Advisory Visit undertaken on behalf of Milnthorpe Angling Association and Dallam Tower Estate

River Bela

16/17th May 2013

Introduction

This report is the output of a site visit undertaken by Gareth Pedley of the Wild Trout Trust to the River Bela in South Cumbria on the 16th and 17th May, 2013. Comments in this report are based on observations during the site visits and discussions with Ian McMurdo, John McKay, Bob Brockbank, John Buchan and Mike Hitchmough regarding Milnthorpe AA waters; and Susie Villiers-Smith and Julian Oston regarding the Bela Anglers water.

Normal convention is applied throughout the report with respect to bank identification, i.e. the banks are designated left hand bank (LB) or right hand bank (RB) whilst looking downstream. Location coordinates are given using the Ordnance Survey National Grid Reference system.

1.0 Catchment

The River Bela forms as the confluence of Stainton and Peasey Becks, flowing through the rich limestone grasslands of the Morecambe Bay Limestone Natural Area, before discharging into the sea via Morecambe Bay. The geology surrounding the river comprises predominantly limestone, with superficial deposits of clay, silt and sand, which create a fertile, alkaline catchment; this not only increases the productivity of the river, but also the surrounding farm land, which correspondingly is used predominantly for livestock grazing, particularly sheep

(http://www.naturalareas.naturalengland.org.uk/Science/natural/NA_search.asp).

Spot tests have revealed the River Bela and tributaries to be around pH 8.5 (I. McMurdo, pers. comm., 16th May), which reflects the strong limestone influence within the catchment which benefits both the fish, and the aquatic invertebrates, including native white-clawed crayfish *Austropotamobius pallipes*.

2.0 Fishery Overview

Two fisheries exist on the River Bela; the upstream fishery is controlled by Milnthorpe Angling Association, for which Dallam Tower Estate are the primary landowner, with some tributaries owned by other interests; the downstream section, fished by Bela Anglers, is completely owned and controlled by Dallam Tower Estate. As each fishery is managed independently the fishery overview will be separate for each.

2.1 Milnthorpe Angling Association

Milnthorpe AA controls over 3.5 Km of the River Bela, from its upstream limit, at the confluence of Stainton Beck and Peasey Beck (SD5180381251), downstream to Beetham Bridge (SD4968779688), with additional water on Stainton, Peasey, Lupton and Holme Becks. The Water Framework Directive (WFD) waterbodies incorporating these watercourses all achieve "high" or "good" status for all parameters monitored under the directive, except for phosphate on the Lupton Beck, which is assessed as "moderate". This indicates that each of those parameters meets the standards required by the WFD, except for phosphate levels on the Lupton Beck, which are higher than they should be.

It should be noted, however, that none of these waterbodies appear to have been assessed for fish stocks under the WFD, and that the River Bela and Peasey Beck are designated as heavily modified waterbodies (HMWB), which indicates that the channel morphology has been altered by human activity to a level that is significant enough to lower their status.

The stocking of 300 marked diploid (fertile) brown trout (*Salmo trutta*) is currently undertaken at locations between Hang Bridge and Beetham Bridge, in two batches (May and June), consisting of 150 c.280mm fish in each. This is a significant reduction on historic figures. Catch and release is practised by many club members, although around 40-50 fish are retained annually. Club protocol is that only marked fish should be taken, which is a good method of preserving the wild spawning stock, however, in practice such rules may not always be adhered to.

The association has a full compliment of 50 members, most of which are believed to actively fish.

The area of Morecambe Bay in which the Bela lies is within one of Natural England's Nature Improvement Areas (NIA), and as such, funding may be available for habitat improvement works and initiatives that encourage community engagement with habitat improvement work.

2.2 Bela Anglers

The Bela Anglers waters run from Beetham Bridge (SD4968779688) to the estuary in Morecambe Bay (SD4883881449). This incorporates the downstream end of the River Bela WFD Waterbody which, as discussed previously, is classed as heavily modified, but not considered to have any issues with the other parameters assessed.

Bela Anglers consists of 21 members, who fish with a variety of methods, including fly, worm and spinner. No stocking is undertaken on the water and fish are allowed to be taken from the fishery. Catch return data available suggest that a good number of fish are returned each year; however, the figures in the unknown category make it impossible to make an accurate assessment of exploitation on the fishery.

3.0 Habitat Assessment

3.1 River Bela

The Bela is a medium/low gradient limestone river that flows through relatively open, improved and semi-improved grassland, with occasional arable land use. Ordinarily, rivers of this type would generally maintain relatively stable, clear water flow, being fed predominantly by the limestone aquifer. To an extent this remains the case, and although the river was considered to be above normal flows during the visit (c.200-300mm), the water remained relatively clear; however, adjacent land use, particularly field drainage, channel modifications (re-sectioning and realignment) and intensive over-grazing, are likely to have increased its flow variability, also leaving the river channel less able to maintain a natural morphology.

Evidence of the past channel maintenance and dredging activity is very obvious along the river, with several overly straight sections and elongated pools (Figure 1). These actions have created a lack of channel sinuosity and inhibit the natural erosion and depositional processes that would ordinarily scour deeper pool areas, on the outside of bends, and facilitate natural channel narrowing through sediment deposition on the inside. The removal of materials is also likely to have altered the river gradient in many areas, increasing the gradient over short sections, but reducing the size, frequency and quality of valuable gravel riffle features.

