River Sowe (Wyken to Stoke Floods)

Advisory Visit

	Sowe
River	River Sowe
Waterbody Name(s)	Sowe - conf Breach Bk to conf Withy Bk and Sowe - conf Withy Bk to conf R Avon
Waterbody ID(s)	GB109054044660 and GB109054044540
Management Catchment	Avon Warwickshire
River Basin District	Severn
Current Ecological Quality	Poor/Moderate for two respective waterbodies
U/S Grid Ref inspected	SP3778780467
D/S Grid Ref inspected	SP3742278723
Length of river inspected	3.2 km

Wild Trout Trust Report – Following a Site Visit on 23/11/2017

1. Introduction

A site visit and habitat appraisal of the River Sowe was carried out at the request of Lyn Dowling and Sylvia Jackson (Friends of Sowe Valley) and Lee Copplestone (Waterside Care), with support provided by the Environment Agency through Sarah Pick.

The section of the River Sowe visited encompasses two separate "water bodies" under the Water Framework Directive (the scheme currently used to assess Ecological Status and Ecological Potential of our surface watercourses in Britain). For waterbodies classified as "heavily modified", such as the Sowe, the classification of Ecological Potential is applied. The Environment Agency (EA) data held for these two waterbodies indicate that they have an overall Ecological Potential of 'Moderate' and 'Poor' according to the most recent assessment in 2016.

The main reasons for the waterbodies not achieving Good Ecological Potential appear to be related to water quality (particularly phosphate levels) as well as biological indicators such as the combined higher plants and riverbed algae communities ("macrophytes" and "phytobenthos" respectively). A failure for an (unspecified) priority hazardous material in 2009 was noted for GB109054044540 but testing for those substances was not required in 2016 – resulting in a "Good" status in 2016. It is unclear whether that failure would re-emerge if tests were repeated for that same priority hazardous material. The information on both waterbodies is available on the following links:

GB109054044660: http://environment.data.gov.uk/catchment-planning/WaterBody/GB109054044660

GB109054044540: http://environment.data.gov.uk/catchment-planning/WaterBody/GB109054044540

Due to the requirement for clean, well-oxygenated water, structurally-varied habitat and free movement between different habitat types; the UK's native wild brown trout makes an ideal indicator species for healthy rivers. These characteristics lead the Wild Trout Trust (WTT) to derive a simple and effective assessment for river health based around the lifecycle requirements of brown trout (which forms the basis of this Advisory Visit report).

The factors required for robust populations of wild trout also map very well onto the more general requirements for healthy, diverse communities of flora and fauna in river corridors. In fact, the quality and diversity of riverbank, overall structural variety and associated fauna is of vital importance to the prospects of aquatic species (including trout).

Identifying and noting the presence or absence of habitat features that allow trout to complete their full lifecycle is a very practical way to assess habitat quality. By identifying the gaps (i.e. where crucial habitat is lacking), it is often possible to design actions to solve those habitat bottlenecks.

To put this into context, *there are three types of habitat* that are needed in order for wild trout to complete each one of the *three key lifecycle stages* identified below (Fig. 1). Those requirements (Figs. 2-4) create a demand for varied habitat, which is (in turn) vital for supporting a wide variety of species.

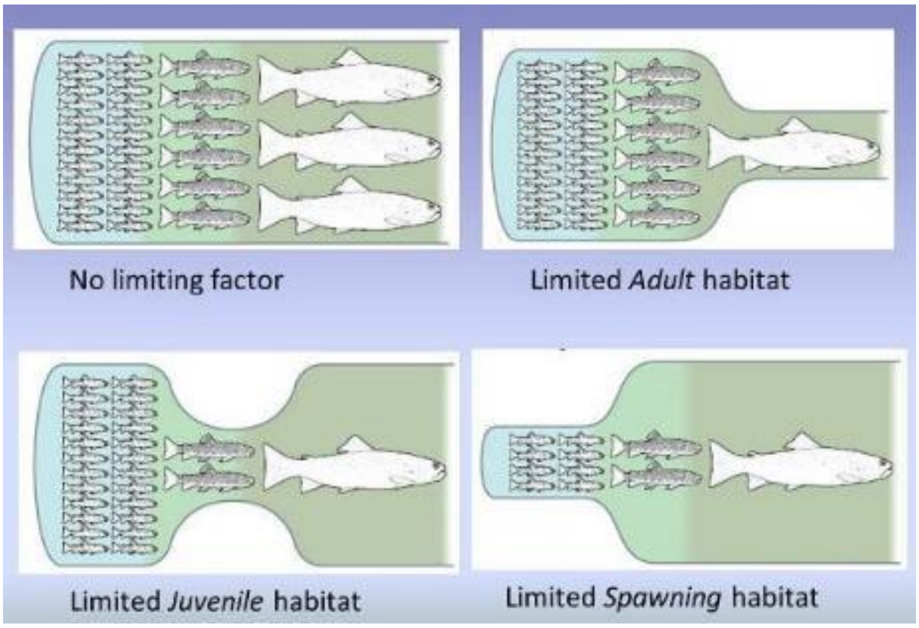

Figure 1: The impacts on trout populations lacking adequate habitat for key lifecycle stages. Spawning trout require loose gravel with a good flow-through of oxygenated water. Juvenile trout need shallow water with plenty of diverse structure for protection against predators and wash-out during spates. Adult trout need deeper pools (usually > 30cm depth) with nearby structural cover such as undercut boulders, sunken trees/tree limbs and/or low overhanging cover (ideally trailing on, or at least within 30cm of, the water's surface). Excellent quality in one or two out of the three crucial habitats may still not be able to make up for a "weak link" in the remaining critical habitat.

