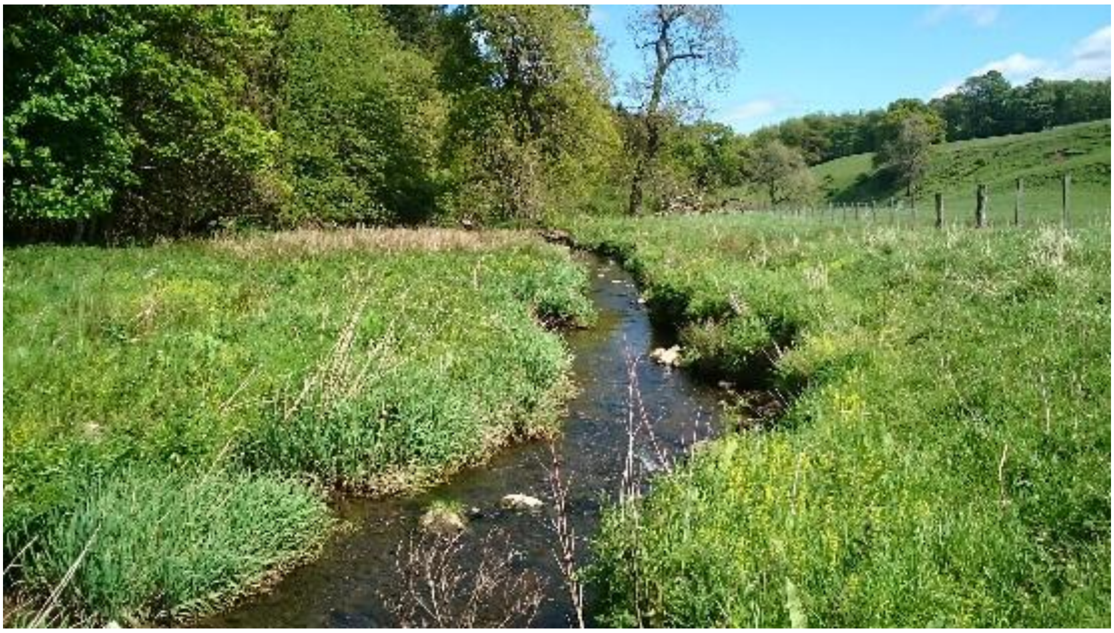
Advisory Visit

Midhope (Pardovan) Burn

26/05/2015



Executive Summary

An executive summary was provided to Donald Noble ahead of the preparation of this report in response to a potential funding meeting, and is appended.

1.0 Introduction

This report is the output of a site visit to the Midhope Burn, West Lothian, undertaken by Jon Grey & Gareth Pedley of the Wild Trout Trust. The visit was requested by Donald Noble of Hopetoun Estates prior to a funding bid for improving habitat for wild fish populations.

The Scottish Environment Protection Agency (SEPA) refer to Midhope Burn as Pardovan Burn (see Table 1).

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.

	Upper Section	**Lower Section**
River	Pardovan Burn	Pardovan Burn
Waterbody Name	Pardovan Burn / Haugh Burn / Riccarton Burn (Source to d/s Bridgend)	Pardovan Burn (d/s Bridgend to estuary)
Waterbody ID	SEPA 3401	SEPA 3400
Management Catchment	Forth Estuary (South) Coastal	Forth Estuary (South) Coastal
River Basin District	Scotland	Scotland
Current Ecological Quality	Overall status of **Good** ecological potential with Medium confidence in 2013 with overall ecological status of **Good** and overall chemical status of **Pass**	Overall status of **Moderate** with High confidence in 2013 with overall ecological status of **Moderate** and overall chemical status of **Pass**
U/S Grid Ref inspected	NT0394175699	
D/S Grid Ref inspected		NT0798679299
Length of river inspected	50 – 200m sections at bridges, STWs etc	~4km from M9 to estuary

Table 1. Overview of the waterbody: details of sections visited. Information sourced from (http://www.environment.scotland.gov.uk/get-interactive/data/water-body-classification/)

Under the Water Framework Directive (WFD), the upper section (SEPA ID: 3401) is classified as a Heavily Modified Water Body (HMWB), yet is given a *Good 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.

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 status has changed from *Degraded* in the previous cycle, but it is difficult to judge what has improved since then as the previous report was not available. Potential issues are listed as diffuse source pollution and morphological alterations.

The lower section (SEPA ID: 3400) achieves only *Moderate* status which has not changed from the previous cycle. Issues flagged are alien species and various sources of point and diffuse pollution.

2.0 Catchment / Fishery Overview

The Midhope Burn arises from various drains in a lowland calcareous landscape underlain by oil shale sedimentary rocks. This has given rise to rich arable farmland and estate woodland, reflecting both the fertile soils and a dry east coast climate. Hence the water should be reasonably productive (naturally), but will be augmented by nutrients derived from farming practice across the wider catchment and from various small Sewage Treatment Works (STWs) that cater for the small townships that have sprung up.

Historic mining of oil-shale and post processing to drive off the hydrocarbons left the same volume of oil-shale spoil as was mined, resulting in the flat-topped red shale 'bings' that are to be seen at various points throughout the upper catchment. This friable material would have been especially susceptible to erosion and has probably contributed substantially to the ingress of fine material to watercourses in the past.

According to Mr Noble, no stocking has been attempted in the past. There have been sporadic catches of larger trout (possibly sea trout) and the occasional salmon reported in the lower reaches.

The burn was examined at specific points (bridges, culverts, sewage treatment plants, and field edges) from an u/s limit at Bridgend Golf Course (NT0394175699) to the confluence with Errick Burn (NT0558677889) and then walked from that point, d/s, to the mouth at Nethermill Bridge (NT0798679299). Land use, fish passage, invertebrate life, river bed integrity/channel morphology, fish cover, and fish presence were noted. Water depth was probably not far from base-flow as there had been no significant rain in the previous 48h.

3.0 Habitat Assessment

3.1 Midhope Burn (walked section from u/s to d/s)

The starting point of the walked section was at the confluence with Errick Burn (NT0558677889), just below the culvert running under the A904. Potential access through the culvert appeared to be good for fish, with sufficient depth of water provided by almost natural substrate (small cobbles and gravels) throughout. The burn at this point is shrouded by mixed deciduous woodland (providing shade and leaf litter input), with plenty of low hanging and trailing branches (cover), and with a good quantity of Large Woody Debris (LWD) instream (Fig 1).

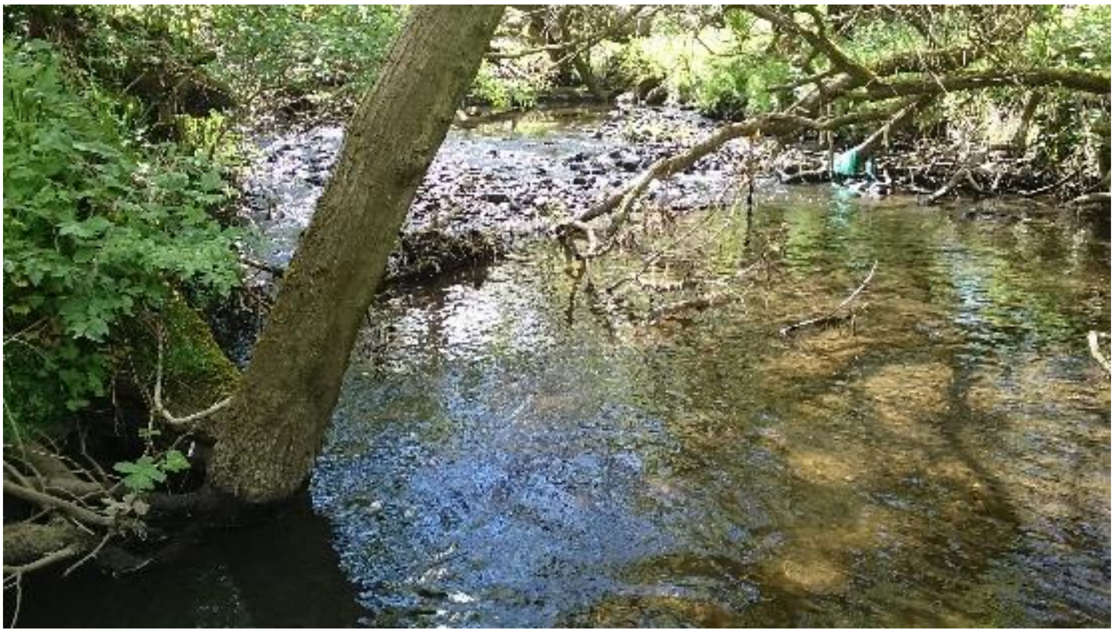


Fig 1. Midhope Burn just above the confluence with Errick Burn. Channel structure (riffles, pools) and cover from Large Woody Debris and riparian vegetation generally good.

LWD introduces diversity in flow pattern and water depth arising from scour as the water is forced over, under, or around the woody obstruction. It also provides refuge for fish from spate flow and predators, as well as providing invertebrates with food and shelter. Despite the presence of LWD, fine sediments were apparent in all but the fastest flowing riffles (Fig 2).

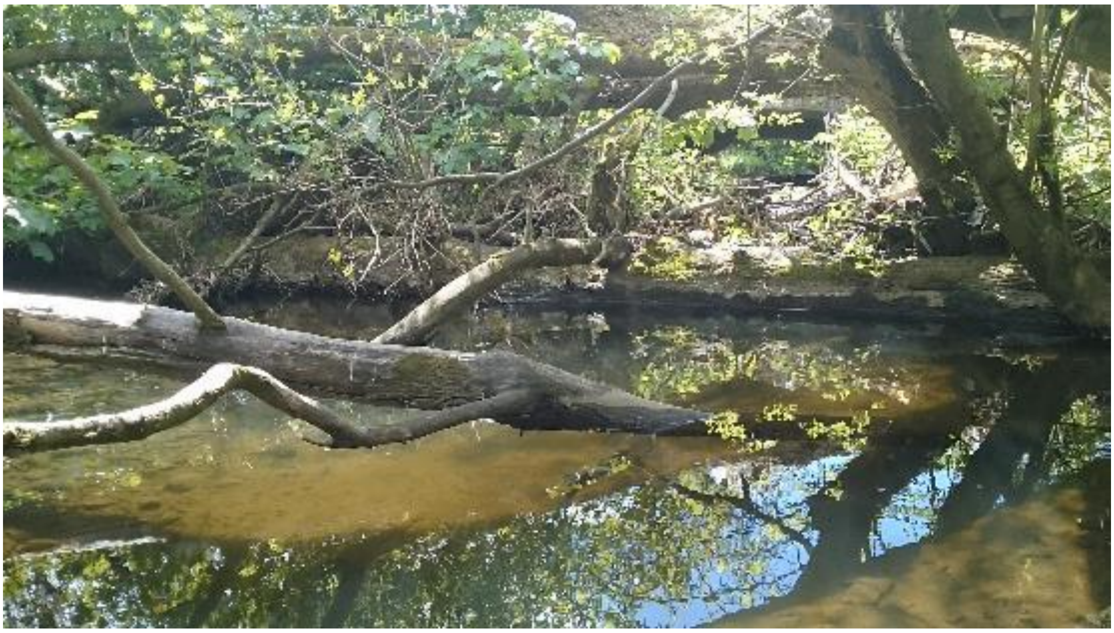


Fig 2. Despite generally good habitat structure as depicted in Fig 1, fine sediments were obvious throughout, smothering the substrate.

Errick Burn was followed u/s until just beyond the woodland edge. Here, it is bordered by arable fields, and although it has been fenced to enclose a buffer strip of several metres width on both banks, the lack of tree cover and nutrient loading has led to excessive growth of nuisance algae. It is also clearly a considerable source of fine sediment to the Midhope Burn: u/s of the confluence, almost the entire bed was uniformly smothered in silt (Figs 3 & 4) suggesting possible issues before the fencing was erected and likely issues upstream (possibly field drains, surface runoff and unrestricted grazing).

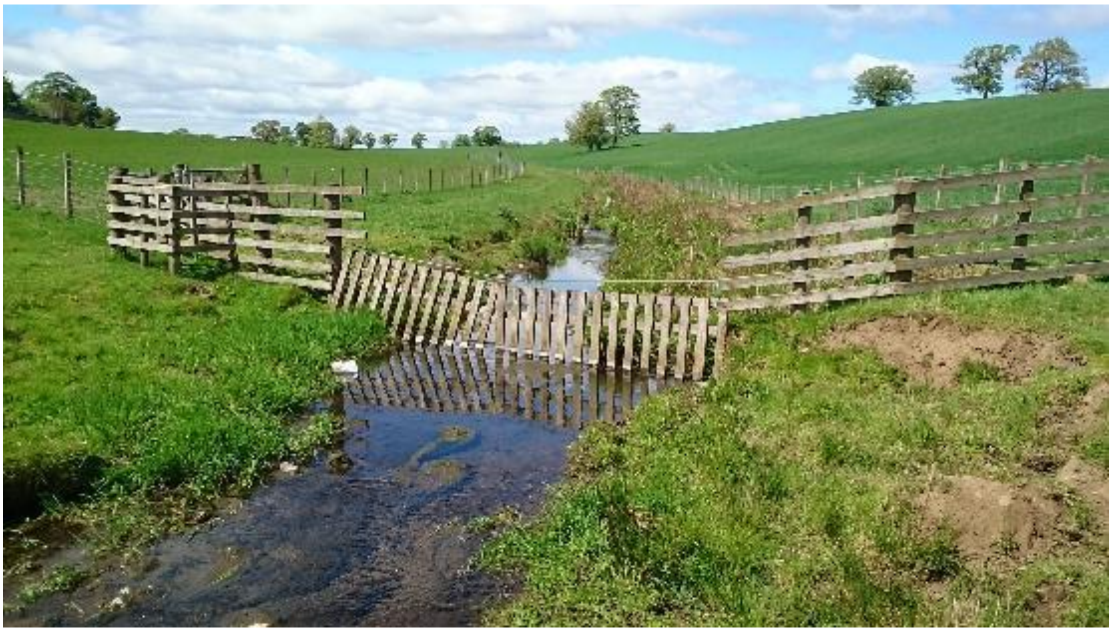


Fig 3. Errick Burn 100m above the confluence with Midhope Burn. Buffer fencing allows natural vegetation to grow (especially on LB). However, there is no shade and silt and algae choke the channel in the foreground.

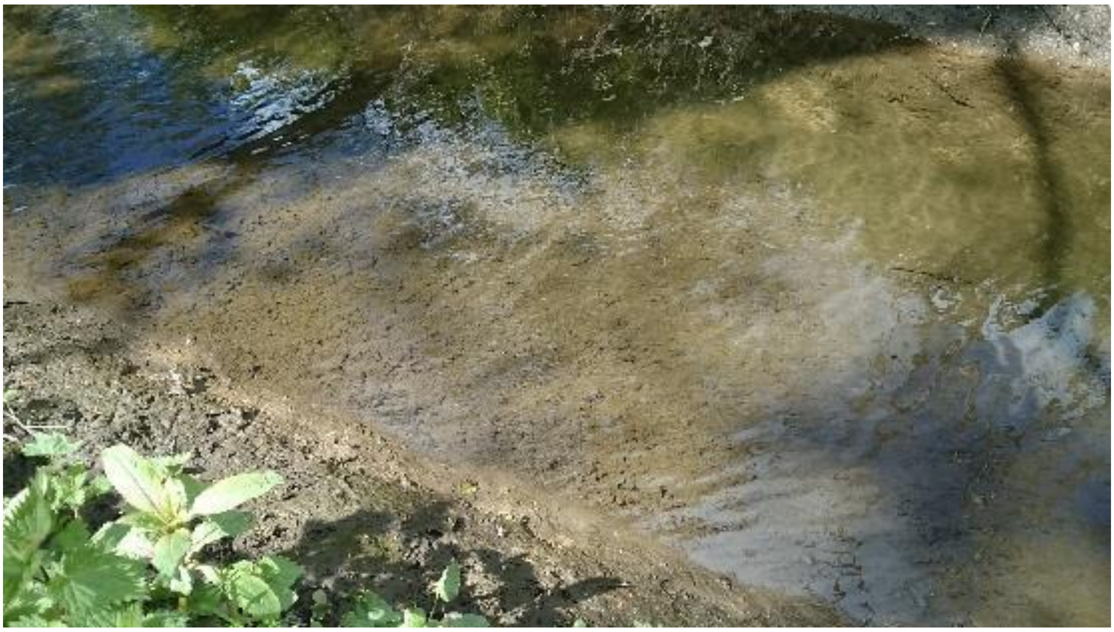


Fig 4. The bed of Errick Burn just above the confluence with Midhope Burn is a uniform layer of fine sediment. Note the Himalayan balsam in the foreground.

