Advisory Visit

River Aire, Bradford City Angling Association

04/02/2016

Key Findings

- Aside from Eshton Beck, there is limited access to spawning and nursery habitat. It is therefore important to maintain access to and ensure good water quality in all the small tributaries, and promote retention of suitable sized gravels in the main stem Aire.
- Impacts of livestock with access to the wetted margin are evident throughout the Gargrave section. Exclusion of grazing livestock will be absolutely essential if meaningful improvements in in-stream and riparian (bankside) habitat are to be achieved.
- The historical weirs installed by the Club are now dilapidated and should be allowed to continue to degrade; there are greater environmental issues such as straightening and constraining that cannot be overcome, and so their presence diversifies the character of the channel. However, notching these further by removing some elements and reinstalling the material downstream, or using it elsewhere should be an aspiration. The weirs are passable to most fish of most sizes but they still impound upstream sections and hence may cause greater predation mortality by providing deeper, slower moving water favoured, for example, by goosander and cormorant.
- Relatively simple and low cost tree management (planting / laying / coppicing) will improve the riparian habitat for both aquatic and terrestrial fauna provided that any works are protected from livestock influence.
- The populations of wild trout and grayling are relatively healthy with a good size range of individuals, probably reflecting the productive nature of the underlying limestone geology. However, the simplified habitat (straightened uniform channel with lack of cover) makes these populations more vulnerable to extreme events (spates) or predation pressure. Habitat improvements will increase population resilience; e.g. by introducing habitat complexity that fry can use as refugia, they will be less susceptible to washout in spates or predation by birds.
- The Upper Aire project was a 2015 Wild Trout Trust Conservation Awards winner, and so there is impetus in the catchment and an existing support network including the local Environment Agency and the Farming & Wildlife Advisory Group to take habitat improvement work forward.

1.0 Introduction

This report is the output of several site visits to the River Aire, N. Yorkshire, undertaken by Jon Grey of the Wild Trout Trust. The visit was requested by Jim Munden (Secretary) of the Bradford City Angling Association, who accompanied Jon on the initial walkover in late October, 2015. Jon re-walked the same section in late January, 2016, following unprecedented spates in the period between.

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 system is used for identifying locations.

	Bradford City AA 'Gargrave section'
River	River Aire
Waterbody Name	Predominantly Aire (Eshton Beck to R Worth); the top ~500m is Aire (Otterburn Beck to Eshton)
Waterbody ID	GB104027063033; GB104027063050
Management Catchment	Aire & Calder
River Basin District	Humber
Current Ecological Quality	Overall status of **Moderate** ecological potential based upon an overall ecological status of **Moderate** and overall chemical status of **Good**
U/S Grid Ref inspected	SD9374253945
D/S Grid Ref inspected	SD9612251670
Length of river inspected	~3500m in total

Table 1. Overview of the waterbody. Information sourced from: http://environment.data.gov.uk/catchment-planning/WaterBody/GB104027063033

Under the Water Framework Directive (WFD), the Aire from Eshton Beck to the River Worth (GB104027063033) has the designation Heavily Modified Water Body (HMWB). Through two cycles of assessment, it has achieved *Moderate Ecological Potential* overall. It is important to note that five ecological classes are used for WFD Water Bodies: high, good, moderate, poor, and bad. These are assessed against 'ecological status' (or 'ecological potential' in the case of HMWBs).

The status (or potential) of a waterbody is derived through classification of several parameters: water quality, physical condition and barriers, invasive non-native species, fish, and flows and levels. The overall status is then dictated by the lowest score amongst those parameters. However, it is important to note that, in the case of HMWBs, the status of fish (and benthic invertebrates) are often discounted as the HMWB designation already highlights a potential impact on those biological indicators, but as these are of the greatest immediate importance to angling clubs, they should not be overlooked.

For example, a HMWB could have mitigation measures in place to allow it to reach good ecological potential e.g. a fish pass installed on a dam required for hydropower generation, but if water quality is poor due to elevated phosphorus, its overall ecological potential assessment could be moderate, poor or bad depending on the severity of the impact and associated score for that parameter.

The overall status of *Moderate Ecological Potential* was derived from an overall ecological status of Moderate and overall chemical status of Good; i.e. the waterbody is failing.

2.0 Catchment / Fishery Overview

The River Aire rises near Malham in North Yorkshire in a landscape dominated by the underlying carboniferous limestone geology. Limestone has a significant influence in providing a nutrient base and typically good clarity water for plant (primary) productivity that further supports a diverse ecology, including abundant invertebrate communities, and where habitat allows, fast-growing, abundant fish populations.

The Aire catchment lies within Natural England's National Character Area (NCA): 21 Yorkshire Dales and is classified from an abstraction perspective as 'water available', including from the underlying

Carboniferous Limestone (Aire and Calder Catchment Abstraction Management Strategy, Environment Agency; 2007). Flows generated within the NCA contribute to flooding events outside the area, particularly along the Aire in Leeds, hence the considerable amount of engineered bunds along its length.