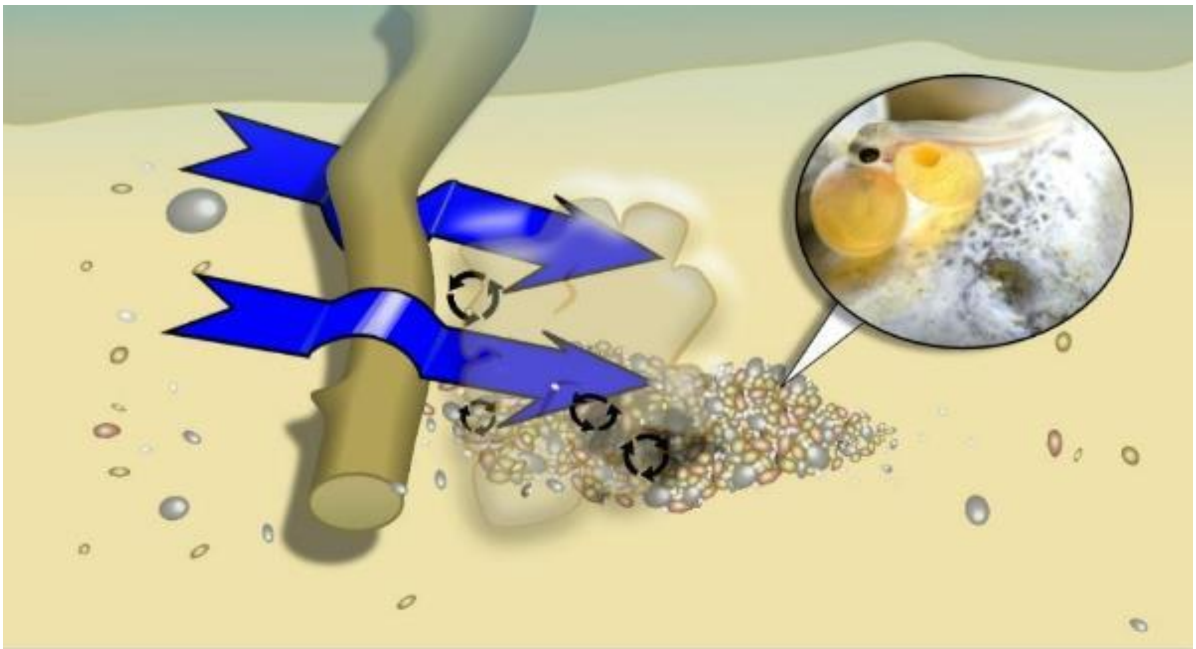

Figure 2: Features associated with successful trout spawning habitat include the presence of silt-free gravels. Here, the action of fallen tree limb is focusing the flows (both under and over the limb as indicated by the blue arrows) on a small area of river-bed that results in silt being washed out from between gravel grains. A small mound of gravel is deposited just below the hollow dug by focused flows. In these silt-free gaps between the grains of gravel it is possible for sufficient oxygen-rich water to flow over the developing eggs and newly-hatched "alevins" to keep them alive as they hide within the gravel mound (inset) until emerging in spring.

Figure 3: Larger cobbles and submerged "brashy" cover and/or exposed fronds of tree roots provide vital cover from predation and spate flows to tiny juvenile fish in shallower water (<30cm deep). Trailing, overhanging vegetation also provides a similar function and has many benefits for invertebrate populations (some of which will provide a ready food supply for the juvenile fish).

Figure 4: The availability of deeper water bolt holes (>30cm to several metres), low overhanging cover and/or larger submerged structures such as boulders, fallen trees, large root-wads etc. close to a good food supply (e.g. below a riffle in this case) are all strong components of adult trout habitat requirements.

With these broad descriptions of the elements of spawning, juvenile (nursery) and adult trout habitat in mind, measures to address the issues identified during the survey can more easily be described.

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.

2. Habitat Assessment

At the upstream limit of this visit at National Grid Reference SP 37787 804467 there is a well-developed woodland corridor (Fig. 5) but the riverbed is relatively uniform and probably historically-straightened.

Figure 5: Highly beneficial woodland flanking the river. More structural variation could be created by light rotational coppicing and using some of the arising material to diversify the habitat within the river channel.

The straightening of the river has created a relatively uniform current-speed and depth-profile across the full channel cross-section. The reduced structural variation provides fewer niche opportunities for different species. As a result, species diversity is likely to be limited compared to more complex habitat.

In common with many realigned channels (particularly in relatively soft/sandy geology), the Sowe tends to be quite incised (e.g. Fig. 6). This means that the riverbed is a long way below the top of the banks in many places – and there is little connectivity between the main river and its floodplain. Although it is (normally) undesirable for water to spill into the floodplains that have been inappropriately developed with infrastructure (housing, buildings, roads etc.) –

ecological status and flood-mitigation performance of rivers are impaired when any and all floodplain connections are removed.

Figure 6: The "Bank full" depth in this photo would be approximately where the tree (left of frame) joins the undergrowth. This is several feet above the normal water level. If the bank-top is as high as this throughout the reach - the river would need to be running extremely high before it could spill out onto the (undeveloped) flood plain.

There are some locations (e.g. riffle at SP37832 80404; Fig. 7 and SP3800380335; Fig. 8) where greater floodplain connectivity is evident.

Figure 7: Riffle with increased availability of smaller gravels (potential trout spawning habitat) and less incised channel profile. All these characteristics are probably associated with the bend in the river visible in the top right of the frame).