Interestingly, the riffle in the foreground of Figure 1 (SD4973379632) is believed to be one of the primary spawning sites on the main River Bela. Being directly adjacent to Beetham Bridge, the area may historically have been subject to less dredging activity and so retains a more natural substrate than most other areas. However, assessment of the site suggests the habitat is far below optimal, as the overly wide channel leaves gravels that are significantly impacted with sediment due to a lack of scouring, and increased sediment deposition. This will greatly reduce the survival of any eggs deposited within the gravel, and as such, its use is likely due to a lack of other suitable locations.

Figure 1. Low diversity trout habitat resulting from straightening and dredging which, in combination with over-grazing, has resulted in an over-wide channel significantly lacking in flow diversity and unable to maintain clean gravels. The lack of marginal vegetation and trees also provides a paucity of aerial cover.

Overgrazing by sheep represents significant impact and was also a recurring issue on the river (Figure 1). Unlike the acute, very visible issue of bank poaching by cattle, sheep grazing is often more chronic problem. The lack of foliage and root structure of closely grazed banks means that erosion through high flows occurs at a much faster rate, resulting in ongoing river widening and loss of river bank land. This also means that where banks slump into the channel (Figure 2) they are more likely to be washed away, rather than holding together long enough to become vegetated and form a re-graded bank.

Over time, this can be greatly damaging to a river, leaving over-wide channels that are unable to narrow naturally as the riparian vegetation that would ordinarily encroach into the channel (particularly in low flows) to form new bank is eaten before it consolidates the new bank line (Figures 2 & 3).

Figure 2. Slumped material resulting from bank erosion. If left un-grazed it is likely that this material would consolidate to form a new toe to the bank. It is also likely that over time, the bare bank face and areas between would become vegetated to form a shallower bank line that would encroach into the river, providing valuable channel narrowing.

Similarly, over-grazing can actually result in the loss of trees over time, with the scour occurring around trees along un-vegetated bank-lines eventually eroding round them (Figure 4, 5 & 6), creating a tree island and eventually leading to wash out of the tree in high flows. To compound this issue, grazing of any self-set trees and propagules prevents any natural regeneration. The issue of intensive stock grazing, and resultant over widening of the river channel, is very evident throughout unfenced areas of the river, and in particular, through the estate parkland. It is likely that this is actually the primary reason behind the lack of bank side trees along many bank lines where grazing occurs, rather than any historical, conscious effort to maintain river banks to be clear of trees.

Figure 3. Over-wide channel, prevented from naturally narrowing by continual grazing pressure, which has also left the banks devoid of trees and vegetation and lacking low aerial cover for trout.

Figures 4, 5 & 6. These figures demonstrate progressive erosion around mature trees, and how over time, over-grazing with sheep often leads to a loss of trees and significant river-widening.

Overly wide channels are also very poor at conveying excess sediment (often carrying nutrients bound within the soils, and fertilizers), due to the lack of flow energy and diversity, and an associated reduction in scouring of the substrate. This can greatly increase the issues arising from sedimentation input to a watercourse, causing sediment to be deposited across the channel, smothering gravels, and vital weed beds, particularly water crowfoot (*Ranunculus spp.*), which rely upon clear water, a firm river bed and adequate flows to flourish. The excess nutrients then also lead to issues with elevated levels of algal growth, which can smother weed and gravel and deoxygenate the water when they die and decompose (particularly in pools). Smothering with fine sediments and algae also has a very detrimental impact upon invertebrate diversity, deteriorating the gravel/cobble and weed habitats that they require.

These issues are certainly likely to exacerbate the suspected issues of high sediment input to the River Bela catchment, which were evident throughout the sections walked, right to the upper limits. The issue is likely to result from the land use in the surrounding catchment, with sediment inputs occurring though runoff from arable crop production, particularly in periods of bare earth, and early in the growing cycle when there is little vegetation structure in the soil, and on areas grazed by livestock.

In areas where livestock have been excluded from the river bank, the transformation to a naturally recovering river margin can be quite astonishing; marginal and emergent vegetation will encroach into the river, naturally narrowing the channel to a width that is naturally maintained by the flows it carries (Figure 7: SD5019579354).

Figure 7. An excellent example of a fenced river section that is already narrowing naturally. Note how the slumped material from previous bank slippage has consolidated in the absence of grazing pressure, and the emergent vegetation is encroaching (left to right – green arrow). This is increasing flow velocities within the channel and providing and valuable cover and protection of the new river margin. This is also excellent fry cover.

Deer fenced areas within the parkland on Bela Anglers' water, where sheep and cattle access is prevented, were also of much higher habitat quality. The untouched habitat within those areas is close to optimal, with overhanging trees and marginal cover, and significantly increased flow diversity through a natural gravel, cobble, and boulder and bedrock substrate. These provide high quality habitat for all stages of the trout and salmon lifecycle, particularly juveniles, which will find refuge within the numerous shallow riffles (Figure 8). The wooded upstream limit of Bela Anglers waters (between Beetham Bridge and the Paper Mill Weir) was also of high quality, with living trees providing branch and root cover, and fallen trees providing beneficial large woody debris (LWD), which create valuable cover and flow diversity. Towards the weir, habitat becomes degraded by the impoundment, but the good levels of marginal cover will hold fish.


Figure 8. Excellent juvenile trout and salmon habitat, with increased flow diversity, and a good balance of marginal and aerial vegetation to provide varied light and shade.