Below the confluence, despite the shape of the valley, the land on both banks for several hundred metres appeared to be flatter and marshier than would be expected. Willow (*Salix* spp.) dominated in the wetter soils and Himalayan balsam (*Impatiens glandulifera*) was also present and likely to dominate the understory later in the season. The reason for this landform became apparent at Binns Mill (NT0574077911). An historic mill pond has clearly filled in with tonnes of sediment over the years, and Midhope Burn is now cutting down through those sediments (as evidenced by the amount of woody debris laid down perpendicular to the current flow direction; Fig 5).

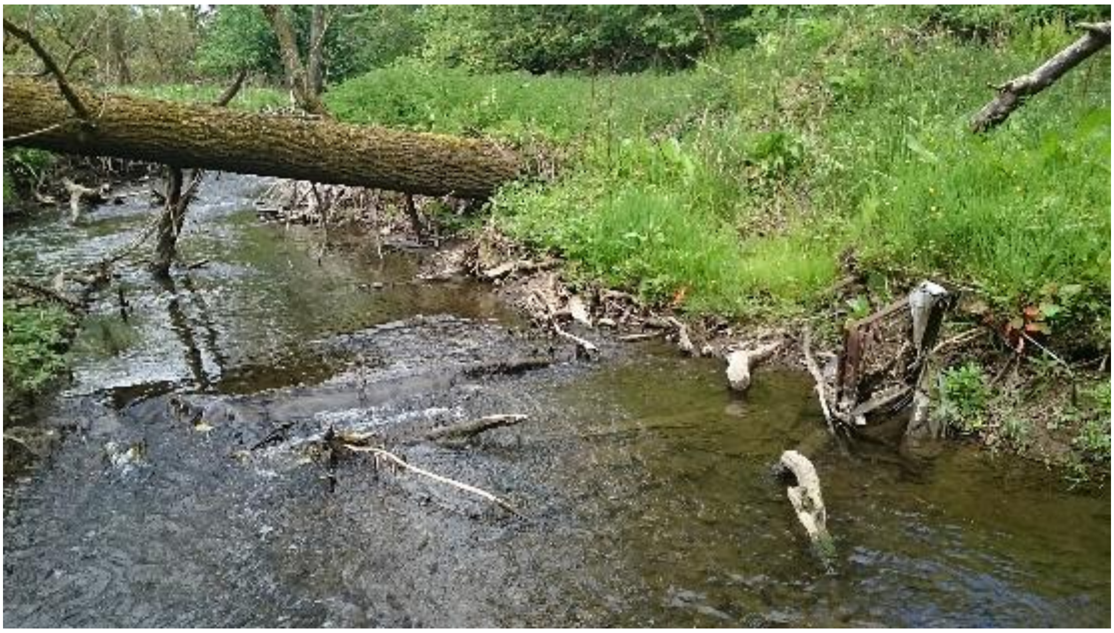


Fig 5. Midhope Burn, just above Binns Mill, where it appears to be cutting down through sediments deposited in an historic mill pool.

The barrier is a stone wall and bridged weir where, at low flow, the water is funnelled through a narrow sluice, with a board at the u/s end and a sill and two steps at the d/s end (Fig 6). A much wider spillway accommodates higher flows. At any flow regime, either structure is a considerable obstruction to fish passage, exacerbated by scour at the d/s side of the weir that has left it perched above the d/s water level. The bridge structure appears to have been maintained / repaired recently. The pool d/s is wide as a result of erosion, presumably during spate conditions, but allows space for remedial options for fish passage (see Recommendations).

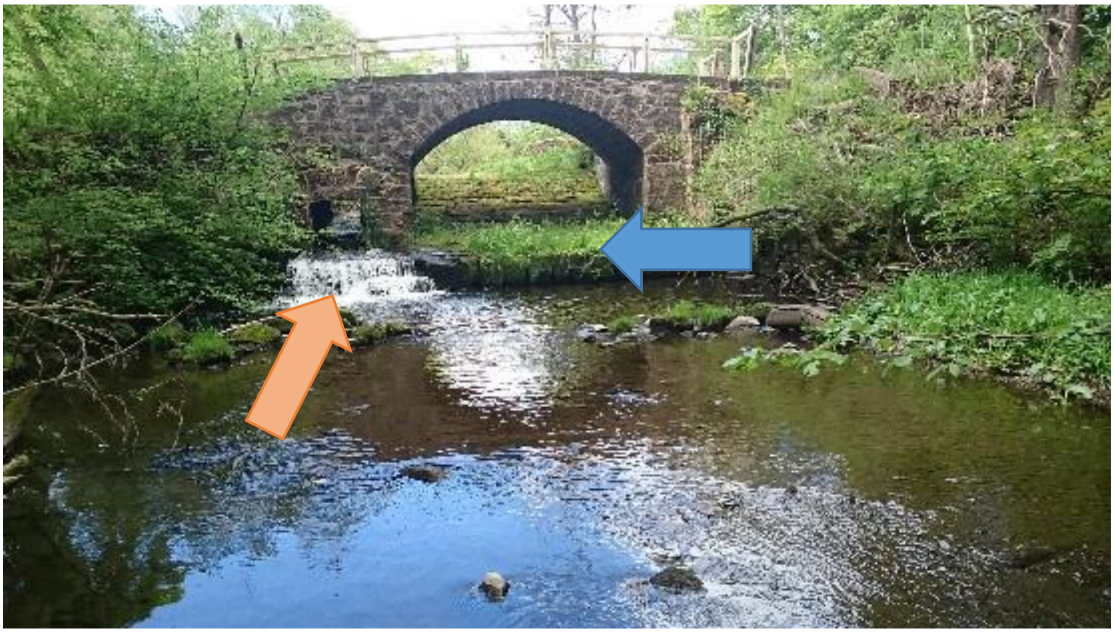


Fig 6. The sluice (orange arrow) and bridged weir (blue arrow highlighting how the d/s side is now perched above the water level) on the site of the former Binns Mill. Both structures present serious challenges to fish passage.

From this point d/s to Terrace Rigg, the burn meanders naturally through more open rough meadow but with plenty of riparian (bankside) trees such as alder (*Alnus* spp.) and willow. Both banks were populated by a diverse mixture of herbaceous plants, some trailing into the water. These provide cover, a diverse root structure to maintain bank stability and reduce the risk of erosion under spates, and of course provide food and refuge for a host of terrestrial insects, some of which will undoubtedly end up in the water. The channel form appears quite natural, with pools, riffles and glides, and LWD is in abundance (Fig 7a-c). While this may look 'untidy', it is actually excellent habitat for both fish and fish food. It is important not to remove this natural material to make it easier for anglers. Remove the material, and one will remove the good holding spots for fish, so there will be nothing there for anglers to catch!

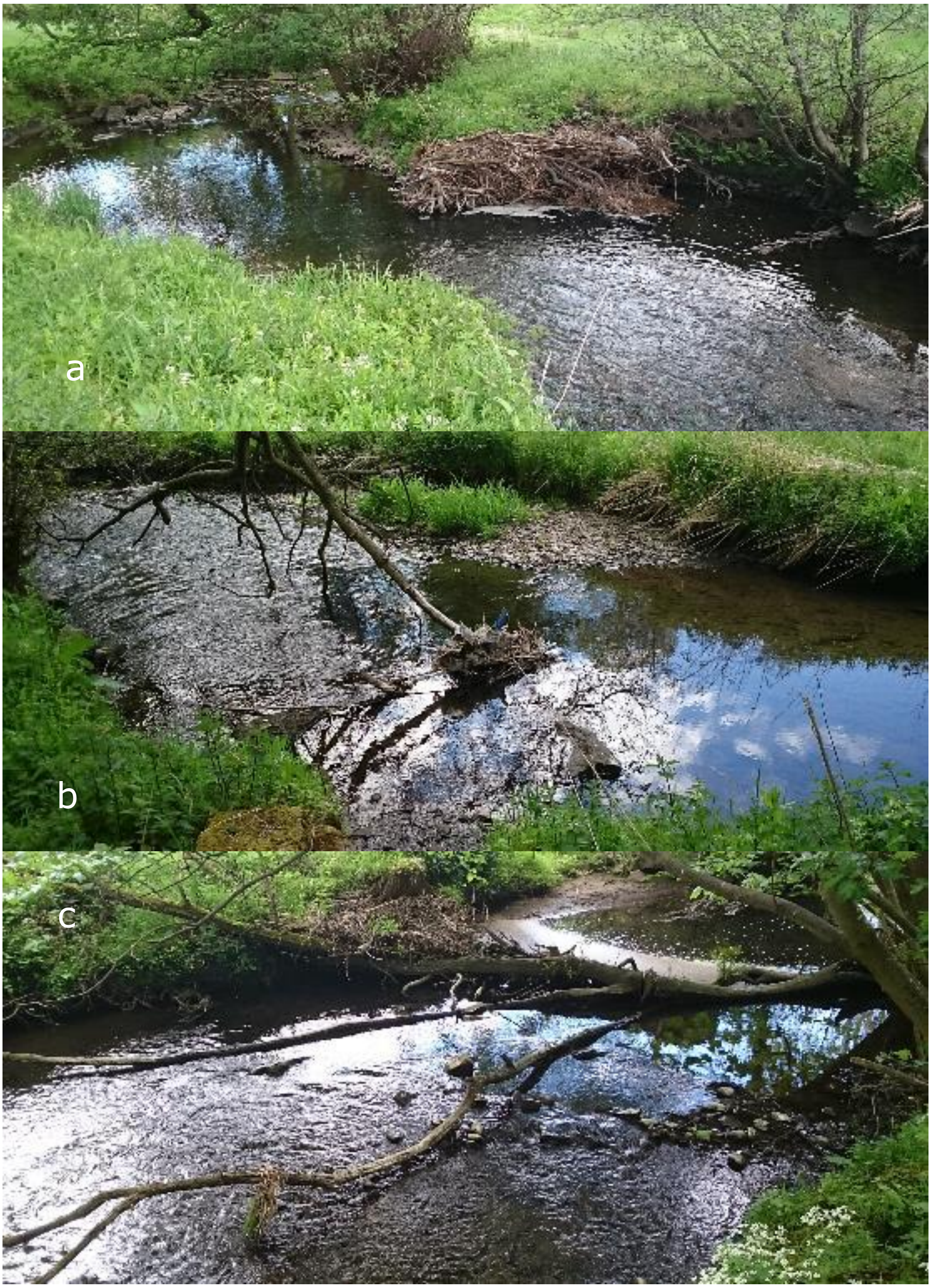


Fig 7a-c. Examples of trapped woody material creating good habitat features: (a) helping to maintain scour and create pool depth; (b) diversifying flow direction and trapping smaller debris material; and (c) creating a temporary log-jam and forming a pool.

Again, despite all the natural features being in place, the gravels were choked or smothered with fine sediment (silts and sands) suggesting that the supply of these materials from u/s must be considerable and ongoing (Fig 8a,b).

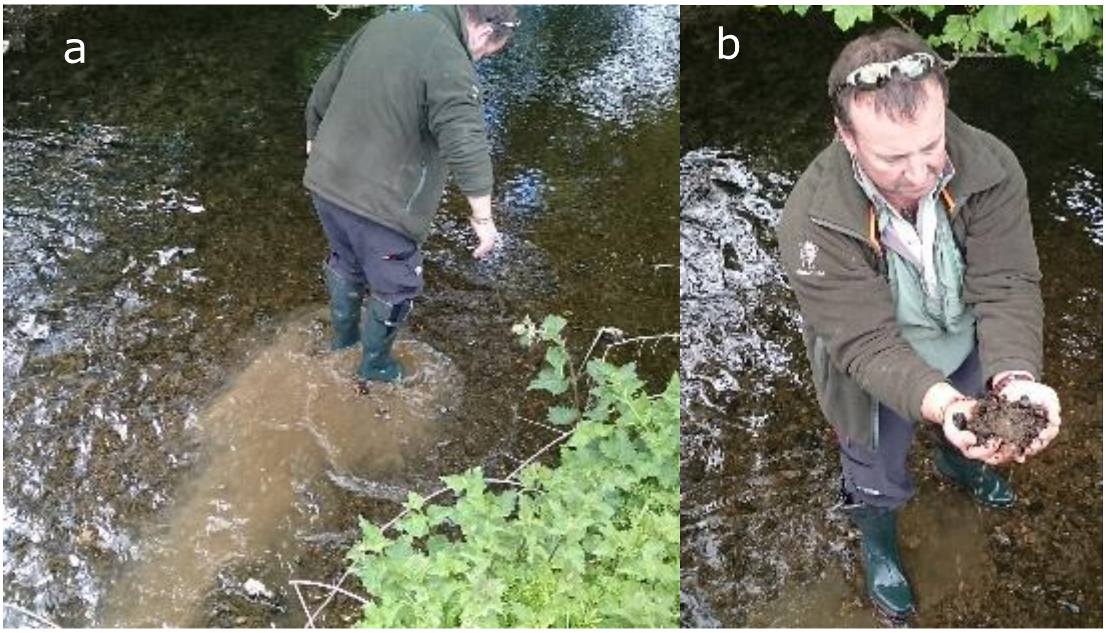


Fig 8a,b. Minor disturbance of gravels revealed the extent of fine silt and sandy sediments.

On the left bank, there is a small conifer plantation, which does not overhang the burn as there is still a narrow deciduous buffer strip between. The burn appears to have been straightened at this point but as it is for <100 metres, is nothing to worry about.

Below the conifer plantation, the valley broadens into what is known as Terrace Rigg. This whole section has been seriously degraded. Across the terrace, the burn has tended to meander naturally and there is clear evidence of oxbows. Livestock, currently cattle, have complete access to the burn throughout the terrace. As a consequence, the banks are in many cases poached where cattle have accessed the burn to drink. This erosion has several consequences. The channel is over-widened, and the additional input of soil is contributing to the sediment problems on the riverbed (Figs 9 & 10). The access points also become focal drains for surface runoff, ‘guttering’ fine sediment into the burn during heavy rains.

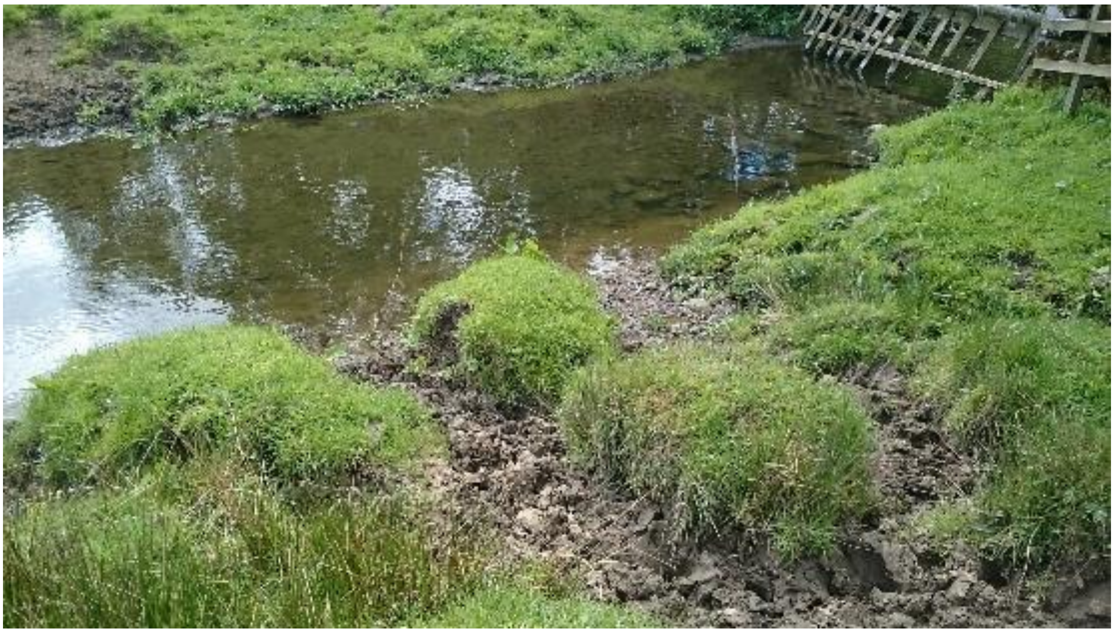


Fig 9. Cattle poaching of the banks at the u/s end of Terrace Rigg.