Most Yorkshire Dales' rivers have been affected by drainage and heavy stock grazing in both the catchments and floodplains, resulting in rapid transit of water and flashy hydrographs with narrow, high peaks and troughs of flow, excessive erosion, and a scarcity of wetland features. There is typically over-supply of cobble and gravel resulting in pools filling in to become uniformly shallow, especially where natural geomorphology is interrupted i.e. behind weirs.

Various UK Biodiversity Action Plan priority species are found in the Aire and its tributaries including eel (*Anguilla anguilla*), brown trout (*Salmo trutta*) and native crayfish (*Austropotamobius pallipes*). Restoring a more natural flow regime, geomorphology, and riparian and in-stream habitat mosaic to the river will certainly assist in fulfilling the ecological aspirations for the upper Aire, which suffers obvious impacts from past land drainage and channel realignment.

In the last round of the Common Agricultural Policy - Countryside Stewardship Scheme (up to 2014), much of the land surrounding the River Aire was in a Higher Level Stewardship (HLS) target area, with some land already signed up to Entry Level Stewardship (www.magic.gov.uk). With this in mind, it is hoped that the next round of new schemes (2016) will also target these areas, and that subsidies may be available to landowners/tenants prepared to enter land into stewardship options such as buffer-fenced river margins.

It may also be that Catchment Sensitive Farming initiatives are running on this land and this is well worth investigating with the local EA, Natural England and Woodland Trust. Such schemes may assist with funding for improvements in riparian land management.

3.0 Habitat Assessment

The starting point for the walkover was BCAA's upper fishing limit at the weir in Gargrave at SD9374253945 (Fig 1). The weir was installed to impound water for a leat into the factory site on the LB; the head-loss generated by the structure is ~3m. It is a considerable obstacle to fish passage (a function of the head-loss combined with the shallow gradient concrete apron >10m in length, which is also perched), alters the free flowing character of the river u/s by impoundment for ~100m and prevents free transport of substrate, thereby impacting upon geomorphology d/s. See a WTT video outlining key impacts, here: https://youtu.be/ILofBcLiDts

The pool immediately below is deep, containing many large stone boulders and concrete structures providing a complex habitat and hence good adult trout and grayling holding habitat, especially under low flow conditions.

Fig 1. The weir marking the u/s fishing limit of BCAA waters at Gargrave. Major fish passage issues arising from the head-loss (~3m) and perched apron (>10m length). Note riparian vegetation protected by fencing immediately u/s on the RB (white arrow).

Recent remedial work using single-strand, breast-height fencing to protect the RB immediately u/s of the weir from livestock (primarily cattle) poaching has worked, and the riparian (bankside) vegetation is recovering. However, cattle still gather to be milked at a gate precariously close to the river u/s; it acts as a focal point for faecal material and it appears that a gulley is regularly cut to the river from this low-lying point to clean the gateway thereby introducing fine silts and nutrients directly to the watercourse (Fig 2).

Fig 2. Focal point for cattle to gather at gateway to farm. White arrow depicts lowest point where there was evidence of a drain cut to the river. Note single-strand breast-height fencing allowing recovery of vegetation to right of shot

It is clear that immediately d/s of the weir, the channel has been dredged and straightened. It is heavily incised and the spoil from historic dredging can be seen piled along the bank top. During low flows, the channel is over-wide and uniform in depth, there is no focussing of flow energy and hence, fine sediments uniformly coat the bed (Fig 3); the weir u/s intercepts coarse sediments that may otherwise have been supplied to replace the removed material and re-establish the inherent dimensions and form of the pre-dredged channel. The LB has been heavily modified with large boulders to protect the leat. However, little management on that bank has meant that several willow species (*Salix capraea* and *S. fragilis* – goat and crack willow, respectively) have established and where they are close to the water line, provide some low cover for fish refuge, some trailing and broken branches to create small but vital flow diversions, and introduce leaf litter and woody debris for aquatic invertebrates (as well as foraging and nesting / roosting sites for terrestrial organisms). In contrast, the RB is open to cattle grazing and is virtually devoid of anything other than short-sward grasses (see Fig 3).

Fig 3. Upper panel: beginning of straightened section. Note difference in plant cover on ungrazed (LB) *versus* grazed (RB) banks. One 'cracked', still living branch from the willow (shown in both Upper & Mid panels by white arrow) is playing a vital role in causing scour (underneath the branch) and deposition (immediately d/s) thereby creating diversity in channel-form and hence habitat for fish. Mid panel: Vegetation on the deposited gravels (protected in the lee of that branch) was still evident despite the unprecedented floods. Lower panel: impounded, straightened section alongside factory leat; brown arrow points to silty deposition across the bed.

