Pont and Blyth Investigation

River Blyth – from Bellasis Bridge to Hartford Bridge

(Waterbody ID - GB103022077050)

Date – 23/02/12

1.0 Introduction

This report is the output of a site visit undertaken by Gareth Pedley of the Wild Trout Trust to the River on 23 February 2012. Comments in this report are based on observations on the day of the site visit.

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.

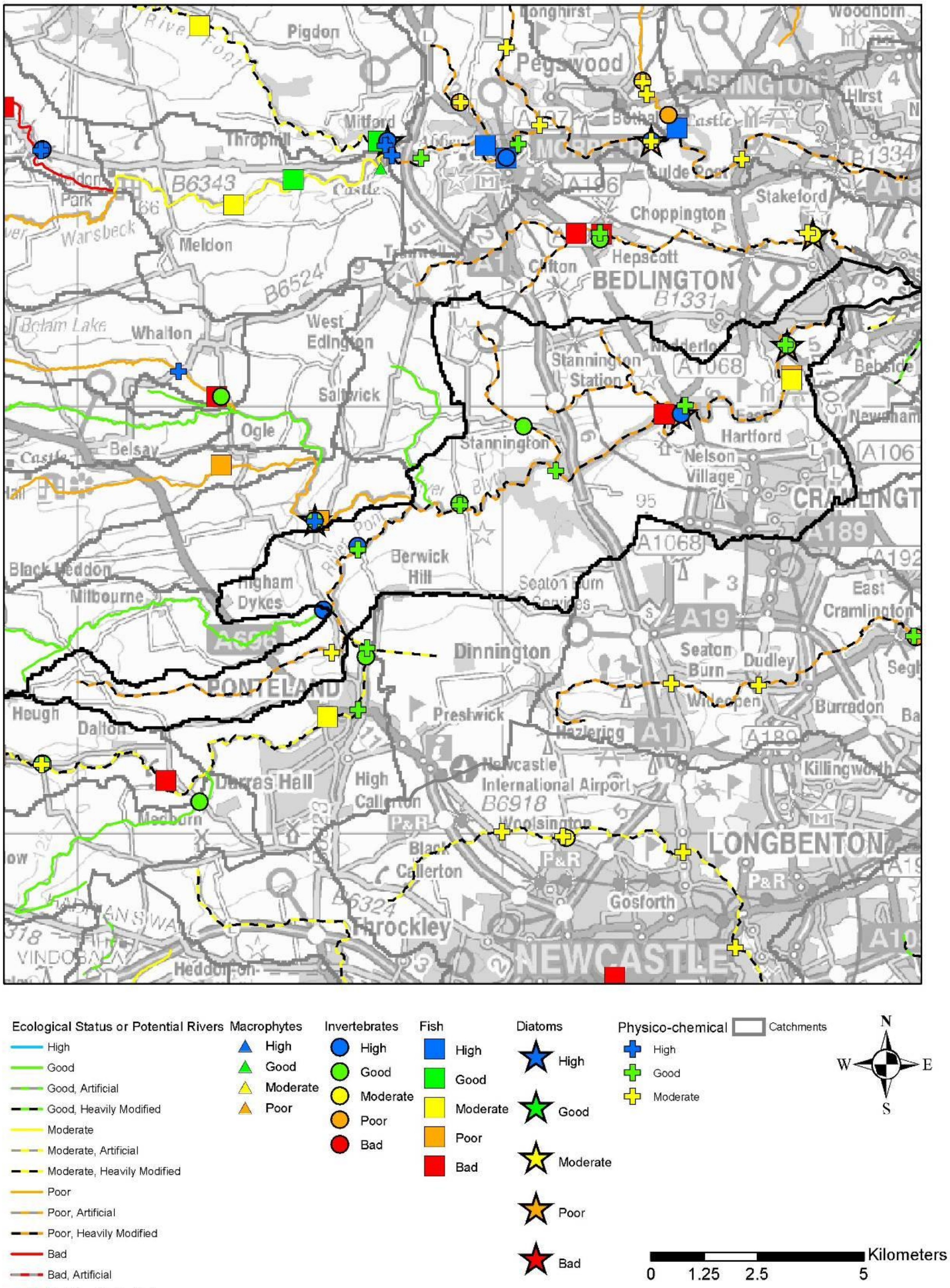
The walkover assessment was undertaken from Bellasis Bridge (NZ1901877668), following the course of the river downstream to Hartford Bridge (NZ2427779989).