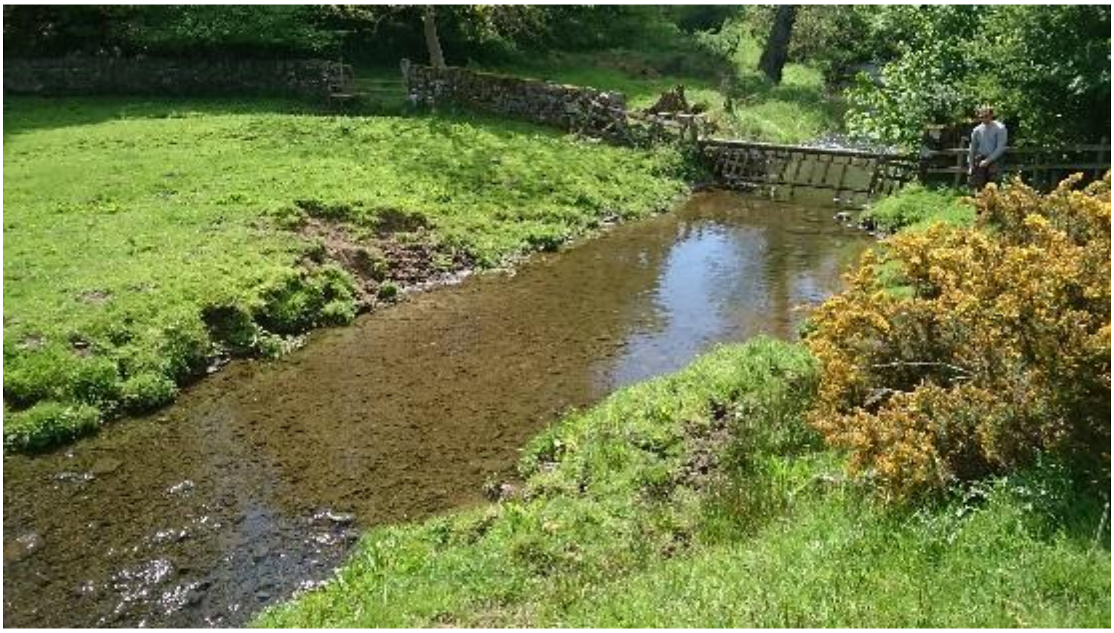


Fig 10. Over-widened, shallow, exposed and highly silted section of Midhope Burn as it enters Terrace Rigg. The erosion on the RB is from cattle poaching, visible in Fig 9.

Over-widening the channel means that it is also shallower, and the energy required to mobilise the extraneous fine sediment is dissipated so that the bed becomes smothered in silt and takes on a uniform character (Fig 11). This reduces the quality of habitat for invertebrates and potential spawning gravels are compromised as the reduced flow fails to actively sort bed materials and keep the spaces between the gravel free from fine sediments.

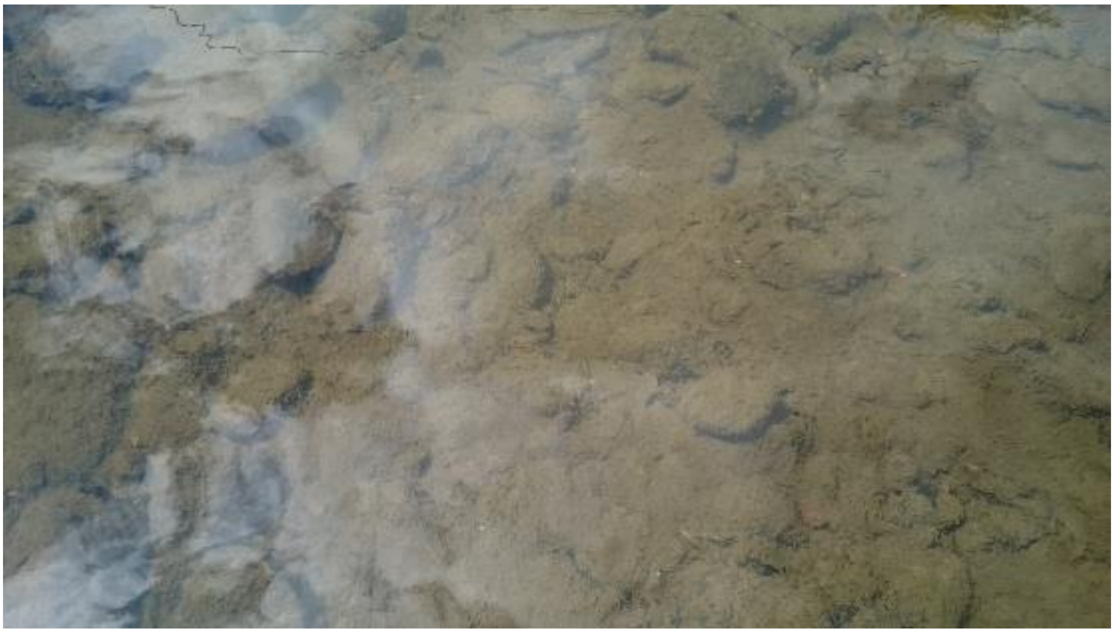


Fig 11. Heavy smothering of fine silt throughout the Terrace Rigg section of Midhope Burn.

Some sparse, mature trees (alder) remain but these were few and far between. Interestingly, one or two of these had been 'hinged' in the past (a form of management to promote low-lying, living cover by cutting smaller trunks part-way through and laying them parallel to the water surface; Fig 12). Both banks demonstrate the inhibition of herbaceous vegetation and self-set shrub establishment that occurs with any riverbank grazing. This is because such higher nutrient vegetation is actively sought out by browsers and grazers, in addition to being eaten off as an unintended consequence during grazing. Fig 13 shows how immature trees (foreground) which were presumably self-set on the bank of an historic oxbow have been browsed heavily by cattle. As a result of the lack of vegetation (aside from shallow rooting grass), the riverbanks are more susceptible to erosion because they have less physical protection and root structure below the ground (Fig 14); a lack of shade, cover and structure means the river margins are a much less hospitable place for fish. Decreased bank stability simply by grazing has also led to over-widening of the channel in many areas, and is exacerbating the erosion on the outside of the meander bends (Fig 14) that is accelerating the rate at which the meanders would naturally cut through and create the oxbows.

The soil appears to contain some clay and, combined with the gravel deposits beneath, has facilitated the formation of deeper pool areas along the outside of bends by deflecting flows downwards into the river bed, rather than allowing complete lateral scour of the bank (which is still continuing because of the lack of vegetative root

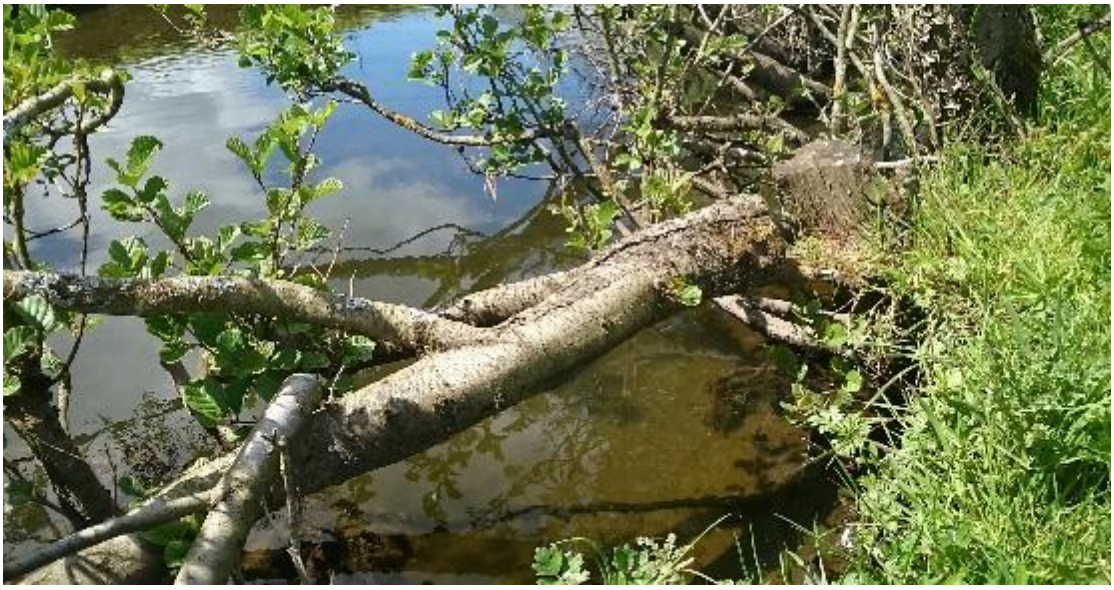


Fig 12. Evidence of previous tree management on Terrace Rigg: hinging of alder and laying the part-cut, living trunk parallel to the water surface and aligned to the flow.

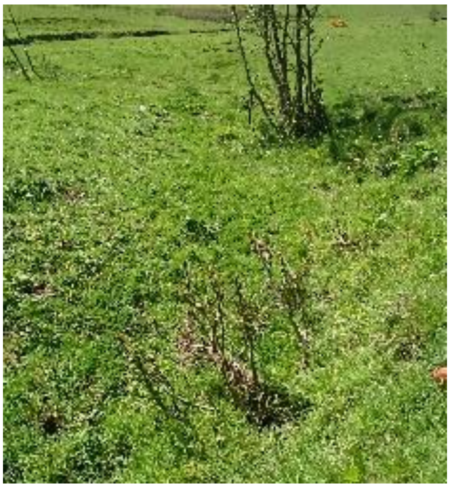


Fig 13. Browsing of self-set trees and inhibition of herbaceous vegetation along an old oxbow on Terrace Rigg demonstrates the capacity of livestock to significantly reduce riparian habitat quality.

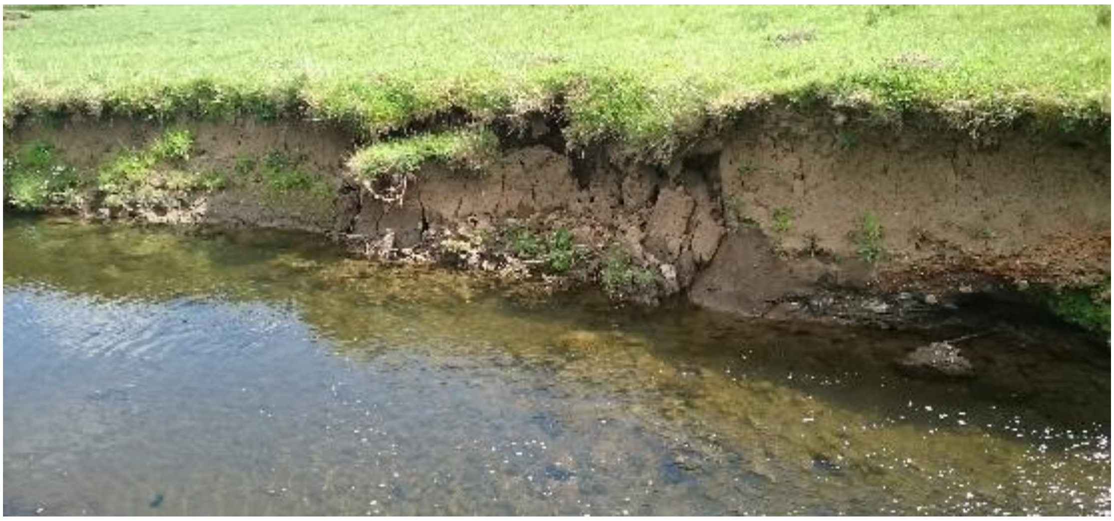


Fig 14. Erosion and block failure caused by livestock grazing and trampling. Heavily grazed grasses divert energy into replacing lost shoots rather than roots so there is less physical structure holding the soil together.

structure). These pockets of deeper habitat are capable of holding adult trout and thus promote angling prospects but the lack of overhanging riparian vegetation or tree cover is hampering colonisation by fish.

One or two of the few trees are in danger of being lost completely (Fig 15). Their root structure has been undermined by livestock access from the field side. Rather than removing these trees, they should ideally be secured *in situ* to provide the function of LWD.

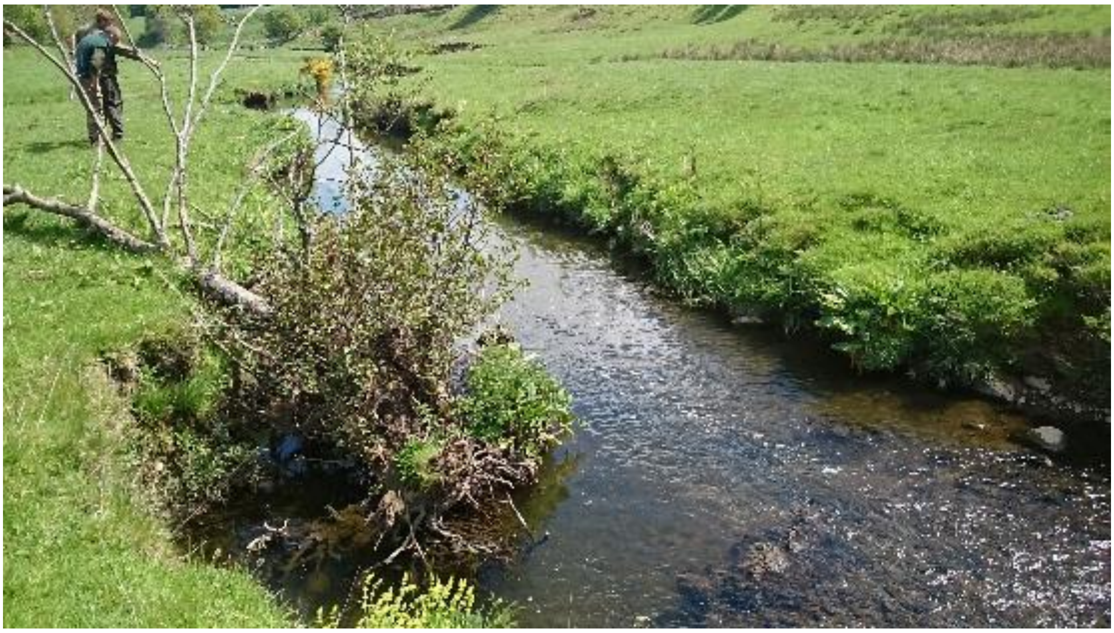


Fig 15. One of the trees on Terrace Rigg in danger of being lost to a future spate. It is still alive and should be secured *in situ* as it provides valuable cover and flow diversion.

Stone turning, and cursory inspection of the emerging insects, revealed that despite the sediment issues on Terrace Rigg, a relatively healthy invertebrate assemblage, including mayflies (Ephemeroptera), caddis flies (Trichoptera), and freshwater shrimps (*Gammarus* spp.), was present in the burn and more than capable of supporting wild fish populations. However, by excluding the livestock and reducing erosion, introducing more LWD, and increasing cover to improve the habitat quality, the density and diversity of the invertebrate assemblage would increase. Minnows (*Phoxinus phoxinus*) and stone loach (*Barbatula barbatula*) were also in apparent abundance, and the former would certainly be preyed upon by adult salmonids. Three loach were observed with fungal growths on the tail, and bloody gills and vents; this could have been related to spawning but should be monitored and reported to a SEPA Fisheries Officer if it continues or worsens.

