Moat Brook (The upper River Penk): Advisory Visit & Initial Project Proposal

Paul Gaskell Wild Trout Trust (WTT) 06/10/2016

	Groundwork West Midlands/Friends of Bilbrook/Environment Agency
River	Penk (Moat Brook)
Waterbody Name	Penk, Source to Saredon Brook
Waterbody ID	GB104028046680
Management Catchment	Trent Valley Staffordshire
River Basin District	Humber
Current Ecological Quality	Poor
U/S Grid Ref inspected	SJ8754204172
D/S Grid Ref inspected	SJ8823303720
Length of river inspected	~750m in total

1 Introduction

A site visit and habitat appraisal was carried out by Paul Gaskell at the request of Steve Cook (Groundwork West Midlands) and Matt Lawrence (Environment Agency) and hosted by Keri Lloyd (Friends of Bilbrook) to explore the potential for habitat improvement on the Moat Brook at Bilbrook, Perton. The Water Framework Directive (WFD) identifies this within the single Waterbody "Penk, Source to Saredon Brook" which has the Waterbody ID code GB104028046680.

The 2015 classification for the full waterbody cites "poor" status for fish ("high" in 2009 assessment) and "moderate" status for invertebrates ("bad" in 2009). Overall the 2015 published classification data show that the Ecological Potential of this waterbody is "poor", though chemical water quality is not highlighted as a significant limiting factor. Consequently, there is significant scope for improvement within the waterbody – and such opportunities were explored in the section of the upper River Penk adjacent to Bilbrook (where it is known as the Moat Brook).

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 notes

The upstream and downstream limits of the surveyed reach were SJ8816803908 and SJ8823303720 respectively. A portion of the land adjacent to this reach has benefited from the excellent work of Friends of Bilbrook. Here, tree and wildflower meadow planting has been coupled with wildlife habitat construction as part of their creation of Jubilee Woods. The Friends of Bilbrook group is now keen to contribute to schemes that would help to improve and protect the Moat Brook as a habitat corridor (with its attendant potential to act as a vital "connecting corridor" to other high quality patches of habitat for wildlife).

Due to the generally low starting condition (at least for aquatic flora and fauna within the river corridor), there is plenty of scope for improvement. For instance, historic records from nearby fish population surveys indicate a patchy, low density of coarse fish (and an absence of trout). The stream invertebrate populations that have been surveyed for the waterbody under the Water Framework Directive are also poorer than would be expected in a healthy stream. Identification of factors that are likely to be contributing to this status are a valuable first step in improving matters.

The particular niche requirements of native brown trout (*Salmo trutta*) in streams such as the Moat Brook allow a relatively simple but effective assessment of positive and negative habitat features to be carried out. Due to the brown trout's requirement for well-oxygenated water, structurally varied habitat, healthy riparian flora/fauna and connectivity between markedly different habitats at different stages in its life-cycle; providing those features also provides multiple, wider biodiversity benefits.

To see this clearly, it is helpful to refer to the requirements of three key lifecycle stages of wild trout. These three key stages are spawning, juvenile and adult phases. Each phase has specific habitat features that are necessary for successful completion. If those features are not all present within a single habitat "patch", there is a requirement for good "connectivity" such that the fish can migrate between the habitat features throughout the full lifecycle. Clearly, this makes connectivity incredibly important – even for those river species that do NOT make marine migrations.

It is important to stress that trout do not exist in a vacuum. The food-webs that they belong to have many components. The various members of those food-webs (and the energy-sources that they depend on; such as leaf-litter and in-stream algal films) very often bridge the (perceived) gap between the aquatic and terrestrial habitats of a river corridor.