Figure 8: Another spot where the bank-top is not as far above the normal water-level compared to the predominantly "incised" profile (typical e.g. in Fig. 9).

Figure 9: Typical degree of channel incision for the visited reach – photographed at SP 38136 80312.

However, there may be potential to achieve significant ecological and floodwater-management benefits via the creation of wetland scrape habitat that is connected to the river. Figure 10 shows the current footpath and riverside park at SP 37902 80358 – where it may be possible to connect the river channel to a periodically-inundated wetland scrape.

Figure 10: The creation of a wetland scrape to the right of the frame (coupled with a connecting channel cutting through the footpath and associated footbridge) would be highly beneficial ecologically, while offering new measures for managing floodwater in the Sowe catchment.

Care must obviously be taken with any earthworks – as highlighted by the presence of services pipes crossing the river at SP38170 80311. Full service checks are just one of the many permissions and pre-works precautions that are vital to carry out.

Figure 11: Service pipes crossing the (incised) river channel. A basic, essential precaution before undertaking any ground penetration works is always to determine the location and path of any underground services.

Further (or alternative) opportunities to create floodplain wetland scrapes connected to the river channel exist at SP 38250 80295 (Fig. 12) and SP 38347 80256 (Figs. 13 and 14). In all cases the channel connection must run beneath the existing footpath. If an open channel/footbridge scheme was unworkable – an alternative would be square-section buried culvert beneath the footpath.

Figure 12: Potential wetland area at SP 38250 80295 (would need to be connected to river underneath footpath).

Figure 13: Further potential wetland scrape (view of floodplain) at SP 38347 80256 with associated river corridor shown in Fig. 14

In all cases, it would be necessary to survey the relative elevations of the riverbed and the proposed wetland bed levels to check for feasibility. Care would need to be taken to minimise the potential for the wetland to act as a (temporarily-wetted) "fish trap". For instance, avoiding the creation of a "step" between either the inlet or outlet ends of channels connecting the main river to the wetland area. A formal survey and detailed feasibility investigation would be required before deciding to adopt this option.

2.1. River Sowe Wetland Creation and "Lateral Connectivity" Rationale

As well as creating extra floodwater storage capacity, the rationale for creating this "lateral connectivity" between floodplain wetlands and the main river channel can be summarised as follows:

- Deposition of nutrient-rich sediments within the wetland – instead of contributing to nutrient-enrichment/low dissolved oxygen within the river
- Creation of under-represented niche habitats and an associated increase in local biodiversity (for both flora and fauna)
- Enhanced landscape amenity for walkers

The need to reduce nutrient loadings within the channel is indicated by the predominance of filamentous algae coating the riverbed in many places. Excessive algal growth is associated with periods of much lower dissolved oxygen levels and a loss of the aquatic species that cannot tolerate that reduced oxygen content.

Although the creation of floodplain wetlands is unlikely to solve the nutrient enrichment of the river on its own; it could be a valuable component of a solution. One of the most valuable things that any "friends of" group can do for their local rivers is to identify the likely sources of high nutrient and sediment inputs – and also to monitor the more general water quality.

Figure 14: Confluence with the Withy Brook at SP 38474 80194 – note the milky colour of the Withy Brook water in the background before it becomes fully mixed with the water of the Sowe. This indicates elevated inputs of fine sediment (possibly from tilled soil on arable fields or hard-standing drainage from ongoing building development upstream) on the Withy Brook.

For the Sowe, it is possible that both wastewater and agricultural inputs (e.g. Fig. 14, potentially) are elevating phosphate levels in the river (as highlighted in the Water Framework Directive assessments described in the introduction to this report). In future it is likely that water companies will find cases where it is more cost-effective to fund solutions that tackle nutrient enrichment at the source (compared to attempting to strip nutrients once water arrives at a treatment works). A pilot project by United Utilities demonstrates the potential of this approach with phosphate. For all stakeholders in river water quality, it is important to understand that both fertilizer and livestock waste have high potential to increase nutrient levels in rivers.

Waterside Care has already established great resources for citizen science water chemistry testing and invertebrate community monitoring. A crucial part of involvement in Waterside Care is the ability to report misconnections in the wastewater system that can lead to grey or foul water being wrongly discharged into rivers. One of the most common forms of misconnection are those involving the plumbing of washing machines into the surface water drainage system. The Connect Right website also provides a great resource to help identify and tackle misconnection issues.

It is not only misconnections that can lead to the unintended discharge of foul water. The aptly-named “fatbergs” resulting from fats, oils and grease poured down sinks and draining from dishwashers can block sewer systems. Often this leads to the redirection of foul waste into the surface rainwater drainage system. In turn this causes the discharge of foul water via Combined Sewer Overflow (a system designed to discharge to rivers only when sewers are overwhelmed by excess rainfall). Being vigilant for grey-water, sanitary towel “rag” waste and any foul-smelling discharges into rivers, particularly during dry weather (when they are also the most harmful, owing to low river flows and poor dilution), is the first step in tackling this type of problem. Any and all pollution events should be immediately reported to the Environment Agency Incident Hotline by phone (24hrs a day): 0800 80 70 60.

Phosphate binds readily to sediment. Consequently, in combination with tackling the sources of elevated dissolved phosphate, allowing floodwaters to deposit phosphate-rich sediments in floodplain wetlands is beneficial for rehabilitating polluted watercourses. This is the process which naturally fertilizes lowland riversides in catchments where the rivers have not been artificially cut-off from their flood plains. That deposition of nutrient-rich silt during spate flooding events has been the basis for fertile farmland around the globe (The Nile and the Egyptian civilization is one very famous example).