The waterbody has been assessed as poor for fish under the Water Framework Directive (WFD) classification which suggests that less fish are present than would be expected. The waterbody is also classed as heavily modified.

This report will assess the suitability of habitats for fish within the waterbody, identifying pressures and possible mitigation measures that can be undertaken to improve habitats.

A map showing the extent of the waterbody and brief detail on its WFD designation can be found on the next page.

Ecological Status or Potential for GB103022077050



2.0 Habitat Assessment

Habitat within the Bellasis Bridge to Hartford Bridge section of this waterbody can be separated broadly into three sections. Section 1 – Bellasis Bridge to the woodland u/s A1 road bridge; Section 2 – woodland above A1 Road Bridge; Section 3 – A1 road Bridge to Hartford Bridge.

2.1 **Bellasis Bridge** (NZ1901877668) **to the woodland u/s A1 Road Bridge** (NZ19817577824)

The River channel downstream of Bellasis Bridge is broadly similar to that in the section above, ranging in width from 6-9m in most areas and incised by 2-5m below the bank top, with a water depth generally ranging between 30 and 150cm. However, unlike the upstream section, the River exhibits some more acute bends, which have led to the formation of large, deep pools where the width is over 12m (Picture 1) and depth was estimated to be in excess of 2.5m.

Directly below the bridge some more natural bed characteristics remain, with patches of gravel and cobble substrate and some water crowfoot (*Ranunculus sp.)* beds (Picture 1). This is likely to be the result of reduced dredging around the bridge to limit disturbance of the bridge footings. Even so, the channel is still deeply incised here (2-3m) and follows an obviously realigned course. Below, the channel reverts to lengths of more heavily dredged and straightened channel between sharp bends.

There was an obvious lack of tree cover along the river bank throughout this section, creating a scarcity of aerial cover over the water and structure within the channel. Some cover is provided by the abundance of grasses and vegetation that has established along the banks, within buffer zones, but this does not create the same level of shade or range of habitat as mature trees. The full length of this section has a generous buffer strip along both banks.

The general lack of marginal trees, particularly mature ones, leave a shortage in supply of branches and large woody debris (LWD) to the River, resulting in a lack of in-channel structure. Where occasional willow/sallow shrubs and trees (*Salix sp.*), or LWD are present they provide very valuable habitat through fish cover and creation of flow diversity. The variable flow also encourages sinuosity to the river channel, by increasing areas of scour and deposition, which over time will assist in reinstatement of pools and riffles. If the numbers of trees and shrubs were increased the process could be accelerated, through tree structure on the banks and greater provision of fallen timber and their root wads to the channel.

Picture 1. The River channel directly below Bellasis Bridge, where some natural substrate was present in the 20m d/s of the bridge, before the impact of deeper dredging returns. In the foreground a sharp bend has created a large pool.

In many areas the River is attempting to re-meander, and re-grading of the over steep banks is resulting (Picture 2). Where the banks have become undercut the turf and topsoil is slumping down to the river level and forming a new bank toe. In many areas the healthy root mass provided by vegetation is holding the bank together long enough for it to become established, with further growth consolidating it into a shallower profiled channel. The process is affecting the land for a considerable distance back from the river in places (over 10m) and appears to have influenced land use in the area with large buffer strips of un-cultivated land left on either bank.

Picture 2. Natural erosion on the LB, which is leading to increased channel sinuosity. Vegetation is consolidating slumped areas of the bank and facilitating natural re-grading.

On the sharper bends, deeper water and more erosive flow is inhibiting the re-grading process and the bank material is being washed downstream. This is a common problem where a channel is deeply incised, and it could take years and significant channel movement before it stabilises (Picture 3).

