Howl Beck, Guisborough Angling Club

An advisory visit carried out by the Wild Trout Trust – July 15th 2014

1. Introduction

This report is the output of a Wild Trout Trust Advisory Visit (AV) undertaken along sections of the Howl Beck (and tributary Sandswath Beck) in the area of Guisborough in Redcar and Cleveland. The main objective of the report is to identify problems and positive aspects of the watercourse with respect to its ability to sustain resident and migratory trout.

The visit was carried out by Dr. Paul Gaskell and generously hosted by Allan Spanner and Bob George of Guisborough Angling Club Ltd. (GAC). The report concentrates on the section of river between an upstream limit at NGR (National Grid Reference) NZ 59451 16009 (on Sandswath Beck) and a downstream limit at NZ 64757 19618.

Throughout the report, normal convention is followed with respect to bank identification i.e. banks are designated **Left Hand Bank** (**LHB**) or **Right Hand Bank** (**RHB**) whilst looking downstream.

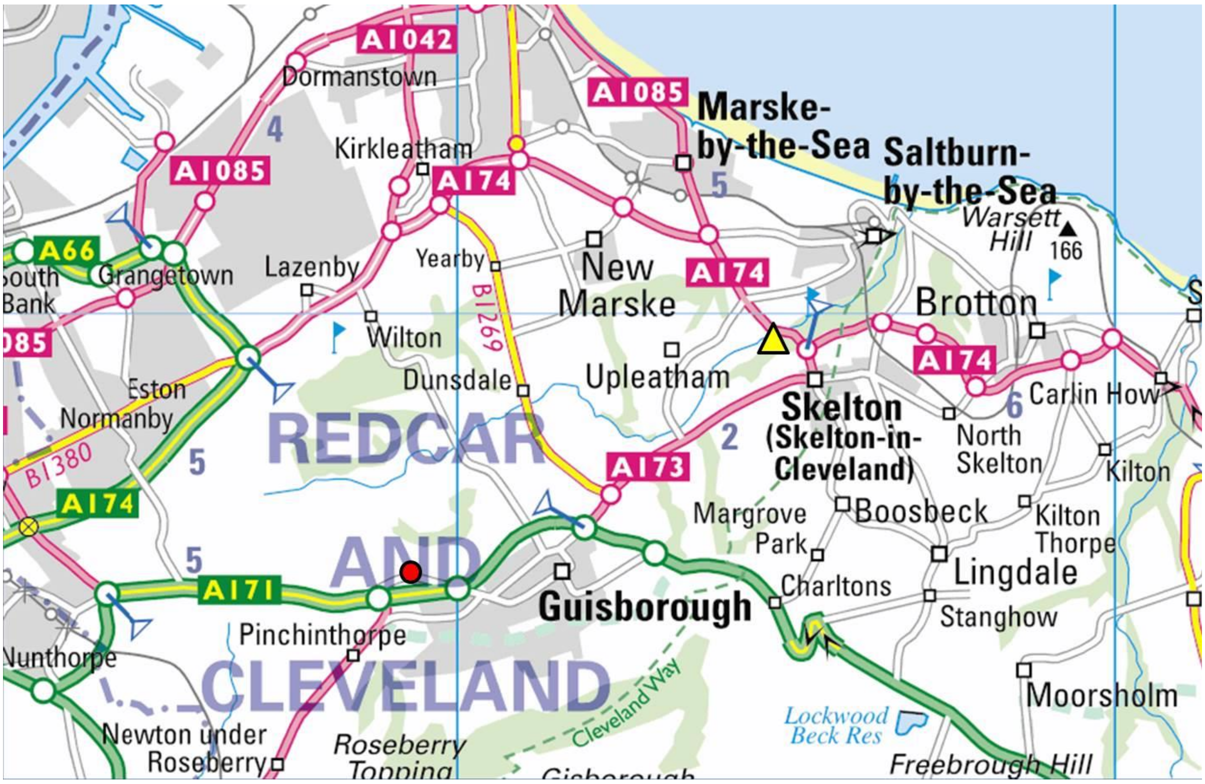


Figure 1: Map overview of the catchment including upstream (red dot) and downstream (yellow triangle) limits of inspected reaches

2. Catchment overview

The surveyed sections of watercourse are all captured within a single waterbody (GB103025071970) listed as "Skelton Beck Catchment, Tributary of North Sea" under the European Water Framework Directive. The streams drain the horseshoe formation of the surrounding Cleveland Hills and discharge into the sea at Saltburn-by-the-Sea. Underlying bedrock geology is dominated by mudstone, siltstone, sandstone (with some limestone and Oxford clay also evident) overlain by till, clay, sand and gravel superficial deposits. The river itself is a "peat-stained" upland stream with a gravel and sand bed and is known by a variety of names – both colloquially and as it appears on maps (e.g. Fig. 2, showing part of "Howl Beck" visited during the survey).