The lack of diversity in the riparian vegetation on the RB (due to grazing) has many detrimental impacts. Firstly, continuous cropping of the short sward grasses (and associated compaction of the soils) means the plants divert energy into replacing shoot growth and little into root structure, leaving the soils beneath without a matrix of deeper roots holding them together and hence vulnerable to erosion (See WTT video example, here: https://youtu.be/00tcTY_UEk4). Greater diversity of plants, and especially with some larger shrubs and trees, increases that root matrix complexity. Secondly, there is little floral diversity and resultant habitat structure to support a diverse invertebrate community which includes the adult stages of aquatic insects that require such plants for shelter, focal points for mating swarms, and egg-laying substrates. Thirdly, a lack of resistance to lateral erosion will also prevent formation of scour pool habitat for adult fish (since the channel will widen instead of producing the deeper, self-cleaning pools that it would in areas in which both banks have increased resistance provided by plants).

As a consequence, the RB has suffered considerable erosion by block-failure (in which the bank toe erodes, temporarily leaving a hanging cliff-face which then collapses and washes away) over the winter 2015-16 period (Fig 4). While erosion is a natural and vital source of spawning gravels for example, in this particular location it is causing over-widening of the channel at an unnatural rate, exacerbated by the livestock pressures.

There is another fish passage issue at SD9412953955 where a pipe (presumably from the factory to the Sewage Treatment Works; STW) crosses the river with a 'weiring' effect (Fig 5). The impoundment effect u/s is clear for ~100m and while the weir pool does introduce some much needed variety in channel form, the lack of riparian vegetation means that: a) the pool is exposed; and b) the banks d/s are vulnerable to eddy erosion stemming from the hard weir structures (Fig 5: mid panel).

Fig 4. Upper panel: looking u/s, note the strandline of debris following the highest ever levels recorded on the Aire, and the shadows cause by historical dredging spoil deposition on the heavily grazed RB. Mid panel: fresh erosion of the RB by block-failure; note the undercutting of the turf and the negligible root structure. Lower panel: looking d/s at scalloping erosion caused by livestock from above and the river subsequently acting upon weakened soils; again, note difference in vegetation cover on opposing banks.

Fig 5. Upper panel: pipe and concrete / stone structures causing impounding u/s. Mid panel: the fence-line becoming vulnerable to erosion, even on the ungrazed LB because of the eddy erosion from the weir structures and insufficient vegetative buffer zone; behind the fence, the lawn is mown. Lower panel: looking d/s at the straightened channel which is essentially one long glide with little riparian cover; two goat willows have managed to establish out of reach of livestock grazing.

The channel is essentially straight and uniform in plan, lacking a natural pool, riffle, and glide sequence (Fig 5: lower panel) until the confluence with Eshton Beck on the LB. Consequently, there are few fish holding habitats. Occasional heavy flows from Eshton hit the main-stem Aire at a perpendicular angle, and the divergence of energy has caused the formation of a wide and deep pool (Fig 6). Eshton introduces gravels, and while heavily incised at its confluence with the Aire, is reasonably well protected from livestock in its lower reaches and up to the newly installed fish pass on the Environment Agency gauging weir at SD9427154772. Due to a lack of suitable-sized spawning gravels (10-40mm) in the main-stem Aire, it is important for BCAA to consider the health of, and to maximise un-delayed free passage to, any potential spawning tributaries like Eshton Beck that will contribute substantially to wild fish populations.

Fig 6. Upper panel: The confluence of Eshton Beck where it joins the LB of the R Aire; note the deposition of gravels and diversity of flow paths. Lower panel: looking u/s to the confluence with Eshton Beck (white arrow). Note the widening caused by the flow from Eshton (blue arrow), and also the vulnerability of both banks to erosion (especially the vertical face of the LB).

The channel is very wide and uniform below the pool with few obvious features to hold fish and little in the way of riparian vegetation as both banks are now open to grazing (Fig 7). The LB has short sections of livestock fencing in place but this needs to be maintained and extended to realise the benefits (see *Recommendations*). Already, in the lower panel of Fig 7, some of that fencing is teetering on the brink as the bank threatens to collapse beneath it. This is most likely because livestock have had access behind the fence (it is poorly maintained) preventing the natural regeneration of shrubby vegetation, and/or the riparian strip was too narrow in the first place.

Fig 7. Upper panel: almost canal-like flow below the confluence with Eshton Beck. The crack (larger) and goat (smaller & greener) willows are the only trees of note along this straightened section (photo taken in October). Lower panel: just d/s from the willows in the upper panel, the overly wide, uniform flow continues (photo in January); note the imminent loss of a section of ill-maintained fencing on the LB (white arrow).