This erosion is increasing siltation of the watercourse and exacerbating to existing problems of high sediment loading from upstream. However, unlike the land use issues upstream, the adjustment that is occurring on the bends will ultimately lead to a more natural watercourse when it starts to stabilise.


Picture 3. Sharp bend with a very steep bank that is unlikely to re-grade as the depth and flow mean that any slumped turf will be submerged, inhibiting growth of vegetation and allowing the earth to wash away over time (NZ1926477568).

Shortly below this point, a drainage channel on the LB leads from a low lying area of field, directly into the watercourse (NZ1927577645). This is likely to provide a significant supply of sediment and nutrient washout to the river.

Between bends the River channel was straight for long sections but flow variation within the channel has facilitated areas of deposition, with some being colonised by emergent vegetation. Over time these will increase flow diversity within the channel, creating meanders, but at present much of the river still resembled the channel section in picture 4.

Picture 4. Very straight, uniform channel, with little habitat or flow diversity.

The bed material throughout this section predominantly consisted of earth and silt, with thin layers of gravel and occasional cobbles present in narrower sections, although there was not enough to support productive salmonid spawning. These narrower points were also the only areas with velocity capable of supporting water crowfoot.

The issue is attributed to the dredging, which has left an over-deep channel that has to be restricted to between 1.5-2.5m, in most areas, before flow reaches a beneficial velocity for salmonids, due to the increased depth. In contrast, the areas of increased velocity in natural un-dredged areas would shallow riffles, 6-12m wide and 15-40cm depth.

Approximately 1km below Bellasis Bridge, directly below the remains of old bridge footings, the habitat improved slightly, with the first of a series of three, cobble-bedded riffles observed (Picture 5). Again this would appear to be due to a reduction in the extent of dredging below the bridge, as the improvement only exists for around 100m downstream, after which the channel is again heavily dredged. None of the riffles provided suitable substrate for salmonid spawning as the material was of too coarse diameter.

An existing footbridge slightly further downstream adequately demonstrated the scale of flood events. Although the bridge was 4.5-5m above the current level of the watercourse, flood debris was lodged on the side. This demonstrates a major issue in this area of the Blyth. Flood flows are constrained within an incised channel, unable to spill out onto the floodplain and relieve the pressure in most events.

In high flows this increases detrimental scour and erosion, mobilising fine sediments, and leaving a lack of habitat and features when flows subside. Sediment deposits would naturally assist narrowing and re-meander, and their loss is likely to inhibit re-naturalisation of the river channel. This demonstrates a further benefit of re-profiled banks through increased flood capacity and relieving pressure within the channel.

Picture 5. Steep and straight channel resulting in cobble and boulder substrate.

2.2 **Woodland** (NZ19817577824) **to A1 Road Bridge** (NZ2168878358)

Within the wood the characteristics of the river channel remained very similar to those in the upstream section, aside from having trees set around 5m back from either bank top. The channel was predominantly straight and over deep with little flow diversity. After around 750m an apparent reduction in the level of dredging and increased sinuosity has allowed an area with some more natural characteristics to remain, and the first semi-natural riffles were observed (Picture 6). The substrate in this area remained silty, limiting, but not precluding salmonid spawning potential. The greater diversity of substrate in this area is also likely to increase suitability for many species of invertebrate.

Picture 6. One of a series of more natural riffles observed (c.6-8 wide)

A reduction in fine sediment supply from upstream and an increase of in-channel structure from LWD and marginal trees, to increase gravel sorting, may facilitate improvement of the substrate in this area to a state capable of supporting viable salmonid spawning. As demonstrated by the presence of suitable sized gravels in picture 7.

Picture 7. Gravel of a suitable size (5 – 50mm dia.) for spawning of small salmonids, currently compromised by a high sediment composition.

At the lower extent of the riffles the channel develops into a pool with relatively high habitat quality, but the improved habitat does not continue far downstream as the level of dredging increases and the channel becomes over deep with limited features.

