WILD TROUT TRUST

Advisory Visit

River Swale, Richmond & District Angling Society, Jan 2021

Prof J Grey: jgrey@wildtrout.org

Key Findings

- The Swale within the demesne of Richmond & District AS is already a relatively large river and affected by topography and land management in various guises beyond the reach of the club, for better *and* for worse.

- In an area of high rainfall and depauperate vegetation in the upper catchment, conveyance is high, and the river response is 'flashy', ie the level rises rapidly and decreases quite quickly afterward. This exacerbates erosion in a catchment of already friable soils and can degrade habitat (especially the substrate) throughout the club waters, and beyond.

- Much of the channel is highly modified and constrained, well beyond the means of the club to address, but interaction with bedrock introduces some fantastic physical diversity around Richmond. The riparian zone (bankside vegetation) along many reaches is relatively natural mixed deciduous woodland providing a plethora of benefits to the fishery. More artificially flood-bunded or heavily grazed sections offer considerably less.

- There is potential for simple, low-cost, small-scale habitat improvements by, for example, engaging with landowners and reinstating livestock exclusion fencing or using locally sourced woody material laid into the channel.

- Overall, considering the physical habitat, water quality and quantity, and from a cursory evaluation of food supply, the Swale around Richmond appeared eminently more suited to salmonids than coarse fish. These factors, in isolation or acting synergistically, could be responsible for declines in angler match weights reported by the club. Also, recent electrofishing data would seemingly support this assessment..

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1.0 Introduction

This report is the output of a site visit to two separate lengths of water on the River Swale held by Richmond & District Angling Society (RDAS; Maps 1 & 2 for an overview). An independent assessment of the habitat and fishery potential was suggested by the local Environment Agency Fisheries Officer and requested by the RDAS committee. A walkover was undertaken by Prof J Grey of the Wild Trout Trust, unfortunately unaccompanied by RDAS members because of Covid-19 restrictions.

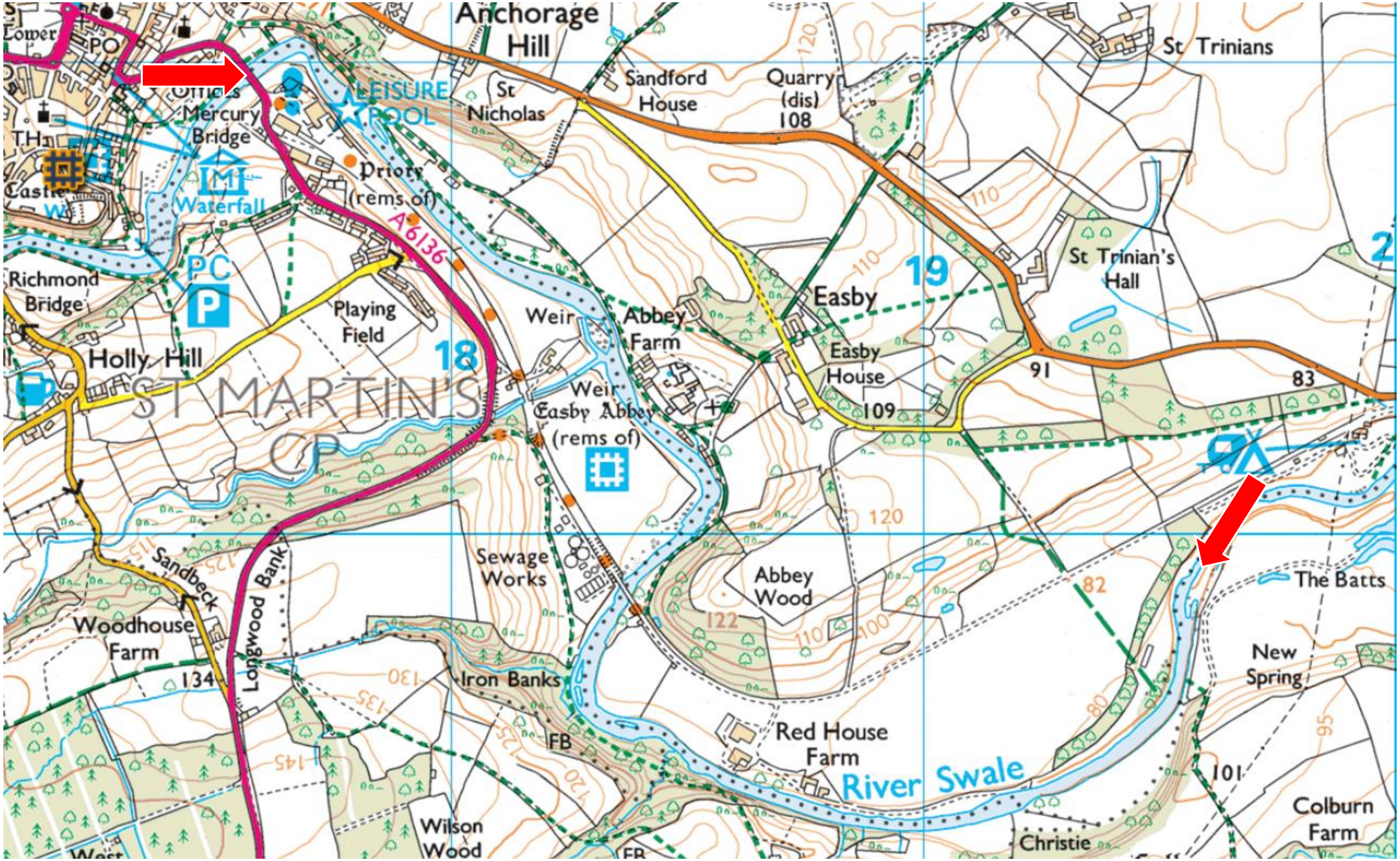
Normal convention is applied with respect to bank identification, i.e. left bank (LB) or right bank (RB) whilst looking downstream. Upstream and downstream references are often abbreviated to u/s and d/s, respectively, for convenience. The Ordnance Survey National Grid Reference (NGR) system is used for identifying locations.

