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Advisory Visit
River Sheaf (Leyburn Rd to Climbing Works)

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River	River Sheaf
Waterbody Name	Sheaf (Source to River Don)
Waterbody ID	**GB104027057750**
Management Catchment	Don and Rother
River Basin District	Humber
Current Ecological Status	Moderate
U/S Grid Ref inspected	53.351667, -1.484167
D/S Grid Ref inspected	53.357778, -1.480278
Length of river inspected	1.00 km

1 Summary

- *Several barriers to the transport of riverbed material and fish migration were encountered during the visit (including both stonework and sheet-pile/metal construction).*
- *Very little suitable spawning habitat was present in the surveyed reach. A lack of bank erosion imposed by engineered channel walls, washout within confined, incised channel and trapping of substrate behind weirs all contribute to a scarcity of gravel.*
- *An overall lack of complex, in-stream cover was observed (with observed exceptions likely to significantly improve survival rates in self-sustaining fish populations).*
- *The river is disconnected from its floodplain – occupying an incised channel (often with high, stone walls on both banks).*
- *Invasive Non-Native Species (INNS), notably Himalayan balsam and Japanese knotweed, should be controlled to relieve pressures on biodiversity.*
- *Extensive modification via hard engineering, a lack of naturally-arising large and coarse woody material, restricted spawning gravel availability, INNS and the threat of episodic pollution appear to be the most significant ecological pressures.*

2 Introduction

The Wild Trout Trust (WTT) were invited to assess habitat in the River Sheaf by representatives of Sheaf and Porter Rivers Trust. The purpose of the visit was to identify priority opportunities to protect and improve the ecological potential of the watercourse. Throughout the report, banks are designated as right (RB) and left (LB) while facing downstream. Locations are specified using Decimal Degrees format – enabling co-ordinates to be pasted directly into common mapping platforms.

3 Habitat Assessment

For this report, the River Sheaf was surveyed from a downstream limit at 53.357778, -1.480278 and observations are reported sequentially in a downstream to upstream direction as far as 53.351667, -1.484167. Due to physical access constraints, almost all observations were made by wading in the river. This also provided close, physical as well as visual inspection opportunities.

Adjacent to the downstream limit of this survey there is a grassed park and playground area on the LB. Within the river corridor, both banks feature mixed woodland and diverse understory vegetation (Figs. 1 and 2). The brick wall on the LB at the downstream limit appears to be close to falling into the river (Fig.2). This would probably be more of a problem from an infrastructure perspective rather than having significant negative ecological impacts. Coarse stone substrate arising from such a collapse is inert/non-toxic and would locally increase structural complexity of habitat.

Figure 1: Facing upstream away from the downstream limit, the LB is shown on the opposite side of the channel from the camera and has a variety of native understory vegetation species as well as shrubs and mature trees.

Figure 2: Facing downstream towards the downstream limit and the brick wall on the LB is clearly leaning over at a steep angle.

The undercut bank and trailing vegetation (foliage and roots) along the LB shown in Fig.3 is providing fish with refuge from predation. The surrounding tree canopy is a valuable source of shade and terrestrial subsidies to the watercourse. Leaf litter and invertebrate prey falling from the canopy into the water support particular groups of aquatic organisms. In turn, the emergence of aquatic insects from the water in their adult form provides essential prey for terrestrial predators, including (but not limited to) birds, bats and spiders.

Figure 3: Understory ground coverage with diverse vegetation among mature trees

These reciprocal subsidies play a highly significant role in maintaining diverse, healthy foodwebs within river corridors. Riverine foodwebs are not restricted to only the wetted portion of habitat.

Figure 4: Year-round ground cover with a range of understory plants also reduces inputs of sandy substrate during winter storms – in contrast to seasonal die-back of invasive, annual plant species. Wood anemone (white flowers) indicates long-established woodland.