There was in general, however, a lack of trees in most areas of the Bela where livestock have access to the river bank. In addition to a lack of bank protection, this greatly reduces the availability of cover and the fish holding capacity of the river through a lack of shade, canopy and root cover, and correspondingly a lack of fish holding lies. In some areas, mature trees are present, and provide valuable cover, but there are generally far less than would be ideal. In areas where stock have been excluded, Milnthorpe AA have initiated tree planting schemes, which will greatly enhance the availability of cover, but these initiatives rely upon adequate stock exclusion.

For the above reasons, simply excluding cattle is insufficient, and planting in areas where sheep have access is likely to be futile, as they will target any new growth. Figure 8 shows a perfect example of a bank line that left completely un-grazed is likely to fully vegetate, including the currently sparsely vegetated bank face and toe. However, as can be seen to the right of shot, the fencing only excludes cattle, with sheep allowed underneath, to graze the riverbank. Aside from significantly degrading the habitat along this margin, the lack of vegetation and roots is likely to lead to more rapid erosion of the bank.

Figure 8. Bank with sheep access (under the bottom wire), where increased vegetation would enhance habitat and reduce erosion.

Fish passage on the upper section of the Bela and tributaries visited is relatively uninhibited, with no significant impoundments or obstructions to fish movement. Within the Bela Anglers section, however, there were several significant barriers that form varying levels of obstruction to fish.

The natural obstruction underlying the Paper Mill Weir may have been an impassable or near impassable barrier originally, but appears to have been altered to improve fish passage. A Pool and traverse fish pass is installed on the LB, although it takes a low volume of water in comparison to the total flow of the river and is likely to be lacking attraction flow to draw fish to it. The installation of a hydropower plant, with a high discharge volume is likely to have further muted the attraction to the pass. A further complication is that a large volume of water currently passes the falls on the RB, creating another attraction flow that will draw fish away from the pass (Figure 9).

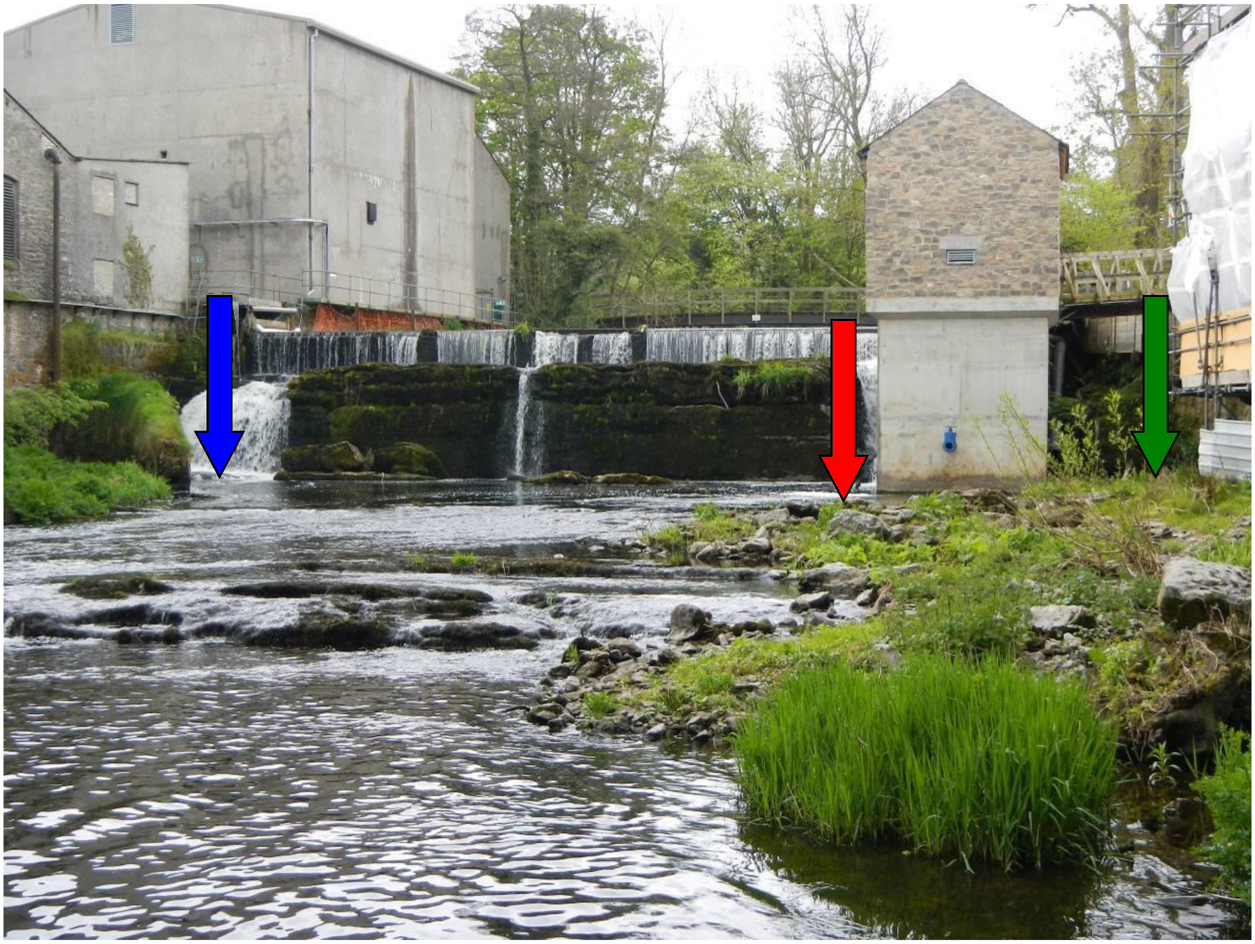

Figure 9. Paper Mill Weir, with significant attraction flows from the hydropower discharge (red arrow) and overspill (blue arrow), likely to detract from the much lower volume fish pass attraction (green).