Under the Water Framework Directive (WFD), the club waters examined fall within one waterbody (GB104027069122; see Table 1) which is designated a Heavily Modified Water Body. The extent to which the river has been artificially realigned and constrained is evident from aerial photography and mapping: long straight section, abrupt turns, and pinning to one side of the flood plain to accommodate historic abbeys, agriculture, and roads. Alternatively, to understand how dynamic the river would be if not constrained by bank revetment, there are examples of where the river has broken through bank protection work and been actively eroding laterally for considerable distances. It should be noted, however, that the rate of erosion at these points is likely exacerbated by channel modifications upstream: straightening of a channel shortens the distance water travels and over a steeper gradient, thereby imparting greater power to erode.

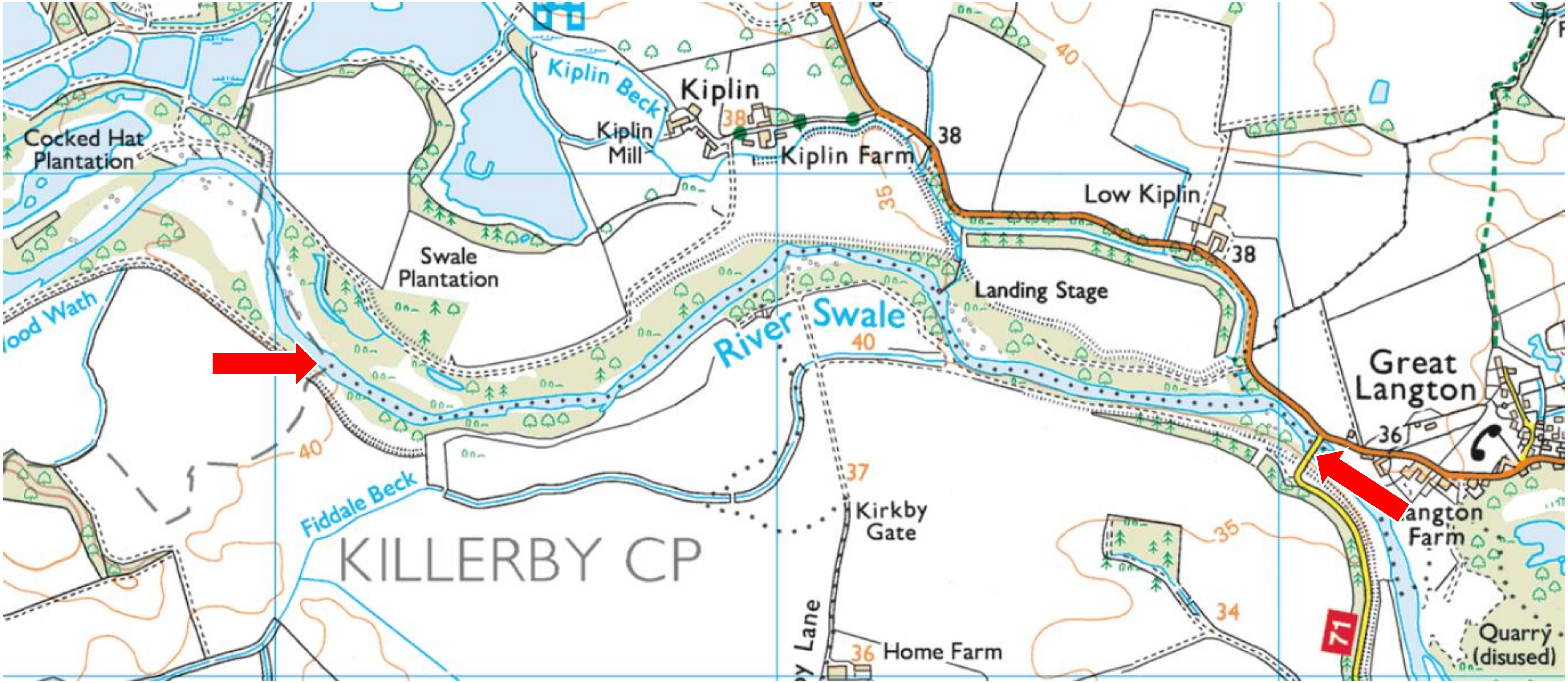
Throughout the 2013-2019 period of assessment, the waterbody has consistently failed to achieve good ecological potential, primarily for physico-chemical quality elements driven by dissolved oxygen. An overview of the waterbody is given in Table 1, overleaf.

	Richmond & District AS	
River	River Swale	
Operational Catchment	Swale Ure Nidd and Ouse Upper	
River Basin District	Humber	
Waterbody Name	Swale from Clapgate Beck to Bedale Beck	
Waterbody ID	GB104027069122	
Current Ecological Quality	Heavily Modified Overall potential of **Moderate** has been sustained from 2013 - 2019	
RDAS water	Clink Bank Woods / Station Bend to Red House Farm inclusive (both banks)	Full extent of Great Langton (RB)
U/S NGR inspected	NZ 17569 00982	SE 27296 96478
D/S NGR inspected	SE 19565 99844	SE 29065 96463
Length of river inspected	~3650m	~2000m

Table 1. Overview of the waterbody. Information sourced from: https://environment.data.gov.uk/catchment-planning/WaterBody/GB104027069122



Map 1. Red arrows denote limits of walkover on the upper reaches, from the Mercury Bridge d/s to the limit of Red House Farm water.



Map 2. Red arrows denote limits of walkover on the Great Langton water.

2.0 Catchment Overview

The mainstem River Swale flows for approximately 110km, with a total length of contributing watercourses >670km. The 1231km^2 catchment is split into upper, mid and lower operational catchments for management, and it is within the mid catchment that RDAS waters lie.

The Swale headwaters are in the North Pennines of the Yorkshire Dales National Park: Birkdale Beck, Great Sleddale Beck and Backstone Beck. The upper Swale and a large portion of the mid Swale catchment are underlain by a mix of millstone grit, limestone and sandstone. A north-south band of dolomitised limestone runs parallel to the west of the A1. East of the A1, a band of sandstone conglomerate runs north-south through the eastern edge of the mid catchment (ie around Great Langton) and west of lower catchment. The rest of the lower catchment is underlain by mudstone. Due to the underlying geology, the topsoil generally comprises a high proportion of sand, creating light friable soils susceptible to erosion. The combination of relatively permeable bedrock, erodible sandstones, and higher alkalinity limestone contribute to a neutral-alkaline pH which should support a relatively productive watercourse.