Floral species richness (e.g. Fig.4) is strongly linked to faunal diversity. Consequently, when non-native, invasive plant species out-compete stands of diverse native flora, the river suffers a reduction in subsidies from the terrestrial environment. At the time of the visit, invasive Japanese knotweed shoots were beginning to re-grow (e.g. Fig. 5).

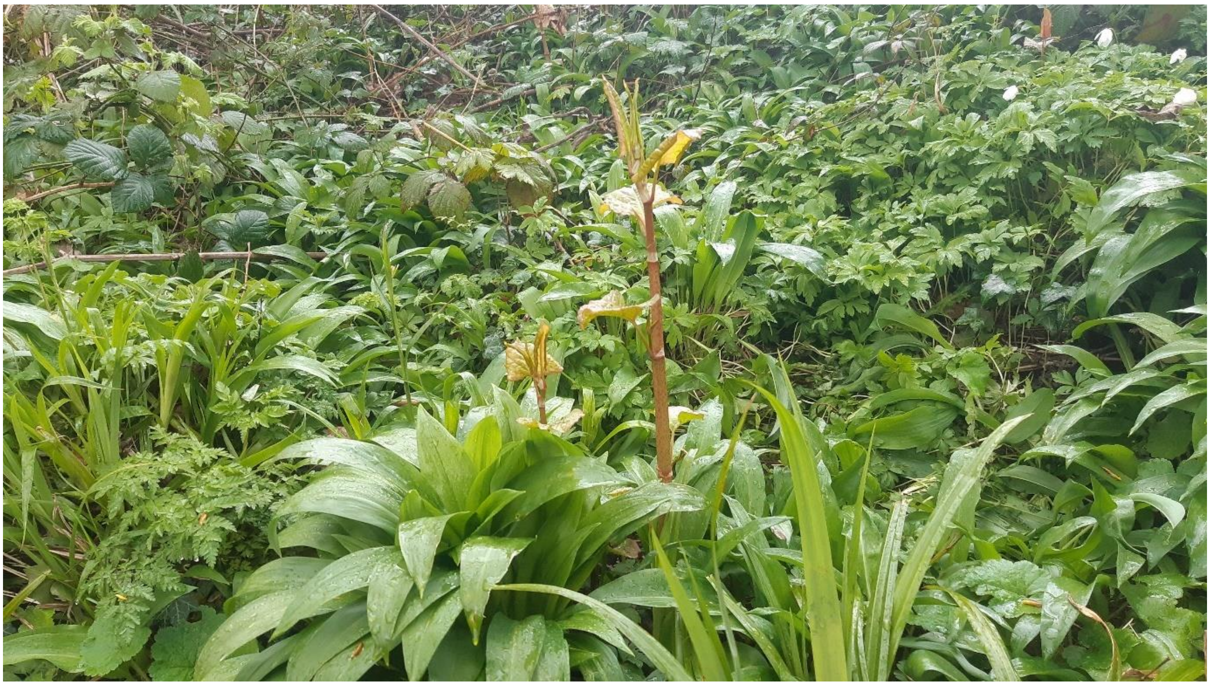

Figure 5: Japanese knotweed shoots (centre of frame) threaten this diverse vegetation.

Protecting the native vegetation of the Sheaf by controlling invasive, non-native species (INNS) is important – particularly in view of the extensive channel modifications throughout the surveyed reach that limit opportunities for vegetated riparian zones to become established and persist. Stem injection by appropriately-certified personnel is an effective means of achieving control of Japanese knotweed – while avoiding impacts on non-target vegetation and the adjacent watercourse.

In the face of channel modifications, the relatively steep gradient has enabled some recovery of varied geomorphological features in the reach pictured in Figs. 1 and 2. Some cross-sectional variation in depth is evident where the channel bends and riffle, glide and pool habitat is represented. However, while cobble and small boulder-sized substrate is common, there was a *notable lack of gravel-sized particles* in this reach (e.g Fig.6).

Figure 6: Mainly cobble substrate, with a very thin scattering of gravel-size particles. For successful spawning, gravel deposits should ideally have a depth of at least 30 cm.