The next obstacle downstream is Bela Sit, a typical flat-V type EA gauging weir, which are inherently poor for fish passage, due to the steep gradient, high velocities, shallow water, and standing wave downstream that disorientates approaching fish (Figure 10). Larger migratory salmonids are likely to pass under medium and high flows, but at low flows it will form a major obstacle. Similarly, smaller species, including resident trout, eels and lampreys, all of which migrate to utilise different habitats, are likely to find it impassable at most flows. Eel passes are installed at either side of the structure; however, neither pass is in operation and the upstream ends fail to meet the upstream water level, reducing their functionality (Figure 11). There may also be issues with power supply to the passes (J. Oston, pers. comm., 17th May).

Figure 10. Bela Sit, flat-V gauging weir, posing a significant obstacle to fish movement in most flows.

Figure 11. Upstream exit to eel pass, which is perched well above the water level and should be submerged.

Further downstream, Comb Mill Weir, believed to be redundant (J Oston, pers. comm., 17th May), creates another barrier. This weir appears to have fed the mill on the RB, and creates an obstacle to fish passage due to the vertical drop, and in particular, the shallow flows over bedrock on the downstream side, that provide no pool from which fish can jump over the weir. A raised area of bedrock on the LB does provide some easement to fish passage, but it is still likely to be a barrier in low/medium flows and impounds the river for >100m upstream, degrading the habitat through loss of flow variability.

The final and farthest downstream obstruction on the river is Tidal Weir, which currently forms the tidal limit of the river (Figure 12). This again forms a significant barrier to fish migration at low water, although the obstacle will be reduced on higher tides. Discussions with Pete Evoy (South Cumbria Rivers Trust) revealed that the weir does drown out on high spring tides, but on a normal tidal cycle, in low/medium river levels the weir is likely to remain an obstacle. A gap has been left in the centre of the weir that may assist fish passage to an extent, by concentrating flows to a central notch and providing a greater plume of water; however, the raised area at the downstream side of the weir reduces the depth of water from which fish can jump to ascend the weir. A large metal bar, presumably for reinforcement of the structure provides an additional obstruction to fish, restricting the depth of the gap through which fish can pass (Figure 13).

Figure 12. Tidal Weir, which will provide an obstacle to fish in low water, until it is drowned out by high spring tides, with a potential to significantly delay fish ascending the river.

Figure 13. Slot through which fish passing the weir will have to travel in normal flows. The bar across the top of the gap further reduces the passability of the weir.

Himalayan balsam (*Impatiens glandulifera*), which is a non-native invasive plant was also encountered on the river at several locations, and is likely to result in out competition of beneficial native river bank species. Similarly, possible signs of mink (*Mustela vison*) were also noted, and these too have the potential to wipe out native species through competition and predation.

A pollution incident was also observed during the AV on the Bela Anglers water (Figure 14: SD4972980031), and it was suggested that this is a recurring event (I. McMurdo, pers. comm., 16th May). It is likely that the severity of this incident will depend largely upon the toxicity of the dye that the mill is using; however, even if the dye is non toxic there may also be issues of pH, if the discharge contains bleaches that are used in the paper making process, or nutrient enrichment if the whiteness of the discharge is caused by paper pulp. Either way, this is a pollution and should be reported to the Environment Agency whenever it occurs and prevented from happening in the future.

Figure 14. Pollution occurring via the outflow from the Paper Mill. The milky-blue plume was visible for some distance downstream.

3.2 Tributaries

Two tributaries of the River Bela were also visited, and while angling pressure on them was considered to be light, due to currently poor fish stocks, they are likely to be important contribution to the overall fishery and should not be neglected.

3.2.1 Stainton Beck

The lower end of Stainton Beck, adjacent to the disused water treatment works (SD5183281875), had many of the issues described on the main river Bela, having been subject to historic dredging, and overgrazing, due to a lack of fencing or poorly maintained fencing, leading to poorly vegetated banks and an over-wide channel (Figure 15). There was also a general lack of trees along the bank, and a corresponding lack of low-level and trailing cover.

In the whole of the lower reach inspected, very little gravel or coarse substrate was evident, due to the lack of flow diversity and associated scour, resulting in high sediment deposition in most areas of the bed (Figure 16). These factors significantly limit the potential for spawning, on what should naturally be a spawning tributary, as well as severely degrading habitat for many of the beneficial native invertebrate species that should be present.

Some areas of slightly higher quality habitat were present, where channel sinuosity was higher to facilitate scour and erosion, and more of the natural substrate remained to form a riffle. Areas of slumped bank that have remained *in situ*, and have become vegetated also provide some in-channel features (Figure 17). However, noting the largely impacted nature of the reach it is not surprising to hear that it yields few fish, and much could be done to enhance it.

Figure 15. Poorly maintained stock fence allowing sheep access to the riverbank, as evident by the monoculture of grazed grass within the buffer strip.

Figure 16. Over-wide channel with significant smothering of the bed through sediment deposition.


Figure 17. Slightly higher quality habitat, although livestock access through the fence remains a problem.