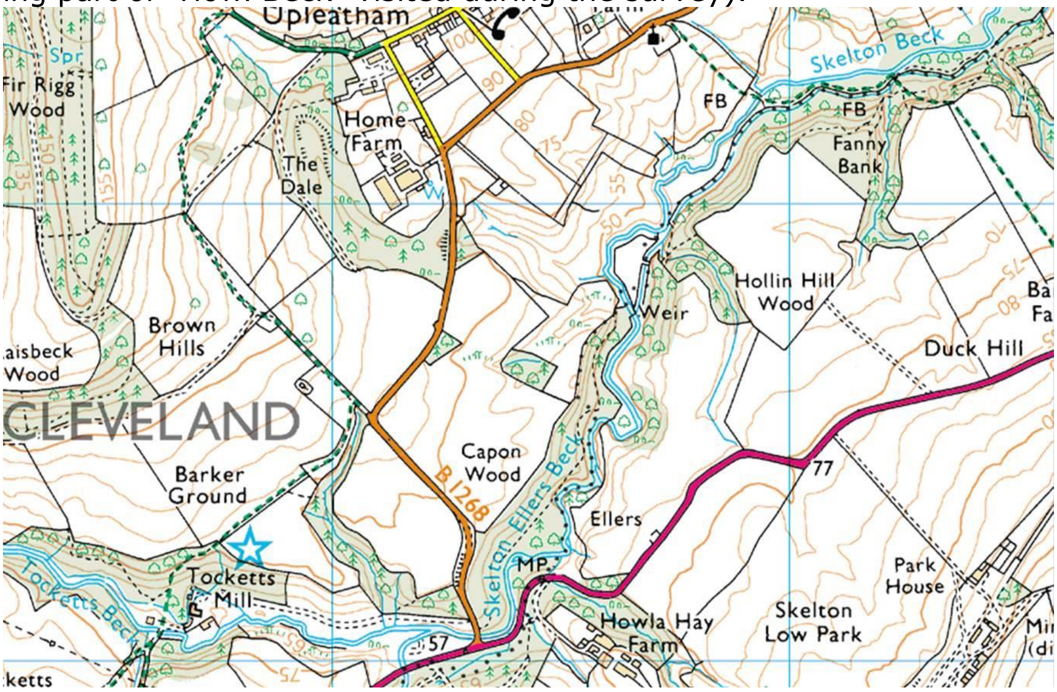


Figure 2: "Howl Beck" reaches named, variously, on the map as Tockett's Beck, Skelton Ellers Beck and Skelton Beck. Maps show the watercourse as Howl Beck upstream of Tocketts Dump Wood (where it joins Dunsdale Beck to form Tocketts Beck. Local derivative place names (e.g. Howla Hay Farm) indicate the colloquial/historic names for the watercourse and GAC refer to the main river as Howl Beck.

Table 1 gives a summary of the Beck's ecological status and current characteristics as assessed for Water Framework Directive objectives. Somewhat surprisingly, the status of the Beck is designated as Poor, with a high degree of certainty. The classification stems from the poor fish population survey results – which in turn may be linked primarily to the water quality failing for Ammonia. Surprisingly, the invertebrate results appear to be good – perhaps suggesting an intermittent rather than continual/chronic degradation; due to shorter generation times for invertebrates relative to fish. Furthermore, it is equally surprising that the reason for not reaching good ecological status is cited as technically infeasible/disproportionately expensive. This is especially so given the GAC's recent successes in bringing a prosecution and associated civil sanction against pig-slurry pollution (high in ammonia/nitrogenous pollutants) offenders on the Sandswath Beck, a significant headwater tributary of the Howl/Skelton Beck watercourse. The campaign to bring those offences to book only gained traction when the impacts of the pollution invoked the Bathing Water Directive due to impacts seen at Saltburn-by-the-Sea.