When lateral connectivity to floodplains is lost or greatly reduced, the nutrient-enriched sediment cannot be deposited on the surrounding land. Instead it accumulates in riverbed material – promoting excess algal growth. The bacterial decay of dead algae is one of the major causes of dissolved oxygen being stripped from river water.

In contrast, wetlands and the plants growing there are adapted to sediment with low/no dissolved oxygen as their rooting substrate. The plant communities are also adapted to the nutrient-enriched sediment deposited by the river – and phosphates are taken up into plant tissues. That uptake of and retention of excess nutrients and other pollutants is the basis for artificial wetland treatment systems.

In order to realise the full landscape amenity benefit of wetlands created in this way adjacent to the Sowe, it may be appropriate to undertake some supportive planting with native, locally-suitable, emergent and marginal plant species. When combined with any control of invasive, non-native species (such as Himalayan balsam) that may be necessary, those wetland plant communities would also support a wide variety of native invertebrate and vertebrate fauna.

2.2. River Sowe Habitat Structural Diversification Rationale

The other major constraint acting to restrict the ecological status of the Sowe throughout the visited reaches is the extensive historic straightening of the channel. One of the major impacts of straightening is the huge reduction in structural variation over the cross-section of the channel. Basic examples of variation in habitat conditions include depth, current-speed and the size of particles that make up the riverbed.

Because different species are adapted to particular combinations of depth, current-speed, particle-size and many other physical habitat conditions, the greater the physical variation in habitat; the more species that can potentially be supported.

A straight channel tends to have very similar conditions throughout its whole width (e.g. Fig. 15).

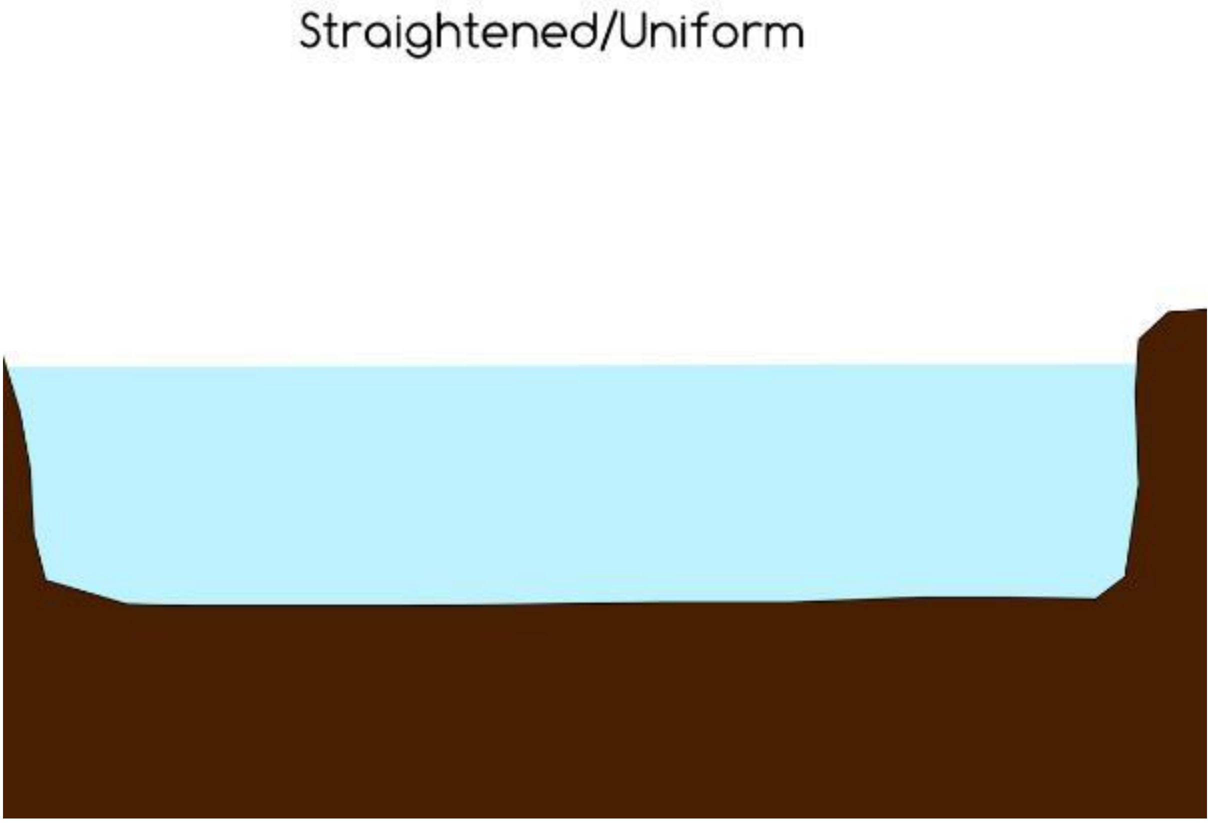

Figure 15: Example cross-section of a straightened channel. Little variation in current speed, substrate or depth from bank to bank.

As a result, fewer species (or fewer separate lifecycle-stages within a species) can be supported by the limited range of conditions. Similar, artificially created conditions occur when water is held back by a weir (or "impounded").That simple habitat creates a massive advantage for predators – which carries the risk of serious depletion of prey populations. In simple habitat, there is nowhere for prey to effectively hide, making hunting more efficient (Fig. 16).