The mid and lower sections of the Swale catchment are a mix of agricultural land uses. The natural productivity of the soils is reflected in the area for arable production comprising ~35% of the catchment, whereas improved grasslands for pasture comprise another ~25%. Sheep grazing takes place on most of the low-quality moorland and permanent grasslands are established in lower-lying areas, where cattle are grazed also. A lack of appropriate buffering in the riparian zone, ie a protected interface between the agriculture and the river to intercept diffuse pollutants such as sediment and nutrients, was noted in the Catchment Plan (2014).

Earliest mapping of the river clearly showed extensive deposition bars within a meandering channel, although it should be noted that even back in the 1850s, the river had already been extensively modified (Map 3).

Map 3. Part of the Great Langton water showing extensive deposition bars, as surveyed in 1891. Note, flood bunding already *in situ*. Reproduced with the permission of the National Library of Scotland.

3.0 Habitat Assessment

3.1 Mercury Bridge to Red House Farm

Both banks were accessed between the Mercury Bridge and disused railway bridge, and then only the LB d/s through the Red House Farm water. The majority of the upper reaches benefitted from relatively natural, mature, mixed deciduous tree cover along the banks In part this was due to natural pinchpoints in the valley, but also the channel having been realigned and pinned into a more straightened course against one side of the valley or the other, and the steeper land being unsuitable for either farming or development (Fig 1). Trees impart various ecological benefits to aquatic ecosystems, some of which are realised on the RDAS waters.

Fig 1. Looking d/s from the Mercury Bridge towards Clink Bank Woods, the channel was broad and straightened to accommodate the bridge and grounds of the former priory on the RB. Mixed, native deciduous trees provided reasonable cover along both banks although there was evidence of some low branch clearance.

Overhanging branches offer shade, increasingly important with climate change, and overhead cover providing limited sense of security to fish; trailing or submerged branches are better. They also provide feeding and shelter for a host of terrestrial invertebrates that may drop into the water and provide extra food, as well as resting areas for many of the emergent aquatic invertebrates. Leaf litter in autumn is an extremely important food and shelter resource for aquatic invertebrates if it is retained within the channel.

Despite the amount of tree cover along the banks, there was scant evidence of woody material within the channel aside from a few small willows and alder that had been laid flat over time. The Swale is clearly a large and powerful river at Richmond, and the erosive forces severe when a large spate would have an extra 3-4m of water within the channel (based upon u/s & d/s gauge readings). However, there was also evidence of limbs and trunks having been cut back in the past and removal of such material robs the river of the tools to function naturally.

The vantage point of Mercury Bridge provided a useful window onto the channel morphology in a modified, straightened reach (Fig 1). Due to the lack of flow variability, the substrate was dominated by larger cobble and boulder spread relatively uniformly over the full width of the channel and hence there was not much variation in depth either. Fast flowing, shallow riffles like this make good habitat for salmonid parr but do not offer the depth or cover to hold other life-stages or many other species.

Riffles occur naturally and are an important component of a healthy river system when recurring between pools and glides. However, as will become apparent throughout the report, continuous riffle or shallow glide dominated much of the RDAS waters due to the modified nature of the channel.

Slower, deep pool habitat, ideal for holding larger fish was available directly d/s where the river hit the sheer bedrock of Clink Bank Woods and, unable to scour laterally, has scoured downwards before bending abruptly to the right (Fig 2). The inside of the bend exhibited a classical slip-off slope of deposited material (see inset Fig 2). Redundant weir infrastructure which appeared to have been placed on a seam of bedrock was (fortunately) degraded to the extent of allowing free sediment transport and fish passage.

From Station Bend to Abbey Woods, the river was effectively straight for ~1km and mostly shallow riffle or glide of limited holding potential for coarse species (see background to Fig 2).

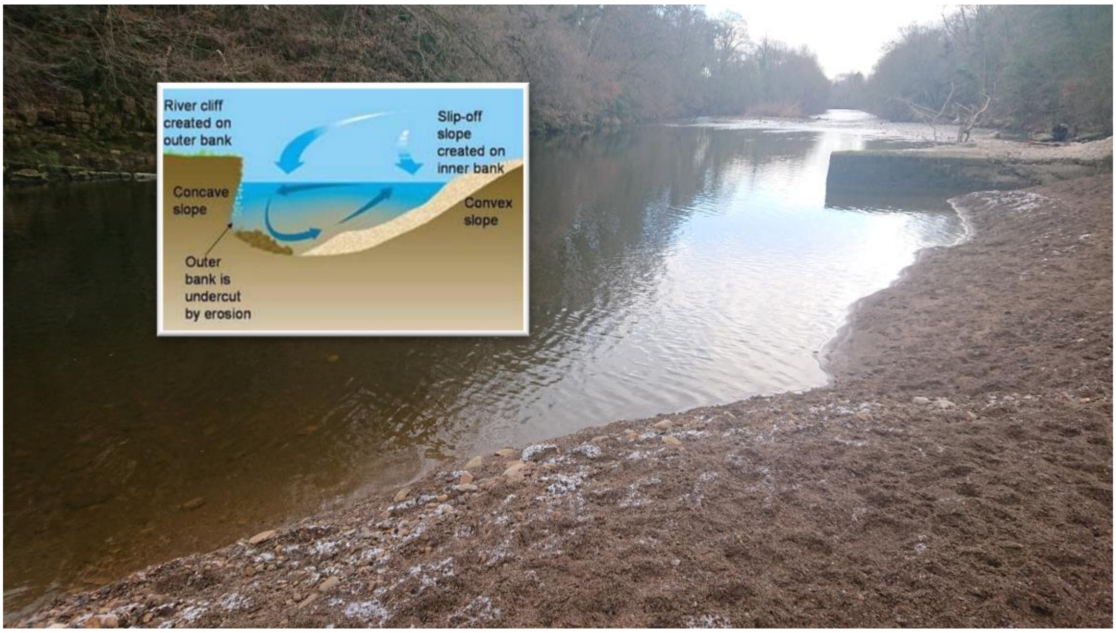


Fig 2. The deep pool and associated deposition (see inset) on the inside of the bend at Clink Bank Woods. There was also part infrastructure from an old weir and sluice-gate which has degraded over time.