In areas favouring substrate deposition, sand and fine silt were the predominant particle-size fractions (often smothering any gravel present). Surface water drainage from the extensive surrounding roads and urban development is often associated with elevated inputs of sand.

Where groups of mature riparian trees were present, these tended to be quite uniform age and size (e.g. Fig.7). This is probably a result of periodic blanket felling as a management strategy in response to perceived flood or structural risk. A better approach would be to undertake very light-touch rotational coppicing. Coppicing a scattered selection of ≤10% of trees every two to three years – and promoting regrowth from stumps – would add structural variety in both the physical cover and light/shade regime. It is important to select the appropriate individual trees - at the appropriate percentage of total canopy – to ensure sufficient light for coppice regrowth.

Low, bushy regrowth of coppiced stumps close to the waterline can provide valuable refuge habitat and maintain local cooling – while also allowing light to reach adjacent understory species. Coppicing is much preferred to pollarding. Bushy regrowth from coppiced stumps occurs at a height that is much more beneficial to aquatic species.

Figure 7: Serried ranks of uniformly-aged mature trees can limit structural diversity in habitat and light/shade regime.

Having mature trees with well-established root systems at the waterline also provides an ideal opportunity to increase complex, submerged cover. Appropriately-sized crown material arising from coppicing can be lodged around these stable anchor points in a manner that closely mimics stable, naturally-arising large woody material (e.g. Fig.8).

Figure 8: Lodging a union (joint between major stems) around the **upstream** side of a stable anchor point mimics nature and creates fantastic habitat (particularly important to overwinter survival of a range of aquatic species).

In common with many trout streams surrounded by urban development, large and coarse woody material is seldom tolerated in the channel. Even where the material risk of flooding is low, the presumption is usually to remove wood from the channel. Ironically, the presence of stable, hydraulically-rough, woody material can be used to reduce flood risk on watercourses which have multiple, permanent bottlenecks imposed by culverts or bridges.

From an ecological perspective, the extremely stable tree "hanger" structures exemplified in Fig.8 are a vital means of maximising the conversion of hatched eggs to juvenile fish that survive beyond their first winter. In systems such as the Sheaf, where spawning habitat is scarce, complex, submerged brash has a huge potential to increase resilience of self-sustaining wild trout populations.

Equally importantly, in the absence of submerged brash, leaf litter tends to be exported out of fast-flowing reaches. In rain-fed rivers such as the Sheaf, leaf litter is hugely important in supporting aquatic foodwebs. In contrast to base-rich (limestone and chalk) streams, there is far less scope for in-stream photosynthesis to support a species-rich, high-biomass foodweb.

The compounding beneficial effects of stable woody material (both large and coarse) give it a very high ecological value. Using lodged tree crown material to create tree "hanger" installations is a secure method to achieve ecological and flood-risk gains.

A sheet piling weir (Fig.9) was noted at 53.357500, -1.481389. While the intended function is not known, its negative ecological impacts are obvious.

Figure 9: Sheet piling weir impounding a significant upstream reach and eroding the foot of the steep RB (ringed in red). This pattern of erosion is typical when barriers are installed perpendicular to the bank. While this could naturally bypass the weir, the bank supports a path and associated infrastructure. The weir is a barrier to up and downstream migration as well as a trap for substrate on its upstream side. Interventions could deliver ecological and local infrastructure benefits.

Impounding (holding back) water on the upstream side of a weir reduces the structural complexity of habitat. Fewer distinct micro habitats are supported in uniform habitat and this reduces biodiversity. As mentioned already, the essential transport of riverbed substrate is interrupted by weirs, starving the downstream reach of raw materials to create diverse habitat. The importance of downstream migration of fish and other mobile aquatic organisms is often under-appreciated compared to upstream migration. A wide range of species need to move between different habitat features to complete full lifecycles. Such movements are often not confined to a single direction of travel. Fitting a fish pass or fish-passage easement to a weir has many limitations. Such structures can be passable to one species – while representing a near complete barrier to others. Downstream migration is rarely improved and habitat typically remains degraded by impoundment and substrate-trapping effects. While fish passes can be an essential "least-worst" last resort, they should never be the first option considered.