The GAC's membership has noted the decline of water crowfoot (*Ranunculus spp*.) growth within the channel – along with increased fine-sediment within the river channel that coincides with an increase in clear-felling/coniferous forestry activities at the top of the catchment. The club stocks with around 500 six to eight inch fish each season and the Environment Agency's most recent stocking of fry derived from sea trout brood-stock numbered around 7000 this season. In addition, GAC report that the access to the river for marine-migratory fish is generally good; with possibly only one significant remaining weir on the system.

Table 1: Summary designations for the Skelton Beck catchment under the Water Framework Directive waterbody classification system

Ecological Status			
Current Status (and certainty that status is less than good)	Poor (Very Certain)		
Biological elements			
Element	**Current status (and certainty of less than good)**	**Predicted Status by 2015**	**Justification for not achieving good status by 2015**
Fish	Poor (Very Certain)	Moderate	Technically infeasible (B2a)
Invertebrates	Good	Good	
Supporting elements			
Element	**Current status (and certainty of less than good)**	**Predicted Status by 2015**	**Justification for not achieving good status by 2015**
Ammonia (Phys-Chem)	Moderate (Quite Certain)	Moderate	Disproportionately expensive (A1a)
Dissolved Oxygen	High	High	
pH	High	High	
Phosphate	Good	Good	
Temperature	High	High	
Copper	High	High	
Iron	Moderate (Very Certain)	Moderate	Technically infeasible (C3a)
Zinc	High	High	
Ammonia (Annex 8)	Moderate (Quite Certain)	Moderate	Disproportionately expensive (A1a)
Supporting conditions			
Element	**Current status (and certainty of less than good)**	**Predicted Status by 2015**	**Justification for not achieving good status by 2015**
Quantity and Dynamics of Flow	Supports Good	Supports Good	
Morphology	Supports Good	Supports Good	

3. Habitat assessment

The watercourse was surveyed at several points – starting at the downstream limit at NZ 64757 19618 and working upstream. The first point visited (the road bridge where the A174 crosses the Beck), revealed a small to medium-sized stream sited within a mature woodland corridor. Some modification to the channel course and margins was evident in the form of old block-stone (sandstone) retaining walls. The river-bed comprised aggregated (i.e. unsorted) pebbles and fine sand/silt and the water carried an amber peat stain along with a very fine milky particulate (probably mineral) suspension. Marginal and tree-canopy vegetation appeared to be well developed and was providing some cover from predation as well as mitigation for the high-temperature/low water level conditions evident during the visit.

In this section, there was an apparent lack of the invasive, non-native plant Himalayan Balsam (*Impatiens glandulifera*); which is a notable observation on many river corridors at this time of year. Heavy infestations of this plant (with its very shallow root system and winter-die-back habit) can lead to greatly increased inputs of fine sediment material during winter storms and associated spate flows and surface-water runoff.

Figure 3: Downstream limit of inspection at NZ 64757 19618, viewed from road bridge facing upstream

Moving upstream to NZ 64617 19607 revealed some very nice habitat produced by erosion and deposition processes – combined with a varied surrounding vegetation structure. Sections of more open canopy/low, bushy marginal cover were present adjacent to excellent dappled light/shade habitat produced by bank-side mature woodland (Fig. 4). The presence of marginal point-bar (Fig. 4A) was complemented by scour pool, riffle and mid-channel gravel bar features (Fig. 4B). Such variety is one of the crucial elements to providing for all stages of wild trout lifecycles (Fig. 5).

This largely excellent habitat was only compromised with respect to its ability to support high proportions of trout egg survival. This is due to the prevalence of sand and silt particles entrained between gravel grains in the deposited bar features. Although the catchment is naturally sandy – and the watercourse will transport fine materials away during spate flows – there is a possible indication of an over-supply of fine material which may compromise egg survival. In other words, it is possible that the supply of fine sediment (for instance via accelerated/more extensive bank erosion – or inputs associated with forestry activity) overwhelms net export. . Investigating ways to control and reduce the supply of fine sediment material to the river from surrounding land would be a potentially extremely valuable way to improve spawning success for salmonid (and other gravel-spawning) fish. It is important to recognise that it is the presence of deep root systems (associated with mature woodland) that is providing sufficient resistance to lateral erosion in this very sandy soil to allow the formation of deeper pool habitat on the outside of bends in the river.