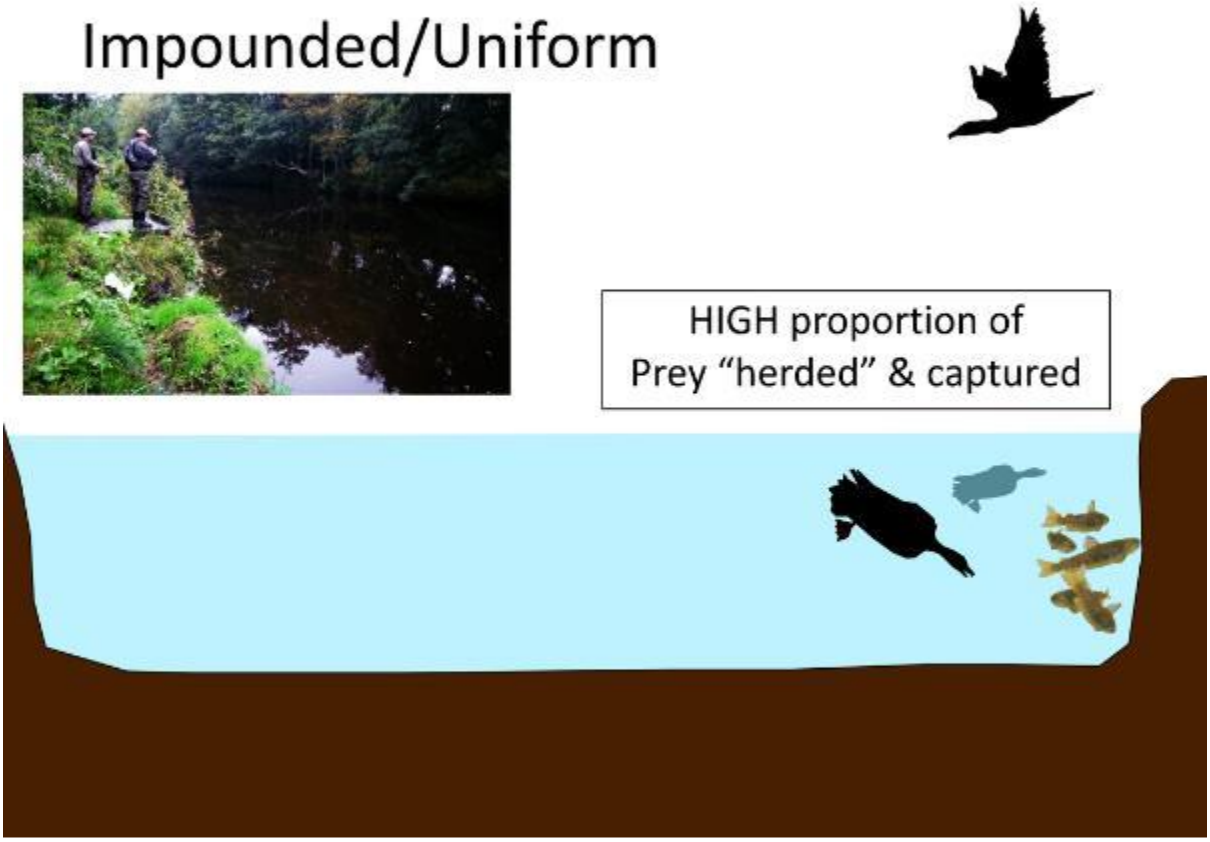

Figure 16: Simple habitat makes it profitable for predators to continue hunting until a greater proportion of the population is depleted. It also allows predators to deplete a population rapidly. In complex habitat, predators must seek new hunting grounds even when larger numbers of prey still remain (because, in complex habitat, it soon takes more calories to find and catch prey than the calories gained by eating that prey).

In contrast, rivers can create far more varied habitat when they are allowed to develop naturally (by processes of "geomorphology" – with a simple explanation here: www.wildtrout.org/blog/why-presume-remove-weirs-river-dove-case-study). Not only do the channels "wiggle" more (and create a natural slowing of floodwater), but their cross-sections are far more varied in terms of current speed, depth and bed material (Figs. 17 and 18).

Water flowing over land experiences small differences in friction, fractionally slowing the water on one side then the other. This is exactly what happens to rain-drops on car windscreens (and is the reason that even on smooth glass, raindrops follow a wiggling path down the glass). As well as "steering" the water towards the slower-moving side, that small reduction in pace causes some of the sediment being carried along in the water to fall out of suspension. When it deposits, that material creates a more varied course and even more friction – further slowing and steering the water.

That self-compounding effect is what leads to the deposition of "point-bars" on the inside of bends in watercourses. At the same time, the faster-flowing water is funnelled to the outside of the bend – where it can erode away river bed and river bank material. The erosion on the outside of bends and the deposition on the inside combine to create the variation in both depth and current-speed throughout the cross-section of a meandering stream.