In other words, there is not a meaningful biological separation between the wettest parts of the habitat and the land surrounding a river channel. It is all strongly connected – and problems in one part of the system frequently have knock-on effects in other parts. Realising that problems within rivers are commonly solved by tackling issues in the surrounding landscape is an important mental leap. Given that bottlenecks can arise from problems on land or in water, it is useful to examine habitat requirements and consequences of particular limiting factors (where crucial habitat features are absent):

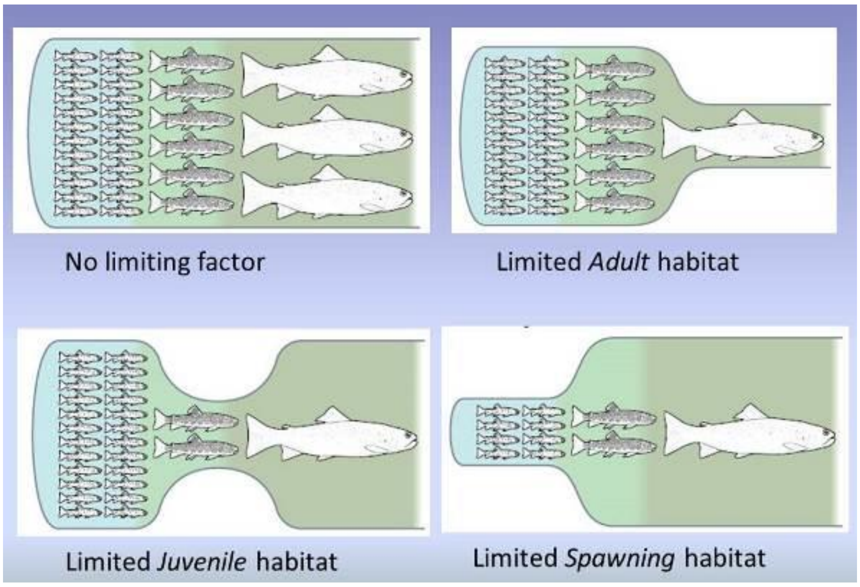

Figure 1: The impacts on trout populations lacking adequate habitat for key lifecycle stages. Spawning trout require loose mounds of gravel with a good flow of oxygenated water between gravel grains. Juvenile trout need shallow water with plenty of dense submerged/tangled structure for protection against 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 within 30cm of the water's surface. Excellent quality in one or two out of the three crucial habitats cannot make up for a "weak link" in the remaining critical habitat.

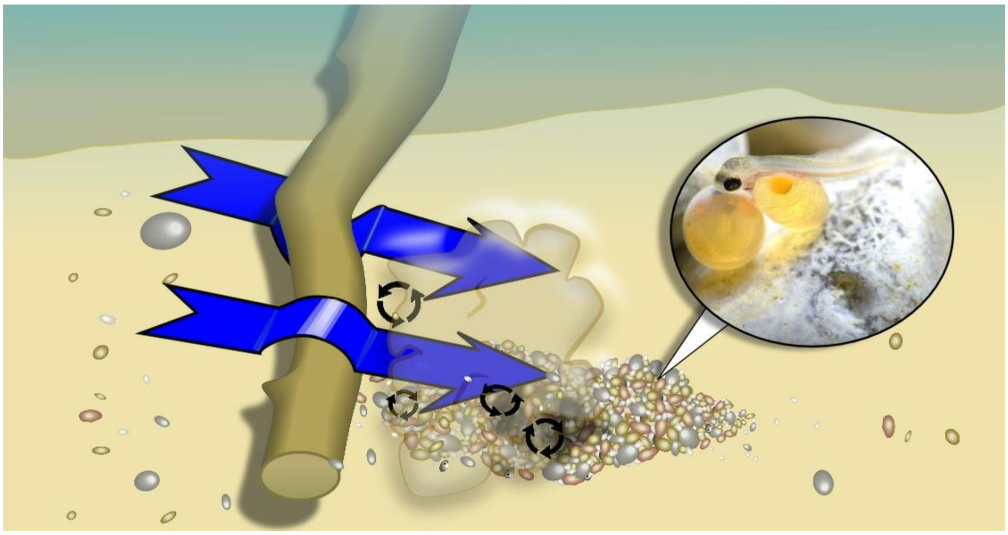

Figure 2: Features associated with successful trout spawning habitat include the presence of silt-free gravels. Here the action of fallen tree limb is focusing the flows (both under and over the limb as indicated by the blue arrows) on a small area of river-bed that results in silt being blown out from 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.