In this case it is likely to be worth comparing the outcomes of complete removal (best ecological option) versus notching out the central third of the weir down to the downstream bed-level (close second - to be used if there is a risk to infrastructure). Hydraulic modelling and structural engineering assessments are recommended. This is the best way to understand the response of the channel to each alternative intervention – and to assess the associated structural consequences. The financial costs of such assessments may well be lower than the average cost of technical fish pass construction and installation.

Reduced impoundment is also likely to provide additional opportunities for riparian vegetation to re-establish in areas where marginal habitat has been drowned out by a weir (e.g. Fig.10 showing the impounded reach upstream of the weir featured in Fig.9).

Figure 10: The wetted perimeter of the impounded reach includes the stone walls of riverside buildings on the LB (right of frame) and prevents natural riverbank formation.

That unnatural, box-shaped channel is typical of the majority of the reach surveyed for this report (e.g. Figs. 11 and 12)

Figure 11: Walled, incised channel cut off from its floodplain with limited opportunity for riparian woodland growth. Locking the channel in place with stonework also prevents the natural migration of a river across its floodplain over time. This lack of temporal variation is highly significant and generally under-appreciated when compared to structural complexity. Washout of gravels is also likely within the confined, vertical-walled "chute".

Figure 12: Walled channel with box-shaped wetted cross-section. The ecological value of patches of mature woodland is magnified by the extent of engineered modifications to the river.

Another sheet-piling weir was encountered at 53.356944, -1.483056 (Fig. 13). The same recommendations for investigating the feasibility of either complete removal or notching of the central third of the weir are proposed.

Figure 13: Sheet piling weir at 53.356944, -1.483056. Proposals to notch or remove the weir need to investigate whether walls within the impounded reach rely on hydrostatic pressure from the river for stability. Again, the existing erosive forces amplified by a barrier placed perpendicular to the walls should be incorporated into decision-making.

The longitudinal bed slope of the River Sheaf enables it to create riffle and pool sequences, despite the many engineered constraints (e.g. Fig. 14).

Figure 14: Pool, riffle and boulder-rapids sequence providing habitat variety in the face of multiple constraints. Every instance where even a short section of channel has its retaining walls set back from the channel results in the formation of a more natural, vegetated riverbank (left of frame, foreground).

More extensive stands of Japanese knotweed were observed in the vicinity of 53.356111, -1.483889 (e.g. Figs. 15 and 16). These should be targets for control efforts as, while substantial, they still occupy a relatively limited proportion of the full reach length. Protecting ancient woodland species further downstream (e.g. the slow-spreading wood anemone, Fig.4) is an important benefit of proactive Japanese knotweed control.

Figure 15: A more significant stand of Japanese knotweed putting the footings of this wall at risk as well as shading-out native riparian plant species.

Figure 16: Japanese knotweed on the RB and gradual erosion of stonework on the LB.

Along with surface water drainage from surrounding urban development, Combined Sewer Outfall (CSO) discharges were also evident (Fig.17). Rag waste trapped in trailing vegetation is a typical symptom of untreated sewage discharges. Outfalls with significant volumetric capacity were noted at 53.355833, -1.483889 (Fig. 18).

Figure 17: The type of complex flows known as "pocket water" to fly fishers in the foreground – with the remains of rag-waste from untreated sewage discharges trailing from strands of vegetation in the background.

Figure 18: Paired outfalls at 53.355833, -1.483889. Discharges can be within consented values while still having a negative ecological impact. However, when it comes to discharges outside of consented values, the vigilance of members of the Sheaf and Porter Rivers Trust could be highly significant. At a basic level, ensuring discharges are consistent with extreme rainfall rather than unregulated discharges during dry weather helps to identify potential problems.