At several points throughout the next c.1.5km the river is heavily dredged, but areas of significantly improved habitat occur where woody debris within the channel and dense willow shrubs along the bank have increased in-channel structure. This has improved flow diversity and increased depth variability. While shallow riffles and gravel substrate are still scarce, these areas provide greatly enhanced juvenile and adult salmonid habitat (Picture 8).

Picture 8. A good example of beneficial LWD that has increased flow diversity and scour to create lies for a range of salmonid life stages.

The last c.1km above the A1 (from NZ2073078638) is of a higher habitat quality, and although the River has been dredged in places, and appeared to have been straightened, there were significant areas of pool and riffle habitat present. The variation of water depth, and flow velocity throughout this section are the factors that set it apart from areas observed upstream, for habitat diversity and the bed through this section became much coarser. Correspondingly, gravel and cobble substrate was present, some areas of which were abundant enough to form shoals and bars within the channel. Some boulders were also present in areas of higher flow velocity.

The channel also widens towards the A1, increasing to 10-15m wide in most places. These improvements in habitat quality are likely to be closely related to a reduction of dredging pressure in the area, with another significant factor improving being an increase in LWD and marginal tree cover, which enhances the already increased flow velocity and diversity, provides in-channel cover, and assists gravel retention and sorting (Pictures 9 & 10).

Picture 9. LWD providing cover and assisting deposition of sediments on the nearside bank (RB).

Picture 10. Overhanging willow, with trailing branches that will greatly enhance the habitat of the pool. The structure provided, and deposition it encourages, will optimise flow within the channel.

A series of weirs were also present within the section (NZ2119378472, NZ2134178395 and NZ2151178240), which although in a poor state of repair cause some impoundment to the River (Picture 11). It is recommended that these impoundments are removed down to river bed, at least in the middle third. Retention of the structure at either bank would create a pinch point to increase velocity and scouring, but it may be difficult to achieve. A more ecologically friendly option would be complete removal of the structure and tree planting, or installation of LWD in its place, on opposite banks.

This would create a similar effect, replacing some of the flow enhancement benefits downstream of the weir, without the negative impoundment. These weirs are not of a significant height to cause obstruction to fish passage, but in an area with such limited gradient, any impoundment is likely to have a significant negative impact.

Picture 11. One of the weirs that should be removed or lowered. This structure demonstrates the flow benefits of narrower pinch points. Note the river level in relation to the bank where a more natural bed is present (1.5m below the bank top) in contrast to the 3-5m of incision observed upstream.

It is considered that although this section has an improved level of LWD and tree cover compared to other sections, there is a real opportunity for further habitat enhancement throughout. The reduction in dredging, and natural substrate present leave greater potential for habitat enhancement. Increased flow diversity and scour that could be created with in-stream structure would greatly assist gravel cleaning and sorting, while also encouraging marginal deposition. Marginal deposition of finer sediments would also assist channel narrowing and create habitat for species such as mayflies (*Ephemera danica*) and lamprey (*Lampetra fluvitalis & L. planeri*).

Approximately 600m upstream of the A1, the Catraw Burn (Picture 12, NZ2124878502) enters the Blyth and represents the only tributary in the section with potential as a spawning tributary. The Burn was small and carried a high silt loading, but appeared subject to little or no dredging, with a sinuous course, and coarse, salmonid spawning-sized substrate. If the sedimentation issues on the Burn could be addressed it could form an important spawning and nursery area for salmonids. This is dependant on other water quality and quantity parameters. To this end, it is suggested that the Catraw Burn be investigated further.

In the bottom 300m above the A1, areas of bedrock became apparent along the river bed, marking a change in character of the river, after which it became steeper, with an increasing number of riffles. Correspondingly, areas of higher quality, cleaner gravels observed (c.100m upstream of the A1 Bridge), which were of a suitable size and composition for salmonid spawning. Within this gravel were several clearer, recently disturbed areas that appeared to represent salmonid redds (Picture 13). The size and location would suggest that they were created by larger migratory salmonids, possibly sea trout.

Picture 12. Potential spawning and juvenile nursery habitat on the Catraw Burn.