The friable, sandy nature of the catchment soils was evident on both banks (Fig 3). Public access so close to the city will always cause a conflict: people (and dogs) wanting to see and access the water, but associated footfall actually causing detriment to the flora and ultimately the stability of the banks. The mature canopy of riparian trees naturally reduces the density of understorey plants to species tolerant of shady conditions, and recurring spate flow brings fresh deposits of sandy material onto the banks, but these should stabilise over time as the plants bind them together. Only in places inaccessible to people was the understorey flourishing. Wherever there was constant footfall, much of the natural understorey was degraded and the soils around tree roots were disturbed leaving them susceptible to erosion.

Many trees at the edge of the channel were multi-stemmed, hinting at historic coppicing (Figs 3&4), and provide opportunities for habitat improvements by laying (hinging) or felling (creating a tree-kicker) one trunk into the channel while retaining an anchor point to the bank (see Recommendations). Site selection is key to ensure benefits such as flow and predation refugia or flow diversity are realised.

Fig 3. Examples of the bankside characteristics on Station Bend to Fence End, and Clink Bank Woods waters. The mature canopy from the riparian trees would naturally result in a 'thinner' understorey, but the banks were essentially bare because of footfall and/or recurrent deposition of fine sand preventing establishment. Note the exposure of the tree root system.

Multi-stemmed trees along both banks hinted at previous coppicing. To simulate the naturally laid trunks in the lower image, trunks could be felled or hinged (dependent upon species) and wedged or tethered to increase diversity of habitat within the channel.

Within ~500m of the Mercury Bridge, wherever the channel was shallow enough to see the substrate clearly, there was a distinctly darker colouration to the bed consistently along the LB which appeared to be algal or biofilm in nature (most obvious in Figs 1&4). The association with the LB was striking, as parameters such as flow path, depth and angle of incident light which one might expect to govern algal growth varied considerably. However, several pipes were noted in the LB (Fig 4), and since the city of Richmond lies predominantly on the LB, there could be multiple sources of chronic nutrient addition affecting the substrate which should be investigated.

Fig 4. For at least ~500m (see Fig 1 from Mercury Br), the substrate toward the LB appeared markedly darker in colouration, despite changes in depth, flow path, shade / angle incident light etc. Various pipes were noted and the majority of Richmond infrastructure lies to the LB so this could reflect chronic inputs of nutrient from multiple sources.

The degradation and collapse of a relatively modest height weir at Easby Abbey (Abbey Farm) was assumed to be in part responsible for increased erosion of the LB u/s, and which has since been curtailed by a substantial block stone revetment (Fig 5). While classified as bank 'restoration' according to the plaque at the top of the structure, such hard engineering in a sweeping curve simply transfers the full force of the energy further d/s. The walling does not allow any natural bank vegetation save for one willow which has managed to establish in a crack at the toe. On the slope above, there seemed to be a variety of non-native species planted, such as buddleia, contributing little to the natural functioning of the channel at this point. Conversely, the natural reclamation of the weir has been remarkable (Fig 5 inset) and a fantastic stand of mainly alder now thrives, providing shade and natural flood management benefits amongst many others.

Fig 5. A highly engineered solution of boulder revetment / walling to the LB to prevent the river returning to a natural course u/s of Abbey Farm (Easby Abbey Mill). It is unclear how long ago the weir (shallow, dressed stone; inset) that fed the mill failed, but the increased gradient at this point probably contributed to the excessive erosion.

Cobble and gravel deposition bars below the weir were not mapped in 1854, but a substantial island had developed by 1891 forming a distinct channel against the RB (ref to OS maps). Evidence of that still remains today, connected and flushed sufficiently during modest to high spate flow to retain water and provide good fry nursery habitat with adequate overhead cover (Fig 6).

The tail of the channel was discharging into Sand Beck, which almost immediately then discharged into the Swale. The lowest reach of Sand Beck had been historically straightened; the confluence was mapped originally as perpendicular (OS map 1854; Fig 6). However, in conjunction with the collapse of the weir, it appears that the deposition bars have developed to such an extent in a d/s direction as to surpass the confluence and force Sand Beck to the right. Scouring flow from Sand Beck against alder roots on the deposition bar has created a deep pool in a perfect location to provide fish moving in and out of the smaller watercourse with good refuge.

Fig 6. Upper: from the confluence of Sand Beck, looking u/s along an old leat or relief channel parallel to the Swale, fish passage into the beck (which bends to the left) was unimpeded. Such a backwater, with ample overhead cover, creates good nursery habitat.

Lower: the lowest reach of the beck was artificially straightened and has been so for at least 150 years according to the 1854 Ordnance Survey; probably much longer associated with Easby Abbey.

Sand Beck hints at the underlying geology of that small sub-catchment. A cursory examination of modern OS maps and satellite images indicates that the tributary is reasonably well buffered with mixed deciduous woodland for several kilometres and, assuming there are no artificial barriers on the system, potentially an important spawning tributary for salmonids.

The top section of the Easby water (Abbey Farm to Abbey Woods) switched from fast, shallow riffle to deeper, slower glide, culminating in a deep pool at the end of the straight (Fig 7). Hence there was greater diversity of habitat for larger specimens of coarse species like grayling, barbel and chub, but limited opportunities for eggs, fry and juveniles. The artificial impoundment was due to the river being forced into a perched position towards the LHS of the floodplain and there coming into contact with bedrock seams. The RB has been planted up with alders relatively recently (Fig 7: mid) but only a few specimens or a very thin fringe have been placed on the inside of the bend. Increasing power, duration and frequency of recent winter spates has started to take a toll on the inside of the bend where block-failure erosion was evident (white arrows on Fig 7). In a natural functional channel, the inside of a bend is a deposition zone, further evidence that the channel has been perched out of position and trying to return to the lowest point in the valley.

The landowner on the RB has excluded horses from the channel with a buffer strip varying between 5 and 15m and implemented some planting with native tree species. However, there was ample room within the protected strip to increase the density of planting, and extend into another fenced section between that strip and the channel at NZ 18497 00046 (see Fig 8).