A

B

Figure 4: Dappled light/shade and point bar/scour pool (A) facing upstream and lower bushy/more open marginal vegetation, central gravel bar and good variety in flow depth/pace (B) facing downstream at NZ 64617 19607

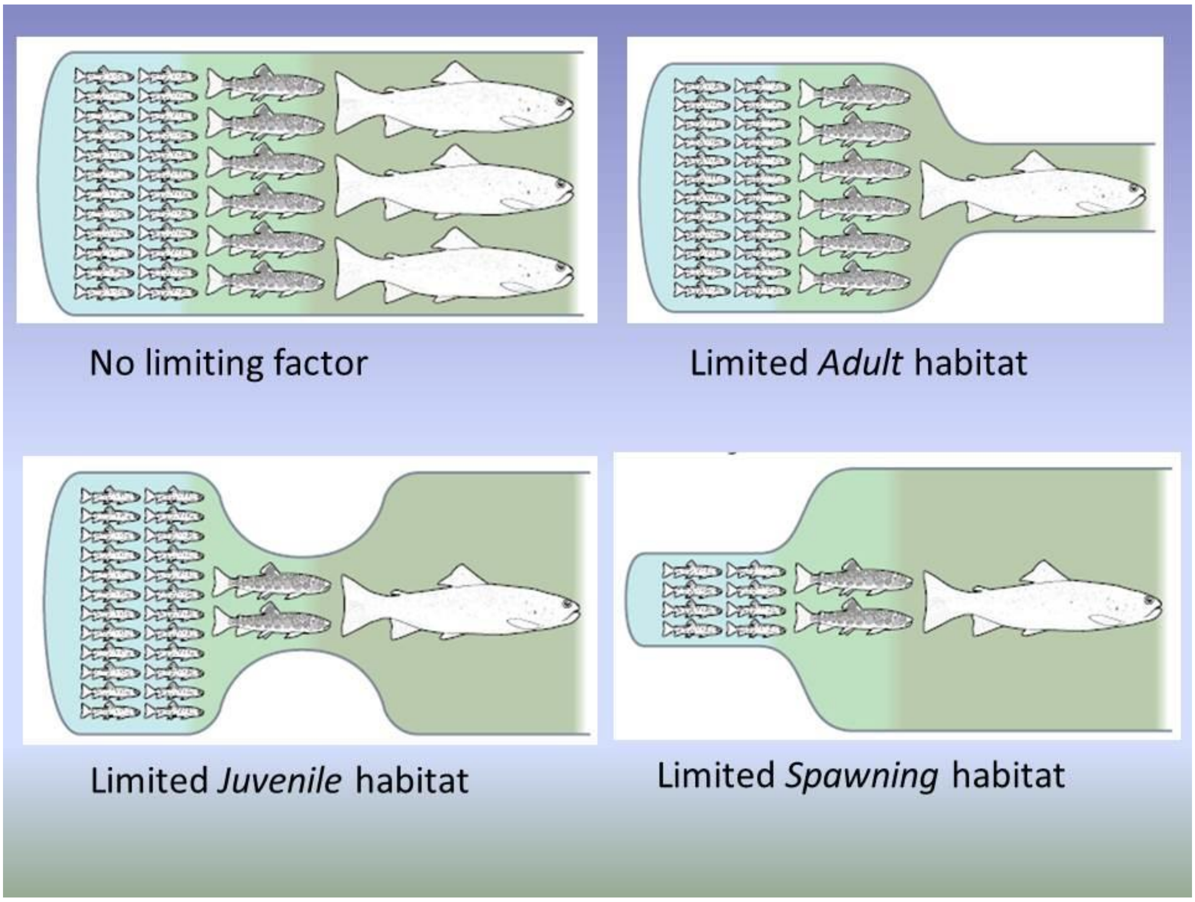


Figure 5: The knock-on impacts to fish populations caused by a lack (or degradation) of specific types of habitat at three crucial lifecycle stages; spawning, juvenile/nursery and adult. Spawning trout and require loose mounds of gravel with a good flow of oxygenated water between gravel grains. Juvenile trout require shallow water (quite variable around an average of 20-cm) with plenty of dense submerged/tangled structure for protection against predators and wash-out during spates. Adult trout require deeper pool habitat (generally > 30cm depth) with nearby robust structural cover such as undercut boulders, sunken trees/tree limbs and/or low overhanging cover (ideally within 30cm of the water's surface. Strengths (i.e. excellent quality) in one or two out of the three crucial habitats cannot make up for a "weak link" in the remaining critical habitat type.