Picture 13. One of several suspected salmonid spawning redds on the River Blyth (NZ2164078286).

2.3 A1 Road Bridge (NZ2168878358) to Hartford Bridge (NZ2427779989)

The river through this section was generally wider than that of the previous two sections, ranging between 10m and 16m wide, and followed a particularly straight course for nearly 2.5km downstream of the bridge. While there is some evidence of historic channels set back from the River’s current course and some straightening is likely, the lack of meanders is considered to be primarily attributable to the steep sided, narrow nature of the river corridor in this area.

Progressing downstream, the bed character becomes increasingly dominated by bedrock, with numerous riffles, glides and small pools within fissures and low lying areas of the rock. This represents good habitat for most stages of the resident salmonid lifecycle, with calm sheltered areas for fry in the margins amongst cobbles, boulders and trailing vegetation; faster riffles for larger fry and parr; and slower pockets and back eddies in the deeper areas for adult fish. There was a general lack of deep pools, due to the immovable nature of the bed, but there were sufficient areas between bedrock outcrops to provide some cover for larger fish.

None of these areas provided ideal conditions for the deposition of significant salmonid spawning substrate, although coarser gravels and cobbles do accumulate towards the tail of some pools. In the shallower rocky areas, gravel is likely to be washed trough in higher flows as there are few features to retain it.

If the amount of LWD and trailing marginal trees could be increased there would be a much greater potential for retention of transient gravel throughout the reach. The increased structure along the margins would shelter areas from peak flows, where gravels and finer sediments could accumulate, in addition to the aerial cover they provide. Gravel retained would then have the potential of providing at least some spawning habitat within the reach, which is currently in very short supply. This same process is also likely to be the best method for creating varied channel width, and therefore increased habitat diversity.

Picture 14. A natural bedrock ledge, creating some cascading in the centre of shot, with deeper pool and glide habitat in the foreground. LWD could help to diversify the habitat in reaches such as this.

Historically, there appears to have been a culture of removing much of the LWD and marginal tree branches (as observed by logs on the bank and clean cut), assumed to have been part of attempts to reduce flood risk. While this is valid management in areas with significant flood risk, the practice is likely to be at odds with many outcomes of the Water Framework Directive (WFD) and it is recommended that areas are assessed carefully before any clearing and pruning is undertaken. Fortunately, in this section, none of the work appeared to have been undertaken recently. It is hoped that this is due to a change in management practice, and retention of these vital natural features is continued.

It is suggested that methods are investigated for increasing this type of structure, where there is a minimal impact on flood risk. There is not likely to be a particularly high risk locally to this section, due to the nature of the valley and remoteness to any infrastructure. Any potential risk is likely to be from materials washing downstream.

With this in mind it is recommended that living trees and shrubs be retained, as they are naturally anchored in situ. Simple natural methods could also be employed to retain larger material and LWD in place, as seen in picture 15. There a tree has fallen into the River between several living trees and will be retained in place by the force of water acting on the fallen limb, which will pin it against the upright trees. In areas where flooding is a greater risk, trees and branches could be retained with steel cable, and/or posts, creating tree kickers.

Picture 15. Fallen tree being retained in place by pressure, against other limbs.

Most of the mature trees in this section were ash (*Fraxinus excelsior*) and sycamore (*Acer pseudoplantus*), which generally provide poor low level cover, particularly following pruning of the lower branches when re-growth will be prioritised in the upper canopy. This is in contrast to species like hazel alder that produce valuable bush low-level growth. For this reason it is recommended that planting of alder and more hazel here would be beneficial.

Without the additional cover provided by trees and logs in pictures 15, 16 & 17 the habitat would be of significantly lower quality. In picture 15 the log is facilitating accumulation of other debris, providing increased cover and flow diversity. In picture 16 the wide slow nature of the river would provide little cover or diversity within the channel, but with tree cover the pool has structure and shelter for fish and invertebrates to inhabit. The shallow riffle in picture 17 would equally provide little cover or shelter from the flow, without the tree present.

