Gledhow Beck (Tributary of Meanwood Beck/River Aire), Gledhow Valley

Advisory Visit

	Gledhow Beck (Meanwood Beck Catchment)
River	Gledhow Beck
Waterbody Name	Not specifically captured as a channel – Sits within the catchment specified for "Meanwood Beck (Source to River Aire)"
Waterbody ID	**Meanwood Beck Waterbody ID is: GB104027062900**
Management Catchment	Humber AWB
River Basin District	Humber
Current Ecological Quality	For Meanwood Beck (Source to River Aire) – Moderate
U/S Grid Ref inspected	SE3131337137
D/S Grid Ref inspected	SE3167236662
Length of river inspected	0.4km

Wild Trout Trust Report – Following a Site Visit on 25/03/2019

1. Introduction

A site visit and habitat appraisal of the Gledhow Beck at the request of The Friends of Gledhow Valley Woods (FGVW) following a suggestion by Yorkshire Water.

Although the beck is reported to have previously supported wild trout, the current presence/absence of trout in this short section of watercourse is not definitively known. There is a presumption that trout are probably absent in light of episodic pollution and the presence of barriers that may inhibit natural recolonisation. However, the habitat in the Gledhow Beck can still be assessed for potential to support a wide range of species.

It is especially important to highlight that both the riparian (riverside) habitat as well as the actual wetted beck channel are equally important in terms of stream health. In fact, both the terrestrial and aquatic "compartments" of a river corridor are quite artificial distinctions made by humans. The flora and fauna of river corridors freely interact across that perceived aquatic/terrestrial divide.

In addition, if water quality is too poor to support trout, this also limits the potential for diverse communities of other aquatic species to develop and thrive. As a result, the habitat requirements and pollution sensitivity of wild trout in a small brook can offer a helpful yardstick of the overall health of Gledhow Beck.

To define the general process by which Wild Trout Trust (WTT) advice is derived, it is useful to understand that there are three key lifecycle stages of wild trout (spawning, juvenile and adult). By examining sections of watercourse, it is possible to identify if there are either absences – or a lack of access to – habitat that supports each key lifecycle stage.

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 above (Fig. 1). Those varied requirements (Figs. 2-4) create a demand for varied habitat, which is (in turn) vital for supporting a wide variety of species.

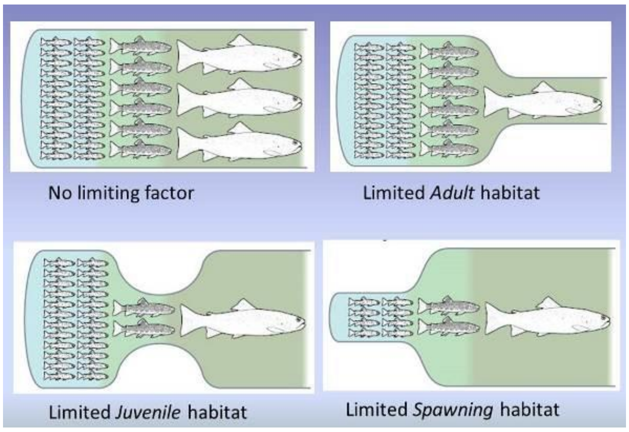

Figure 1: The impacts on trout populations lacking adequate habitat for key lifecycle stages. Spawning trout require loose mounds of gravel with a good flow of oxygenated water between gravel grains. Juvenile trout need shallow water with plenty of dense submerged/tangled structure for protection against 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 trailing on, or at least 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.