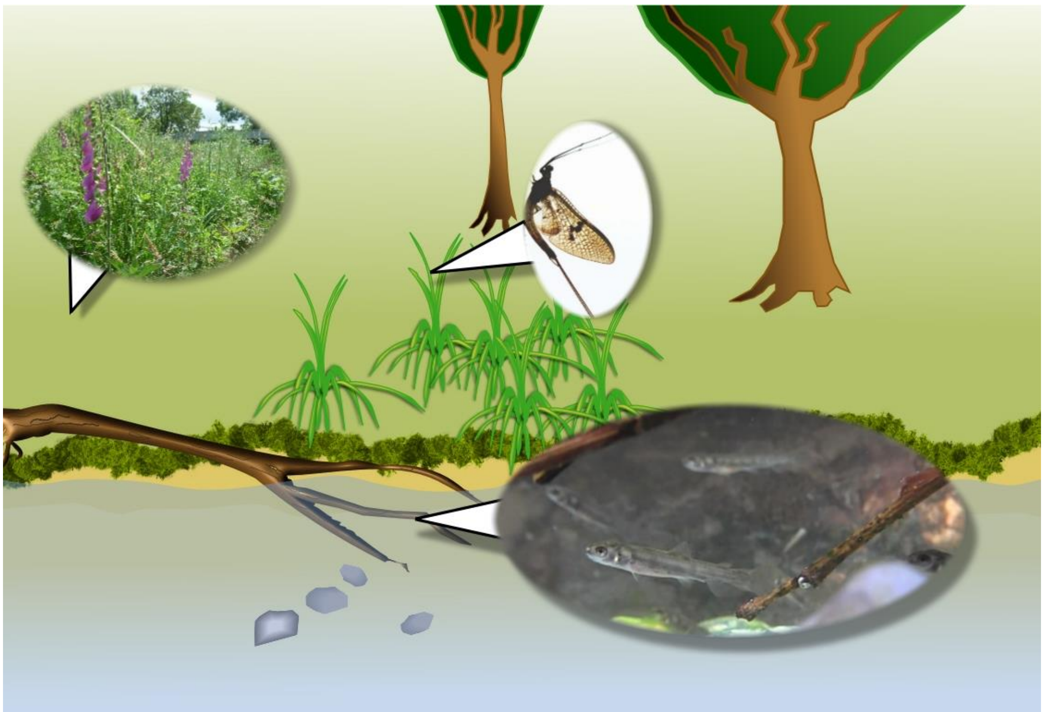

Figure 3: Larger cobbles and submerged "brashy" cover and/or exposed fronds of tree roots provide vital cover from predation and spate flows to tiny juvenile fish in shallower water (<30cm deep). Trailing overhanging vegetation also provides a similar function and diverse bank-side vegetation has many 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 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.

The visited reaches can be divided into two main characterisations. Firstly, the upstream reaches (between SJ8754204172 and SJ8771003965) possess some meandering character. A greater diversity in flow velocity and depth over the cross-section of the channel is associated with those naturally-arising meander features. However, it must be noted that these meandering characteristics are the result of natural erosion and deposition occurring AFTER extensive artificial channel realignment. This straightening would seem likely to have been undertaken so as to conform to field boundaries and the utilisation of land within the flood-plain. Consequently, the structural variety associated with the limited amount of natural "post-straightening" recovery is still low compared to channels that have not been extensively straightened.

In the downstream reaches, the straightening of this channel is even more extreme (SJ8771003965 to the downstream inspection limit of this visit at SJ8823303720 and beyond). Consequently, the in-stream habitat diversity is generally sub-optimal throughout the whole visited reach and the worst of those impacts are evident below approximately the upper 25% of the surveyed reach.

These "upper" and "lower" sections are, therefore, considered separately for convenience and clarity in this report.