In all examples the quality and fish holding potential of the habitat have been massively increased with the retention of natural features. Re-creation of natural habitat features such as these, either staggered (to increase sinuosity within the channel), or paired (Picture 16); the current velocity can be optimised even within wider, deeper sections.

Picture 16. Valuable habitat and cover provided by tree branch structure within a uniform channel.

Picture 17. Aerial cover and slower fish holding water provided by an overhanging tree, with suitable fry habitat in the foreground. The structure of the tree within the channel is also optimising current velocity of the riffle.

From the bend around Plessey Mill Farm (NZ2355779694), the habitat changes again, to a predominantly cobble and gravel substrate. It is assumed that this is in part due to the effect that the Mill weir would have had on the river flow and substrate transport within the reach. The weir is no longer present, and it is probable that after its removal a significant amount of substrate would have been supplied to the reach downstream.

Picture 18 shows a significant channel narrowing downstream of the old weir site. The deposition, and vegetated bar created, now restricts the river to approximately half of the average width for this reach and the benefit of increased velocity at this localised pinch point can be seen.


Picture 18. Significantly restricted channel width creating enhanced flow characteristics, and habitat within the area and pool downstream.

A short distance downstream of the narrowing the River again opens out into a wider channel, influenced by an area of raised bed that was possibly the site of another weir or structure (Picture 19). The minor obstruction is of no real significance, creating little impoundment in an area of reasonable gradient. At this same location a small amount of ochreous discharge was observed entering the river, but the volume was not considered to be detrimental.

Picture 19. Small area of raised cobble and boulder bed which may be the remains of a previous weir (NZ2374079751).

From this point downstream the river can be characterised as pool and riffle sequence for approximately 500m and represents good quality adult salmonid habitat. On the RB of the bend there was an area of healthy willow growth where spiling had been previously undertaken to reinforce and consolidate the bank (Picture 20). With the permission of the landowner, this could form a good source of willow for further planting. Habitat and protection along the bank could also be enhanced if some re-growth were laid down the bank, into the river, in a downstream direction.

Picture 20. Healthy re-growth of willow following bank revetment with living willow spiling. This could be a good source of willow for further work.

Towards the lower end of this section (around Plessey Woods visitors area, NZ2379979456) the impact of riparian tree maintenance again became apparent, and there was a distinct lack of low level aerial cover (Picture 21). From this point downstream to Hartford Bridge the river reverts to a bedrock dominated character, where some areas of gravel and cobble shoals have accumulated.

The impact of tree maintenance and removal of LWD was again obvious through this section, with significantly lifted canopy and reduced amount of low cover within the channel. This greatly reduces the quality of what would be good salmonid habitat and should be addressed by cessation of the tree pruning work.

Planting with species, such as goat willow and sallow (*Salix caprea & S. cinerea*), hazel (*Corylus avellana*) or hawthorn (*Crataegus monogyna*), which were scarce throughout this section, would also be beneficial in increasing low cover; as would one-off coppicing of some of the trees to encourage low-level re-growth.

Hinging could also be undertaken on species like willow, hazel and smaller alders, where already present, to give an instant increase in the available low cover. This could then be undertaken on some of the trees planted, in the future.

Picture 21. General lack of low-level cover resulting from pruning and tree maintenance, which has lifted the canopy well above the water level. This could be addressed with some coppicing, additional planting, or both.

Freshly cut branches could be seen on many of the bank-side trees, and several logs and tree trunks in the area had been cut into short sections. Picture 22 shows what would be a very beneficial piece of LWD before it was cut in half. It was not possible to ascertain whether the work had been carried out by Environment Agency Operations Delivery personnel, the Council, local landowners or the angling club, but this kind of work should be avoided wherever possible to preserve habitat within the river.

Picture 22. This tree trunk would have formed beneficial structure within the river but has been cut through, halfway along the length in the picture. This would now appear to represent a greater flood risk as only the butt is anchored to the bank and the tip is likely to wash out in the next high water.