Probably due to a subtle change in the geology at SD9447653794, the river takes on a more natural channel form and path for the next ~1000m although it is still constrained at points by infrastructure. Notably, these are a series of pipes and outflows from the STW to the river, as well as some rock armouring of the bank to divert flow, presumably to maintain the size / shape of adjacent fields. There has been considerable deposition of gravels, both historically and from recent spates, diverting and constricting the flow into a narrower channel more appropriate for the median discharge for the river, and the resultant meandering has also led to a much more natural geomorphological regime of riffles, pools and glides (Fig 8).

Fig 8. Upper panel: Copious gravel deposition and increased sinuosity of the channel only constrained by the STW infrastructure and pipes on the RB. Mid panel: just d/s of the STW pipes a turn to the right has resulted in more gravel deposition and channel form diversity. Lower panel: reinstatement of more natural pool, riffle and glide sequences, and valuable lateral scour causing varied depth and velocity profile in cross-section; note the channel width compared to Fig 7.

Better exclusion of livestock on the LB has contributed to the retention of many riparian trees (notably ash - *Fraxinus excelsior*, goat and occasional crack willow) and shrubs. Some of these provide low cover; others could be manipulated to do so without compromising perceived flood risk.

The RB is still very susceptible to erosion as trampling, poaching and grazing continue unabated (Fig 9). Indeed, the winter floods have lifted large swathes of shallow-rooted grass turves and overturned them in various locations. The slumps caused by livestock in Fig 9 have actually re-profiled the bank to a more natural form; provided they receive some protection now by excluding stock and introducing some willow whips to stabilise and reinforce the structure, it will create good quality habitat in the future.

Fig 9. While the LB comprises shaggy low scrub and plenty of willows and ash providing much needed protection from erosion and low cover for fish, the RB is still notably exposed to weakening by livestock pressures and subsequent erosion during spates. However, the re-profiling of the bank to a more natural form can be capitalised upon if protected moving forward.

A small tributary enters the Aire from the LB at SD9471153541 which may have potential for spawning habitat; clearly it is a source of appropriate sized gravels to the main river as a deposit at the confluence suggests. Low cover provided by the numerous goat willows at this point on the LB might promote the use of such localised deposits as a spawning site in the absence of many other suitable areas. The tributary may also provide welcome refugia from spate flows in the main channel for young-of-year fish.

Fig 10. A notable diversion of the flow by rock armouring of the LB to force the river to the right. The LB is protected by livestock exclusion fencing here although it requires maintenance. Aside from the scrubby goat willow, this potential holding pool is very exposed.

Immediately d/s of the tributary confluence, the Aire is forced to the right by rock armouring to the LB (Fig 10). This creates deeper water at the erosional face (outside of bend) and consequent deposition on the inside of the bend, but the exposed nature of the pool means that it is probably holding fewer fish than it could. Introduction of some low cover along the rock armouring to the existent goat willows (see Fig 10) will be beneficial.

The aptly named 'crossing point' where BCAA anglers switch banks also signifies a switching in the protection and hence, habitat quality on the banks; the RB is now afforded protection for ~1500m initially by fencing and then the railway line, and the LB is mostly exposed to degradation by livestock trampling and grazing. The tree cover is mostly ash, goat and crack willow with some larger sycamore (*Acer pseudoplatanus*) and horse chestnut (*Aesculus hippocastanum*) further d/s especially along the railway.

The dense line of goat willows on the RB, d/s of the crossing point, could be managed to create even more diverse habitat benefits for both aquatic and terrestrial fauna (see *Recommendations*).

Fig 11. Scrubby goat willow cover not only protects the bank from erosion but provides low cover and causes localised scour and deposition thereby diversifying channel form where trailing branches divert water.

Fig 12. A short section of fencing could be protecting the LB below the 'crossing point' but in its current condition is being compromised; sheep are entering the area to browse preventing regeneration of woody plants.

Although the RB is better protected from livestock by fencing, in places it is also walled; the stones at the toe (i.e. underwater) may provide some crevices for fish and invertebrates, but any trees (except for willows) are often a considerable way from the water surface and hence provide limited cover. The ideal for branches to provide cover is either trailing, partially submerged or within 30cm of the surface.

Fig 13. Frequent and severe erosion scallops in the LB, often occurring where livestock are trying to browse the few remaining riparian trees, or shelter next to them. Note the outward 'lean' of both the trees caused by consistent browsing from the bank.

Fig 14. Rock armouring is apparent in many locations, including some straightened sections like this, presumably to prevent the river cutting toward the enormous flood relief bund that has been built on the LB.

Fig 15. Vertical incised banks which are prone to erosive block-failure because there is insufficient root structure within. The grass sward is cropped to almost bowling green length by sheep. Note the flayed turves cut and overturned by recent spates exemplifying the lack of root structure.

The LB is in very poor ecological condition for the remainder of the section (almost 2000m) as it is either poached and trampled to expose fine soils which are being readily eroded (Fig 13), incised so that there is a vertical bank face of 1-1.5m caused by block-failure (Fig 14), or it has been rock armoured (Fig 15).