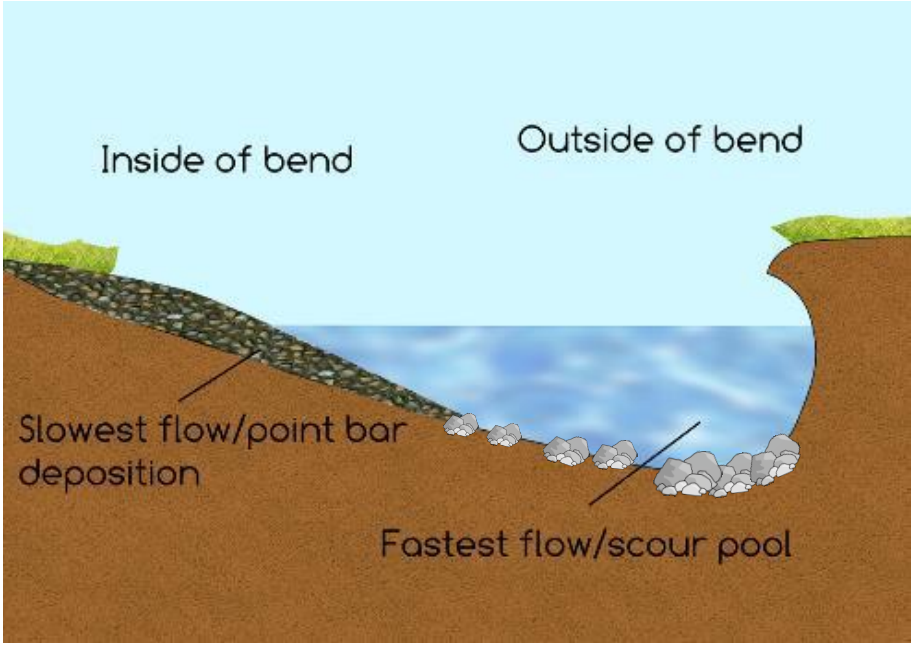

Figure 17: It is easy to see how both depth and current speed vary from bank to bank in a meandering section of channel. The faster the current, the larger the particle-size of sediment has to be in order to remain in place. Fast currents sweep away fine sediment (which then deposit in slow-flowing areas). This separation or "sorting" of sediments provides a patchwork of different habitats to which different species are adapted. With uniform current-speeds, the riverbed becomes blanketed with only one particle-size – providing only one type of habitat.

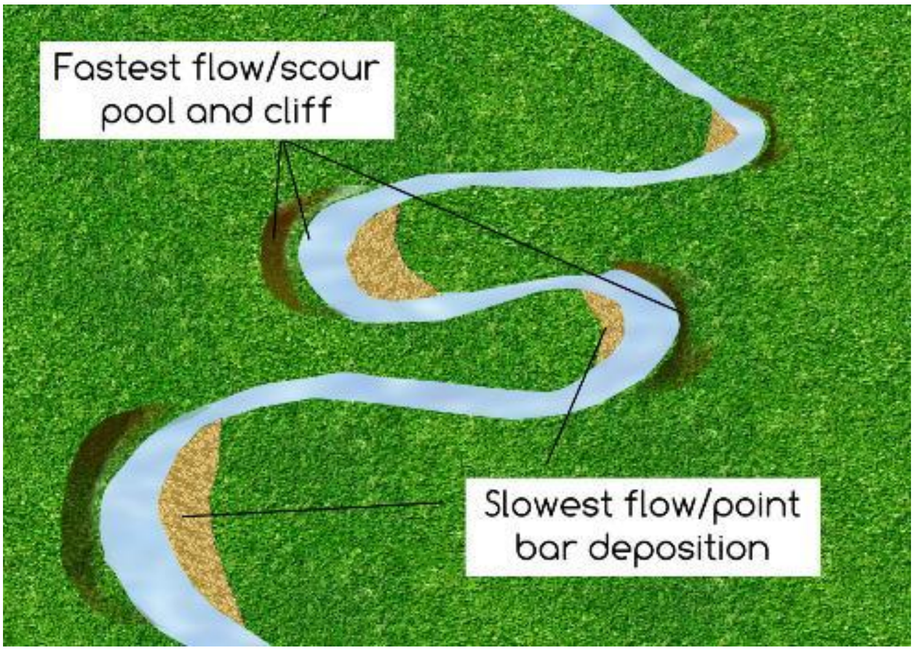

Figure 18: Scour and deposition of riverbed material creates the meandering channel (and the associated physical habitat variation over the full cross-section).

A typical example of the straightened sections of the River Sowe is given in Figure 19 (below). Straightened channels have a shorter path-length than meandering channels – which can have several impacts depending on the flow direction in relation to the shape of the landscape.

If the path runs **across** a contour (i.e. downhill) it makes the channel steeper (because the same vertical change happens over a shorter path-length), causing:

- Increased energy of the flow – leading to cut into the riverbed
- A tendency for increased channel capacity
- A tendency to lose many of the features that would arise through natural erosion and deposition

Conversely, if the path runs **along** a contour:

- The gradient is reduced to almost zero
- There is no energy to create varied geomorphology
- Uniform habitat lacking scour and depositional features results

In both cases, straightening the river removes the majority of biologically-valuable variation in channel structure. The combination of those factors can also inhibit channels naturally recovering their meandering form.

The matter of reduced habitat variation through straightening can be further complicated by the presence of trees in the surrounding land.

On the one hand, reinforcement of fragile soil banks by deeper roots is usually an essential feature if scour-pool habitat is to be deep enough to support adult trout (and to avoid a smothering impact of excessive fine sediment erosion from the banks).

Conversely, planting a line of trees along the banks of a straightened channel is another way of "locking" a straight channel in place. This prevents the natural recovery of the channel. This is why a wider belt of woodland and understory species (with patches of substrate that vary between easily erodible and erosion-resistant root-structures) provides the best "canvas" for a river to recover.

These are the complex processes that need to be kept in mind when surveying a reach of river in order to judge the potential for habitat improvement. A great many rivers will also, of course, have land-use pressures and constraints super-imposed on that river corridor.

For example, there is usually an obvious relationship between the straightening of a river and the desired use of the land on either side of that channel. Whether it is field boundaries, access, infrastructure or other forms of development, it is frequently difficult to return a river to land that has been claimed for a different purpose.

In the case of the River Sowe, it is notable that, for much of the visited reach, there is only a single line of trees along each bank of the river. To give the clearest guidance for this report, it is worth working through the considerations above for this specific reach.

Figure 19: Artificially straightened channel (and an associated, unnaturally uniform cross-sectional profile). Note the single line of trees along both banks.