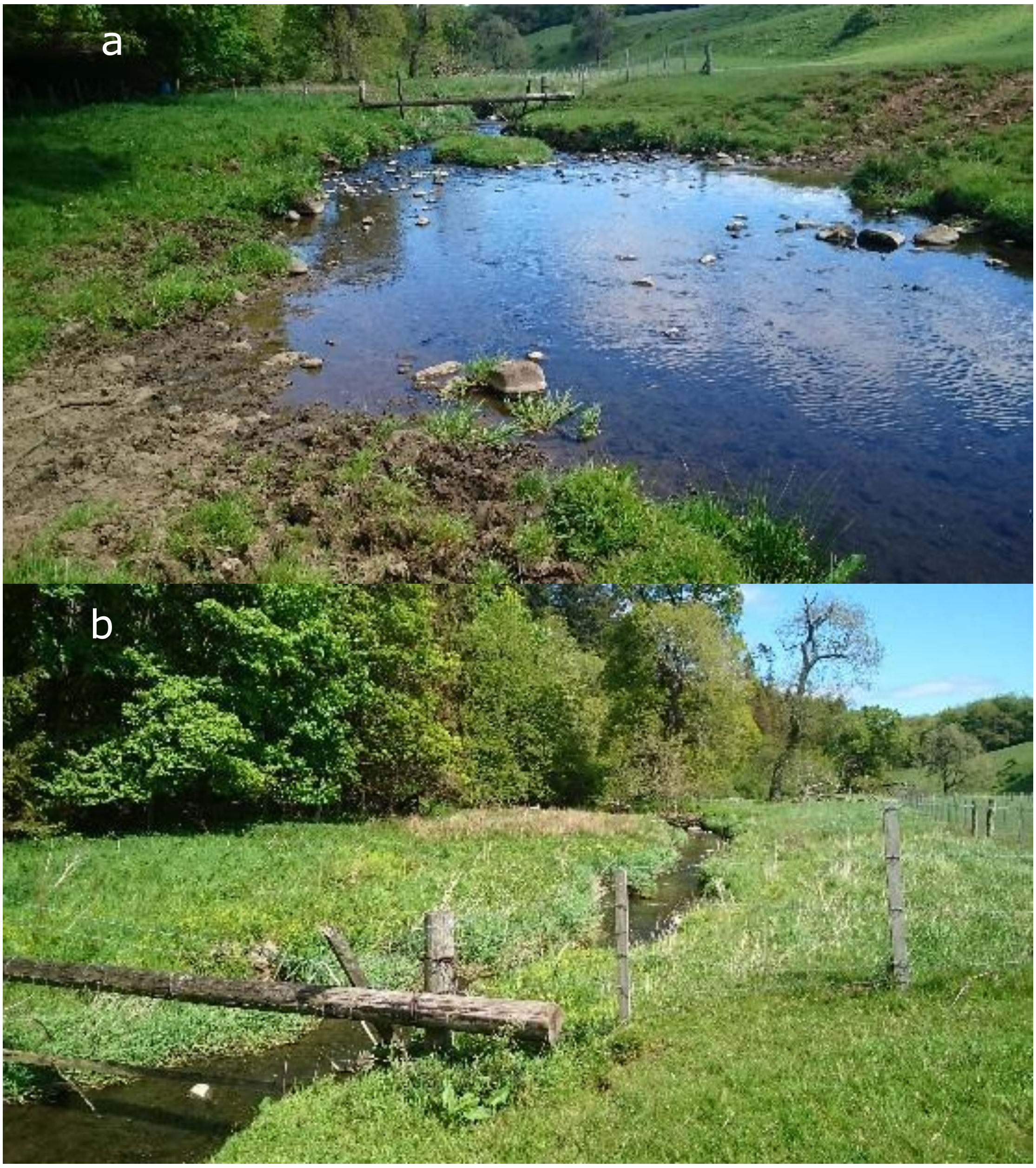


Fig 16. The 'watershed' point at the d/s end of Terrace Rigg: a) looking upstream from the stock exclusion fence the burn is over-wide, shallow, exposed and the riparian vegetation is depauperate; whereas in b) the burn has returned to its natural width and there is plenty of natural vegetation providing cover on the banks.

Fig 16a,b clearly demonstrate the difference livestock access makes to a watercourse. Just u/s of the buffer fencing (while accepting that the channel is stressed by both cattle poaching and its use as a ford for vehicles at this point), the channel is some four to five times the width, and consequently much shallower, than the more natural proportions seen d/s of the fencing. The difference in the diversity and depth of bankside vegetation, and its influence on the margins of the burn, is also readily appreciable in these two images. Several trout were immediately apparent in the first pool within the fenced section d/s of Terrace Rigg.

Indeed, while trout were seen frequently d/s of Terrace Rigg, only one was seen u/s of the Terrace Rigg section (right up until the first major man-made obstruction at NT0574077911). It is likely that the degradation of habitat throughout Terrace Rigg, in conjunction with the impassable bridged weir and sluice upstream, has essentially fragmented the trout population and they appear unwilling to pass u/s through Terrace Rigg to recolonise.

From the buffer fencing at the d/s end of Terrace Rigg to the mouth at Nethermill Bridge, habitat was generally good quality with plenty of in channel features (pools, riffles, glides, and small cascades) created either by LWD or in some cases, especially in the lower reaches, the inclination of the bedrock. Several cascades might appear to be an obstruction to fish passage at the water level seen on the visit (Fig 17 & 18). However, these are natural formations (bedrock and LWD), and the irregularities scoured within the rock make these easier to ascend and descend compared to the flat and/or sheer faces of man-made structures like weirs.

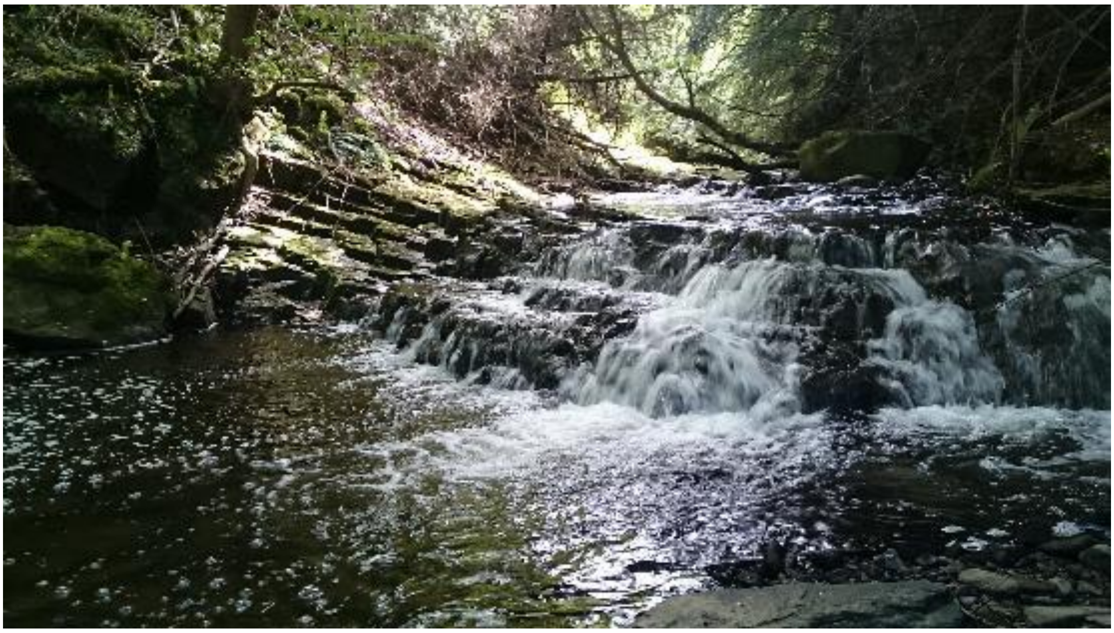


Fig 17. One of the many natural cascades created by the underlying bedrock in the lower section of the Midhope Burn.

The valley becomes quite narrow towards the estuary and the burn is almost wholly under the canopy of mixed deciduous and occasional conifer trees which introduce leaf litter, LWD, and provide shade and cover. Figs 18-20 demonstrate a variety of natural features and it is important to retain this mosaic of habitats to cater for the different life stages of salmonids. Trout were observed throughout the lower section indicating its potential holding capacity. Otter spoor was also noted on a mud bank approx. 500m from the estuary.

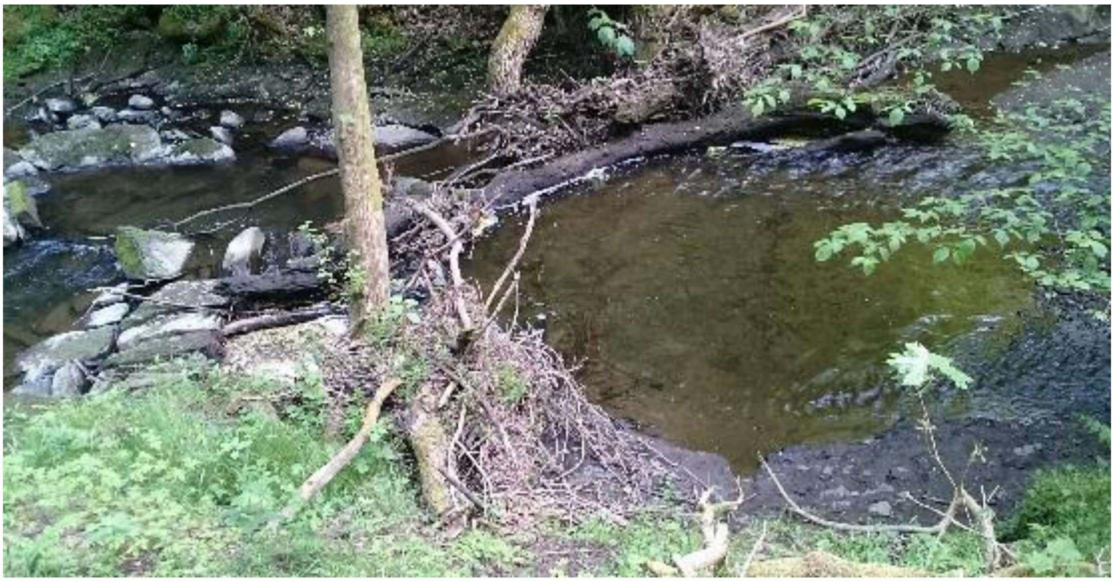


Fig 18. Deeper pool (good adult salmonid habitat) formed by natural accumulation of LWD.

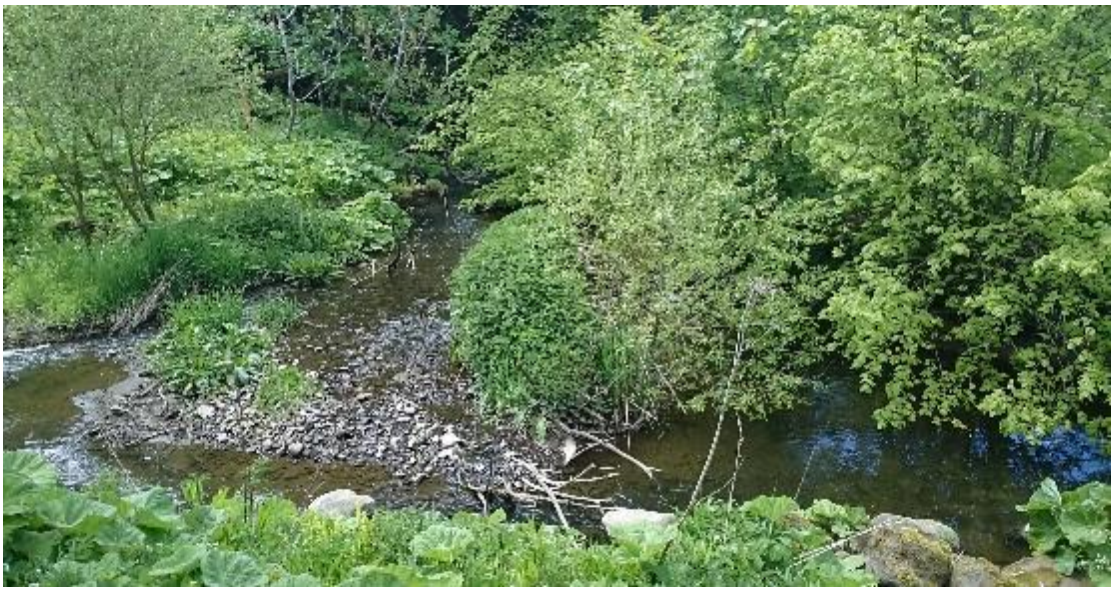


Fig 19. A mosaic of good quality habitat structure in the lower section of Midhope Burn.

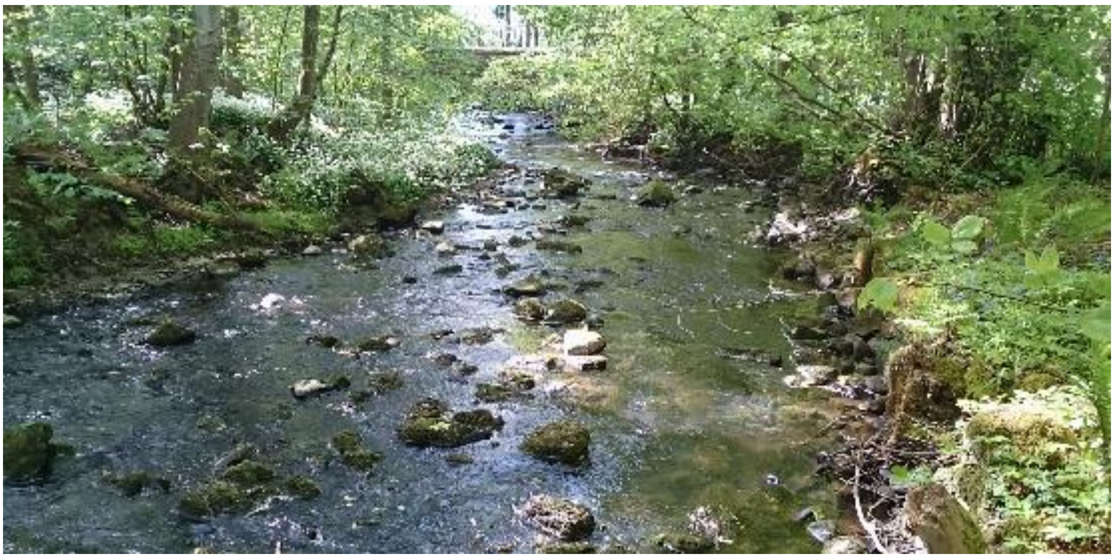


Fig 20. Excellent parr habitat in the Midhope Burn above Nethermill Bridge.

Access to Midhope Burn from the estuary is limited at low water by the local geomorphology i.e. a flat shingle beach over which the burn flows to reach the sea (Fig 21). However, as salmon have been observed in the burn in the past, they can clearly access it at high tide.

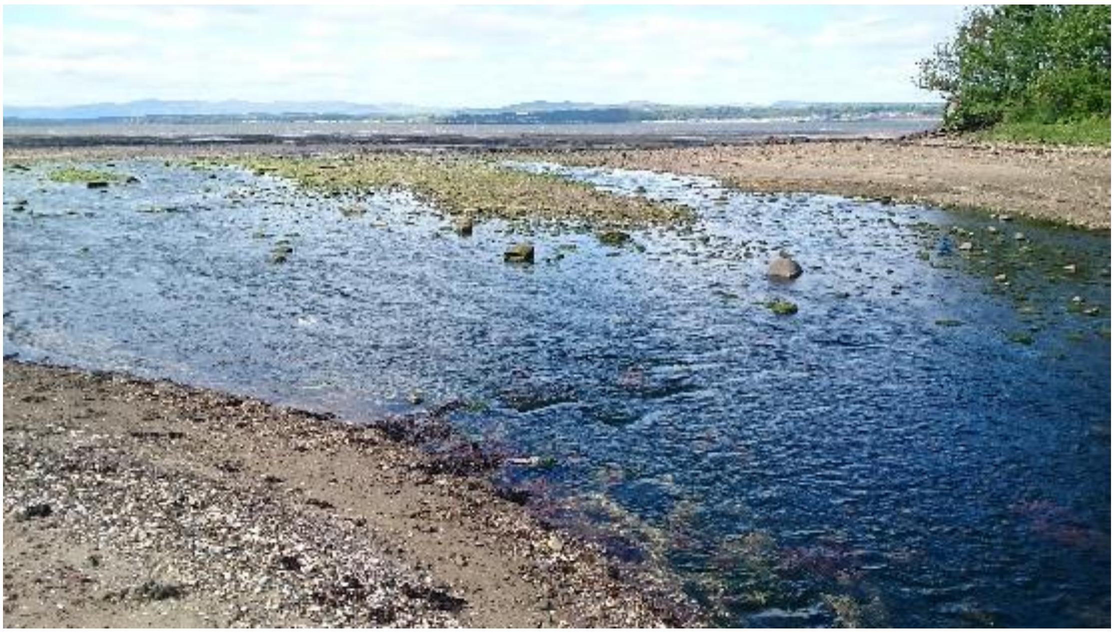


Fig 21. The mouth of Midhope Burn below Nethermill Bridge. Access at low water for migratory salmonids is challenging but sufficient water is clearly available at high tide.