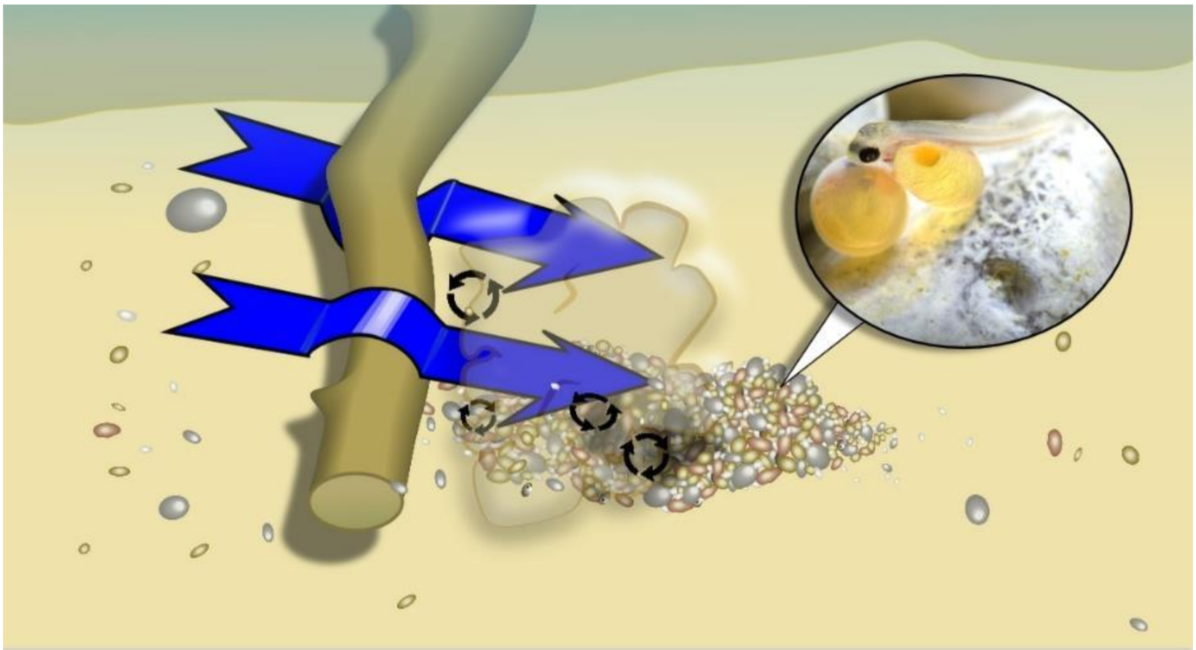

Figure 2: Features associated with successful trout spawning habitat include the presence of silt-free gravels. Here the action of fallen tree limb is focusing the flows (both under and over the limb as indicated by the blue arrows) on a small area of river-bed that results in silt being mobilised from between gravel grains. A small mound of gravel is deposited just downstream of 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 within the gravel mound (inset) until emerging in spring.