2.1 Upper Section

The presence of mature woodland canopy along both banks of the channel in the upper section is a positive factor. Leaf-litter inputs, shading and also the potential to encourage localised bed-scour by making banks more resistant to lateral erosion can all contribute positively when systems are in a natural balance. However, the channel itself is markedly "incised" – meaning that the watercourse has cut downwards to a level that is significantly lower than the surrounding land. It is likely that the straightening of the watercourse – and attendant increase in net erosion – has contributed significantly to this incision. When combined with deliberate tree-planting (designed to maintain the path of the channel after its realignment) the potential for lateral erosion is reduced and, in the soft substrate, causes the river to cut downwards at an accelerated rate. As an overall consequence, this tends to reduce opportunities for the beneficial "lateral connectivity" of the watercourse with its floodplain.

The inundation of floodplains and wetlands during spate flows performs many important biological functions. These include the retention/deposition of nutrient-rich sediments on surrounding land as well as providing vital refuge for fish during spate flows. Appreciation of the importance of lateral connectivity to the management of floodwaters and flood-risk across catchments is currently increasing. In the case of the surveyed watercourse, the pressures from agricultural and housing-development land-use highlight that important balances need to be struck. Although outside the scope of the current report, the strategic use of deliberate flood-plain inundation away from housing or industrial property will become increasingly necessary to incorporate into the management of flood risk.

The agricultural use of land on the LB, combined with an apparent access point used by walkers and possibly pet dogs, has created an obvious input pathway for fine sediments to be washed into the channel (Fig. 5). This is, of course, unlikely to be the only input point – but runoff pathways like this will be responsible for greatly elevating the bed-load of fine sediment (sand and clay particle-sizes). Evidence of this is seen in the stream-bed itself with the compaction of the “interstices” (spaces between ill-fitting gravel particles) with fine sediment. This is likely to significantly reduce the survival prospects of eggs and baby fish that rely on a continuous flow of water through those interstitial “pores” in gravel beds.

Figure 5: Access point from both the near (RB) and opposite (LB) banks of the river. The fine sediment supply, and associated nutrients or chemicals, from surrounding agricultural land and roads appears to be contributing to ecological degradation in the channel.

Growth of filamentous algae directly downstream of this entry pathway for diffuse pollution indicates an elevated nutrient status associated with these sediments (Fig. 6).

Figure 6: Filamentous algae associated with fine sediment that is smothering gravel substrate

There are many land-use practices that can greatly reduce the amount of fine sediment washed into watercourses during heavy rainfall (see below). Some of those measures also increase the retention of valuable topsoil (and the costly improvements to nutrient status of those soils) on the land where they have the most economic benefits.

In the Moat Brook, the result of runoff pathways supplying large amounts of finer sediments and gravels can be seen in areas where the channel's cross-section increases to dimensions that promote sediment accumulation (e.g. Fig.7).

Figure 7: Poorly "sorted" aggregate of topsoil and gravel deposited in this sediment-accumulating reach of the Moat Brook. This indicates a surprisingly large supply of gravel for a small, lowland stream. The wider cross-section is associated with a land-drain outfall (lower right of frame). Localised bed-scour would help to produce deposits of "sorted" particles – whereby fine and coarse sediments are separated and deposited in different areas of the stream.

Exploring and encouraging catchment-sensitive (and economically-beneficial) farming methods provides simultaneous and dramatic benefits to watercourses. Specialist advice should be sought on factors such as the timing and identity of crops that are planted, direction of ploughing, stubble/harvesting practices that reduce particulate runoff and increase fertility/porosity of soils, field entrance/exit siting to tackle runoff pathways along roads/directly into rivers, buffer strips and many other methods that control the runoff of water and sediment from agricultural land. An overview of these issues and their control is available in this pdf published by the Environment Agency on Rural Sustainable Drainage Systems (RSuDS):
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/291508/scho0612buwh-e-e.pdf

Additionally, a significant portion of the guidance in the Wild Trout Trust's "Upland Rivers Habitat Manual" (available to browse as low resolution pdfs for free here: http://wildtrout.org/content/wtt-publications and available to purchase in hi-resolution on CD-ROM here: http://wildtrout.org/product/uplands-habitat-manual-cd) is dedicated to the control of runoff pathways.