A stone weir with a narrow, unfortunately blocked, fish pass was photographed at 53.355556, -1.483611 (Fig. 19). Blockage is another common disadvantage of fish passes compared to weir removal. A substantial deposit of riverbed material has been colonised – and consequently stabilised – by vegetation on the LB downstream of the weir. The combined influence of a wider channel below the weir and the focused scour arising during spate conditions below the weir have created a patch of valuable habitat. However, the ecological value of this feature exists at the cost of habitat degradation in the impounded reach upstream of the weir. Careful assessment of structural implications of notching or removal (via both geomorphological modelling and structural assessment) would be necessary – along with establishment of heritage value.

Figure 19: Stone weir with blocked fish pass on the RB and vegetated cobble bar feature on the LB.

The impounding influence of the weir extends throughout the reach adjacent to the ongoing riverside property development (Fig. 20; photographed from 53.355278, -1.483611)

Figure 20: Riverside development on the RB adjacent to impounded reach created by the weir shown in Figure 19.

The developer has committed to planting locally appropriate riparian vegetation as a condition of their planning. Protecting such vegetation from extreme high and/or low flows while it establishes will be essential to its survival.

Vertical walls at 53.354722, -1.483889 on the LB were previously associated with a large laundry site (Fig. 21). The habitat within this reach is particularly uniform with very little of the complex cover required to balance and sustain predator/prey dynamics. Establishing ivy in tubs and encouraging it to climb down/along the walls would create some cover and improve the river corridor/natural aesthetic

Figure 21: Uniform habitat with very little complex cover.

With that in mind, a remarkable example of cover vegetation arising despite such unfavourable conditions is shown in Fig.22.

Figure 22: A clump of what appears to be pendulous sedge established in narrow cracks in the concrete (right of frame).

The presence of protruding, threaded bar wall ties throughout the concrete-walled section (e.g. Fig. 23) could provide potential anchor points for installations designed to promote similar plant colonisation. This would require some innovative design and installation in order to be successfully delivered. Similarly, it would aid coverage by climbing plants such as ivy.

Figure 23: Protruding threaded bar ties were common throughout the concrete-walled section as far upstream as 53.354387, -1.483811.

Progressing upstream, further above impounding structures, there is sufficient longitudinal bed slope to support riffle and glide sequence formation (e.g. Fig. 24).

Figure 24: Boulder riffle below a bend pool and glide. Some vegetation colonisation of the rougher block stonework was evident here.

Just upstream of the bridge shown in Fig. 24, another sheet pile weir was found at 53.353558, -1.483511. With recent rainfall, this specific structure was drowned out by the flow level within the Sheaf at the time of the visit. It is important to note that this is still a significant barrier to both fish migration and substrate transport.

Figure 25: Sheet pile weir at 53.353558, -1.483511. Notching down to bed level of the central third (as a minimum) or complete removal should be investigated.

In common with the other sheet pile weirs documented in this report, complete removal or notching of the central third of this structure should be pursued. The notch could, potentially, be created by knocking the middle piles further in (following services search). Structural and geomorphological investigations are needed to inform the feasibility of alterations to weirs in these settings.

The largest stand of Japanese knotweed encountered during the survey was noted at 53.353333, -1.483889 (Fig. 26). This is adjacent to the railway line and should be a priority for control efforts.

Figure 26: Dead canes of Japanese knotweed on the LB (right of frame).

A polluting input (smelling strongly of solvent) was identified in the reach upstream of Fig. 26. This was taken up with the business owners by Sheaf and Porter Rivers Trust following the site visit.

Towards the upstream limit of the reach surveyed for this report, the LB is a vertical wall, with some woodland and understory vegetation established on the RB (e.g. Fig. 27). Efforts to monitor and control invasive plant species will provide ecological benefits here as elsewhere in the surveyed reach.

Figure 27: Narrow strip of ecologically valuable riparian vegetation on the RB.