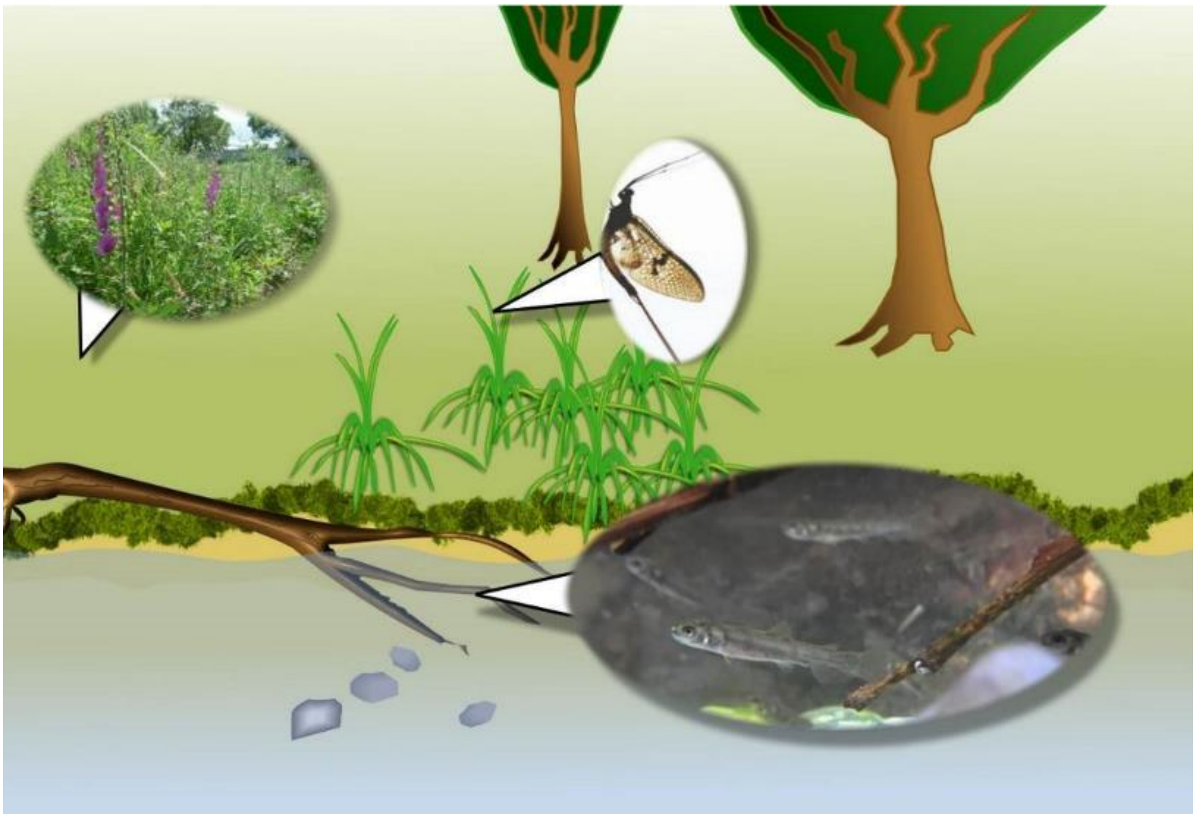

Figure 3: Larger cobbles and submerged "brashy" cover and/or exposed fronds of tree roots provide vital cover from predation and spate flows to tiny juvenile fish in shallower water (<30cm deep). Trailing, overhanging vegetation also provides a similar function and diverse bank-side vegetation has many 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/or larger submerged structures such as boulders, fallen trees, large root-wads etc. close to a good food supply (e.g. below a riffle and with prey likely to fall from overhanging tree canopy 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

The upstream limit of this visit was the exit to a culvert that carries the Gledhow Beck beneath Gledhow Lane at National Grid Reference SE 31313 37137 (Figs. 5 and 6).

Figure 5: Looking off the bridge at the Upstream Limit of the visit

Figure 6: Culvert beneath the bridge at the upstream limit of this visit. Shallow/laminar flow in the base of the culvert that discharges over a vertical lip makes this a serious barrier to fish movement.

The great extent of culverting upstream of this section makes it difficult to estimate the value of improving the ease of fish passage at this barrier under the present circumstances.

Although the banks show evidence of historic reinforcement with stone, the presence of mature surrounding woodland is a great boon for biodiversity within and around the watercourse (Fig. 7).

Figure 7: Woodland surrounding the beck and providing a degree of buffering from the adjacent road. Himalayan balsam and Japanese knotweed were not noted within the beck corridor during the site visit – a quite rare and biologically-valuable situation on most watercourses – particularly those within areas of urban/suburban development.

Concerns over various inputs into the beck were raised during the visit and these fall broadly into the following categories:

- Intermittent organic enrichment from combined sewer network (including impacts of misconnections associated with upstream housing development)
- Sediment washed from the surrounding road network and directly from the steep valley-sides (where understory vegetation is sparse due to footfall from walkers and dogs)
- Leaf litter from riparian woodland

While reducing issues in the first two categories would create ecological benefits– the third (leaf litter) category is actually a highly significant component of upland watercourses.

This observation was borne out by a few minutes of stone-turning in the beck (Figs. 8 - 10).

Figure 8: Pre-copula pair of *Gammarus sp*. (freshwater shrimp) and multiple *Baetis sp*. (olive mayfly) nymphs.

Figure 9: *Baetis* nymphs close to hatching into adults (centre of frame and lower left of frame) plus Chironomid (non-biting midge) larvae mid right of frame (thin orange/pink larvae against white tray background) and upper mid frame (on edge of leaf)

Figure 10: Simuliid larva (centre frame on leaf edge)

There was a great abundance of freshwater shrimp – which feed by shredding up deciduous leaf litter and are moderately sensitive to organic pollution. Although hoglouse were observed (which are much more tolerant to organic pollution), they were greatly outnumbered by shrimp – that ratio gives a quick, shorthand assessment of the severity and frequency of organic pollution events. In samples where hoglouse greatly outnumber freshwater shrimp, it is a strong indication of ongoing organic enrichment and reduced dissolved oxygen levels.