From the bend on Easby water (Fig 7), the river has been shifted unceremoniously from the LHS to the RHS of the valley, maintained on a straightened course to pass through the (disused) railway bridge at SE 18364 99887 (Fig 9). The straighter, steeper channel interacting with numerous bedrock seams has led to the creation of a series of low cascades interspersed with deep pools, and hence a diverse physical mosaic of habitats. However, the excessive erosive power appears to have stripped much of the valuable loose substrate that would be home to invertebrates and cast that aside onto the banks (esp RB, u/s of bridge; Fig 9) or down to the end of the straight, leaving only bedrock.

The abrupt left-hand bend of the Hagg Wood water has clearly received a considerable amount of the displaced substrate and there were numerous deposition bars, some more dynamic and some having been stabilised by alder and willow growth. Bedrock seams still played a considerable part too, and the channel retained a variety of physical habitat as a result (Fig 10).

Fig 7. The straightened reach of Easby water looking d/s from Sand Beck (upper), a mid point of deeper glide (mid), and looking back u/s from the bend at Abbey Wood (lower). The unnatural course has left the river pinned to the LB at Abbey Wood where it is forced abruptly right over a bedrock seam. This has left the river with impounded characters u/s of the bend and much steeper d/s (see Fig 8). White arrows on mid and lower panel indicate the same point on the RB where erosion is evident on the inside of the bend.

Fig 8. Fenced plots with potential for more tree planting on the RB below the Easby water bend. One can see the much steeper gradient in the river alluded to in the legend of Fig 7.

Fig 9. Looking u/s & d/s from the disused railway bridge at SE 18364 99887. The channel has been forced on a straight course from one side of the valley to the other and has cut across several seams of bedrock resulting in a variety of deeper pools amongst the faster riffles and small cascades. The oversupply of substrate has formed huge deposits for >200m on the RB u/s of the bridge (upper image).

Fig 10. On the Hagg Wood water, the channel turned abruptly left as it encountered the steeper valley side, and the habitat diversity and quality remained high because of the varied physical structure: bedrock seams and small deposition bar islands of varying stability. Riparian habitat quality was excellent also.

The varied physical structure imparted considerable flow diversity allowing for the sorting of sediments into discrete patches based upon size or density (Fig 11). Hence, there was likely considerable diversity of niches for different types of invertebrates (stoneflies and shrimp for example exploiting the interstices or gaps between the larger cobble and gravel, while burrowing mayflies and chironomid larvae would favour the finer sands and silts. However, given the highly dynamic and mobile nature of the substrate noted before, these patches of gravel may be too ephemeral for spawning habitat, especially for salmonids that create redds over winter.

Fig 11. That varied physical structure noted in Fig 10 allowed natural processes of sediment sorting to occur; separation of gravel and sand into distinct mosaic patches which would favour different invertebrate taxa. Gravel cleaned of silt and sand is required for successful spawning of salmonids and some coarse fish like chub and barbel but these patches may be too ephemeral in nature to offer potential.

The remainder of the walkover through the Red House Farm water was conducted from the LB. Again, there was evidence of the channel being pinned to the RHS of the valley, probably to create contiguous parcels of agricultural land from the rest of the valley floor. As a consequence, the RB was steep and predominantly native deciduous woodland of mixed age structure, providing plenty of shade and some cover. D/s of the farm, the LB was highly formalised, a level plateau of short sward grass maintained by sheep, with a perilously narrow fringe of previously coppiced trees of mostly similar age (Fig 12).

Fig 12. The channel was pinned against the right-hand side of the valley for much of the Red House Farm water. The LB had a sparse fringe of more mature trees along the channel that were all suffering from exposure of their root systems due to livestock grazing and trampling. Eventually, these will be lost and, again due to the livestock, there was no self-set regeneration to replace them.

Grazing and trampling around the roots had weakened the integrity of the soils around the roots and allowed the river to erode around on the landward side, leading to the recent loss of some sizeable specimens. Continued grazing pressure was preventing any self-set regeneration of trees to help retain the stability of the bank. In time, the current aging trees will be lost and then there will be nothing knitting the bank together and preventing further lateral erosion.

The high density of sheep maintained in a relatively narrow strip between the channel and arable fields adjacent was clearly having a detrimental impact: multiple desire line trails where the animals follow the same track continually, removing the vegetation and compacting the soils; continual disturbance of freshly deposited material from the river, preventing stabilisation by colonisation; and maintenance of a predominantly short sward of grass with poor root structure (Fig 13). In fact, at the time of the visit, the sward had been reduced to such an extent that supplemental feeding was required.

Combined, these factors leave the bank highly susceptible to erosion, and relatively smooth which does nothing to 'slow the flow' of water over the surface during spates. A more diverse herbage left longer over winter would impart hydraulic roughness helping to slow flow, trap sediments and increase resilience to erosion.

Towards the d/s limit, tree cover on the LB increased and there were several large, multi-stemmed crack willow specimens, some of which had leaning and laid trunks. The benefits of retaining these *in situ* were evident at the site; protecting the bank and/or causing the deposition of sediments in their lee (see Fig 14). Crack willow is relatively easy to work with, and further trunks that were already leaning at a d/s angle over the channel could be laid with a living hinge into the channel to provide valuable physical diversity in what was otherwise a relatively straight and uniform reach with limited refugia for fry / juveniles.

Fig 13. There was plenty of evidence of the damage that sheep can do to river banks which leaves the friable soils more susceptible to erosion: continued disturbance of unconsolidated material (upper); desire line tracks weakening the integrity of the soil (mid); and maintenance of short sward grass with poor root systems (lower).

Fig 14. Towards the d/s end of the Red House Farm water, there were many multi-stemmed crack willows that were either laying naturally or could be encouraged to do so to diversify instream and edge habitat. A small, naturally laid and still living tree (lower image) appeared responsible for the retention of the bank on the d/s side (area highlighted by the white oval), although sheep grazing and trampling were degrading it.