As highlighted above, tree roots provide reinforcement to riverbanks and help to promote the formation of scour-pool habitat. Having only a single line of trees, however, can be vulnerable to a breach of that narrow band of reinforcement (for instance during an intense winter spate). When this happens, the river will readily cut into banks that support only shallow rooting vegetation. Mowing or grazing, of course, maintains the very shallow root-horizon associated with close-cropped grass turf – and this will promote more rapid lateral movement of the channel into the grazed fields. From the landowner's perspective, this could be highly undesirable. At the same time, maintaining close-cropped turf often leads to excessive erosion and relatively uniform (wide/shallow) channel conditions – with high inputs of fine topsoil. So, even though an improvement on the current situation, there would be some limitations placed on the scope for habitat-quality improvements.

In contrast, a wider patch of woodland (e.g. Fig. 20) means that the river can't cut too far into the bank before encountering earth that is far more resistant to erosion. When the banks are less erodible than the riverbed, then the river must dig downwards instead of sideways – and this creates deeper pool habitat. Because that pool habitat is formed by the self-scouring action of the river, it is naturally swept clear of finer sediments that would otherwise deposit and cause a reduction in depth.

Overall, creating varied riparian (riverside) vegetation is an effective way of ensuring varied habitat creation within and around the river channel. In areas where fencing boundaries are valued by landowners, a lack of deep tree roots can lead to unwanted lateral erosion of the soft un-consolidated soils (e.g. Fig. 21). At the same time, locking a straightened river in place by planting a single row of trees will put a limit on the ecological potential of that channel.

Figure 20: Broader strip of riparian woodland at SP 38424 80109 (N.B. feeding of birds in this location was noted to be supporting a large population of rats in this area - which is actually likely to have a negative impact on nesting birds).

Figure 21: Shallow root horizons mean that fence-lines are vulnerable to collapse – but locking a straight channel in place has a negative influence on the river ecology.

The difficulty is in juggling the practicalities of various improvement opportunities against current land-use preferences and rights. Suggested options are discussed in section 3 "Recommendations".

Although there are some limited examples of in-channel cover derived from trailing vegetation (e.g. Fig. 22), there is a general lack of this type of habitat, partially owing to the incised channel and steep, high banks. As indicated in Fig. 3, this type of "brashy" refuge is essential for good survival prospects of juvenile fish. It is particularly valuable for over-winter survival of younger fish.

Figure 22: Limited trailing vegetation cover, straightened channel and single-line of deeper-rooting species all acting to constrain the ecological potential of the Sowe. However, even though very narrow, the effectiveness of those deeper-rooting species in protecting the fence-line behind is notable. This may be viewed positively if you want to protect the fence, but also constrains the recovery of a more meandering channel.

There is also a valuable separation of the channel from livestock – in part achieved by the inclusion of a fenced-off "cattle-drink" (Fig. 23) at SP38247 79582, although this method of stock watering does create increased sediment and nutrient issues locally.

Figure 23: Livestock drinking area - separation of animals from the watercourse and associated vegetation is beneficial to the river corridor ecology, but further reduction in sediment and nutrient inputs may also be possible to achieve through offline watering (pasture pumps or solar pumps, or even mains water, which delivers additional livestock health benefits).

During the visit it was reported that 700 houses are planned for the land on the LB. Although there are obvious risks of increased pollution potential, surface runoff and other impacts on the habitat of the river – there may be opportunities for habitat improvements too.

Downstream of the B4082/Clifford Bridge Road there are some shallower and wider sections (Fig. 24). Heavy visitor footfall and shading have contributed to hot-spotted areas of denuded banks (Fig. 25).

Figure 24: Footbridge over a wider, shallower section of the Sowe downstream of the B4082

Figure 25: Heavy footfall and probable dog access to the channel has killed the vegetation to expose bare earth. While being an obvious point of low biodiversity, this type of damage seems to be quite limited in extent.

This section of the River Sowe also had some of the better examples of natural cover habitat seen during the visit – e.g. Figs. 26 and 27.

Figure 26: Great overhanging and trailing cover habitat - retaining valuable nutrients in the form of leaf litter and coarse woody material.

Figure 27: More examples of essential overhanging and trailing cover habitat.

Not far downstream from this section, the impoundment caused by "Stoke Floods" lake is evident. The impounded section of river is associated with some surface scum that is likely to indicate a reduction in dissolved oxygen levels in this reach.

Figure 28: Stoke Floods - the downstream limit of this visit and a home for waterfowl

3. Recommendations

A tiered approach to potential improvements is suggested. First of all, here is a brief summary of the basic improvements that would be universally applicable:

N.B. *Any and all works will be subject to a variety of legal permissions that include, but not limited to, landowners, regulatory authorities for the watercourse (which could be local council, Environment Agency, British Waterways etc.) and other stakeholders such as bodies responsible for underground services that may be affected by works.*

Basic Tier works would include:

- Undertake training in invertebrate identification that allows water quality to be assessed so that problems can be identified and improvements or declines can be monitored
  - The Sowe appears to be a suitable river in which to apply the Riverfly Partnership monitoring approach (www.riverflies.org/rp-riverfly-monitoring-initiative)
- Using the Waterside Care chemical testing kits to monitor phosphate levels (in particular)
  - Identifying potential inputs– whether derived from surrounding land-use or via water-treatment facilities (or a combination of the two as highlighted in the Petteril Integrated Catchment project)
  - Campaigning to mitigate or remove those inputs
- Report any and all pollution events (including runoff with high sediment-loading from agricultural land).
- Particular emphasis should be placed on pollution events occurring at times of low/no rainfall when the receiving watercourse(s) are under low-flow conditions