The trampling, poaching and grazing issues are constant for the remainder of the LB. The rock armouring introduces different issues. Obviously, only certain species can grow amongst the rocks, Himalayan balsam (*Impatiens glandulifera*) being noted and which should be addressed; see *Recommendations* and WTT video, here: https://youtu.be/VijmRm-qd4Y. Willows can establish in such an environment provided there is sufficient soil and their roots can reach the water table; they may even be afforded some protection as would be grazers, particularly cattle, are less likely to traverse the rocks. Introducing solid structures also tends to create localised erosion issues as water eddies around the edges; hence, at the d/s edge of some armoured sections there are already scours forming which will only increase in size over time.

From SD9469153213 down to the Railway Bridge at SD9588852085, there are numerous dilapidated stone weirs (e.g. Fig 16), the majority of which were v-shaped with the point u/s to focus over-topping flow toward the centre of the channel. They were apparently introduced historically (~100 y ago) by the Club to create pools for fishing. They are currently in such a state of disrepair that they constitute little barrier to fish passage although there is little doubt that they still have some impounding effect. Exploiting some of the weaknesses to notch them further effectively creates a pinch point which will retain scour through the pool whilst facilitating natural morphology and easing fish passage further. Those stones removed could be used to create further in-stream structure toward the tail of the pool, or used elsewhere in the river.

Fig 16. The uppermost weir introduced by the Club. All are in a poor state of repair and even under relatively low flow conditions (here in October) this should be easily passable by fish of most sizes and in both directions (but with delay & possible predation issues), due to the plethora of water channels and flow between the rocks. Note the confluence of a small tributary on the RB beneath the debris gate.

Immediately d/s of the first of these weirs (Fig 16), a small tributary joins from the RB. Again, it is probably of limited use as a spawning tributary, but its water quality and habitat should be maintained as a refuge for fry and invertebrate life. It also offers a potential means of escaping any pollution incidents on the main-stem for a small, but vital, proportion of wild fish breeding populations.

Channel modifications have led to rather long sections of glide between the sparse riffles and pools. Some of these are quite deep with overhanging willows and trailing branches trapping rafts of flotsam. While not classic lies for trout (and a relatively difficult to cast to), such areas provide good spate refuge, especially for grayling, and only require some light maintenance work on the willows to encourage continued low cover. Other glides are completely devoid of any natural cover on the banks, although limited weed growth and boulders instream provide sporadic cover and certainly diversify the channel form (see Fig 17).

Fig 17. Two views of the same continuous glide habitat (upper panel – looking d/s; lower panel – looking u/s). Cattle access both banks at riffles up & downstream of this particular stretch, and hence there is no natural riparian cover. The lone, self-set willow (lower panel) has established because cattle cannot access it across the rock armouring.

The glide in Fig 17 holds a considerable number of fish, yet they are vulnerable to piscivorous birds in such a simplified habitat and it could potentially hold more with better cover (refugia) provided by more diverse vegetation on the banks; this would also benefit the fly-life which would in turn supplement fish diet. Livestock access is the major problem as they can access both banks. At either end of this long glide are riffles where cattle are actively encouraged to enter the river. Indeed, a formalised area of hard-standing was created at the d/s end but this has been destroyed in the winter spates (Fig 18). Ideally, these two access points should be removed. It would prevent cattle entering the river, where they have caused extensive erosion of the banks via trampling and poaching and subsequently over-widened the channel; these areas also are a focal point for nutrient and sediment pollution. It would also prevent them gaining access to the RB which should recover to a more diverse vegetative cover quite naturally, although tree regeneration could be augmented to realise the benefits sooner. The area of grazing there is quite limited but will have to be discussed with the farmer.

Fig 18. A formalised cattle drink at the d/s end of the glide in Fig 17 has been severely damaged in the recent winter spates. Note the ~3-4m bunding allegedly for flood water storage on the LB (trailer parked on the top).

Fig 19. A left-hand bend forced by the railway line. The inside of the bend here is a natural area of deposition with an already degraded bank; it could be sacrificed as a cattle access point to substitute for that destroyed in Fig 18, and it is only 150m d/s.

An alternative access point for cattle could be encouraged at the inside of the bend at 'railway corner', as the river cannot move much here; it is constrained by the railway line on the opposing bank (Fig 19). Cattle already access the water here, it is an area of deposition, and because of deep water immediately u/s and d/s, they would be less likely to enter the water, thereby limiting their impact. From here, for almost 900m, the river is forced in a straight path alongside the railway. The RB is part-walled and lined with mostly mature trees providing good shade and some limited low cover. Several large crack willows have split and parts of the trunks overhang and/or provide instream cover and create localised scour. These could be encouraged further to maintain live, low cover, along with laying of some of the numerous goat willow.