As a more general contribution to filtration of runoff within the river corridor, it may be beneficial to consider some light rotational coppice work on the riverside tree canopy. Currently, the age/size structure of the canopy is relatively “flat”. Creating a more varied light/shade regime would help to encourage the growth of diverse understory plant communities.

At the same time, the work on trees would provide ample material that could be used to improve the structural and functional aspects of habitat within the river channel. Specifically, the secure anchoring of marginal “tree kicker” or “laying” (hinging) of saplings into channel margins would greatly diversify sediment accumulation/sediment mobilisation over the cross-section of the channel. Additionally, the stable anchoring of woody material so as to promote localised bed-scour (i.e. Fig. 2) would be an incredibly valuable way of tackling gravel compaction in localised spots. See section 3 “Recommendations” for further details on these proposed methods.

A clue to the form and the associated functional benefits accrued by increasing the amount of woody structure in the margins and within the channel can be seen in this naturally-occurring example in the upper reach (Fig. 8)

Figure 8: Natural woody material leaning into the channel, combined with some gradient and a natural channel width. Some variation in bed-scour and retention of leaf litter (while maintaining a gap underneath much of the trunk) is providing some much-needed overhead cover and structural variety to the channel at this point.

2.2 Lower Section

This section is dominated by completely straight channel planform that is generally over capacity for base flows and also lacks much appreciable longitudinal gradient. As a result, there is very low cross-sectional diversity in the physical habitat (whether in terms of flow velocity, depth, substrate-size or structural cover). The degree of straightening is illustrated by the photographs taken from the footbridge crossing point at (Fig. 9)

Figure 9: Completely straightened channel with uniform fine-sediment bed and low flow velocities under base-flow conditions.

The contrast of this almost stationary flow during dry weather to wet-weather flows where there is very little "roughness" to slow the progress of water downstream has important implications for aquatic foodwebs. Firstly, there is little refuge for fish to hold station against the flow (unless the river spills out onto the floodplain). Secondly, and more broadly, there is little opportunity for leaf litter and coarse-woody substrate to be retained in this straight, smooth chute. That means a loss of much of the nutrition accumulated in leaf litter that is exported out of the reach.

Overall, this is extremely degraded river habitat – the uniform depth at base-flow condition is too shallow to provide opportunities for the adult (and many juvenile) stages of most British freshwater fish species. The homogenous substrate also provides very little niche diversity for aquatic plants, invertebrates or vertebrates. There is little potential for in-stream productivity since photosynthesis is limited by shade as well as a lack of suitable surfaces for many microscopic primary producer species that a wide variety of stream invertebrates commonly graze on.

The degree to which this channel changes in character (and an indication of the loss of material that should be retained to a greater degree across the full reach length) can be seen in the flood debris accumulating on the fallen willow at the downstream limit of inspection (Fig. 10).

In a healthy and diverse channel, features such as these fallen, living, trees are extremely valuable. Even in this case, it is actually one of a very few "hotspots" that retains nutrients in the form of leaf litter after spate flow events. Overall it is a positive feature for this channel, but its benefit is limited due to the excessively straight channel and the lack of longitudinal gradient with an over-capacity channel upstream. In those conditions, even a small accumulation of beneficial nutrients and structural diversity within the channel translates into some slowing of upstream flows.

It is important to recognise that this is a reflection of the degraded state of the upstream channel dimensions and not an inherent characteristic of woody material in rivers. The greater challenge in this instance is to ascertain the scale of measures that could offer sufficient improvement in this channel. At the same time, judging the appetite for actually pushing those measures through is another vital consideration. For instance, how likely is it that the current or future landowners would embrace a full-scale re-meandering scheme (assuming a suitable topography exists to produce a channel of natural dimensions with sufficient gradient to support flowing water)?

Consequently, while some improvements to the availability of cover and, potentially, the formation of some scour-pool habitat may be possible to achieve in the lower section; it is likely that the easier initial improvements should be made in the upper reach. Initial recommendations are given in the next section.