Wherever visible, the riverbed throughout the shallower sections exhibited a significant amount of brown algal growth. This suggests a high nutrient loading in the river. A fact that would be supported by issues observed in other sections of the catchment. This is something that is being investigated by the Northumberland Rural Diffuse Pollution Partnership and needs to be addressed across the whole catchment, as the notable issue observed in picture 23 is the result of a cumulative impact.

The river character below here, to the end of the section, remains similar; comprising of shallow riffles and chutes over bedrock, some deeper pools and glides, with areas of gravel, cobble and the occasional boulder. In the final 100m above Hartford Bridge the impounding effect of Hartford Gauging weir becomes apparent.


Picture 23. Significant algal growth on the riverbed.

3.0 Recommendations

3.1 Sedimentation

As with other waterbodies, and sections of this waterbody, a significant issue that has to be addressed is sedimentation of the watercourse. It is understood that this is currently being tackled by the Northumberland Rural Diffuse Pollution Partnership, and will be pivotal to any future improvements to the river and particularly, fish stocks.

3.2 Channel Realignment

The level of dredging incision within the river channel throughout Sections 1 & 2 (Bellasis Bridge and the wooded area upstream of the A1) has left the river straight for long sections and deeply incised. The solution would be to re-meander the channel, or at least re-grade the banks to increase the rivers ability to naturally adjust.

This kind of re-alignment project would be on a major scale, moving large volumes of earth and involving significant amounts of time and money. Due to the generous buffer strip afforded along the riverbank, particularly in Section 1, this is something that might be feasible, and could be investigated with the landowners.

In reality, while this would be the optimal scenario it is likely that funding and landowner agreement could be an issue. In addition, the river is already starting to naturalise in areas increasing in sinuosity and re-grading the over-steep banks. This means that it may be worth looking at tackling the large-scale improvements in short sections.

At a bare minimum, it will be worth assisting the natural adjustment that is already occurring.

3.3 Assisting Natural Adjustment

Is recommended that the re-naturalisation processes already underway are assisted by planting of trees to increase flow diversity within the channel and promote areas of beneficial scour and deposition. LWD and flow deflectors/pinch points could also be employed to similar effect throughout Section 1 and parts of 2.

For optimal benefit some of these structures could be installed in conjunction with gravel riffles, using the enhanced flow to reduce sedimentation of the gravel.

3.4 Gravel Reinstatement

Any riffle created should be two to three times as long as the channel width and stabilised by first lining the bed with large stones or cobbles, before top dressing with 20-50mm, angular river gravels. The installed riffle should not raise upstream water levels by more than 30cm at normal discharge, and ideally any impact on the impact on upstream water level should be kept to a minimum.

This can be achieved by starting the riffle well upstream of a natural lift in the bed and working down towards the lift, thereby increasing velocity by lifting the bed of the dredged channel; or by working downstream of the lift and ensuring that the highest point of the riffle does not greatly exceed that of the natural lift.

The profile of the riffle should always be designed higher at either bank than the middle, to focus flow to the centre of the channel. The gravel should start shallow at the upstream end, increasing in height (depth of gravel) as it progresses downstream to a crest, followed by a short section of grading back to bed level at the downstream end to reduce scour as water leaves the riffle.

This work would be well complemented by shallower, sheltered areas downstream of the riffles for juvenile habitat, through the inclusion of brushwood, and or cobbles along the margins for increased cover.

The whole of Section 1 would benefit from major gravel reinstatement, but there are specific sites where greater benefit may be gained by working with existing characteristics. Where the river bed already shallows, particularly where the channel also begins to narrow, the acceleration of flow will benefit cleaning of the gravel and these should be the primary locations. Lifts in the bed at the downstream end of any pools, located on bends are also likely to be good locations.

If sections with a more natural, gradual bank profile are available the chance of wash-out during flood events is likely to be reduced. A key aspect in the successful installation and retention of these riffles is likely to be dependant upon creation of an adequate cobble base to each riffle to retain the gravel.

Even where the above criteria are not met, benefit would be gained by interspersing the long straightened sections with at least one raised gravel riffle. These areas may however, require more material to create the desired effect, depending on the severity of dredging in the area.