Probably the largest deposit of gravel with potential value as spawning habitat (Fig. 28) was noted downstream of the large weir which defined the upstream limit of this survey (Fig. 29).

Figure 28: Gravel deposits that appear to have the most potential as spawning substrate out of the examples noted during this survey.

Figure 29: Weir defining the upstream limit of this survey at 53.351603, -1.484237

The fish pass fitted to the LB of the weir was not blocked by debris (and possibly receives some maintenance efforts); though does contain some sizeable vertical jumps between each chamber (Fig. 30). The location and design of the downstream entrance to the fish pass provides very poor attraction flow relative to the attraction flow from the weir itself (Fig. 29).

Figure 30: While much more passable than the weir, finding and negotiating this fish pass will be a significant challenge for all species of fish.

Assessing the feasibility of weir removal here is recommended – with the understanding that there is a high likelihood of significant engineering costs. The stabilisation of infrastructure upstream of the current weir's position appears to be a challenging proposition. Depending on the outcome of removal feasibility assessments, a range of improved fish passage options may be appropriate to consider. In particular, whether there is sufficient space downstream of the weir to successfully construct a rock ramp of a low enough gradient to allow fish passage. While any designs need to be tailored to the size of the site, a large scale example is shown in Fig.31.

Figure 31: Rock ramp overcoming a large weir. Note that the use of stone substrate has created a nature-like riverbed which has inherent habitat value.

As well as actually creating habitat with ecological value, rock ramp designs may not necessarily need to occupy the full width of the channel. The example shown in Fig.31 has a constructed retaining wall that confines the rock ramp to the left of the frame. This allows the lower water level along the LB (right of frame) which, in turn, allows the riverside path and navigation lock to exist below the raised water level created within the rock ramp. This type of solution could be used to mitigate concerns over flood risk.

4 Recommendations

- In consultation with appropriate geomorphology and structural engineering expertise, remove (preferably) or notch (where removal is not achievable) all sheet pile weirs identified in this survey.
- Commission detailed feasibility studies for the two stonework weirs identified in this survey with a view to:

    - Establishing feasibility and cost of removal (including accommodation of heritage value).
    - Where removal is infeasible, seeking innovative designs for rock-ramp style solutions.
- Control Japanese knotweed via a programme of stem injection by appropriately qualified personnel.
    - This could be contracted to local specialists such as the River Stewardship Company.
    - An alternative strategy employed by River Holme Connections has been to fund training and equipment purchases to enable volunteers and staff to undertake their own Japanese knotweed control.
- Control Himalayan balsam via hand pulling and composting on site
- Consider extremely light-touch rotational coppicing as a means of diversifying areas with very flat canopy/age structure of riparian trees.
    - Utilise arising tree-crown material in "tree hanger" installations to provide stable, natural cover habitat.
- Protection of established, species-rich understory vegetation (including ancient woodland indicator species including wood anemone – which indicates continuous forestation for many decades) against development as well as displacement via invasive plant species.
- Undertake volunteer-led water quality monitoring measures such as:
    - Visual inspection programme (and request discharge data) for known outfalls to identify and report problems.
    - Invertebrate monitoring at sample sites above and below known outfalls.
- Seek to establish ivy along the smooth concrete walls at the site of the previous laundry (and consider the same for any concrete walls installed as part of riverside property developments).
- Explore opportunities to establish pendulous sedge and/or field wood rush along the toe of concrete walls to create trailing/partially-submerged cover.

Legal permissions must be sought before commencing work on site. These are not limited to landowner permissions but will also involve regulatory authorities such as the local council as well as relevant departments within the Environment Agency – and any other relevant bodies or stakeholders. Alongside permissions, risk assessment and adhering to health and safety legislation and guidance is also an essential component of any interventions or activities in and around rivers.

5 Acknowledgements

Wild Trout Trust would like to thank the Environment Agency for supporting the work in this report. The advice and recommendations in this report are based solely on the expert and impartial view of WTT's conservation team.

6 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.