Ideally, the LB should have some similar tree cover encouraged, perhaps off-set in clumps to that on the RB which might initiate some slight sinuosity in channel path, but unfettered access by sheep and cattle prevents any natural regeneration via self-setting. The lack of diversity in vegetation and livestock trampling to the very edge of the bank contributes to the constant erosion and results in the vertical banks (Fig 20).

Fig 20. Grazing and trampling on the LB, plus some rock armouring, contributes to the maintenance of the vertical bank face as erosion cuts it back, making access to the water difficult. Note difference in cover on opposing banks.

There is one short section of very valuable willow growth on the LB (Fig 21) which is at risk of loss because of livestock access. It should be protected as a matter of priority.

Fig 21. As in Fig 13, livestock access to browse on these willows is causing erosion behind them, and will eventually lead to their demise in a future spate.

The remainder of the fishery to the railway bridge and on down to the road bridges at the lowest point inspected (SD9612251670) is quite open on both banks, although restricted access (to livestock) to the RB would provide opportunities for some habitat improvements.

One thing of note is the substantial aquatic plant growth in the lower reaches (essentially from railway corner to the road bridge), especially the lowest 3-400m which resemble a chalk stream in summer as masses of *Ranunculus* (water crowfoot) create a mosaic of sinuous channels. Conditions here do not appear to be that different to those found further u/s, for example in Fig 17; an experimental translocation of some plants to increase instream habitat diversity for fish and invertebrates may prove beneficial to productivity.

4.0 Recommendations

Fig 22. The spate strandline on the LB bund, some 30m from the channel and ~3m above the water level.

The Aire is a naturally productive river and so the food base is present to support considerable populations of trout and grayling (and other species too). Historic and relatively recent engineering modifications to the channel to allegedly alleviate flood potential further d/s, mean that habitat is the limiting factor to even better fish production, and some modifications are unlikely to be circumvented; for example, the position of the railway line and the flood defence bund (Fig 22). However, there is tremendous scope for some simple and cheap habitat improvements which will increase the resilience of the fish populations and provide even better sport for BCAA which should not impact upon perceived flood risk. Below is a series of generic suggestions with some examples of where they could be initiated in the Gargrave section.

4.1 Fencing

Preventing livestock from accessing the riverbank is one of the greatest improvements that could be made to habitats on the river. As such, erecting fencing to exclude livestock from sections of the Aire and protect buffer strips will be key to major improvements in wild trout and grayling populations and safeguarding their future resilience over the longer term. Note that in any given field, livestock may still access the water at specific locations and so there should be no need to install watering points; see Table 2.

Existing lengths of fencing should be maintained / repaired to ensure that they continue to fully exclude stock, particularly sheep which will gain access through the smallest of gaps. Sheep, although small, are probably worse than cattle because of their browsing/grazing style which crops any growth back almost to ground level, leaving very little ground coverage or root structure remaining. Fence maintenance is especially important to check in fields that are only sporadically used for livestock; it is easy to forget to check the integrity of these.

Negotiations regarding fencing will have to be undertaken with any tenant farmers. Besides the environmental benefits there are likely to be benefits from a land maintenance / animal husbandry perspective as well. Some incentives may be available through agri-environment schemes.

It is recommended that the local Farming Wildlife Advisory Group and/or Yorkshire Wildlife Trust (YWT) are contacted as an ally in initiating any fencing schemes. Their staff have an understanding of potential funding that may assist with the cost of fencing and are likely to be involved with similar work in the wider catchment; indeed, Don Vine at YWT has reported recent success using 'flood-resistant fencing'. It would also be beneficial to include the local Environment Agency in any discussions (e.g. Pete Turner).

Obviously, the fencing of some of these sections will also require stiles for angler access, probably at both ends on longer sections, with associated costs and maintenance. Note, it is not suggested that fencing is continuous or absolute exclusion of livestock is required in any one field. The solution is a 'chequerboard' arrangement which should appease tenant farmers who may initially resist strongly on the basis of potential loss of livestock watering and/or single farm payments.

Table 2: Proposals for siting of fencing.

#	Fig #	Bank & Rationale
1	Fig 4 upper panel	RB: Site fencing near to top of dredging spoil, on river side. This would be *above* strandline from winter 15/16 spates and hence low flood risk (see Fig 4). Protect bank from below weir pool (allowing cattle access there) down to field boundary / stile at factory pipe. Landowner has already complied at weir (Fig 2). Allow vegetation to diversify and increase resilience to spate erosion ~300m
2	Fig 6 – 10	LB: Try to negotiate complete fence line from Eshton Beck to 'crossing point'. Fencing or walling exists for the much of it anyway but some sections require replacing or maintenance. Some sections are at the very bank edge and require some negotiation of an adequate buffer strip (minimum 2m); these will be lost very soon if nothing is done to protect them. Increase vegetation and hence resilience to spate erosion. ~300m depending upon existing condition.
3	Fig 7 – 10	RB: possibly from lone crack willow (Fig 7) to STW inspection and down to bend at Fig 10. This is mostly former gravel bars and hence poor grazing. Increase stability of these bars, increase resilience to erosion around STW infrastructure and prevent further bank collapse eg in Fig 9. Although low-lying, mostly on inside of bend and hence should be low flood risk. Yorkshire Water should be approached to see if they will contribute to this as it may mitigate some of the damage to their infrastructure. ~500m.
4	Fig 12	LB: Repair of existing fence.
5	Fig 13	LB: Install short section to prevent loss of trees. Sited on top of high bank, parallel to flow and hence low flood risk. ~100m
6	Fig 17 & 18	LB: prevent cattle access. Two short sections to tie in to rock armouring and high bank. 2x ~30m