- Explore opportunities to "hinge" or "lay" (in the manner of hedge-laying) scattered patches of sapling-growth into the channel (e.g. Fig. 29) to promote some bed redistribution during high-flow conditions
- With the help of appropriately-qualified and insured chainsaw operatives (and with all relevant permissions in place), create a more varied tree and shrub canopy structure. This should be achieved by very light rotational coppicing. Aiming for 10 percent or less of the trees being coppiced every one to two years in a scattered distribution would be ideal
- Use materials arising from those routine tree-management activities to securely fix limbs, stems and branches from trees to encourage localised bed and (where safe to do so) bank scour (e.g. Fig. 30).
- Consider introducing signage to discourage the feeding of birds/encouragement of large rat populations.
- Consider approaching landowner(s) to seek installation of alternative stock-drinking arrangements (pasture pumps: https://youtu.be/1Feob01eEGM, mains-water troughs or solar pumps: comparable to pasture pumps, but with a trough maintained by an electric, solar-powered pump)
- Consider more extensive project options (i.e. second and/or third-tier options suggested subsequently in this report) in partnership with organisations that have capacity to deliver more complex/costly interventions.

Figure 29: Hinged sapling growth (in this case hazel) used to create cover habitat in stream margins.

Figure 30: Securely pinned/staked woody material producing localised bed scour during high flows. Using this technique with material arising from tree management would create better habitat within un-impounded sections of the Sowe.

Second tier options could include:

- Seeking a formal topographical survey to establish the feasibility of increasing lateral connectivity with the floodplain in controlled areas to meet the two following conditions:
    - Avoidance of “fish trapping” conditions when the wetland drains to the river (in other words, there is a permanent, wetted connection between the river and any wetland scrape)
    - The size of the wetland must be small enough to avoid entirely draining the river until the wetland is filled
    - The arising spoil should be of a quantity that can be redistributed on-site
- The creation of lateral connectivity and wetland scrapes (while maintaining the existing footpath/public rights of way) could resemble the work done by Sheffield and Rotherham Wildlife Trust for their Centenary Riverside reserve: www.wildsheffield.com/reserves/centenary-riverside
    - A central feature of that reserve is the connection of the main river Don to the wetland/standing water habitat
    - This is achieved by means of sunken conduits (large diameter pipes) that connect the river to the Stillwater/wetland habitat scrapes
    - Walkways are included to protect sensitive habitat and also preserve (sustainable) access all around the site
    - Measures should be taken to avoid creating “fish trap” conditions by using square-section conduits that do not have a “step-up” at the point where they join the wetland – i.e. the base of the wetland scrape is level with the base of the conduit
    - Alternatively, open channels could be dug to create the required connectivity between the river channel and adjacent wetland habitat
    - Locally-appropriate species of wetland plants could be introduced to create an instant kick-start to biodiversity improvements
    - Local Wildlife Trusts may be one source of potential partnership (as demonstrated by Sheffield and Rotherham Wildlife Trust’s project)
- Exploration of ways that the lake/river complex could be bypassed by the river in order to re-establish better longitudinal connectivity up and down the river for fish species. This would also reduce the rate at which the lake fills with sediment.
    - Combining the above with seeking opportunities to reduce the impounding effect of the current arrangements (although apparently not accessible during this visit, it is assumed that a weir is currently used to divert water from the river into the lake complex)

Third Tier Options (integrated with all the above) could be:

- Employing a specialist Geomorphologist to design a “nature-like” (re-meandered) channel that could be constructed at dimensions and sinuosity that are appropriate to the Sowe’s discharge/local geology and site gradient
- Combining the above with stable woody material introduction within the channel and planting schemes to create varied riverside mixed woodland and understory vegetation
- Integration of the re-meandering with wetland scrape connectivity as elements of both pollution and flood-water management strategies for the region

- Developing the public rights of way via the inclusion of walkways that would take account of the new, more sinuous, course of the river
- Partnership with Local Government, Environment Agency and other key stakeholders (particularly Severn Trent Water) would provide the best platform for success for third-tier options
- Explore the potential for securing access to "Section 106" funding from the developers of the new housing adjacent to the river (whereby a condition of sale/construction is to fund ecological improvements/protections to watercourses that may be potentially impacted by such development
    - The Environment Agency and Local Council will have access to relevant information regarding Section 106 funding
    - Monies may already have been agreed – and suitable ways to use that funding may be being actively sought/welcomed

The technical challenges of extensively re-naturalising watercourses means that formal funding bids would be required – along with the establishment of a project management board. Because of the significant effort implied by those actions, it would be essential to make the tackling of water quality issues central to any project. Without that, any improvements in habitat would not translate into increased diversity in aquatic wildlife.

The WTT is willing to provide support (within its capacity) to meet our recommendations. We'll also work to provide assistance in establishing contact with appropriate partners where further support is required.

We are often able to provide demonstration and training in delivering the basic recommendations made in our Advisory Visit (AV) reports (like this one). This commonly takes the form of a "Practical Visit" (PV) where one or more of our Conservation Officers help you to carry out the habitat improvement measures recommend in our AVs. A significant component of PVs is the training we provide that allows recipients to deliver similar work in future.

Demand for PVs is high and subject to the availability of our Conservation Officers, funding for staff time, mileage and materials.

For any clarifications on the observations and recommendations given in this report (or any other related questions/comments) please feel free to contact me on pgaskell@wildtrout.org.

4. Acknowledgement

The WTT thanks the Environment Agency for supporting the advisory and practical visit programmes (through which a proportion of this work has been funded) in part through rod-licence funding.

5. 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.