The presence of deeper pool habitat – close to low overhead cover – is vital for adult resident trout and also resting adult sea trout and, as mentioned, only exists because of the sections of mature woodland that are allowed to encroach up to the bankside. A great example of valuable structure promoting adult pool habitat and overhead cover was noted at NZ 64597 19606 (Fig. 6) – along with a few specimens of Himalayan Balsam. Similarly, the more open areas with shallower riffles and exposed tree/shrub roots and/or overhanging bushy vegetation provide excellent habitat for juveniles.

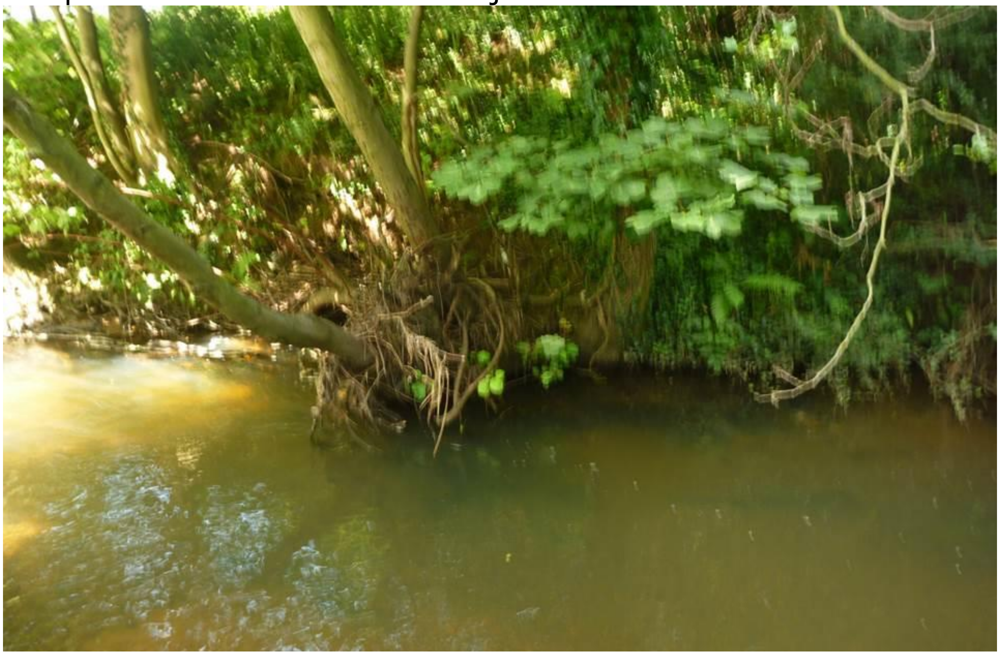


Figure 6: Lateral resistance in the bank provided by deep root system in otherwise crumbly soil - combined with "undershot scour" beneath the curving/overhanging trunk and root-wad - has produced a great holding pool for an adult trout (resident or migratory)

Gravels are plentiful in the river – and would certainly support wild fish breeding attempts. Their value (in the form of increased egg survival) could be improved by exploring ways to reduce fine sediment inputs and also where fallen woody debris promotes localised scouring (and silt-cleansing flows) down into the river bed (see section 4 "Recommendations"). The potential gains to be made in egg survival is evident from the entrained fine particulate material dislodged when walking on gravel bars in the stream at NZ 64607 19559 (Fig. 7).