Stainton Beck, upstream of the Fire Fighter Experience, is subject to even greater human modification. Removing much of the natural substrate, in conjunction with the over widening, has left the channel resembling a trapezoidal drainage ditch (Figure 18: SD5200282699), designed to convey water as quickly as possible with no regard to habitat within the watercourse. The result is a channel where high flows wash out any natural substrate, while deposition is increased in low flows. This has resulted in significant sediment deposits, severely compromising the reach for salmonid spawning and invertebrates. In places, some degraded gravel and cobble riffles remain (Figure 19), but for the majority of the reach inspected, the channel was incredibly straight and featureless.

This is a major concern as the issues appear to have been exacerbated further by recent increases in sediment input to what was, until an important spawning tributary of the Bela (P Evoy, pers. comm., 22nd May).

Figure 18. Significantly modified channel, now devoid of features, which extends for several hundred metres upstream. This was also, historically the site of significant salmon spawning, but current high levels of sediment deposition are likely to significantly compromise this.

Figure 19. Some remnants of in-channel features, but significantly lacking natural substrate and channel diversity.

3.2.2 Holme Beck

Only a short section of the Holme Beck was walked, but it became immediately apparent that there were issues with excess sediment input from livestock damage to the banks (Figure 20). This is likely to significantly reduce the habitat quality for salmonid spawning and invertebrates, and is likely to be contributing to the low fish numbers observed by anglers in comparison to the main river. A significant section of the lower Beck appeared to be man made, with a fixed width channel having been carved into the actual bedrock (Figure 21). There was also a notable lack of in-channel features (LWD etc.), and low-level or trailing cover, leading to a lack of fish holding features and refuge from high flows (Figures 20 & 21).

These issues again degrade what should be a valuable spawning and juvenile nursery stream that would help populate the main River Bela. If enhanced, the Beck could also become a viable wild trout fishery.

Figure 20. A major lack of cover and poor riparian vegetation, coupled with physical damage to the river backs by livestock. Also note the significant accumulations of fine sediment along the near side bank.

Figure 21. Section of the Holme Beck where the channel appears to have been carved out of the bedrock, leaving a featureless fixed cross section. Again, note sedimentation of the bed.

4.0 Recommendations

4.1 Sediment assessment of the catchment

There was an obviously elevated level of sediment input to the Bela, as evident throughout many of the areas observed during the advisory visit. The significant sediment inputs identified at the top end of the fishery are also occurring upstream of the association waters. The impact of this issue is exacerbated by historic channel modifications and over-widening. While improvements to the channel and other habitat enhancements can lessen the impact, identifying and addressing the source of all sediment issues should be a primary objective to assisting the River in reaching an optimal state. It may be possible to enlist assistance on this issue with South Cumbria Rivers Trust.

4.2 Buffer strips along the river bank

Preventing livestock access to the riverbank is vital for many of the required improvements to be initiated on both Milnthorpe AA's and Bela Anglers' waters. Stock exclusion will prevent the physical damage currently occurring to the banks, while allowing more natural diverse marginal vegetation to establish. The additional vegetation will then protect and consolidate the banks, reducing erosion and helping to trap and store sediments that are entering the river through surface runoff. For fencing to be effective, and to provide suitable conditions for trees and shrubs to be planted, it will be vital to ensure that any fencing not only excludes cattle, but also prevents sheep access. The benefits of this treatment are clearly evident in Figure 7, where the river banks and channel are naturally recovering well.

4.3 Increase available cover

With stock excluded from the river banks planting of additional trees along the buffer strips will become a particularly beneficial exercise. Planting willow from whips and saplings of local provenance, particularly the smaller shrub species (*Salix pentandra*, *S phylicifolia*, *S cinerea & S caprea*), will increase bank stability and provide good cover. Planting of other species such as alder *Alnus glutinosa*, hawthorn *Crataegus monogyna*, elm *Ulmus minor* and hazel *Corylus avellana* would also be beneficial in increasing diversity along the river. All of these species will also coppice well for future maintenance and are suitable for laying into the channel, particularly if done as saplings/small shrubs.

Laying trees, as you would a hawthorn hedge, is an excellent way of instantly increasing in-channel structure and cover. Many of the willow trees/whips planted by Milnthorpe AA are now at a stage where they can be effectively laid into the channel (Figure 22). A good example of willow and hazel laying can be seen in Appendix A. It is not recommended that this is done with all trees, but this would be greatly beneficial to selected trees in areas currently lacking flow diversity and cover. Supporting laid trees with posts and wire may be beneficial to aid their retention; however, this may require Flood Defence consent from the EA.

Coppicing is another great way of increasing low level re-growth of trees where the canopy has naturally lifted, or been pruned so that it no longer provides low and trailing cover. Fortunately, very little pruning occurs on either association waters, and it is recommended that none is undertaken, so that optimal cover habitat can be retained. There was, however, two sections on the Milnthorpe AA section (and SD5064179889), where the canopy is raised well above the river and coppicing of every 3rd or 4th alder is recommended to improve the cover provided (Figure 23). A demonstration of the benefits of coppicing can be seen in Appendix B, where a whole run of trees have been coppiced; however, for better results can be achieved by only coppice selected trees, as suggested above, to prevent short term loss of habitat diversity.

Figure 22. A prime example of one of the many locations where willow could be laid into the channel to increase cover and flow diversity (as demonstrated in red, also see Appendix A).