7	Fig 20 & 21	LB: on top of high bank, parallel to river and hence low flood risk. Prevent cutting back of banks and protect existing willows. ~200m
8	-	LB: corner u/s of railway bridge where major field drain enters to lone willow. Very marshy area but sheep access back of willow to browse. Exclusion of sheep from this corner (from bank to bridge over drain and back to willow) will allow better vegetation diversity to develop and prevent bank erosion & loss of willow. ~80m

4.2 Tree Work

Some sections of the Aire have fantastic cover from bankside trees. Others have clearly been subject to pruning and tidying, which, while demonstrating the eagerness and energy of the club membership to address issues, could be more sensitively and efficiently applied to maximise habitat potential. It should be noted that fish do not feed within deep cover; they sit on the fin adjacent to it, so when they are feeding they are reachable with a fly (and would not be there in such density in the absence of the cover).

4.2.1 Pruning of low branches

There is some evidence of historic pruning, which should be resisted in future wherever possible. While slightly more challenging to cast to and between, it should be remembered that the benefits to leaving low cover and thereby providing more lies for fish per unit area, greatly outweighs the cost of the odd fly. More importantly, it provides a greater number of fish to aim at. There is obviously a need to inform club members about such a change in management to ensure everyone understands why this is beneficial.

4.2.2 Planting

Planting is recommended wherever there is a lack of low cover and structure along the river margins, particularly within the fields that have been subject to prolonged livestock access. It will be most effective if trees are trained over into the channel. Most native deciduous species would be beneficial but willow is by far the easiest to transplant and manipulate. Note that adequate fencing is key to protect such measures, as without it, any planting is likely to be targeted for browsing by livestock.

The quickest and easiest way of planting willow is by pushing short sections of willow whip or short sections of stake into the ground, using locally sourced material. This can be undertaken at any time of the year, but will have the greatest success if undertaken within the dormant season, shortly before spring growth begins (ideally late Jan-March). Whips should be planted into soft, wet earth/sediment so that there is a greater length within the ground than out of it, to minimise the distance that water has to be transported up the stem; 30-40cm of whip protruding from the ground is sufficient, providing that it receives light past the other bankside vegetation. Live willow stakes can be hammered deep into the bank and may provide greater structural stability under spate conditions.

Advice and support could be sought from The Woodland Trust. See their guidance manual for 'Keeping rivers cool', here: http://www.woodlandtrust.org.uk/publications/2016/02/keeping-rivers-cool/

4.2.3 Laying

Where trees are already established along the bank, habitat improvements can be easily achieved by laying the trunks, or selected branches down into the watercourse to increase low cover and in-channel structure. This has occurred naturally at various points (Figs 7 & 11) but natural introductions of living wood and woody debris appear to have been removed or 'tidied'. The laying method is usually limited to pliant species such as willow, elm, hazel, hawthorn and small alder, but some others can be laid carefully. Small to medium shrubs tend to work best. The process involves cutting part way through the stem/trunk, a little at a time (like laying a hedge), until it can be forced over (Fig 31). The depth of the cut should be limited to only that which is required to bend the limb over, as this will retain maximum strength in the hinge.

Note, the aim would be to lay the trunks parallel to the bank and maintain a healthy hinge, i.e. the trunks are living and well attached, so as not to increase perceived flood risk.

Fig 23. An example of hinged willow.

4.2.4 Tree kickers

Many of the straightened, and especially the impounded, sections would benefit from more serious intervention to reinstate natural ecohydrological processes. A tree kicker is essentially mimicking natural tree fall but placing it specifically where it can be most beneficial, and importantly, securing it so that it is not a flood risk. A tree is felled either into position (or winched) so that it is parallel to the bank and with the crown d/s. The trunk is secured via a steel cable to either its own stump or to another living trunk nearby, as low as possible so the whole trunk does not ride up and get deposited on the bank during the first spate. The crown may be trimmed to reduce the impact of the kicker.

Table 3: Proposals for tree work.