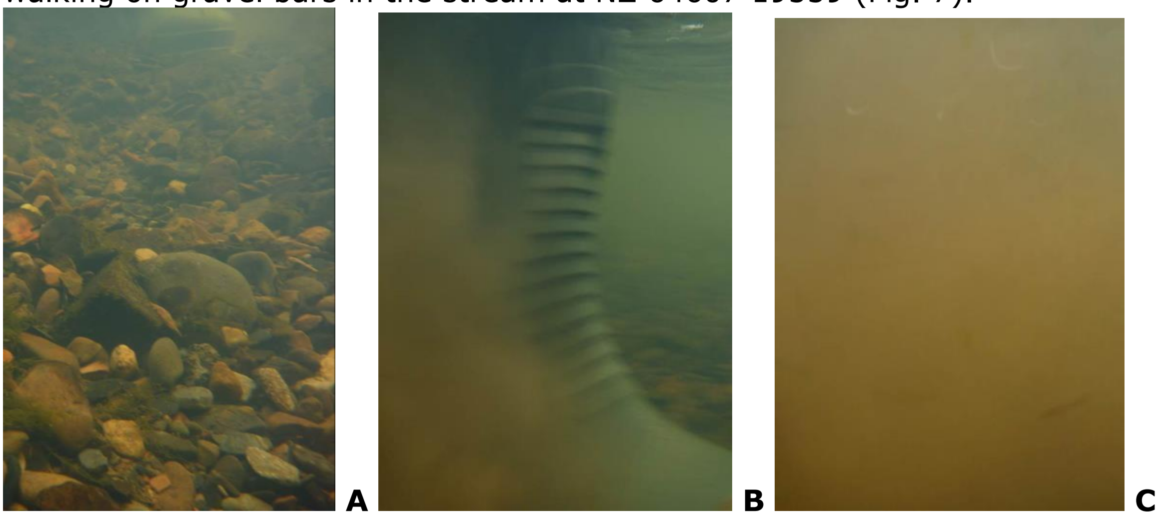


Figure 7: Gravels of an ideal size for trout spawning (A) disturbed by a wading boot (B) shows the large burden of silt trapped between gravel grains (C)

A more open area (with grazed land – but including a fenced buffer strip) illustrated the effects of having only a shallow, grass root-system in a short section of “block failure” bank erosion at NZ 64561 19531 (Fig. 8). However, this feature was both short in length relative to the full reach and also showed recolonization by pioneering willows behind the (recently-installed?) fence. Consequently it is functioning to provide some nice variety in the form of good juvenile habitat. The establishment of deeper root systems (and the control of the early stages of Himalayan Balsam infestation) will limit the amount of fine sediment delivered from this section of riverbank – whilst providing some nice, shallow nursery habitat for parr. If there are long sections of river corridor with only shallow root systems and a great predominance of wide, shallow channel, then the relative lack of adult habitat would be reflected by a lack of adult fish. Consequently, if/where any such conditions exist, it would be worth seeking the establishment of a buffer strip with grazing exclusion and seasonal Himalayan Balsam pulling/control. These measures would act to limit some of the fine sediment inputs that would otherwise smother spawning gravels.

Figure 8: Patches of habitat like this area of "block failure" erosion provide variety and are of value. However, if long expanses of the channel look like this then aquatic life (including wild trout) suffer an impact. Variety is the watchword for managing rivers for wild flora and fauna.

Figure 9: Shoal of minnows in section pictured in Figure 8

Positive encouragement with respect to previous water quality issues (especially those arising from slurry pollution incidents) was seen in the presence of stone loach and shoals of minnow (e.g. Fig. 9) in this section of river. Organic pollution-sensitive invertebrates such as flat, stone-clinging mayfly, stonefly and caddis larvae were also observed.

Further variety and valuable habitat was evident in the colonisation by largely native vegetation of a point bar deposited by good, dynamic river processes (Fig. 10). These kind of sloping bars that also produce valuable and varied riverbed features cannot readily form in rivers that have lots of impounding structures (such as weirs). This type of varied vegetation and riverbed structure helps to support interesting fishing – especially with dry flies – since all aquatic insects require varied riverside vegetation to thrive and complete their lifecycles.