Figure 23. Alder canopy lifted well above the river and no-longer providing optimal low-level cover. One of the few areas where selective coppicing would be beneficial. Note there are no branches below the red arrows.

Great benefits in cover, flow diversity and beneficial sediment deposition (formation of in-channel features) can also be gained through installation of brush wood bundles. Milnthorpe AA have already achieved results employing dead wood bundles; however, living willow bundles can be used in a similar way to create instant bank protection and habitat, eventually forming bushes.

It should be noted, however, that future tree maintenance will be an on-going task to achieve optimal habitat outputs and prolong the life of any features created.

4.4 Channel narrowing

Channel narrowing and realignment can also be undertaken to improve the form and geomorphological function of the River. The extreme end of this scenario would be to reinstate the natural, former river channel and reintroduce a more natural substrate, in conjunction with fencing the banks. While being the optimal solution, this work is likely to be outside the scope and budgets of small angling associations. This being the case, there are options for increasing river sinuosity, and beneficial scour and deposition by installing in-stream structures. These could be strategically placed to narrow the channel and assist the river in dealing with excess sediment. It will not, however, be a suitable long-term solution to the sedimentation issues, and should be undertaken in conjunction with initiatives to reduce sediment input and erosion.

On the longer straighter sections, low–level paired upstream flow deflectors could be employed to force ordinary level river flows through a narrow focus, allowing higher flows to pass over relatively uninhibited (reducing concerns with flooding). This would increase bed scour within the central channel, where flow is accelerated and encourage deposition in the slacker areas provided in the river margins (Figure 24). These marginal depositions should then become vegetated over time, forming a sustainable channel.

A further option, particularly on the lower energy, highly degraded sections, such as the trapezoidal cannel of Stainton Beck, is creation of a new, low-level bank line using living willow or hazel faggots. These can be staked into the bed to create a new bank line. The area behind the new bank could then be backfilled with brash, to create a mattress, and pinned and wired to the bed with multiple stakes to prevent wash out (Figures 25 & 26).

This method increases sediment deposition within the brash, by baffling and slowing the flow over it. The example in Figure 25 also employs geotextiles to encourage deposition and protect the backfilled area until it is colonised by vegetation; however, the use of geotextile may not be necessary in this particular case. Alternatively, the area could be partially filled with material sourced from the river banks, thereby not actually reducing channel capacity, just relocating materials within it, or the area could simply be left open to accumulate sediment transported from upstream.

The faggots used for this should be relatively small diameter (c.300-400mm) and brash backfill kept to a low level, particularly towards the centre of the channel to lower the amount of drag in high flows, and reduce chances of washout. The height of the brash backfill can be graded, being higher at the bank than at the faggot toe, but it is recommended that none of the brash stands more than 400mm above the bed, to maintain the channel capacity.

Figure 25. Bank creation using willow faggots and brash backfill. This example also includes the use of hessian or coir.

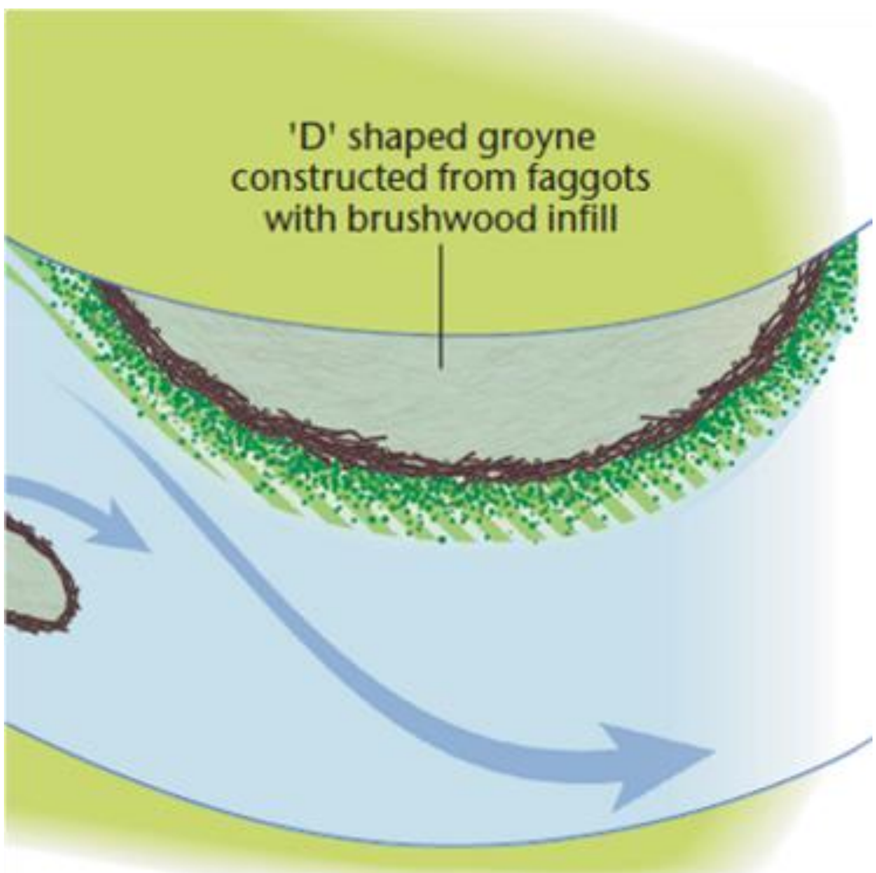

Figure 26. Faggot toe to create a new bank line, backfilled with brash.

