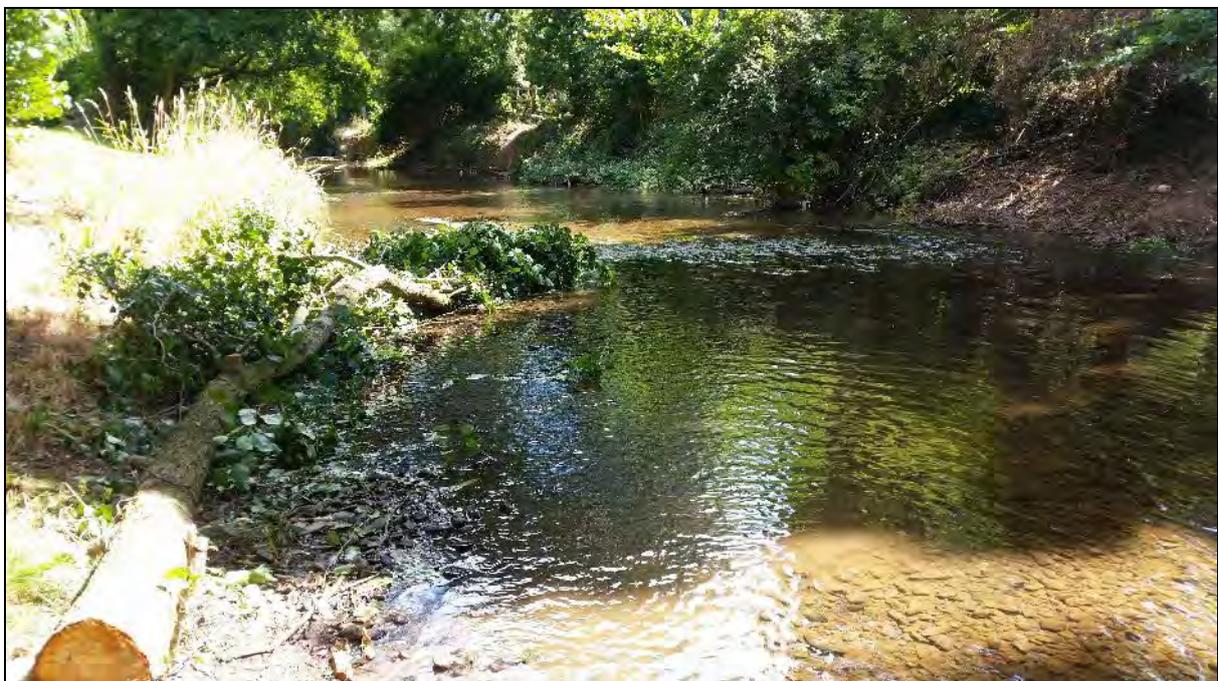


Figure 36: A felled tree secured to the bed. In winter flow this will scour a deep run and create a new trout lie.

Making It Happen

The creation of any structures within most 'Main Rivers' or within 8m of the channel boundary (which may be the top of the flood-plain in some cases) normally require a formal permit from the Environment Agency. This enables the EA to assess possible flood risk, and also any possible ecological impacts. Lower flood risk watercourses are designated as 'Ordinary Watercourses', in which case the body responsible for issuing consent will be the Local Authority. Contacting

the EA early and informally discussing any proposed works is recommended as a means of identifying the relevant authority and 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.