3.2 Great Langton

The full extent of the Great Langton water was examined from the RB. The river was much more uniform in character: long straightened sections with relatively long sweeping bends fixed in position by various methods of revetment with varying degrees of success. As a consequence, the substrate for the most part was evenly spread across the full wetted width of the channel and there was little apparent variation in depth – long, continuous glide habitat. The only marked exceptions were deeper holes on the outside of some of the bends, particularly toward the u/s end, where tonnes of concrete slabs from the former army garrisons had been piled onto the bank top and into the river as bank 'protection' (Fig 15). Preventing lateral movement has resulted in downward scour (see Fig 2 inset), thus creating the pools, but such hard revetment also transfers the energy d/s rather than absorbing or dissipating it, hence causing issues elsewhere. The artificial bank also prevents much of the natural vegetation from establishing, instead favouring 'pioneer' species that can tolerate high disturbance, such as bramble, nettle and Invasive Non-Native Species (INNS) like Japanese knotweed that appeared rife along both banks. Some small willows had managed to eke out an existence but with poor rooting options, there appeared to be an upper limit to the size these specimens achieved.

The understorey was clearly impacted by almost continuous grazing (Fig 16). Fencing was evident along much of the upper reach on the landward side of the flood bund but was in such a state of disrepair as to be ineffective at excluding stock. As for the u/s reaches, this left much of the bank less resilient to spate flow and here, compounded also by the presence of Japanese knotweed. Some might argue that allowing sheep to graze helps to control INNS but they were clearly having negligible impact. Reinstating protection from grazing via a functional fence-line would remove one stressor on the riparian environment.

The other notable feature on this water was the ongoing modification of the channel and banks via gravel and cobble removal (Fig 17a&b). Dredging does not solve the problem of sediment deposition. Creating a deeper hole in a channel at a particular point will simply encourage greater erosion and supply of substrate from u/s to restore equilibrium. Over-widening a channel will simply cause the flow energy to be dissipated further and hence encourage the deposition of new sediment. This was clear at SE 28350 96667. Using unconsolidated material dredged from the river to create banks and prevent erosion elsewhere is similarly futile (Fig 17a&b).

Fig 15. Various example towards the u/s limit where the RB top and face was predominantly concrete slabs dumped on the bank as 'protection'. Willow and bramble had managed to eke out a niche and establish some cover, but where sheep had easy access (eg middle image, white rectangle highlighting path), the cover was reduced and desire lines indicated weakening of the bank structural integrity.

Fig 16. Dilapidated fencing was apparent, especially towards the u/s end, but was not preventing sheep from accessing the riparian zone. The sandy deposits within were pockmarked with spoor. Such continual disturbance over winter will contribute to soil mobilisation and loss during spate events, and during the spring / summer, there would be little chance of any colonisation by understorey plants (aside from Japanese knotweed – see later) to help stabilise the banks.

Fig 17a. An enormous cobble and gravel bar at SE 28350 96667 where the river has recently changed course or, perhaps more likely, been encouraged to do so, straighter rather than arcing around the RB. There was evidence of substantial slumping of the unconsolidated material and deposition in the overwidened channel (arrows, upper image) indicating the river was already trying to return to its natural dimensions and previous course.

The channel in the foreground of the lower image was being maintained by inflow from Fiddale Beck, piped through the flood bund (Fig 17b).

Note the extensive stand of Japanese knotweed (reddish stems).

Fig 17b. Upper: the 'confluence' of Fiddale Beck with the Swale, piped unceremoniously through a perched culvert. There was evidence of recent and ongoing plant activity shifting substrate around , presumably in a futile attempt to protect the culvert pipe environs.

Lower: there was also considerable evidence of cobble and gravel having been removed for bolstering the flood bunds.

Fiddale Beck would once have been an important tributary, meandering across the floodplain and offering a contrasting lower energy environment compared to the mainstem Swale for spawning and juvenile nursery habitat. Unfortunately, it too has been highly modified for >150y; an upper network of smaller tributaries straightened into a series of drains around fields (with no visible buffering) and the lower 1km of channel bunded and latterly piped via a culvert into the Swale (Figs 17b&18). The culvert pipe was of insufficient diameter to accommodate all flows and set at an inappropriate depth; too high for the beck causing severe impoundment and siltation upstream, and perched above the Swale.

The structure has effectively disconnected the beck from the mainstem river, creating a virtually impassable barrier to fish movement.

Fig 18. Looking upstream along the straightened and dredged channel of Fiddale Beck from the vantage point on top of the Swale flood bund and almost directly over the top of the culvert that links the two.

Flow was restricted by the culvert aperture, causing significant and extensive impoundment and hence sedimentation along the channel. An apparent lack of buffer zone, aside from the short (visible) reach on the RB, indicated that sediment ingress was highly likely u/s.

On the lower reaches towards Great Langton bridge, there were further areas of lower-lying riparian habitat 'inside' the flood bunding where willow and alder had established wet woodland, and mature trees were growing from the toe of the bank at the water's edge (Fig 19). Root boles would help stabilise the banks as well as providing valuable cover for fish. Smaller trees laid by high flows along the edge of the channel performed a similar role but the extent of cover was limited. Again, more recent deposits of sand from the river were left exposed and continually disturbed caused by the twin stressors of Japanese knotweed and sheep (Fig 20). The density of stands and sheer extent of the knotweed was concerning. It was mapped and reported via the Yorkshire Invasive Species Forum immediately after the walkover.

Fig 19. Mature willow specimens on the LB created some deeper water and cover around their roots. Small crack and goat willow specimens at the bank toe were providing the only other physical structure and cover within the channel but the extent of this was generally limited to within a metre or so from the bank. These images indicate how the complex of roots and branches trapped debris and caused the deposition of finer sediments (sand and gravel). Unfortunately, a combination of livestock trampling and Japanese knotweed had prevented further stabilisation of these sediments.

Fig 20. The extent and density of Japanese knotweed along the RB on the lower reaches, and the bare sand beneath.

Almost at the d/s limit, Kiplin Beck was assessed at its confluence on the LB (Fig 21). It was highly turbid and contributing a considerable suspended sediment load at the time of the walkover, reported via the Environment Agency National Incident Reporting Service (0800 807060). The extent of discolouration of the water column and silt on the bed at the bridge indicated a chronic problem.

Fig 21. Upper: a plume of discoloured water caused by high suspended solid load was plain to see below the confluence of Kiplin Beck. Mid: Kiplin Beck was affected, bank to bank. Lower: immediately d/s of Great Langton Bridge, along the LB toe of the Swale, the fine sediment from Kiplin Beck was smothering the bed of the main river.