3.2 Problem focal points in the lower section.

While not a major obstruction, the footings of the track bridge by the saw-mill (NT0741978589; Fig22) will pose an obstruction to fish movement under certain flows, particularly for juveniles. There was also evidence of Japanese knotweed (*Fallopia japonica*) here, particularly on the LB.

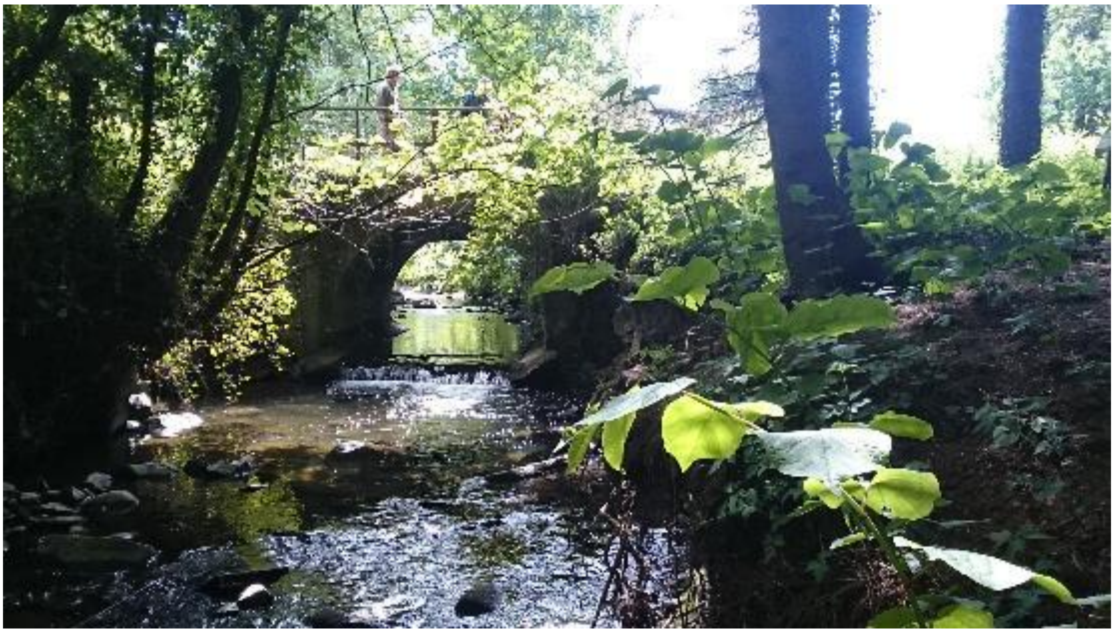


Fig 22. The track bridge at the saw-mill could become a bottleneck for juvenile movement under low flows. Note the Japanese knotweed on the true LB (right of shot).

A small seep was evident on the LB just below the track bridge, with a distinct odour and presence of sewage fungus, implying a pollution source requiring attention.

Two major point sources of pollution were noted: two pipes of 30cm diameter on the LB at NT0795279109 (Fig 23), and a smaller pipe on the RB ~30m d/s (Fig 24), discharging effluent. The former were discharging a considerable volume which seemed to be constant for the 5 minute period it was observed. Sewage fungus was evident across the full channel width within 20m of the pipes (Fig 25) and that, combined with the build-up of solids around the pipes (Fig 23), suggest that pollution has been ongoing for a long period.

These should be investigated as a serious and significant pollution issue.

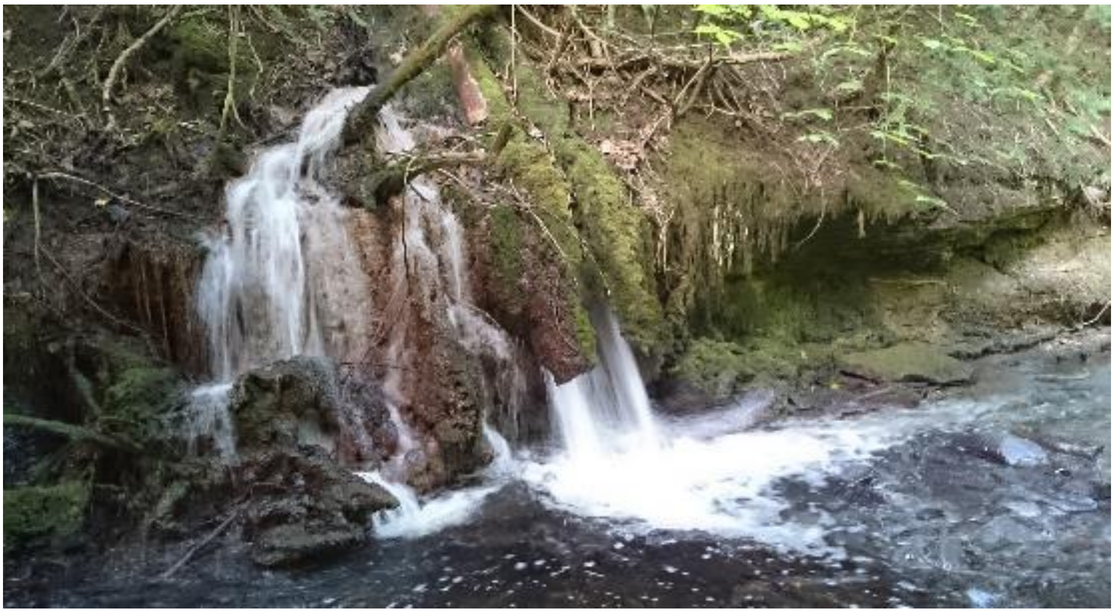


Fig 23. Two large diameter pipes on the LB discharging effluent at considerable rate.

Fig 24. A smaller pipe on the RB also discharging effluent.

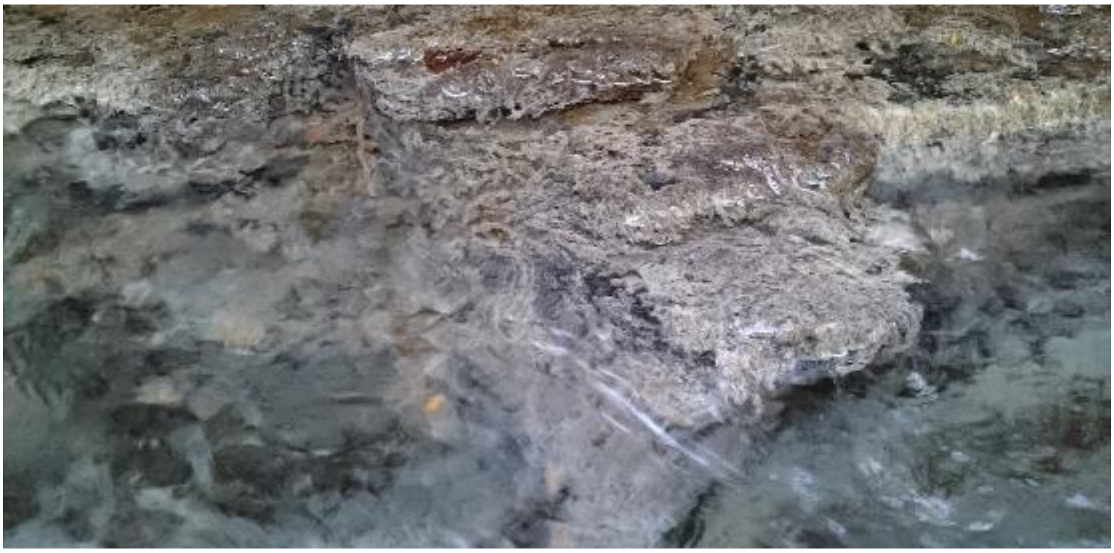


Fig 25. Sewage fungus was evident across the full width of the channel within 20m of the pipes discharging from the LB (Fig 23).

On the RB at NT0804379205, just u/s from Nethermill Bridge, a small tributary enters the burn. It is of a size and gradient, and contains suitable substrate that indicate it might be a useful as a spawning site. However, it is currently inaccessible for two reasons. Its confluence with the Midhope Burn appears to be hampered by a stone building and wall which are now dilapidated. Stone from these structures looks like it is blocking the original channel and the flow has become diverted and braided to such an extent that it is rarely more than a few centimetres deep (Fig 26).

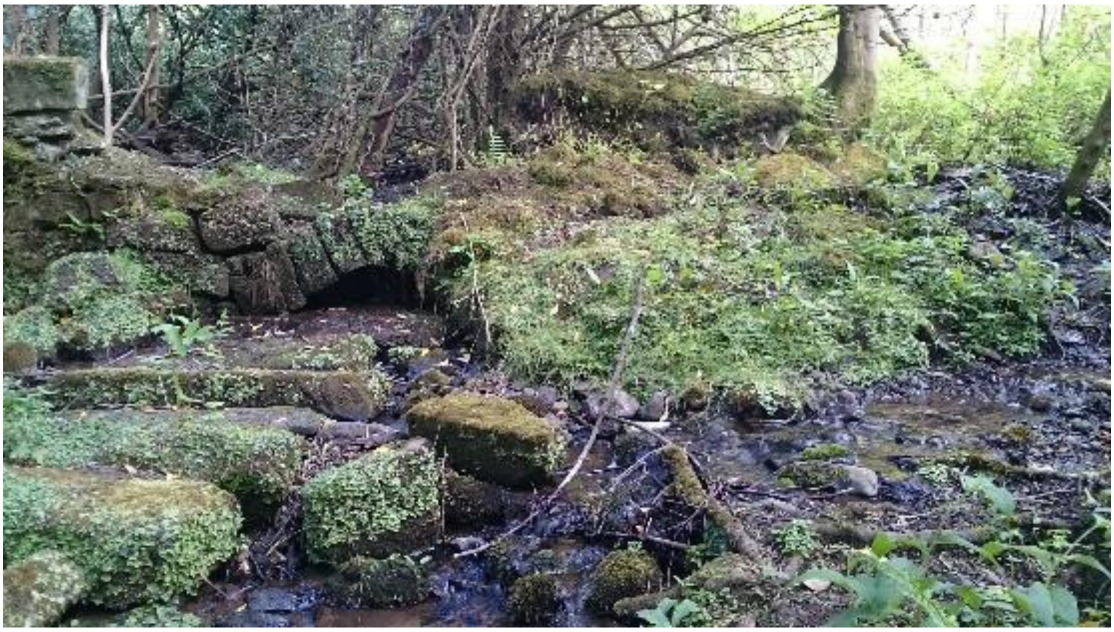


Fig 26. A potential spawning tributary, the mouth of which has been obstructed and braided by stone from a dilapidated building.

The tributary was traced on the u/s side of the building for a distance of ~40m where the second obstruction was found; a culvert under a footpath (Fig 27). The step on the d/s side was not large but the depth of water maintained within the culvert would have been impassable by all but the smallest of fish (which would be unlikely to overcome the step in the first place).

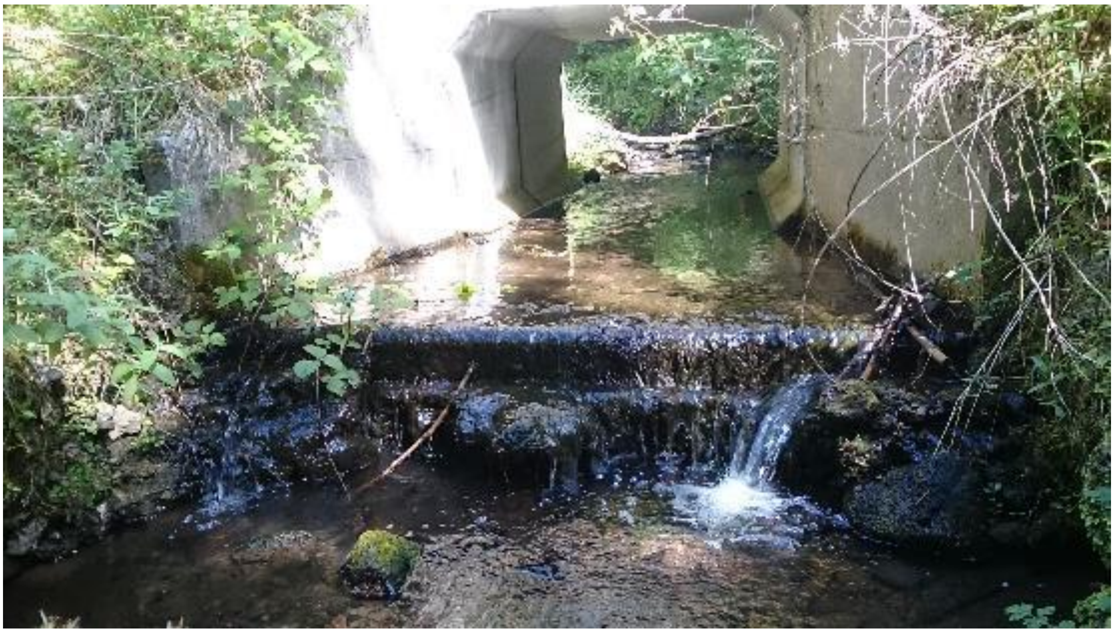


Fig 27. The culvert running under a foot path on the potential spawning tributary close to the mouth of Midhope Burn.

3.3 Point assessments moving u/s from the M9

The double culvert allowing the Midhope Burn to pass under the M9 is obviously quite long and contained insufficient depth of water for fish passage during the visit. However, there is a substantial, man-made pool d/s of the culvert which could be used to increase the mean depth (see Recommendations).

The sections immediately u/s and d/s of the sewage treatment works (STWs) at Philpstoun (NT0420075961) and Bridgend (NT0525077440) were both examined. While both were discharging slightly coloured water to the burn, they appear to be causing no acute problems as evidenced by the frequently abundant and reasonably diverse invertebrate fauna: heptageniid and baetid mayflies, glossosomatid and hydropsychid caddis flies, freshwater limpets (*Ancylus fluviatilis*) and freshwater shrimp. The number of net spinning caddis flies points to lots of particulate material in the water column and the discharges may contribute to elevated nutrient concentrations in the burn, as excessive growth of filamentous algae was observed where light could penetrate to the watercourse. The arable field boundary u/s of the Philpstoun STW appeared adequately buffered by a couple of metres of natural vegetation although the lowest point of the field should be checked for direct runoff into the burn in winter when the crop cover is likely missing (See Fig 28). Again, there was generally good cover from riparian trees, particularly willow.

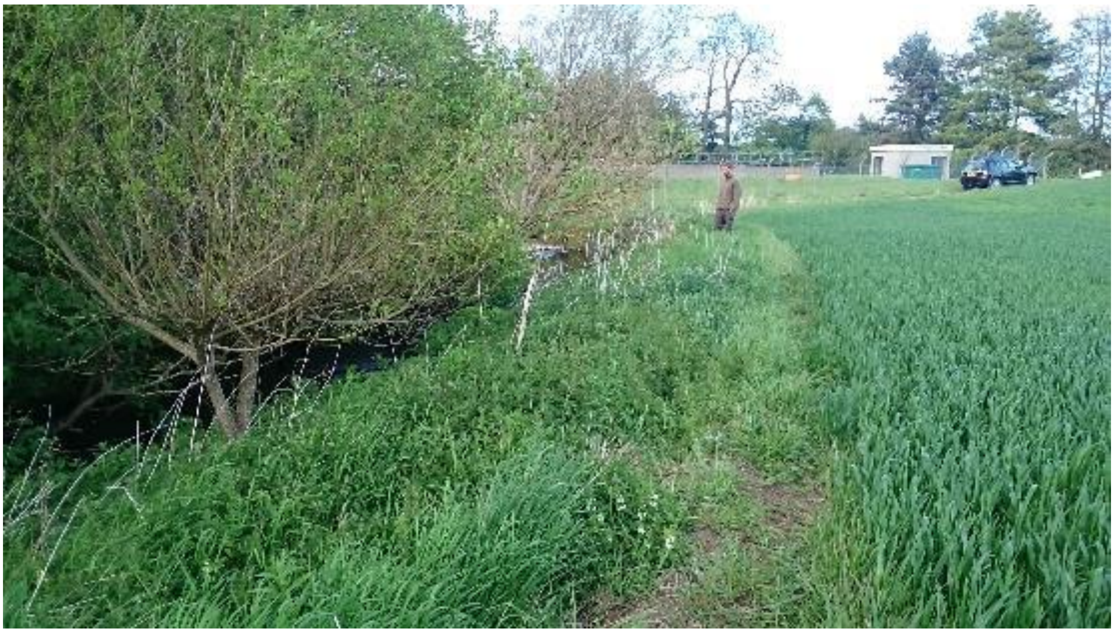


Fig 28. Arable fields border the Midhope Burn u/s of Philpstoun STW (in the background). There is a buffer strip, and the burn is well fringed by willow, but the low point of the field (behind the figure) should be checked for overland flow run-off.