4.5 Improve spawning habitat

Installation of more in-channel structure, along with the channel narrowing options discussed above, are great ways of improving the substrate quality. By increasing the velocity of flows in certain areas, and thereby increasing the scouring effect they create, the gravel and cobble substrates required for spawning can be moved and sorted, leaving cleaner, higher quality spawning habitat. These cleaner gravels allow greater water flow to the eggs deposited within them, while the continued higher flow velocity maintain silt-free gravels, thereby greatly increasing the percentage of eggs that survive through to hatching.

Provision of good marginal cover through well vegetated margins, trailing tree cover, and the introduction of brash bundles will then provide the vital cover and refuge from high flows and predators that fry require. Implementation of these measures has the potential to greatly increase the fry output of a river.

4.6 Improve fish passage

Obstructions in a river prevent, or delay fish from accessing areas required in meeting the ever-changing habitat needs of different life stages. Even if passable at certain flows, the delays can often be significant, making fish more susceptible to stress and increased predation. Weirs often delay, or inhibit both up and downstream fish movements and can therefore have an impact upon all life stages. Astonishingly, research on the River Tweed has revealed that mortalities of smolts attempting to descend a weir can reach rates in excess of 80%, where significant delays are encountered. This can be a particular issue in low flow years, where fish can be held up at numerous barriers, with high mortalities at each.

Despite being passable under certain conditions several significant obstacles to fish passage were encountered, all in the form of historic weirs. The optimal scenario would be to remove all of these structures, to restore fish passage, and to remove the impoundment they create and reinstate the natural geomorphological processes.

4.6.1 Paper Mill Weir

There is nothing that can really be done regarding the natural obstruction underlying the weir; however, it may be possible to make improvements to the flow regime around the weir and fish pass that would increase the ability of fish to use the pass.

More flow could be directed through the fish pass to increase its attraction, providing that it is not supercharged (over filled). The capacity/size of the pass could even be increased, so that it can take more water without becoming super charged. Both of these methods would hopefully draw more fish to the pass, and any remaining flow of water spilling over the weir (RB) could also be distributed more evenly to reduce attraction to other areas. Finally, adequate maintenance of the pass should be ensured at all times, and any materials blocking the pass, as in Figure 27, should be removed immediately.

Figure 27. Poor attraction flow to the fish pass, exacerbated by debris blockage in the pass.

The hydropower out flow is an issue, and although it will draw fish to the same half of the channel as the fish pass, it is likely to have a far greater attraction than the entrance to the pass. The best way to counter this is to increase the volume of water within the fish pass to compensate.

4.6.2 Bela Sit (Environment Agency Gauging Weir)

Initially, the two eel passes on the gauging weir should be reinstated to operational condition, as although not the most enigmatic of creatures, eels are a valuable part of the river's ecosystem and are also seriously endangered. Once functioning, providing enough water is supplied, the pass may also assist other smaller species like lamprey.

The long-term goal for this site, however, should be the installation of more up to date, less intrusive flow monitoring equipment that provide the required flow data without the use of a weir. This would allow the weir to be removed, thereby fully reinstating connectivity within that area of the river for massive improvements in fish passage and habitat. This option should be explored with the EA, and certainly revisited if any maintenance is ever carried out to the weir.

In the short-term, until the weir could be removed, fish passage could be greatly improved through the installation of a loc cost baffle solution on the weir, in line with the EA's own Research and Development on fish passage at gauging weirs.

4.6.3 Comb Mill Weir

As this weir is disused, options for partial, or preferably full removal down to bed level should be investigated further. It may be that there is some requirement for flow to the old mill race for aesthetic purposes, but retention of residual flow to that channel should be possible, while realising the wider benefits of removal by removing the impounded section upstream and increasing connectivity of the river.

4.6.4 Tidal Weir

The weir located at the head of tide is a significant issue for fish migration, only likely to be passable by large salmonids on high tides. The structure will delay migration in both directions, as outgoing salmon and sea trout smolts are also likely to be delayed within the long impounded section upstream, which could lead to significant losses.

As with all weirs, the ideal solution from an ecological point would be removal, if at all possible, although this would lead to alterations to the channel and vistas of the parkland upstream. Interestingly, anecdotal evidence suggests that this weir may only be a more recent addition to the estate, built around the same time as the old viaduct (P Evoy, pers. comm., 22nd May), so its removal would not be detracting from the long-term history of the estate. Further evidence to support this theory can also be observed at www.oldmaps.co.uk, with the weir not appearing on the 1862 map, but present on the 1898 map.

4.7 Fishery management

The waters inspected do contain enough suitable habitat to sustain some wild trout recruitment, as confirmed visually during the visit (e.g. the small trout below stocking size) and via catch reports from the members. This shows that even with all of the current impacts, the waters visited already support wild trout.

Unlike stocked fish (many of which are likely to die, or vacate the areas stocked), wild fish will persist within a reach (it is their natural environment after all). Retaining these priceless wild fish stocks will, therefore, not only ensure that the rivers are restocked naturally, year on year, but also potentially increase the numbers of fish present until the available habitat is filled. In addition, given the time to grow on within the river, the resident wild fish have a much greater chance of attaining larger sizes.