4.0 Fishery overview

There are various ways of classifying the zonation of rivers, the simplified description of typical changes from headwaters to estuaries, using characteristics such as the basis of production (what provides the energy at the bottom of the food web) right through to the fish communities. Figure 22 is a composite schematic of the classical description of zonation as a continuum (the River Continuum Concept proposed by Vannote et al 1980) overlaid by the European fish zonation (as proposed by Aarts & Nienhuis, 2003). Human modification of river channels will impact upon these schema. Essentially, the RDAS waters lie on the cusp of what would be classified as Grayling and Barbel Zones. That is not to say brown trout (and salmon) will not be present and using those waters.

Based upon the observations made and reported here, the physical habitat within the Mercury Bridge to Red House Farm waters generally appeared more favourable for salmonids and grayling than coarse fish species like chub or barbel. While there were a few pockets of holding habitat for larger coarse fish, there was relatively little in the way of fry and juvenile habitat, and the temporal stability of gravel for spawning was questionable although probably sufficient for short periods during the late spring / early summer spawning period of these species. A detailed assessment of invertebrate life was not carried out but a cursory search by turning cobbles revealed a few small mayfly and stonefly nymphs. Food might hence be a limiting factor for some of the coarse species that typically forage on the bed (eg barbel) whereas trout and grayling feed in the drift and from the surface and can be heavily subsidised by terrestrial invertebrates. Furthermore, the slow decline in catches of coarse fish noted by the club (and elsewhere across the country) could also reflect a general trend of increasing water quality which again tends to favour salmonids over coarse species. These factors are not mutually exclusive. The Great Langton waters were more typical of the Barbel Zone but still lacked suitable habitat for fry and juvenile development. Fortunately, the Swale has relatively few man-made barriers (considering its length), and certainly fish like barbel will move considerable distances, spawning, feeding and residing in distinct reaches of a river throughout their life-cycle. Skeeby Beck offers more suitable habitat, certainly for fish like chub.

These observations appear to be borne out by recent electro-fishing data (Environment Agency and Hull International Fisheries Institute surveys) with juvenile salmonids dominating.

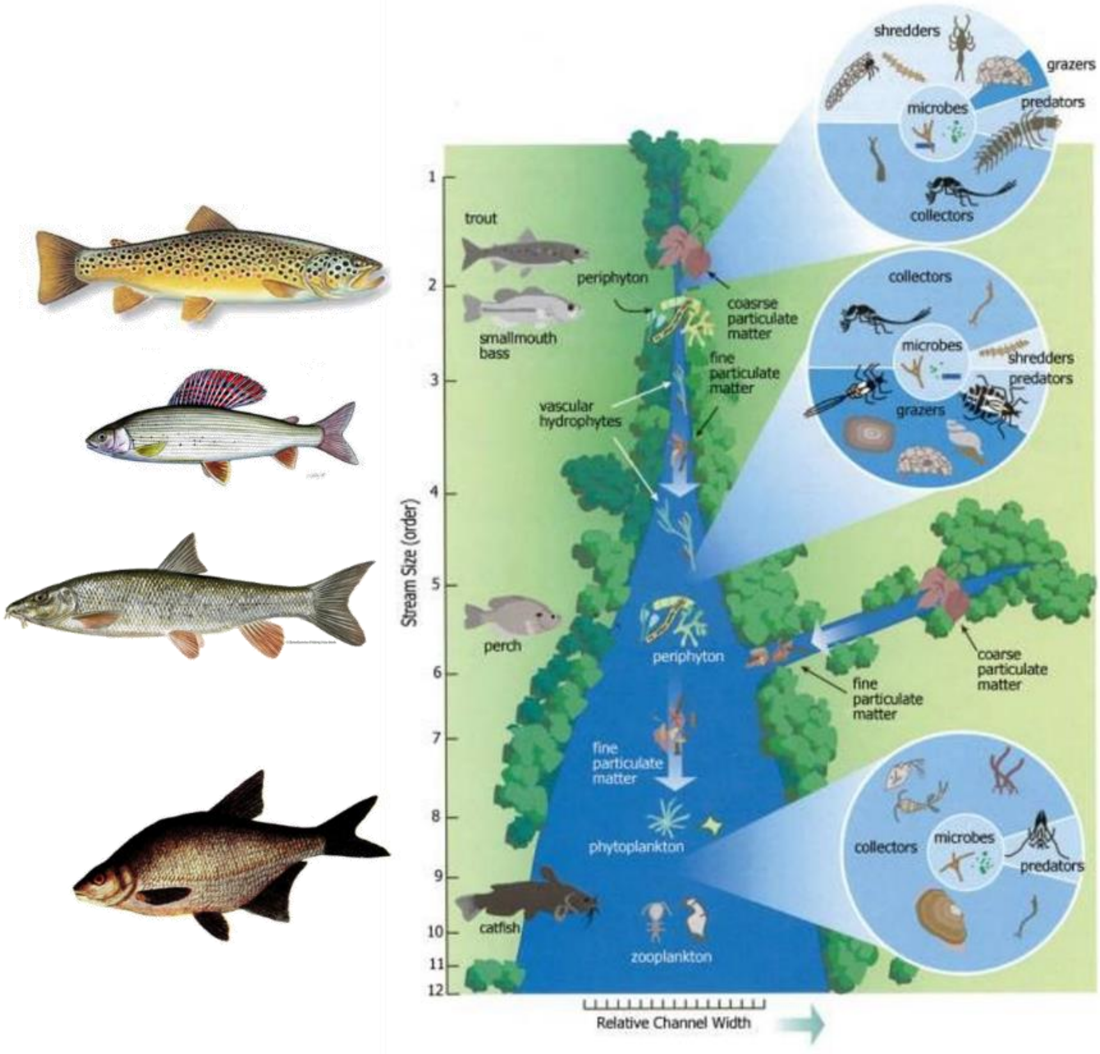


Fig 22. A schematic of the River Continuum Concept (Vannote et al 1980) with the classic European fish zonation (*sensu* Aarts & Nienhuis, 2003) added to the left panel.