However, just the brief (and in no way quantitative) kick sampling with a small net and stone-turning revealed only invertebrates of "medium sensitivity" to reduced oxygen/enriched nutrients levels. No invertebrates that are known to be "highly sensitive" to organic enrichment were observed. This indicates either episodic pollution causing dips in dissolved oxygen or a more continuous input of some organic nutrients.

At the top of the reach/within the culvert, the distinctive smell of treated sewage effluent was evident – though that scent did not persist further downstream throughout the open reaches. In addition, the abundance of invertebrates did not indicate continual poor water quality. Instead, although speculative, it may be more indicative of episodic events that have previously eradicated species that are more sensitive to low oxygen levels. Furthermore, there are many streams with a similar invertebrate community structure that continue to support wild trout and grayling (including many post-industrial rivers of the North of England).

In many Advisory Visit reports, on-site observations would be compared to data obtained as part of the River Basin Management Plan assessments of Ecological Status (natural waterbodies) and Ecological Potential (heavily-modified waterbodies). However, the lack of site-specific information – due to the Gledhow Beck being subsumed into a broader definition of the Meanwood Beck (Waterbody reference GB104027062900, currently rated as "Moderate" Ecological Potential according to the most recent set of assessments carried out in 2016, given here: https://environment.data.gov.uk/catchment-planning/WaterBody/GB104027062900).
The lack of watercourse specific measurements makes that comparison less useful and means that this report will focus on more direct, site-specific observations.

Overall, the input of leaf litter should not be seen as a negative in this environment – since a significant proportion of the aquatic foodweb in lower-productivity/upland streams depend on the calories produced by photosynthesis in the tree canopy. In more calcareous streams, the balance of in-stream primary productivity (the products of photosynthesis) and the subsidies derived from surrounding terrestrial vegetation have a more complex balance of limiting factors.

It would be beneficial to reducing fine sediment inputs derived from road drainage and, potentially, of fine topsoil washed from the wooded valley-sides. Some suggested actions are included in Section 3 "Recommendations".

Figure 11: Topsoil runoff pathways visible where understory vegetation has been eradicated due to footfall (with a contributing influence of dense shading)

Another significant impact on the resilience of the beck is the frequent barriers to migration for aquatic/swimming species (e.g. Fig. 12).

Figure 12: Older structure beneath footbridge at SE 31361 37065 – causing a complete barrier to upstream migration and increasing the erosion of bed material to expose bedrock

Barriers obviously interrupt the free fish passage that allows repopulation following pollution incidents (and also constrain the size of breeding populations by preventing access to potential mates). Additionally, the interruption of gravel and cobble material means that material that is eroded from the bed below such barriers is not continually replaced by material from upstream. Consequently, the physical complexity of the habitat is reduced and provides fewer potential niches for different species to occupy.

There were positive examples of pragmatic management practices – such as leaving structurally-beneficial portions of downed trees in place (following the removal of upper sections that had damaged overhead lines). Once the infrastructure-damaging portions had been removed, valuable root-plate and, stable, main trunk sections were left in place. The result is a more diverse stream-bed (via localised scouring effects) as well as increased cover habitat and physical niche opportunities at SE 31385 36974 (Fig. 13).

Figure 13: Leaving the root plate in place and allowing for bushy regrowth of locally-coppiced trees is allowing some positive structural diversification. It should be noted that a policy of extensive/blanket tree coppicing would, however, result in ecologically-negative impacts. Small, patchy interventions will be much more valuable for promotion of biodiversity.

The relatively steep longitudinal gradient promotes recovery of more diverse channel profiles via the inherent redistribution of bed material (which is further promoted by stable in-channel structure such as fallen trees). An example of a deposited gravel and cobble “point bar” shows the beck recovering some semblance of a naturally meandering profile following historic reinforcement and constraint of the beck’s path (Fig. 14; approximately twenty metres downstream of the root plate shown in Fig. 13).

Figure 14: Obvious "point bar" on the RB naturally creating a deeper, "low flow" slot towards the LB while producing a shallow incline of gradually decreasing depth towards the RB. The gabions on the LB are clearly designed to protect the footpath and the ongoing stability of that structure could be augmented by strategic tree-planting to create a more resilient matrix of bank material – and would also create enhanced habitat.