It was suggested that the Milnthorpe AA operate an informal rule that no wild fish should be taken, only the marked stocked fish, and it is recommended that this is continued. A further beneficial step on the Milnthorpe AA waters would be to reduce stocking, thereby lowering the pressure and competition on wild fish and freeing up money to be spent on habitat improvements that will increase the carrying capacity (number of fish an area can hold) of the river. The simplest method of reducing the impacts of stocking is likely to be restricting fish introductions to a much smaller lower section of Milnthorpe AA waters, preserving the waters upstream for wild fish, and enhancing the habitat within those upper reaches.

It is advised that catch and release is strongly promoted within both angling association, to protect the valuable wild fish, and that stocking of the river is reduced to a much smaller section of the lower reach, with a move to phasing it out completely, in favour of promoting wild fish.

4.8 Invasive species

Evidence of potentially two non-native invasive species were observed during the AV, Himalayan balsam, and possibly mink, as suggested by a half eaten duck carcass on a clump of alder roots.

It is strongly advised that stands of Himalayan balsam are searched for throughout the season. Several methods can be employed to tackle balsam, but to be effective they should be undertaken before the plant flowers.

The simplest, but highest exertion method is for working parties to undertake periodic balsam pulling events. Pulled balsam should be retained on site and composted well back from the high water line. Alternatively, if a strimmer is available, this can be a useful tool for tackling larger areas of balsam, but may need undertaking several times in a year. If a strimmer is used, it is important to hit the plant below the 1st node to prevent re-growth. NB. It is very important not to strim Japanese knotweed, as this will actually spread the plants. The other method is the use of the herbicide glyphosate; however, its use by watercourses requires consent from the EA (more information on this can be found on the EA website). Work with invasive species is another area that South Cumbria Rivers Trust may be able to provide some assistance, or at least advice.

4.9 Improved catch reporting

Some data were available on the numbers and species of fish caught, but only limited data for the numbers of those fish returned/taken. For accurate conclusions to be drawn from any catch data, the information on numbers returned or killed is very important. In addition, for this data to be accurately comparable from year to year, information on the length of time fished is also required, to give a catch per unit of effort.

The Wild trout Trust are in the process of developing a generic log book that can be employed by angling clubs for obtaining this data, but is not available yet. If more detailed data were sought to better inform management of the fisheries, logbooks can be found on the internet. The Tweed Foundation website provides a good example

http://www.tweedfoundation.org.uk/ttgi/Take_part/Log_Books/log_books.html.

Issue	Action	Locations	
		Milnthorpe AA	Bela Anglers/Dallam Estate
High sediment input to the river system	Sediment assessment of the catchment to identify sediment sources	Throughout the catchment	Throughout the catchment
Overgrazing and damage to river banks	Fencing along all river sections with livestock access	Any unfenced fields where livestock have access	Any parkland possible, starting with the less visible sections (e.g. the section downstream of the Paper Mill).
Lack of cover	Tree planting along open sections of river bank	Beneficial in areas throughout, but likely to be of limited value where stock have access	Beneficial in areas throughout, but likely to be of limited value where stock have access
	Laying of established, suitable species (willow, hazel and hawthorn) into the channel	Beneficial in areas throughout, where suitable species are present, particularly SD5010079310; SD5019779482; SD5020979699; SD5038679753	
	Coppicing of alders to promote low-level re-growth	SD5019879507 and SD5064179889	
Over-wide channels	In-stream Structures - where appropriate	Particularly on the Stainton Beck	
Stocking	Limit stocking to lower section and reduce numbers stocked, ideally ceasing stocking		
Non-native invasive species	Arrange for spraying, strimming or pulling of Himalayan balsam	Wherever identified, particularly on the LB around the disused water treatment works SD5183281875 and upstream around SD5200282699	Wherever identified, particularly in the area directly downstream of the Paper Mill
	Mink Control – running a mink raft and trap, if required	In the area around the beef sheds	
Fish passage	Modification, or ideally removal of Tidal Weir		SD4883881449
	Removal of Corn Mill Weir		SD4957781052
	Replacement of Bela Sit (EA gauging weir) with modern un-intrusive monitoring system		SD4959580579
	Improvements to attraction flows at Paper Mill Weir		SD4962279933

5.0 Making it Happen

The Wild Trout Trust may be able to offer further assistance with aspects such as:

- WTT Project Proposal
    - Further to this report, WTT can devise a more detailed project proposal report. This would usually detail the next steps to take and highlighting specific areas for work, with the report forming part of a land drainage consent application.
- WTT Practical Visit
    - Where clubs 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 day for a club. This would consist of 1-3 days work with a WTT Conservation Officer teaming up with interested club members 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.
- WTT Fundraising advice
    - Help and advice on how to raise funds for habitat improvement work can be found on the WTT website –
    - http://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

We have also produced a 70 minute DVD called 'Rivers: Working for Wild Trout' which graphically illustrates the challenges of managing river habitat for wild trout, with examples of good and poor habitat and practical demonstrations of habitat improvement. Additional sections of film cover key topics in greater depth, such as woody debris, enhancing fish stocks and managing invasive species.

The DVD is available to buy for £10.00 from our website shop http://www.wildtrout.org/product/rivers-working-wild-trout-dvd-0 or by calling the WTT office on 02392 570985.

6.0 Acknowledgement

The Wild trout Trust would like the Environment Agency for their continued support of the advisory visit service.

7.0 Disclaimer

This report is produced for guidance and not for specific advice; 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**.** Accordingly, 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 comments made in this report.

Appendix A

Willow after laying.

Hazel after laying into the channel margin.

Appendix B

Alder shortly after coppicing

Alder 5 years after coppicing