3 Recommendations

A summary of recommended actions include:

- Initiate a process of improved agricultural land management to minimise/intercept sediment runoff pathways
- Identify and tackle runoff pathways as they enter the river (e.g. dog-access points, sediment runoff pathways discharging into the river)
- Create more staggered canopy within the densely-wooded river corridor areas
- Seek opportunities to install tree kickers using material arising from canopy works
- Utilise any trees or root wads that may arise from tree work - or even local forestry - to create focused bed scour to create higher quality spawning areas (via gravel "sorting")
- Seek opportunities to hinge (lay) saplings into margins to produce refuge habitat
- Install interpretive signage at prominent points associated with habitat works (e.g. footbridge crossing and/or Jubilee woods path leading to river)

It is recommended that these measures are initiated in the uppermost section of the surveyed reach. The opportunities at the top of the surveyed reach are easier to identify and completing an initial phase of works will act as a useful demonstration plot and proof of concept.

Discussions involving as many stakeholders as possible will be necessary to identify achievable interventions in the lower sections of the visited reach. The most heavily-modified sections also suffer from a reduced longitudinal gradient – limiting the scope for easily harnessing natural river processes to effect sustainable improvements. As a result, generating significant improvements is likely to be associated with greater challenges.

In addition to suggested land-use and canopy-management recommendations, a series of structural habitat improvements can be made within the river channel. Illustrations and explanations of simple, in-channel techniques suggested in the summary list (above) are given as follows:

The “sorting” of gravel can be achieved by promoting localised bed-scour. As well as providing an excellent structural refuge and promoting some sinuous flow, a limited amount of such gravel-sorting is often associated with marginal tree “kickers” (Fig. 10).

Figure 10: Newly-installed tree "kicker" (attached to a secure anchor point using braided steel cable).

A guide to installation and the typical effects of a tree kicker can be seen in this video: https://vimeo.com/72720550.

A suite of benefits comparable to those associated with tree-kickers, can be won by using simple “hinging” or “laying” (as in hedge-laying) of riverside saplings into the channel (Fig. 11). Tree species such as willow and hazel – or any species that thrives after being hinged – should be chosen for this technique.

Figure 11: Hinging or laying of saplings to create marginal cover (in this case using hazel).

More extensive gravel "sorting" to improve spawning success can be achieved by secure installation of features like root wads (Fig. 12) or by pinning the "free" end of a tree kicker so that the trunk becomes an upstream-angled log which promotes scour (Fig. 13).

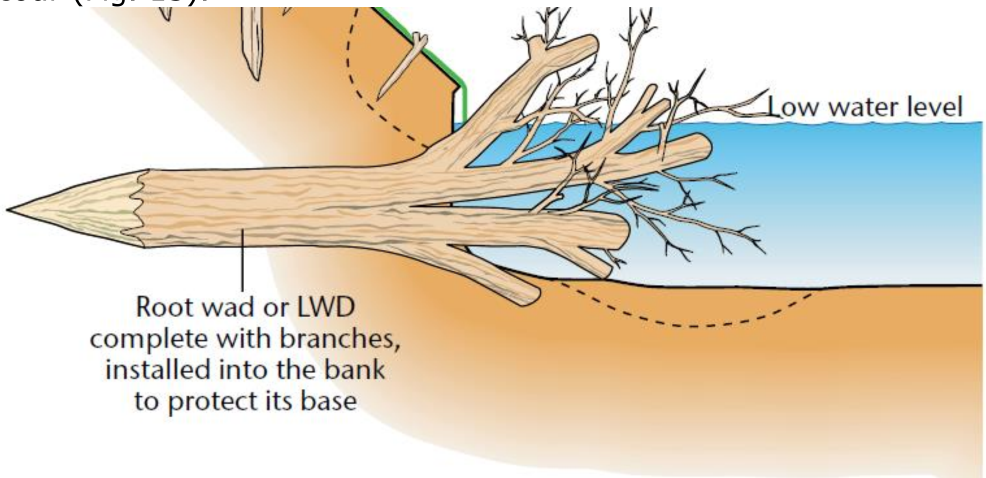

Figure 12: Root wad (arising from forestry work). The upright trunk is cut to an appropriate length - with a sharpened "point" cut into it. When driven into the bank using an excavator bucket, these are very secure (and often used to protect eroding banks).