The channelised sections where the burn was forced to travel under the railway, road (several times) and canal aquaduct around Philpstoun between NT0503577240 & NT0493076855Y presented little problem to fish passage as there was a relatively natural substrate present and sufficient depth of water (e.g. Fig 29).

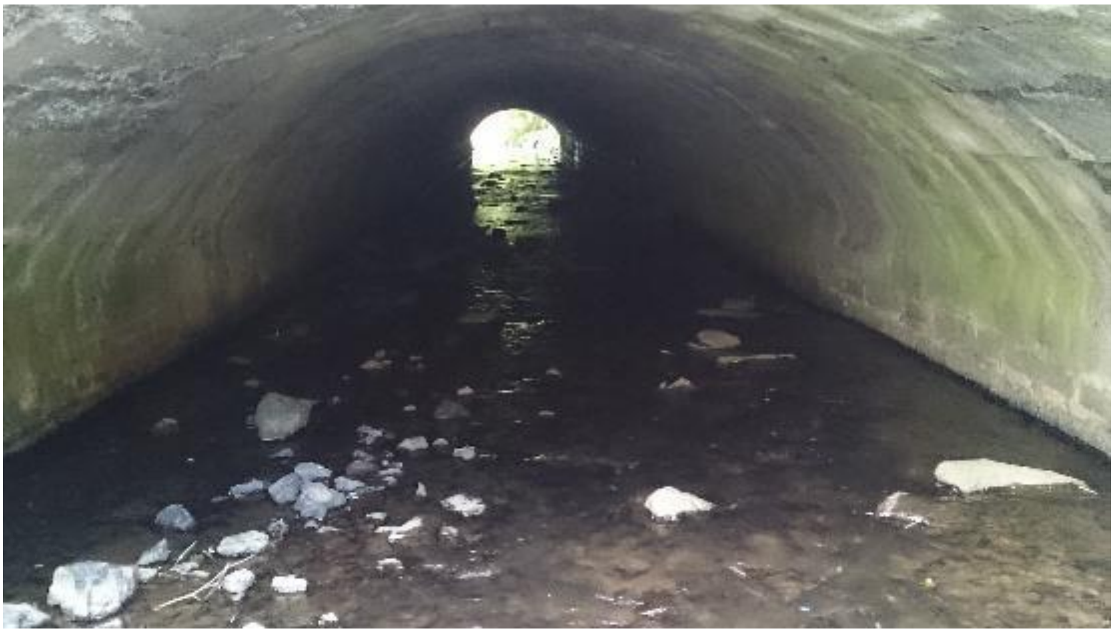


Fig 29. The channelised section of Midhope Burn under the road and the canal aquaduct to the south of Philpstoun provides fish passage due to the 'natural' substrate and sufficient depth of water.

Immediately u/s of the aquaduct, there were ploughed fields on both banks, and while a narrow buffer strip was in place (Fig 30), it had clearly been breached in at least one location, apparently intentionally to remove standing water accumulating in the field at the lowest point (Fig 31). Fine silt was immediately apparent d/s of the breach and throughout this section of the burn.

The natural vegetation within the buffer strip provides bank stability but only where the strip is of adequate width (>2m). Bank failure was evident where the strip was observed to be narrowest (~1m). This was on the outside of a bend and so it is feasible that the river had eroded and hence reduced the width of the buffer strip at that point. However, it would appear prudent to adjust the ploughing of that particular field edge, and hence reinstate a wider buffer strip, as the weight of machinery might soon cause catastrophic bank failure, and / or the slope of the field at that point will soon lead to runoff breaching the buffer (see arrow in Fig 30).

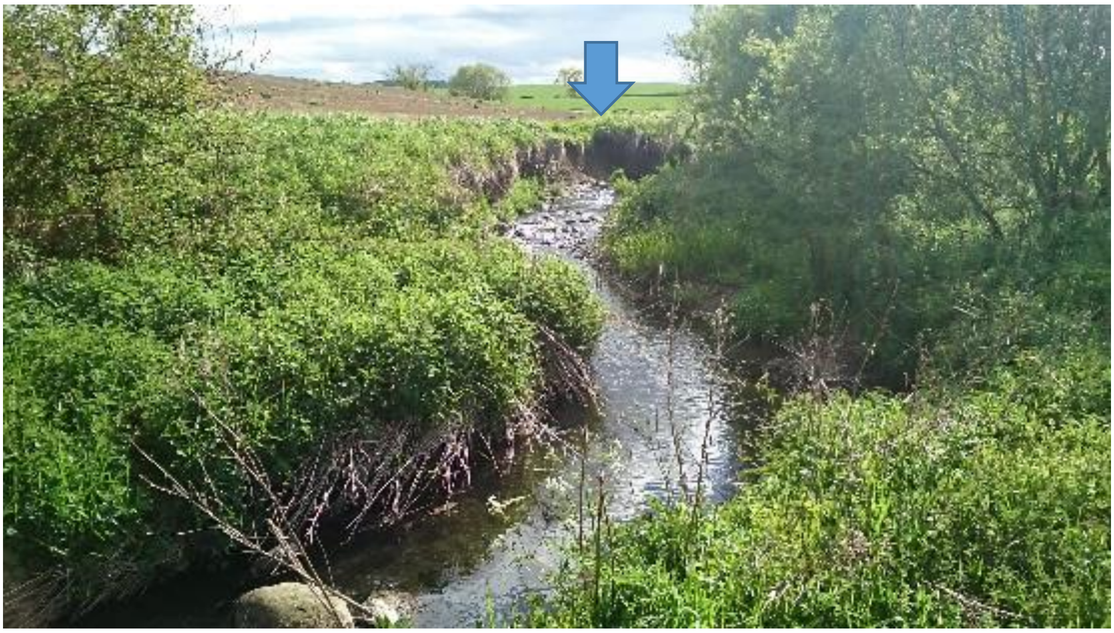


Fig 30. The Midhope Burn winding between arable fields south of Philpstoun. While a buffer strip and reasonable riparian vegetation was evident, in several places it had been breached (see Fig 31) or the strip had been compromised (blue arrow).

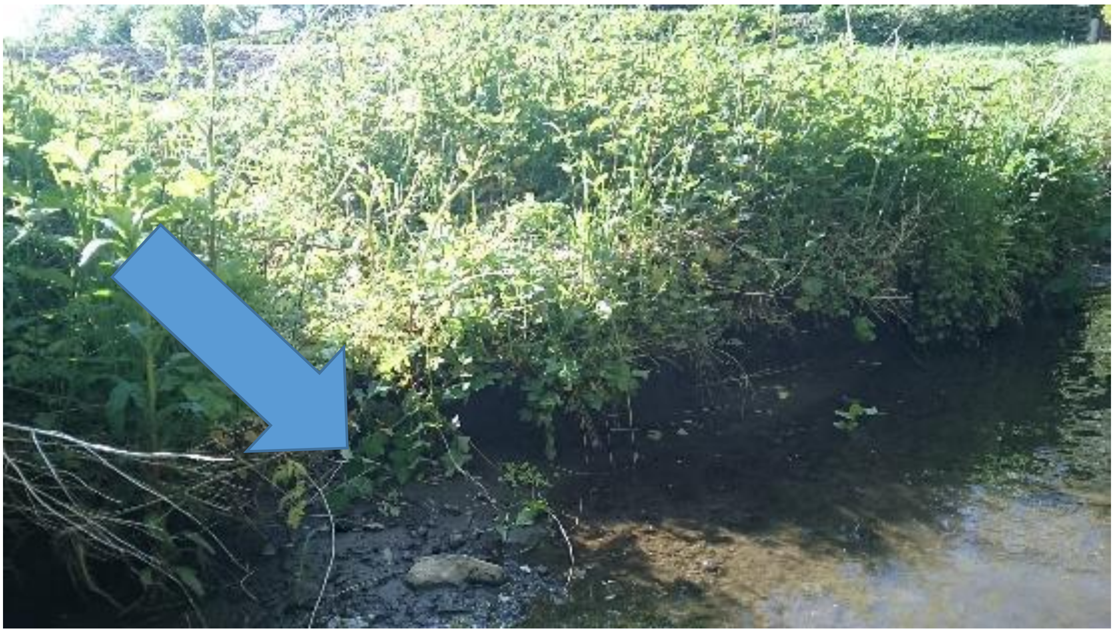


Fig 31. An erosional channel (above the blue arrow) leading from ploughed fields directly across the buffer strip into the Midhope Burn. Silt depositions (at the point of the arrow) indicate overland flow is a source of agricultural fine sediment and nutrients to the burn.

Willows and hawthorn (*Crataegus monogyna*) trees were occasionally found within the buffer strips. More cover and hence salmonid holding habitat could be provided by introducing willow whips at the toe of the banks, with the added benefits of bank stabilisation during spate flows and shade to keep the water cool during low flows. Where already present, pliable species such as willow, hawthorn, hazel (*Corylus avellana*) and elm (*Ulmus minor var. vulgaris*) can be laid into the channel (almost parallel to the bank), like laying a hedge, keeping the shrub alive but increasing valuable low-level and trailing cover. The laying is designed to replicate (but speed up) the natural process which occurs as trees grow and break/fall into the watercourse, thereby ultimately introducing LWD.

At NT0488876281, there is a small field with a relatively low number of cattle. However, despite this low density, the effects previously observed at Terrace Rigg were all apparent: bank erosion due to poaching and grazing, sediment ingress, lack of cover and diversity in the vegetation, nutrient focussing at the food trough situated on the bank.

At NT0438576105, d/s of the B9080 (Bridgend), the burn was again well protected with a wooded riparian strip on the LB and an adequate herbaceous buffer strip provided by stock fencing to exclude sheep grazing on the RB. The piped culvert under the B9080 at this point is long and shallow and a significant obstruction to fish passage (Fig 32). It has not been installed in an environmentally sensitive manner; the groundworks should be over-capacity to allow installation with at least 1/3 of the pipe below the bed level, to reduce unwanted bed scour at the mouth (which can leave the pipes perched), and to allow formation of a more natural bed within the culvert.

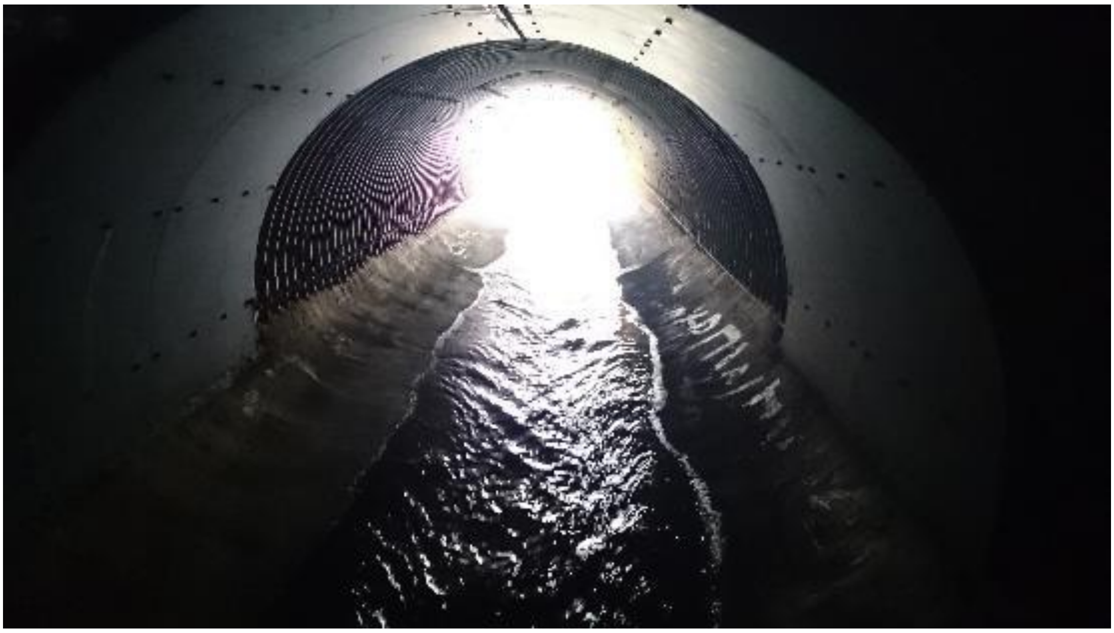


Fig 32. The piped culvert under the B9080 at Bridgend contains insufficient depth of water for fish passage at base-flow.

The burn was examined along the length of the arable field immediately u/s of the B9080. It has been straightened and pushed to the boundary to accommodate a maximum single area of field, and while it has a buffer strip of herbaceous vegetation on both banks, it is lacking tree cover along the length of the field margin.

The introduction of goat willow whips (*Salix caprea*) would be the obvious choice in this section as they remain small and bushy. In several reaches, there are lots of tyres in the bed of the burn which should be removed. The source might be the next location.

On the RB at Bridgend (NT0420075961), there was recent evidence of dumping of material (soil, tarmac, concrete) to 'create' land, which is sloughing into the burn (Fig 33). In addition to the impact of the material, it may also be leaching hydrocarbons and other noxious compounds into the watercourse. This is probably in breach of SEPA regulations and should be brought to their attention. That material also appears to be the source of the Himalayan balsam that was observed throughout the d/s section, as none was found u/s.

The same property should be checked for adequate drainage from all the farm outbuildings that looked like they held livestock. The slope of the land would lead any waste from those buildings directly into the burn over the unconsolidated material mentioned above (see Fig 33).

Fig 33. Unconsolidated material (tarmac, concrete etc) sloughing into the Midhope Burn from a property in Bridgend. There is apparently nothing to stop waste from the outbuildings being washed directly into the burn (see arrow).

The most u/s point visited was Bridgend Golf Club, which is very likely to have been an historic source of sediment to the burn during construction, and its current drainage system should be inspected. The newly dug channel in Fig 34 is a significant erosion risk and further sediment source. The burn was sluggish at this point and provided little habitat of a suitable quality for salmonids.

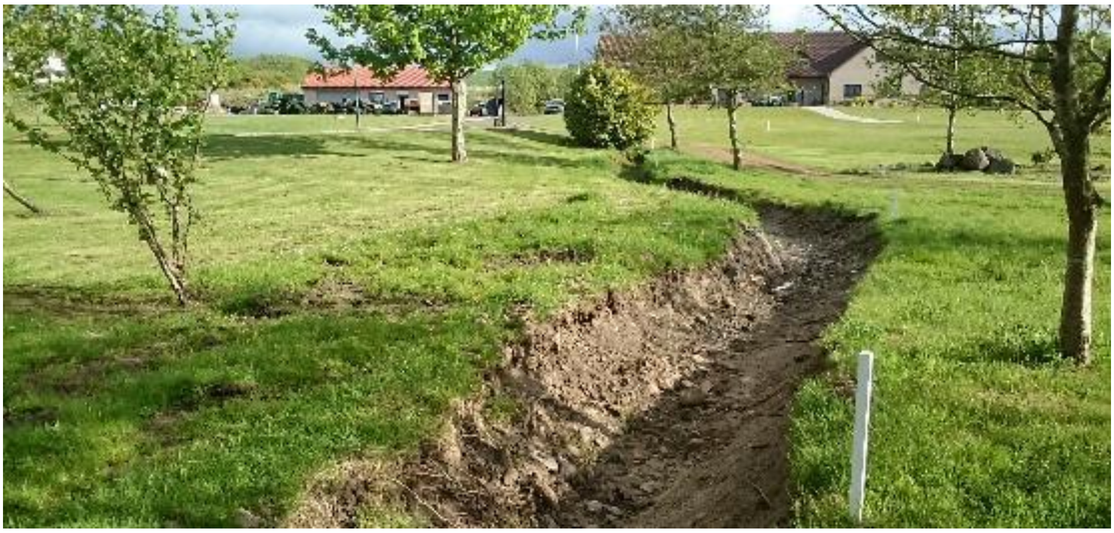


Fig 34. A potential sediment source to the Midhope Burn from drains at Bridgend Golf Club, the most upstream site visited.