The ability of the beck to create valuable habitat structures like this depends on free-flowing water and a lack of structures that hold back (impound) water. Impoundment effectively removes the longitudinal gradient of the river that is needed for the redistribution of bed material.

This is what creates such a negative impact on the habitat within the engineered silt-trap structures just upstream of the on-stream lake (Figs. 15 and 16).

Figure 15: A series of stepped silt trap/settling ponds at SE 31314 36897 directly upstream of the onstream lake are designed (with a need for ongoing, periodic removal of deposited material) to reduce the rate at which the lake fills in with sediment.

Figure 16: Looking downstream along the lower silt trap section towards the bride that marks the beginning of the channel widening out into Gledhow Lake. Note the uniform "box-shaped" channel

Not only are the cross-sectional profiles within these open-topped "tanks" much more uniform and trapezoidal, but there is little to no variation in flow velocity throughout the full width of the channel. It is important to stress that each variation in flow depth, flow velocity - and the associated changes in substrate particle-size – are the physical variations that create a wide variety of opportunities for a wide range of species.

Physical diversity will map on to biological diversity – as long as water quality is not a limiting factor and colonisation routes exist. This, of course, provides the impetus to tackle water quality and access to habitats as part of the whole plan of action.

The lack of flow energy and structural diversity is what dramatically reduces the value of the habitat within each of the silt-trap/settling pond structures designed to intercept silt and leaf material upstream of Gledhow Lake. Each impounding weir is also a barrier to free movement of fish (and other aquatic life) that prevents access to mates within the full breeding population as well as access to the full range (and amount) of habitats required to complete lifecycles in many species.

As the channel widens out into the on-stream lake (created both by an increased cross-sectional area as well as a large impounding weir), flow velocity drops to around zero. The physics of that mean that it is inevitable that fine sediment will fall out of suspension and begin to build up on the lake bed.

Figure 17: Fine silt accumulation in the lake - despite upstream sediment trapping weirs

In the presence of hugely increased cross-sectional area and the removal of any longitudinal gradient by impoundment - there is no action that can reverse the results of those conditions. Silt and vital leaf-litter will build up inexorably over time.

As soon as a lake of this nature forms it is continuously tending back towards one condition – that of a woodland climax community. Therefore, to maintain that condition, will always require artificial intervention to continually reset that process.

The counter-intuitive aspect of this process is the result of what, at first, seems to be an obvious process. Specifically, the majority of silt will be transported during spate-flow conditions. However, it is precisely under those conditions that the silt-trapping efficiency of the weirs are lowest. Under those spate conditions the full volume of water within the silt traps is replaced multiple times (all the while continuing to suspend and transport fine silt particles through the traps and into the lake).

As a result, it is only as that "full volume turnover rate" begins to substantially fall that the sediment will start to drop out of suspension within the silt trap. At which point, a large proportion of the total loading of particulate matter has already been transported into the lake. Essentially, only roughly the last remaining "silt-trap-full" volume of water and sediment that is left at the end of the storm will be "cleaned" in the silt trap.

While the cost of completely de-silting the lake is always going to be extremely high, the costs of removing a volume of silt equivalent to that which is ever retained in the silt traps ought to be comparable to the costs of the periodic trap-cleaning programme. The apparent access arrangements seemed to be broadly similar in terms of cost implications between silt removal from either the lake or the silt trap section of the beck.

Taken together, this means that there is a natural (and quite low) limit to the amount by which lake sedimentation is slowed by the silt trap. Ecological costs from the impact on beck habitat that is extensively culverted below ground both upstream and downstream of the surveyed reach are highly significant.

By the same token, the potential for any in-channel silt interception is extremely limited. To be effective, it would mean sacrificing free flowing beck habitat. In addition, it would entail the creation of swamp and woodland that is precisely the habitat structure which is being resisted by maintaining the lake a few yards downstream.

Consequently, the more effective way to reduce silt inputs into the lake would be to intercept particulate runoff from roads (where possible) and also to reduce and intercept more particulate runoff from the surrounding, woodland valley. This could be coupled by spending funds required for periodic silt-trap cleaning on removing/redistributing silt within the lake. When coupled with removing the impoundments used to create the current silt-trapping system, substantial benefits to the beck ecosystem could be won.