As the installation of gravel will be reducing the channel capacity at that point, it is advised that an area of protection is provided along the bank-line to reduce the potential for bank erosion. This would be best achieved through the planting of trees, or installation of brushwood along the margins, with would also further enhance habitat in the area, particularly for salmonid fry. Re-grading of the banks in the areas tackled would also be highly beneficial and should be considered as a complimentary measure with the riffle creation.

3.5 Weir Removal

Due to the lack of natural bed features, deep over-wide channel, and low gradient in Section 2, the weirs present, although in a very poor state of repair, are adding to the impoundment of the River. It is recommended that these impoundments are removed down to river bed level, at least in the middle third. Retention of the structure at either bank could be facilitated, creating a pinch point to increase velocity and scouring. This would also reduce the amount of materials that have to be removed. For some of the weir this process may simply be a case of removing or rearranging the cobble and boulder fill from the centre section of the weir.

If the weirs are completely removed, installation of LWD or tree planting in its place on opposite banks would help to increase velocity through the centre of the channel and replace habitat features lost through the removal.

3.6 Tree Management and Planting

Tree planting would be beneficial throughout all sections, but particularly in 1 & 2, as there was a general lack of marginal tree cover, even throughout the wooded area, as most of the trees are set back from the bank top.

It is recommended that as a bare minimum, willow/sallow whips should be planted along the waterline to break up the long sections of riverbank where trees are absent. Planting of other species of tree would also be beneficial to increase diversity and the type of habitat created. A mix of alder (*Alnus glutinosa*), ash hawthorn and hazel would be beneficial.

Similar species planting would also be beneficial through Section 3, to improve the under-storey, as most of the trees are mature ash and sycamore. However, the major issue with the trees in this section is the way that they have been managed managed.

Ideally they would be allowed to grow out over the river channel and trail into the water. Any trees that fall into the river should ideally be left in situ, forming LWD, as would naturally occur. If there is a perceived flood risk it may be appropriate to adjust the location of the LWD, anchoring it to other marginal trees, or posts driven into the bed or bank. Removal of this material, and tree pruning should be avoided where at all possible as LWD forms a vital part of any river habitat. This is particularly of Section 3, where in channel structure will be vital in retaining bed material, increasing flow variation and providing cover through the predominantly bedrock sections.

Hinging and sparse coppicing be beneficial throughout all sections where low cover is lacking, taking care to leave plenty of diversity in tree and shrub height.

3.7 In-stream Structures

Although well-placed trees will provide some flow variation, the extent of the dredging and straightening on the Pont and Blyth have left the channel so over capacity that it will be beneficial to artificially restrict the channel and deflect the flow in areas.

Several options for achieving the desired narrowing exist but it is recommended that natural techniques will be the most appropriate. Methods like introducing LWD into the channel and narrowing with living willow hurdles or bundles would work well. They can be either paired, or alternating, to create pinch points and meanders within the channel. The benefit of living willow bundles is that they are quick and easy to create and install. They are also likely to accumulate and consolidate the sediment from the abundant supply of the river, consolidating and creating new bank-lines rapidly.

These methods would work well in conjunction with areas of gravel introduction, where the increased flow velocity and diversity can be employed to keep the gravel clean. LWD should be installed throughout all sections covered in this report, with full consideration given to potential flood risk issues.

3.8 Catraw Burn

It is recommended that the Catraw Burn (NZ2124878502) is investigated further as a potential spawning tributary. Enhancement of the Burn could help to mitigate the lack of suitable spawning on the Blyth system. The Burn appeared to have potential as a spawning tributary, but the quality of the gravel was compromised by high sediment loading. It may be that periods of low flows, as are common throughout the Blyth, are exacerbating sediment deposition and may reduce the potential as a spawning tributary, but the sedimentation should also be investigated as a source to the Blyth.

Investigation into the water quality of the Burn, and the water quantity likely to be experienced throughout the spring and early summer at least, would be useful. If these parameters were suitable it may be worth installing features such as brash bundles and branches within the channel that would enhance juvenile salmonid habitat and potentially increase juvenile output.

4.0 Disclaimer