Stocking with hatchery bred and raised fish to 'supplement' wild fish populations in open river systems is heavily flawed in many aspects and there is negligible evidence to demonstrate that angler catches improve as a result. Declining catch records of coarse species from the RDAS waters indicate that the carrying capacity for those species has declined, and simply stocking more fish will not address the underlying issues. In a high energy system like the Swale, the majority of stocked fish will inevitably redistribute in a d/s direction until they find suitable holding habitat. However, to be sustainable at the population level, there needs to be spawning and fry habitat for those species as well. As indicated throughout the report, the current state of most of the river is better suited to salmonids.

5.0 Recommendations

The character of the Swale (including the tributaries) throughout the RDAS waters has been shaped strongly by the natural topography of the catchment and land management practices, both historic and ongoing. The channel forms of every watercourse bear evidence to extremely high spate flows and rapid conveyance leading to excessive erosion on those sections of bank inadequately protected (eg from livestock or INNS).

5.1 Slowing the flow

This is a bit of a catchphrase at present but clearly applicable on rivers like the Swale and its tributaries. Obviously, there is a considerable area of catchment u/s of the RDAS waters and well outside a direct sphere of influence but support for organisations like the Yorkshire Dales Rivers Trust that is instigating work to reduce conveyance, plant trees, tackle INNS etc, across the catchment is worthwhile. It would be worth engaging with the YDRT to explore avenues for mutual benefit.

Within the RDAS waters, engagement with some of the landowners, either directly or perhaps brokered via YDRT, to discuss small changes in management will also bring mutual benefits. For example, excluding livestock from within riparian buffer strips will reduce erosion of the banks and increase resilience, in part by allowing for natural regeneration of trees and understorey. There are numerous funding streams available to help with the cost of flood-spec livestock exclusion fencing because of the environmental and flood risk benefits accrued.

5.2 Channel habitat

It was notable throughout the walkover that retention of large wood in the channel was relatively scarce, despite a rich potential supply from the wooded sections of bank. Whether that was due to removal from a perceived flood risk management perspective or simply the power of the Swale along a modified channel in full spate could not be ascertained; most likely a combination. However, there were one or two examples where sizeable material had been retained naturally, either as 'debris' (see Fig 23) or still attached via a living hinge (eg Figs 3 or 13). Wood fall and associated habitat can be simulated by hinging pliant species (eg willow) or felling and tethering trunks back to the their living stump or adjacent trunks (Fig 24).

Fig 23. An almost intact tree retained on the inside of the (slight) bend and hence the more depositional area (Red House Farm water), providing localised scouring around the bole and cover under the roots and trunk.

Fig 24 LH upper - hinged trees laid into the margins; RH upper– the impact of the crown of a tree kicker encouraging deposition in the lee and providing complex refuge habitat; Lower – felled alder and cabled back to living stump.

Any activity like this requires careful planning and consent from landowner and the relevant authority (in this case, the Environment Agency for work on main river) but can be achieved relatively easily and cheaply. Appropriate areas where this type of habitat improvement might be attempted would be: Station Bend to fence end, lower parts of Red House Farm, and the Great Langton waters. Working with previously coppiced, multi-stemmed trees is advantageous as the felling of one or two trunks does not alter significantly the aesthetic or shading function. The anchor point can also be protected by trunks on the u/s side.

5.3 Tributaries and spawning habitat

Suitable spawning habitat in the main stem Swale appeared to be a potential bottleneck to population productivity. Hence access to, and the condition of, smaller tributaries increase in importance. Of the three tributaries observed, Sand Beck appeared the least impacted and of a size to achieve maximum bang for buck. Fiddale Beck was effectively disconnected and so highly modified as to be of lowest priority. Kiplin Beck should be a productive spawning tributary but clearly has ongoing issues in terms of water quality, possibly associated with gravel extraction works in the locality.

There are other notable tributaries, particularly Skeeby Beck (where WTT & YDRT have done some work to improve habitat) which appears to offer better spawning, fry and juvenile habitat mosaics for species like chub. Interventions to improve spawning potential include: slowing the flow, introduction and retention of large wood, planting of low cover, and reduction of fine sediment ingress from livestock activities.

5.4 Pollution

Diffuse pollution sources from silt / soil ingress were apparent wherever livestock had access to the bank, and especially emanating from Kiplin Beck (although the latter might feasibly have been a point source from gravel washing). These should be reported whenever noted via the Environment Agency hotline (**0800 80 70 60**).

5.5 Invasive species

Japanese knotweed was particularly problematic on the Great Langton water. There have been arguments made for keeping banks accessible to livestock to help control invasive plants but there was no evidence of any beneficial impacts of the sheep on the knotweed stands at Great Langton. Rather, the negative impacts of continually disturbing the soils and browsing of self-set tree regeneration outweighed any perceived benefit.

It would be useful to establish the most u/s point of this pernicious plant and coordinate its removal. Knotweed requires chemical rather than physical control, and hence appropriately training and licencing for chemical application. All RDAS members should be made aware of the issues surrounding this plant, and encouraged to follow simple biosecurity protocols to ensure they are not transporting propagules.

Yorkshire Wildlife Trust and Yorkshire Dales Rivers Trust have produced detailed information on controlling INNS in various publications and should be contacted for their advice.

6.0 Making it Happen

The WTT may be able to offer further assistance:

- WTT Project Proposal
    - Further to this report, the WTT can devise a more detailed project proposal report. This would usually detail the next steps to take and highlight specific areas for work, with the report forming part of a flood defence consent application.
- WTT Practical Visit
    - Where recipients are in need of assistance to carry out the kind of improvements highlighted in an advisory visit report, there is the possibility of WTT staff conducting a practical visit. This would consist of 1-3 days' work, with a WTT Conservation Officer teaming up with interested parties to demonstrate the habitat enhancement methods described above. The recipient would be asked to contribute reasonable travel and subsistence costs of the WTT Officer. This service is in high demand and so may not always be possible.
- WTT Fundraising advice
    - Help and advice on how to raise funds for habitat improvement work can be found on the WTT website - www.wildtrout.org/content/project-funding

In addition, the WTT website library has a wide range of free materials in video and PDF format on habitat management and improvement:

http://www.wildtrout.org/content/index

7.0 Acknowledgement

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8.0 Disclaimer

This report is produced for guidance only; 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.