4.0 Recommendations

There is enormous potential to enhance the Midhope Burn as the raw ingredients are *in situ* to support excellent wild fish populations. It is only the habitat which is underperforming, and so it is recommended that effort is directed to, and funding sought for, habitat restoration on the land of Hopetoun Estates.

4.1 Fencing

Preventing livestock from accessing the riverbank is one of the three greatest improvements that could be made to habitats on the river; the others being dealing with obstructions to fish passage and the ubiquitous sediment inputs. As such, erecting fencing to completely exclude livestock from the burn and protect buffer strips will be key to major improvements in wild fish stocks. Of course, this may require mains water, solar pumps (Fig 35) or pasture pumps (Fig 36) to supply drinking water. Watering points should be sufficiently removed from the watercourse so any poaching that develops around the focal point does not act as a source of sediment.

The existing lengths of fencing should be maintained/improved to ensure that they continue to fully exclude stock, particularly sheep (in the upper reaches towards Bridgend) which will gain access through the smallest of gaps. Sheep, although small, can cause significant issues due to 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 an animal husbandry perspective as well. Some incentives may be required (possibly available through agri-environment schemes).

It is recommended that the Forth Fisheries Trust is contacted as an ally in initiating any fencing schemes. The Trust staff have an understanding of the potential funding that may assist with the cost of fencing and are likely to be involved with similar work in the wider catchment. It would also be beneficial to include the SEPA in any discussions as they too may be able to find funding.

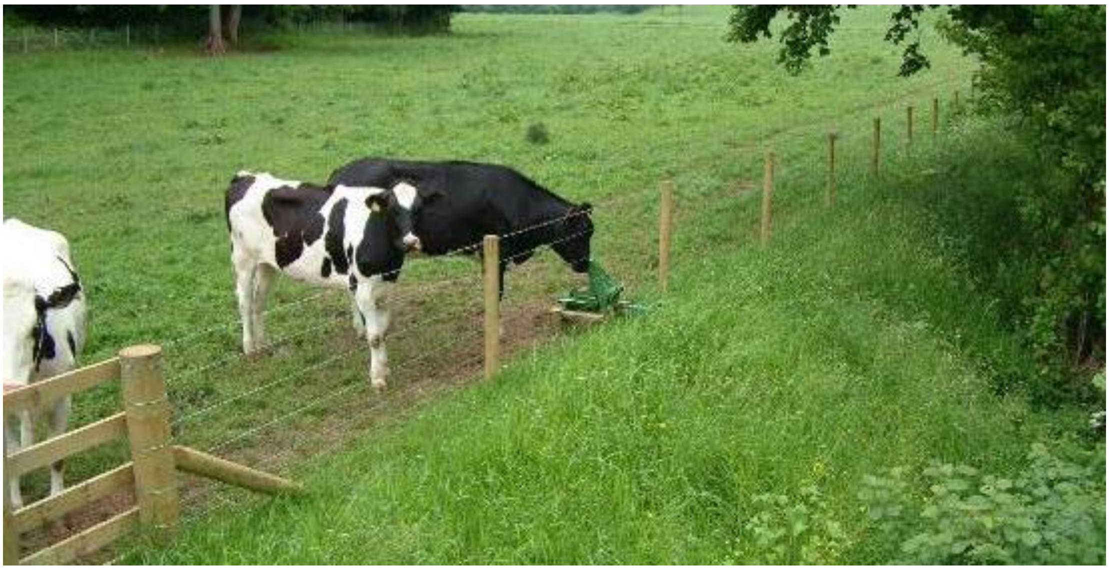


Fig 35. Cattle excluded from a river bank and drawing water from the river via a pasture pump which they activate themselves by pushing it with their noses.

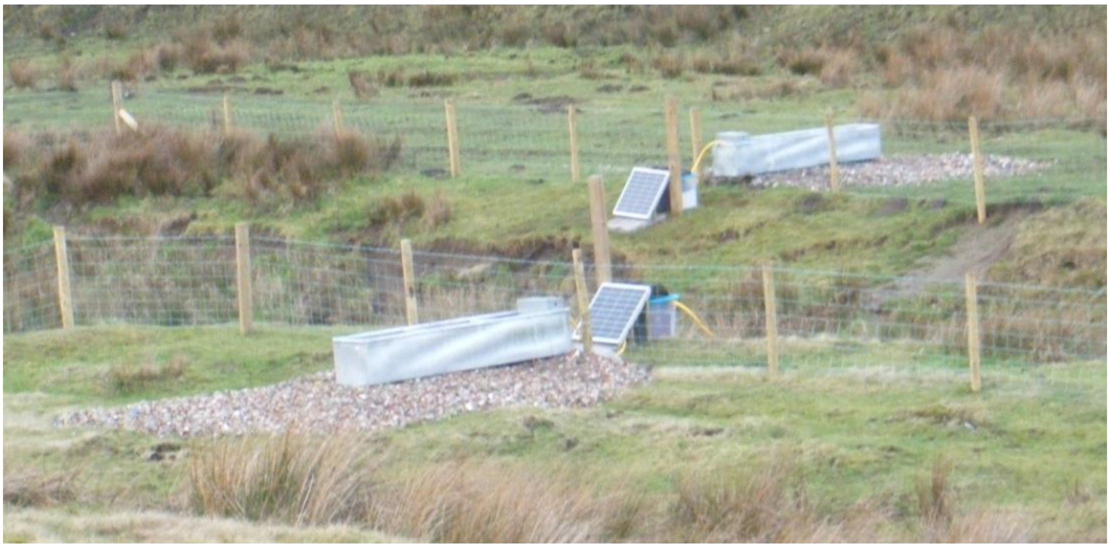


Fig 36. Solar-powered pumps used to fill water troughs. Image courtesy of Ribble Rivers Trust.

4.2 Fish passage improvements

Removal of any redundant obstruction, be it a weir or culvert, is always greatly beneficial to both river geomorphology and ecology. It is not only migratory species that require passage throughout a system. Barriers prevent upstream migration, to take advantage of spawning and juvenile habitat, but also prevents fish from downstream (and to a certain extent upstream) moving into the reach to take up new residency, which is one of the ways riverine fish stocks naturally achieve optimal habitat use.

The lowest major obstruction on the Midhope Burn was the sluice and weir combined beneath the old mill pool bridge at Binns Mill (Fig 6). The remaining weir appears to be purely aesthetic and could be partially or fully removed with little obvious consequence apart from redistribution of the accrued sediments in the mill pool to further downstream. It was noted that some renovation of the weir and bridge structure had occurred (possibly by the National Trust?) but the footpath leading over it was clearly not in regular use. The owner should be approached with regard to potential removal of these limiting structures.

Weir removal is likely to be costly (£5k-20k depending on contractor and how the process is managed), but funding *may* be available through the SEPA or the local Rivers Trust to assist, and it should be recognised that the structures are a long term liability that will degrade over time, potentially causing greater issues in the future.

If removal of the weir is not acceptable, work to ease fish passage should be undertaken. Since the mill pool has long since filled with accumulated silt, improvement could be made by removal of the sluice board on the u/s side, which would probably only result in the burn adjusting its bed by cutting slightly deeper into the accrued silt. This would preferably be done in conjunction with the installation of a rock ramp on the d/s side of the weir, to gradually bring the bed up to the level of the weir; however, this option is also likely to be quite costly. Alternatively, the sill on the d/s side should be baffled and the water level immediately below should be raised via a series of resting pools, which could quickly be achieved using some of the large stone already available in the current weir pool. It should be noted, however, that these options can never be as effective and beneficial as full removal.

Access to the culverts under the B9080, the M9, the footpath on the tributary near to Nethermill Bridge, and indeed the track bridge at the saw mill, could be improved in a similar manner to the sluice at Binns Mill (above); with remedial structures downstream. The overarching problem is that at low flows when fish could potentially overcome the flow velocities and swim up them, the water depth is generally insufficient. At each of the sites listed, there is sufficient space immediately downstream to back-up the water (and hence increase depth throughout the obstruction) via a series of breachable cascades / holding pools using locally won materials. Any such structure should allow a full-depth notch (down to bed level) at some point, to allow the passage of sediment and smaller fish. This approach should not have any associated flood risk but all instream works such as this need consent from SEPA.

Baffles within the shortest culvert and under the track bridge could also be employed to increase the water depth and dissipate flow energy but would require monitoring and occasional maintenance to remove any accrued obstructions; see Fig 37.

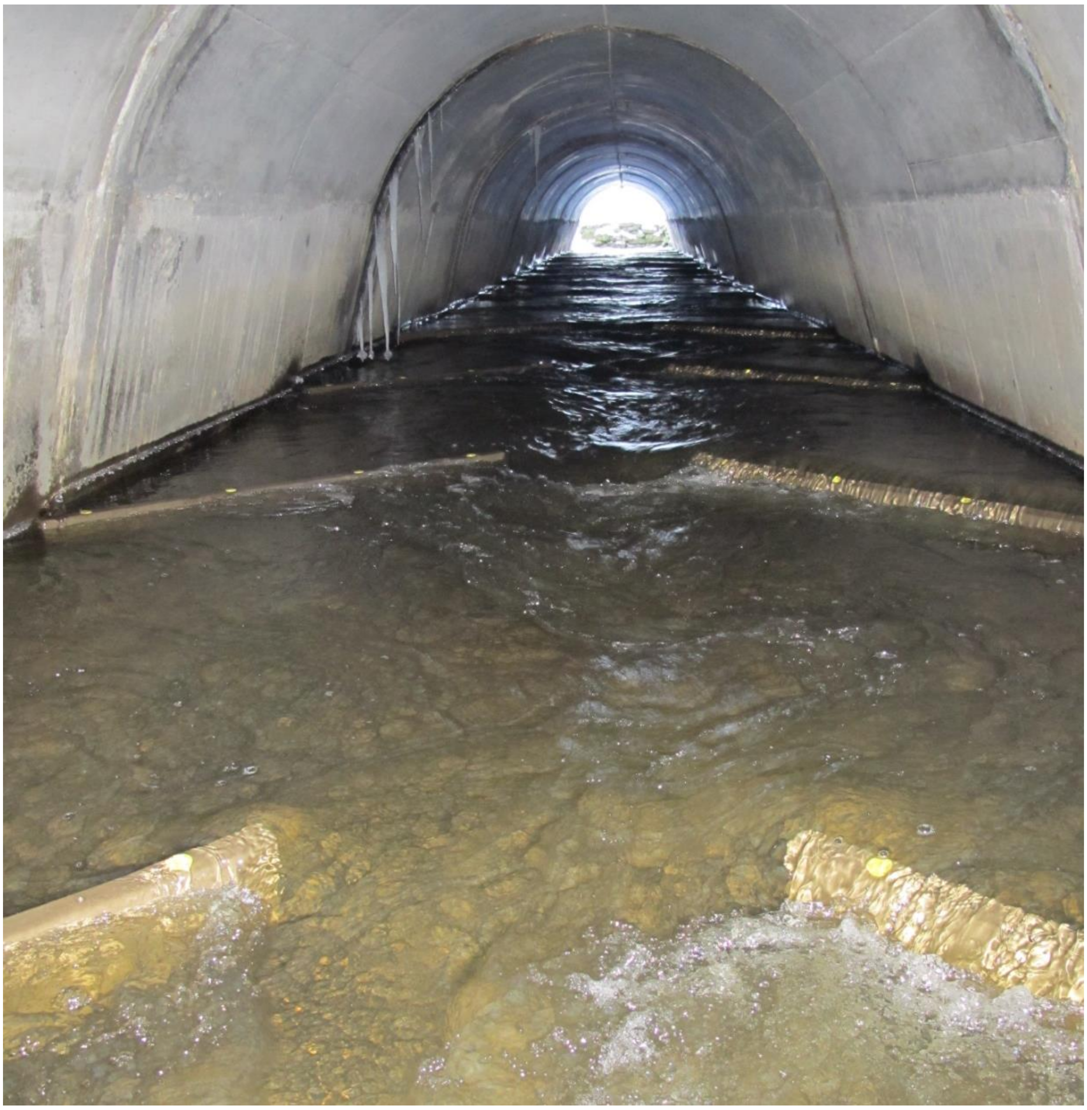


Fig 37. Baffles installed into a culvert on the Cong Burn. Image courtesy of Gareth Pedley

Redefining the mouth of the potential spawning tributary just u/s of Nethermill Bridge on the RB (Fig 26) would be beneficial for resident and migratory spawners alike. The majority of the lower section of Midhope Burn is constrained within a steep valley and does not typically retain much gravel of a suitable size (10-40mm) for resident brown trout, whereas the small tributaries do. Hence, rehabilitation of this small tributary at the lower end of the system means residents need not travel so far upstream to locate suitable spawning habitat. To initiate this, the original channel should be located and any stone obstructions from the dilapidated building removed. Channel modifications to accommodate the footpath alongside the main burn should also be checked so that the confluence is unobstructed. To make this work worthwhile, the issue of fish passage at the culvert under the footpath (already mentioned above) needs addressing too.

4.3 Tree Work

4.3.1 Planting

The majority of Midhope Burn has good cover from appropriate native trees. Planting is recommended wherever there is a lack of low cover and structure along the river margins, which on the Midhope Burn is only through the fields that have been subject to cattle access (particularly Terrace Rigg), and in the buffer strips of some of the arable fields between Philpstoun and Bridgend. It will be of particular use 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, as without it, any planting is likely to be eaten off by livestock.

The quickest and easiest way of planting is with willow, by pushing short sections of willow whip into the ground. 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.

Small bundles (faggots) of freshly cut willow can also be employed to rapidly increase marginal cover. If they are staked to earth sections of river bank, along the waterline, they have a good chance of rooting and becoming valuable, dense cover.

4.3.2 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 been attempted by someone in the past (see Fig 12). The method is usually limited to 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 into the channel (Fig 38). 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 and maintain the health of the tree/shrub.

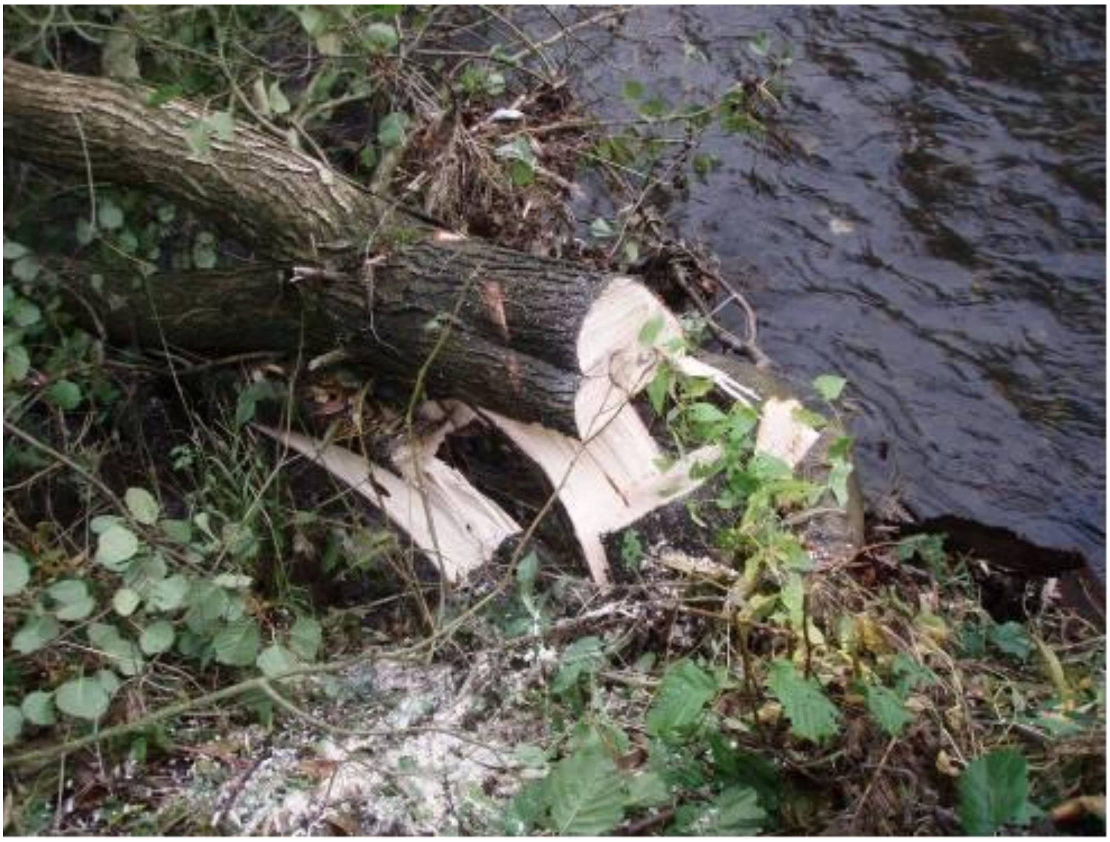


Fig 38. An example of hinged willow.