A more sustainable and costly plan would be to investigate means of taking the lake "offline" from the beck (while retaining sufficient inputs to maintain a water level). Creating a nature-like bypass channel which allows for as much natural geomorphological and ecological process as possible to occur would be a better option in ecological terms. However, from a purely natural perspective, the best way to provide high quality habitat within the wood would be to completely remove all of the barriers and reinstate a naturally flowing, well connected watercourse (broadly comparable to that which was present prior to the creation of the ornamental lake). The WTT recognises that balancing competing interests and affection for landscape features is never straightforward.

In the interim, ways to improve conditions within the current scale of likely funding over a relatively short timescale are suggested in the following section.

3. Recommendations

There follows a brief summary of both basic and more aspirational improvements that could be put into place in the Gledhow Beck/Gledhow Lake habitats visited for this report. Prior to listing those recommendations, please pay attention to the important information relating to permissions:

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 or even drainage boards) and other stakeholders such as bodies responsible for underground services that may be affected by works.*

- 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
    - For the Gledhow Beck, the standard Riverfly Partnership monitoring protocols would be highly appropriate (http://www.riverflies.org/rp-riverfly-monitoring-initiative).
- Liaise with South East Rivers Trust/Wandle Trust on their experiences with intercepting road runoff (both water-column and particulate pollutants) into the river Wandle (https://www.wandletrust.org/tag/silt-traps/) through a variety of mycofilters (https://www.wandletrust.org/mycofiltration/), in-pipe "downstream defender" technologies (https://www.hydro-int.com/en/products/downstream-defender) and other approaches.
- Proceed with (already planned) "Fascine" installation along the contour lines of the valley to both help to intercept surface runoff from the woodland valley AND reduce the amount of understory vegetation erosion due to footfall/dog access on steep slopes. Some very relevant information on fascine impacts on slope stabilisation and runoff interception can be found on the section labelled "Erosion Control" in the following guide: http://slowtheflow.net/wp-content/uploads/2016/12/Understanding-the-Hebden-Water-Catchment-LOW-RES.pdf.
- Undertake some very light rotational coppice work within the surrounding woodland to help promote recovery of understory/herbaceous plant communities (and continue to be vigilant against/undertake control of) Himalayan Balsam and Japanese Knotweed infestation). Coppicing can be undertaken away from the watercourse to retain the valuable bankside cover while diversifying the broader habitat of the woodland.
- Look for opportunities (as already planned by the group) to create wetland scrape/runoff interception ponds on the wetter slope areas of the valley (coupled with ensuring sufficient daylight to promote wetland plant species growth).
- Explore opportunities to "hinge" or "lay" (in the manner of hedge-laying) scattered patches of sapling-growth into the channel (e.g. Fig. 18) to promote some bed redistribution during high-flow conditions
- Use materials arising from 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. 19).
- Seek permission to remove the small weirs creating the silt-traps directly upstream of Gledhow Lake (and the potential to notch or bypass the weir below the footbridge at SE 31361 37065) to reinstate more diverse channel morphology
- Consider using bioengineering (e.g. goat willow planting) to reduce the need for gabion replacement/maintenance at the location shown in Figure 14.
- Allocate future silt-trap funds to ongoing periodic removal of a comparable amount of silt from the lake (in addition to funds already won to redistribute silt within the lake footprint)
- Consider more extensive project options (e.g. second-tier options suggested below) in partnership with organisations that have capacity to deliver more complex/costly interventions.

Figure 18: Hinged sapling growth (in this case hazel) used to create cover habitat in stream margins.