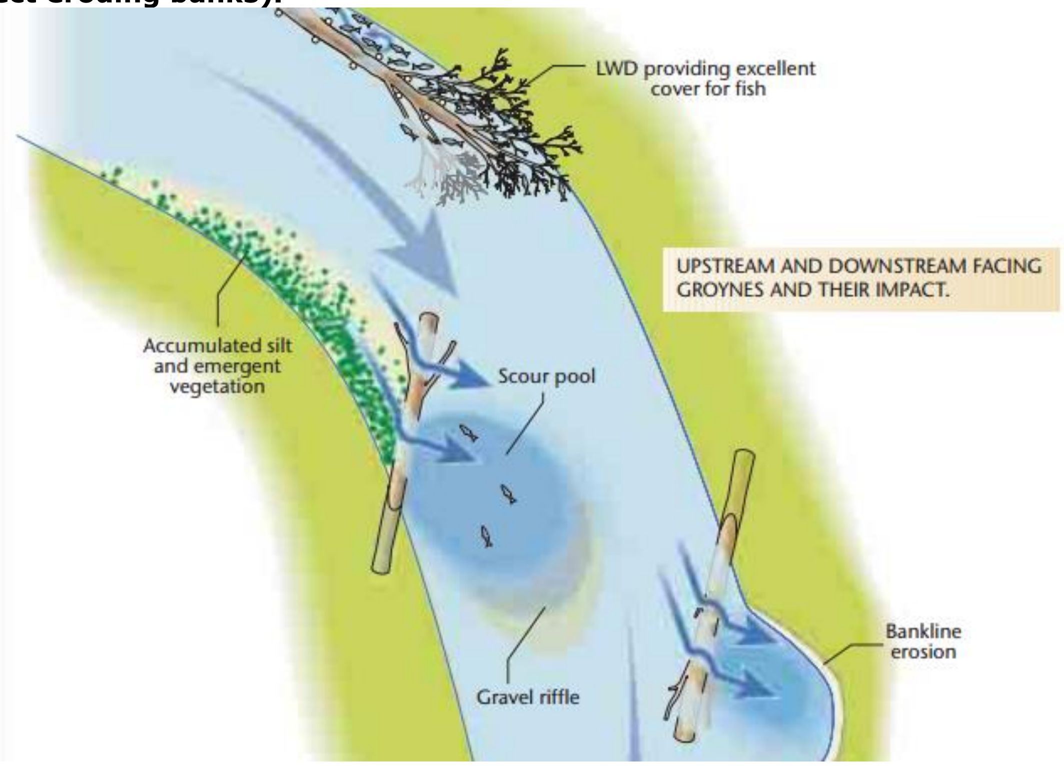

Figure 13: Note the counter-intuitive effect of upstream versus downstream-angled tree trunks. The upstream-angle promotes scour of the riverbed in the channel. Conversely, downstream angled installations create bank erosion. N.B. the necessary anchoring of the bank-side end of this installed material can either be achieved by burying or by cabling (as per tree kicker installations).

With each of these recommended options, we advise that a staff member from the WTT be present on site to guide the selection and installation of specific in-channel features. As discussed during the site visit, ascertaining and meeting the requirements for any and all permissions associated with works in and around this channel will be an essential step before any practical work can take place.

4 Next Steps

Following the circulation of this report to relevant stakeholders (and subsequent arising discussions), it may be appropriate to draw up a more specific project proposal in partnership with Groundwork West Midlands. The WTT is happy to contribute to that process and may also be able to help to deliver the suggested objectives of such a proposal. Similarly, the WTT is happy to participate in discussions and activities required to secure project funding.

5 Acknowledgement

The WTT would like to thank the Environment Agency and Groundwork West Midlands for supporting the advisory and project proposal work associated with this project – including a portion of funds arising from rod licence sales.

6 Disclaimer