4.4 Pollution

As mentioned in the Assessment part of the report, the two major sets of pipes introducing a considerable volume of effluent should be reported to SEPA, as should the land management problem at Bridgend.

4.5 Invasive species

Himalayan balsam was present d/s from NT0420075961, particularly in the deposited sediments of the historic mill pool u/s of Binns Mill (NT0574077911). Japanese knotweed was apparent at the track bridge (NT0741978589). Both require a concerted effort to control, starting at their u/s extent to prevent recolonisation. Unchecked, they cause erosion problems and reduced invertebrate abundance and diversity. The logical start is to address whether the land management problem at Bridgend is the source of the balsam.

Mink spoor and one individual was seen. The Estates keeper seems to be quick to control these which should be commended.

4.6 Fish stock management

It should be noted that during the day of the Advisory Visit, many trout (up to 35cm) were observed in the lower section, where the habitat and connectivity was good. Sea trout and salmon have been observed in the burn in the recent past. The elements are all *in situ* for a wild fishery to flourish so long as habitat improvements are made on the degraded sections to form contiguous good habitat, the fish passage is improved at current bottlenecks, and measures to reduce further silt ingress are put into place. There is no need to stock the burn. Indeed, it is likely to be counter-productive.

The native trout populations of Britain possess great genetic diversity, making them amazingly resilient to changing environmental conditions and able to adapt to a wide range of habitats. This has enabled them to thrive in our rivers since the last ice age (without human interference) and they should continue to do so in the future if we can limit our impact upon them and their habitats. However, in the latter part of this period (50-100 years), the human impact upon those fish populations has increased exponentially, with major issues arising from the way in which we manage riparian land (e.g. significant intensification of agriculture) and how we manage rivers (e.g. dredging to increase flood conveyance, and denuding vital habitat to reduce perceived flood risk or to ease angler access to rivers). All of these factors have a significant detrimental impact on the wild fish populations that rivers can support.

To compound the habitat related issues, direct interference with wild fish populations also increased, with large numbers of hatchery fish introduced to rivers. Stocked fish (both diploid and triploid) are affected by domestication and unnatural selection, even within one generation in the hatchery (<u>so this includes fish from wild brood-stock schemes</u>). Having grown and survived in an unnatural captive environment (concrete raceway, earth pond or tank) they are poorly adapted for the very different conditions of a natural river. Adaptation to a farm environment is cumulative, with the wild traits (genetic diversity and behaviours), and survival rates in the wild decreasing with each generation in captivity. The forced mating that occurs in a hatchery also bypasses vital chemical and visual aspects of wild sexual selection that exist to ensure mate compatibility and maximise the fitness of wild fish.

It's a *'catch 22'* situation: if stocked fish don't survive long enough to reproduce in the wild, or are infertile (triploids), they are just an additional impact upon the ecosystem (as the river only has a limited amount of resources: food and space); if they do survive long enough to breed then they have the potential to suppress wild fish production through 'hybridisation', as their offspring (<u>including crosses with wild fish</u>) have much poorer survival than the native, wild fish.

Well managed, natural river habitats (without stocking) have a far greater capacity to produce and support healthy fish populations, at all life stages. From emerging out of the gravel, wild trout disperse throughout the available habitat to find territories appropriate to their individual size and dominance. They constantly compete to maintain a 'pecking order' which ensures the dominant fish maintain priority over the best lies, where drifting food is the easiest to intercept for the least energy expenditure. They will remain (often for years in the case of a large, dominant fish) until displaced by another more competitive individual or until they die (or are removed).

This ensures that the available habitat is always used to best effect. In addition, as salmonid survival is density dependant, the greater the habitat variation and abundance available (cover and in-channel structure), the greater the number of trout that will survive each year and the more fish a reach can hold. For this reason, maximising the occurrence of those features and avoiding unnecessary tidying/pruning ensures that the river holds the maximum number of fish possible under the given conditions (something not possible through stocking).

In contrast to wild fish, stocked fish are often transient and select less energy-efficient lies; they, therefore, lose condition and tend to leave or die within a few months (sometimes weeks) of being stocked. In the meantime, however, they cause increased competition and potentially displace wild fish.

It must also be remembered that, even without stocking, the river will be naturally re-populated. Wild trout spawning and recruitment means that new fish are produced within, and enter into a river section each year for anglers to catch. These new naïve fish may often be the smaller ones, but the overall greater population resulting from appropriate management will provide sport for fish of all sizes.

Note that introducing stocked fish can easily disrupt this balance: the habitat required for five 0.5kg stocked fish may have originally supported many more wild fish, in a range of sizes from parr upwards.

Although it may appear counterintuitive at first, for all of the above reasons, stocking can often lead to less fish within a river by suppressing the wild population (particularly if undertaken year upon year), whereas wild fisheries have the potential to support much greater overall fish populations. Consequently, most angling clubs actually report increased catches after ceasing stocking (see the many case studies that are accumulating on the WTT website link below).

To further safeguard natural fish populations, catch and release fishing is advisable, for both resident and migratory species. This need not be mandatory but will greatly assist in preserving valuable wild spawners and improving salmonid production. Consider the fact that the larger, 'trophy' fish caught may have taken several years to reach that size but possess the characteristics necessary to survive well in the wild. If these fish are returned, they have a good chance of attaining even larger size and reproducing many times, further enhancing angling opportunities.

A detailed, referenced explanation of this rationale can be found on the Wild Trout Trust website in the Trout Stocking section (www.wildtrout.org/content/trout-stocking).

More information on the measures discussed and many other enhancement and restoration techniques can be found in our various publications on the Wild Trout Trust website, under the library tab (http://www.wildtrout.org/content/library).

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 land drainage 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

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 WTT would like to thank the Environment Agency for supporting the advisory and practical visit programme in England, through a partnership funded using rod licence income.

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.

Advisory Visit: Executive Summary

Midhope Burn

26/05/2015

This summary is the output of a site visit to the Midhope Burn, Hopetoun Estates, requested by Donald Noble and undertaken by Jon Grey & Gareth Pedley of the Wild Trout Trust.

Normal convention is applied with respect to bank identification, i.e. left bank (LB) or right bank (RB) whilst looking downstream. The Ordnance Survey National Grid Reference system is used for identifying locations.

The burn was examined at specific points (bridges, culverts, sewage treatment plants etc.) from Bridgend Golf Course (NT0394175699) to the confluence with Errick Burn (NT0558677889) and then walked from that point, downstream, to the mouth at Nethermill Bridge (NT0798679299). Land use, fish passage, invertebrate life, river bed integrity, fish cover, and fish presence were noted.

In general:

- Where natural bankside vegetation or adequate well-protected (fenced) buffer strip to exclude livestock from the watercourse was present, fish habitat was good.

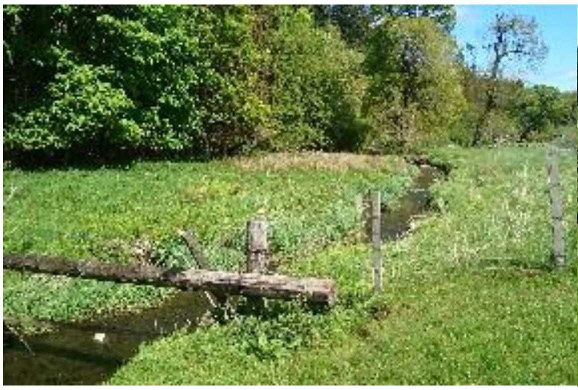
- The abundance of instream woody debris is to be commended.

- There appeared to be sufficient 'fly' life to support resident salmonids as evidenced by emerging adults and manual stone turning.

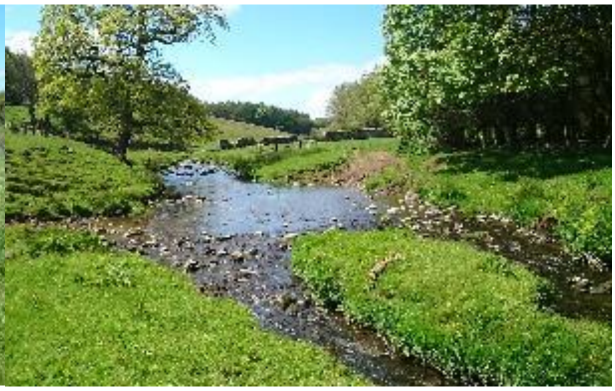
- **However, salmonid numbers appeared well below potential capacity** given the above. There was a clear 'watershed' point at NT0677278169, the downstream end of Terrace Rigg: below the livestock fencing, trout were present and easily seen; above, they were virtually absent (only one seen).

See overleaf for pictorial evidence:

Watershed point



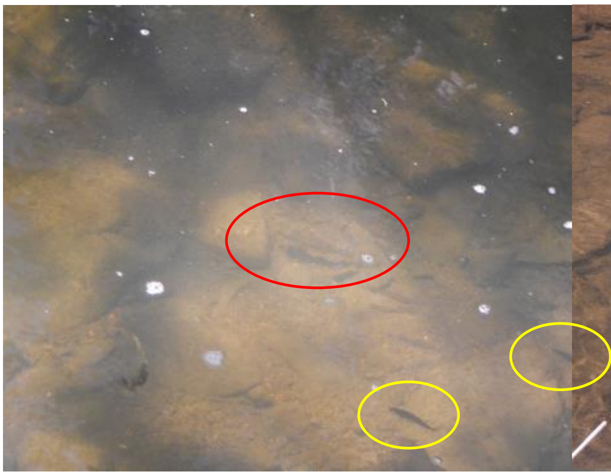
NT0677278169 looking downstream:
Buffer fenced to exclude livestock
Channel width appropriate for flow
Intact, diverse riparian vegetation
Instream woody debris
Salmonids present



NT0677278169 looking upstream:
Accessible to livestock
Excessively eroding banks
Channel overwidened and greater deposition of silt
Lack of instream and bankside cover
Salmonids virtually absent

Evidence of resident salmonids in the livestock excluded section.

NB the excess fine sediment smothering the bed in both of these photos



Red oval identifies a trout parr. Yellow ovals identify minnows.

Red oval identifies a large, adult resident trout of ~35cm.

Key Findings:

The main concern is sediment ingress throughout the burn. Fine sediment fills the gaps between larger gravels and cobbles, and smothers aquatic plants, creating a uniform, featureless river bed. Under such conditions, salmonids struggle to reproduce successfully as they require access to clean, well-oxygenated gravels for spawning. Sediment in Midhope Burn has been accruing for considerable time and from multiple sources. Potential spawning gravels were seriously compromised wherever tested; there was a fine covering in all but the fastest-flowing sections, and the gravels felt compacted underfoot. As sediment was present at the most upstream site visited, there is clearly input from the field drains that form the sources of the burn (evident on the OS map) and the standard farming practice of dredging those ditches is likely to present an ongoing and problematic sediment input. Historical inputs will include, for example, the development of the golf course at Bridgend. However, there are numerous current inputs that can be addressed.

1. Dumping of material (soil, tarmac, concrete) on the RB at Bridgend (NT0420075961) which is sloughing into the burn. This is probably in breach of SEPA regulations and should be brought to their attention. That material also appears to be the source of Himalayan balsam on the burn.
2. Arable fields bordering the burn between Bridgend NT0420075961 and the M9 culverting (NT0548077556) should be checked for adequate buffer strips, especially at lowest points where run-off from the field will collect against the burn side.
3. Livestock access: cattle at NT0488876281 and NT0641078218, Terrace Rigg (see below)

Livestock access. Habitat in the two fields under cattle grazing is heavily compromised due to stock access along the river bank. One aspect is sediment ingress - cattle access points are heavily ‘poached’ and the pathways to those access points act as focal drains, transporting sediment from the field to the burn. The second aspect is bankside (riparian) vegetation - grazing reduces the diversity of plant species and limits the root depth of marginal plants. Natural regeneration of trees along the banks is also prevented as these are targeted for their nutritional value. Loss of such plants impacts in many ways, the main ones being:

1. Loss of bank stabilisation via plant roots leads to increased susceptibility to cattle poaching and excessive erosion during spates.
2. Loss of cover from bankside vegetation leads to lower habitat quality and a lack of safe lies (from predation or spate flow) for trout of all life stages.
3. Loss of inputs of large woody debris (to diversify flow and form instream fish lies) and leaf litter supporting many invertebrates (i.e. trout food).

As a result, the channel is overly wide in these sections, further exacerbating the deposition of sediment as flow energy is dissipated.

Fish passage. Access from the sea for migratory salmonids is only available on high tide as the depth of flow across the mudflats of the Firth of Forth is insufficient. The lower, relatively steep, wooded section contains many natural minor obstructions, mostly associated with bedrock, all of which would be passable under higher flows (as evidenced by historical captures of sea trout). The first major man-made obstacle to fish passage (NB: both migratory and resident populations require movement) is at NT0574077911, upstream from Binns Mill, at a bridge and some old sluices. The culvert below the M9 (NT0548077556) and the B9080 at Bridgend Farm (NT0434576093) are also challenging due to distance and depth of water. While not a major obstruction, the footings of the track bridge by the sawmill (NT0741978589) also poses an obstacle to fish movement, particularly juveniles.

All could be addressed with remedial structures downstream of each obstruction to increase the depth of flow. Baffles within the structures could also be employed to increase the water depth and dissipate flow energy.

Nutrient pollution. The sewage treatment works at NT0420075961 and NT0525077440, while both discharging slightly coloured water to the burn, appear to be causing no chronic problems as evidenced by the frequently abundant and reasonably diverse invertebrate fauna: heptageniid and baetid mayflies, glossosomatid and hydropsychid caddis flies, freshwater limpets (*Ancylus* spp.) and shrimps (*Gammarus* spp.). The number of net spinning caddis flies points to lots of particulate material in the water column and the discharges may contribute to elevated nutrient concentrations in the burn, as evident by the excessive growth of filamentous algae where light allows.

Two major point sources of pollution were noted: two pipes of 30cm diameter on the LB at NT0795279109, and a smaller pipe on the RB ~30m downstream, discharging effluent. Sewage fungus was evident across the full channel width. These should be investigated as a significant issue.

Invasive species. Himalayan balsam was present downstream from NT0420075961, particularly in the deposited sediments of the former pool upstream of Binns Mill (NT0574077911). Japanese knotweed was apparent at the track bridge (NT0741978589). Both require a concerted effort to control. Unchecked, they cause erosion problems and reduced invertebrate life.

Quick wins:

Fencing. Given the clear difference in physical channel structure (i.e. an appropriate width), riparian vegetation (diversity and abundance, especially trees), and marked increase in salmonid numbers observed below the livestock exclusion at NT0677278169, effective fencing to exclude livestock from the burn throughout the whole of Terrace Rigg will be of greatest benefit. Once established, habitat should regenerate relatively quickly but could be augmented with selective planting of locally sourced willow whips to stabilise fragile banks and provide cover for trout. Planting of a full range of native deciduous species within areas of the buffer, such as alder and hawthorn will bring a wide range of benefits. This would effectively create contiguous good habitat from the burn mouth until the first major man-made obstruction at NT0574077911.

While it is recognised that the meanders and oxbows in this terrace will naturally wander, form and erode over time, the breaking through of oxbows is likely occurring at a greatly accelerated rate under the present livestock pressure. This is also exacerbating the already significant sedimentation issue. Ideally, fencing should completely exclude livestock from the river bank which may then require solar or pasture pumps to supply water for drinking at several locations. Existing areas of fencing should be maintained to ensure that they fully exclude stock.

Fish Passage. The other major impact upon fish populations in the burn is habitat fragmentation through barriers. Improving fish passage at those barriers will allow better habitat use throughout the burn, access to alternative spawning and feeding sites, and prevent fish populations becoming isolated. This would promote natural fish production.

Further detail and advice on measures to restore and improve Midhope Burn will be provided in the more extensive Advisory Visit report which is peer reviewed by other members of the Wild Trout Trust.