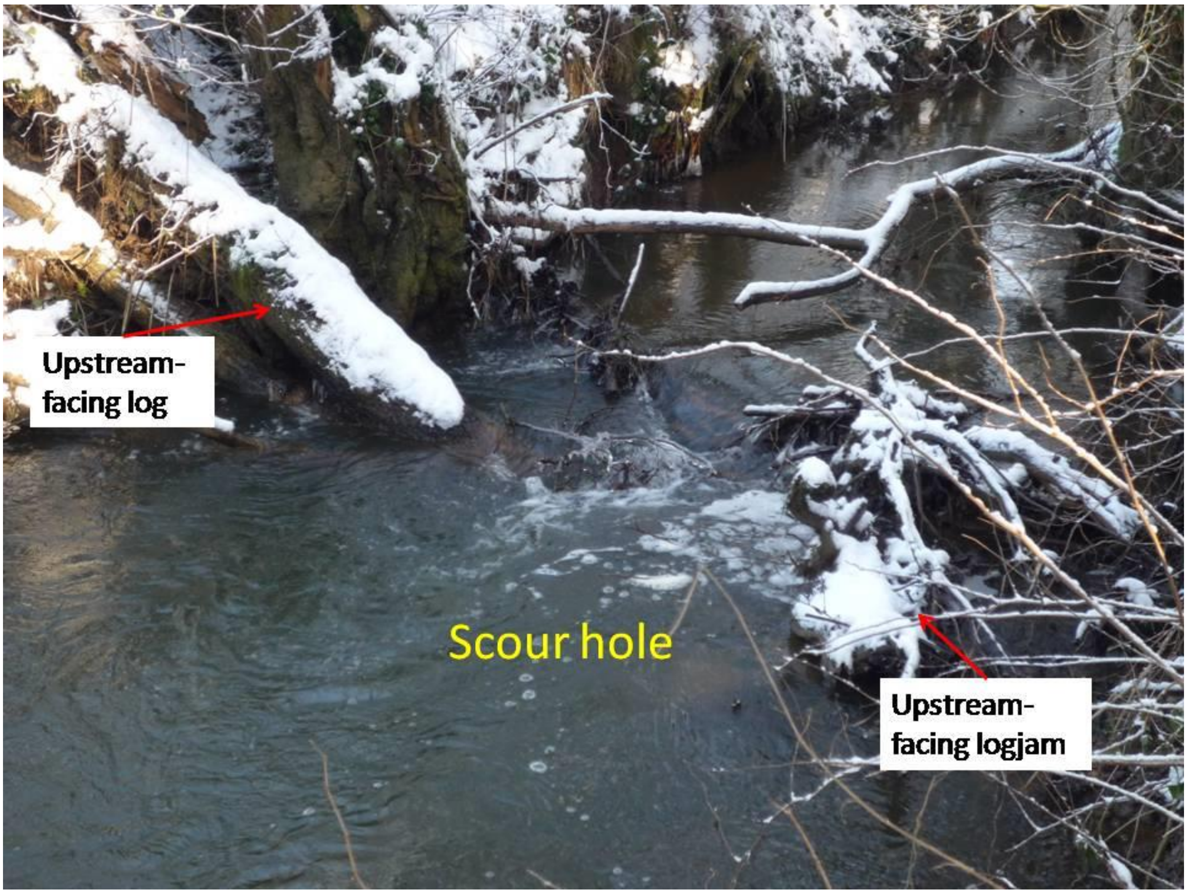

Figure 19: Securely (naturally-occurring in this case) wedged logs producing localised bed scour during winter high flows. Mimicking this with material arising from tree management (as per existing examples on the Gledhow Beck) would be a valuable addition.

Second tier options could include:

- Removing all of the barriers and restoring the beck to a naturally flowing, well-connected watercourse. This option would provide the greatest overall habitat and biodiversity benefits.
- Creating a bypass channel to take Gledhow Lake offline to dramatically reduce the need for silt removal and also increase the length of connected beck habitat (while retaining a head of water within the lake)
- "Daylighting" further sections of the Beck upstream and downstream of the visited reach (e.g. https://youtu.be/GqTb3HdfGfU)

Due to the general technical challenges of extensively re-naturalising watercourses, these second-tier options would require formal funding bids and partnership project management activities. Undertaking that expense and effort would be reliant upon water-quality issues being resolved - either in advance or as an integral part of any project.

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 in instances where the required support is beyond our own capacity. This applies to both first and second-tier recommendations made in this report.

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 habitat improvement measures that we recommend in our AVs. A significant component of PVs is the training we provide that allows you and your partners to deliver similar works under your own steam.

Demand for PVs is high and are subject to the availability of our Conservation Officers (and our ability to identify supportive 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.