#	Fig #	Bank & Rationale
1	3	LB: introduce some low cover amongst existing sporadic willows: lay some of existing along bank; plant whips in armouring.
2	4 - 5	RB: in conjunction with fencing, planting of willow whips / stakes to improve bank stability structure and introduce cover; in clumps to provide some protection for each other whilst establishing. Some laying of trunks on LB (opposite) to provide bank protection.
3	6 - 10	RB: Bank has been subject major gravel deposition and to poaching; planting with willow whips or stakes along the toe of the existing bank, in clumps to provide some protection for each other whilst establishing. Stability, cover, resilience to further erosion.
4	17	LB: Bank has been rock armoured; planting with willow whips amongst armouring at water line to provide low cover. Same for RB if stock can be excluded.
5	20	As for 2 above.

4.3 Fish passage issues

Obviously the weir forming the u/s fishing limit is a considerable obstruction (Fig 1). It is unlikely that it will be removed in the short/medium term because of housing foundation issues u/s but there should be the requirement from the Environment Agency to consider an obstruction of this size for fish passage easement, i.e. a pass. There is plenty of space to do so on either bank. While this will not reinstate the geomorphological connectivity, it will hopefully improve passage for both game and coarse fish alike. Pete Turner (EA) will be able to advise on potential plans for this structure.

The smaller weir over the pipe by the factory (Fig 5) is an issue for fish passage, impounding and geomorphological process. If this pipework is redundant, then the owner should be approached to consider removal. If it is not redundant, passage issues can probably be addressed by installation of further rocky debris below the weir pool to back-up the flow d/s and essentially drown out the head-loss of the weir. This will not address impounding issues but bankside habitat work will mitigate for some of those issues, e.g. providing better cover and increased diversity of habitat.

The stone weirs installed by the Club ~100 years ago should definitely not be repaired. Indeed, existing weaknesses should be exploited to 'notch' them further, so their impounding effect u/s is reduced, but the focussing effect on flow and hence scouring to create deeper pools and runs is maintained under low flows. Material won back from here could usefully be applied to the solution for the small weir (Fig 5; above).

4.4 Pollution

Diffuse pollution from silt and soil ingress is a problem wherever livestock have access (causing guttering to the river) and their poaching and trampling directly erodes banks. Point sources occur at formalised drinks and farm gates (e.g. Fig 2). The STW discharge should be monitored, as should the smaller tributaries which may be treated as drains in some instances. See the Fencing section.

4.5 Tributaries and spawning habitat

The benefits of maintaining the habitat along Eshton Beck have already been highlighted, and if the smaller tributaries can also be protected from livestock access with some exclusion fencing, then so much the better. Small tributaries contribute disproportionate benefits to main river systems (partly because their length contributes enormously to the total of the whole network) and because the ratio of marginal habitat to open water is greater.

The Aire does contain suitably sized gravels but retention points are few and far between. There are good examples of where natural laying of low willow branches has caused deposition of gravel bars with some appropriately sized material (Figs 3 & 11); letting the power of the water effectively sort these gravels according to size is most efficient. The low cover provided by the willow also provides refugia for spawning fish and emerging fry. Hence, more habitat work to manage the trees to emulate this process would provide greater spawning opportunities.

It would be interesting to install short (<2m), well anchored / pinned sections of wood (or potentially stone setts / boulder clusters) into the section immediately u/s of the road bridge where it most resembles a chalkstream, and where there is considerable gravel present but diffused across the bed. The purpose of such installations would be to cause small-scale, localised scour and 'hummocking' of the bed, thereby focussing and retaining smaller gravels in their lee (see WTT video, here: https://vimeo.com/32317564. In terms of perceived flood risk, under spate flow, energy is very quickly dissipated across ~200m width of flood plain at this point as the river is not incised within its banks (hence its resemblance to the chalkstreams, and probably a reason why *Ranunculus* flourishes across the full width of the wetted channel here).

4.6 Invasive species

Occasional Himalayan balsam plants were observed in October 2015; it is present at high density around the car park at the d/s extent of the fishery. Anglers should be encouraged to follow simple biosecurity protocols to ensure they are not transporting propagules u/s from this point; consider installing a warning sign on the access gate. Individual plants should be carefully pulled to remove the roots when found, preferably ahead of any seed set. Eradication of heavy infestations requires a co-ordinated approach from u/s but controlling local infestations will certainly help.

Several individual giant hogweed (*Heracleum mantegazzianum*) were also noted, but again, they are in much higher concentration from the d/s access point and further d/s of the Gargrave section. Low numbers are easier to control but specialist techniques (e.g. stem injection) are required; be wary of the health issues (skin irritation / burn from the sap).

Seek advice from YWT (Ailsa Henderson) on management.

5.0 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 only to 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

The WTT officer responsible for fundraising advice is Denise Ashton: dashton@wildtrout.org

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

Similarly, the Grayling Research Trust have a range of useful materials available from their website, which will soon include a Grayling Conservation Guide:

http://www.graylingresearch.org/

6.0 Acknowledgement

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7.0 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.