Figure 10: Deposited "point bar" of gravel colonised by a varied flora. Great variety that benefits fish and invertebrates

Taking a different route back to the car allowed another section of river to be investigated between the section pictured in Figure 10 and the downstream limit. Here, at NZ 64641 19642, some fantastic adult trout habitat was observed (Fig. 11). The presence of substantial fallen trees within the river channel is a huge boon to wild fish populations. Not only do they help to retain nutrients that provide better feeding for fish, they also create all three types of critical habitat (spawning, juvenile and adult). Large trees are especially important in forming adult fish habitat by shaping and "sorting" (i.e. blowing the silt out) mounds of spawning gravels. They also provide terrific "bolt holes" that enable adult fish to feed confidently nearby in a variety of feeding lies. Without the bolt-hole on hand, these adult fish would desert those feeding lies and the capacity of the river to hold good numbers of larger fish would be greatly reduced. The canny angler can also exploit the cover provided by fallen trees to approach their quarry more closely than is possible in "open ground". Consequently, erratic inputs of fallen tree debris, are simultaneously the best friend of fish and the angler.

Figure 11: Fantastic habitat for fish and for anglers – a habitat providing riffles, pools, shelter/depth and varied submerged structure; trout heaven.

Fallen trees in the river only become a concern to angling or fish populations when debris dams become so large that they actually impound water. The way to tell if this is the case is if there is an appreciable difference (say more than 12 to 24 inches) in the height of the water surface on the upstream and downstream sides of the debris. Similarly, an obvious "step" in the riverbed – caused by bed material accumulating upstream of a dam - would also be cause for concern. If there is no appreciable impoundment, fish will be easily able to pass under/through the apparent barrier and it will also, simultaneously provide both cover and significant "undershot scour" to create deep pool and sorted spawning gravel habitats.

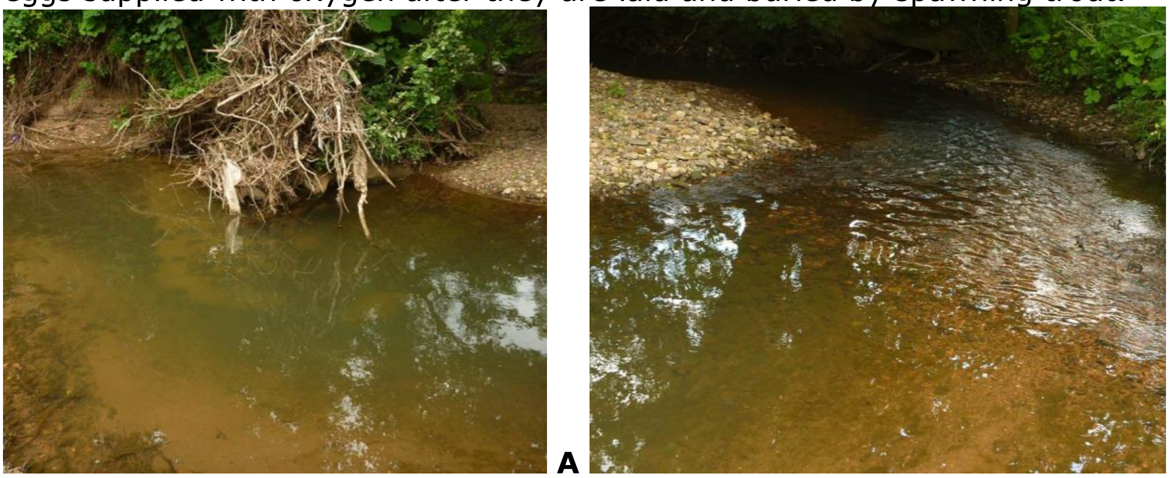
After a short car journey to NZ 63468 18213, some more excellent mature woodland and varied in-stream habitat was observed – including a very large fallen tree (Fig. 12). Even with a trunk of these dimensions, there was absolutely no upstream impoundment of water – as indicated by the free-flowing riffle directly upstream. This was really excellent habitat that a large grey heron was enjoying just prior to our arrival – testament to the recovering fish populations following slurry pollution impacts. It is also important to note that, in contrast to many chalk and limestone streams, a great deal of the whole food supply that supports trout in upland rivers is propped up by leaf litter. Without both plentiful inputs in autumn from bank-side trees AND (crucially) rough, fallen debris to catch and retain some of that litter during spate flows, much of that life-giving nutrition would be lost downstream. Fish cannot exist in a vacuum, and the bugs and grubs that fish eat need calories that plants have trapped from sunlight and turned into the carbohydrates stored in leaves. Of course, if the water where these excellent habitat and nutritional features are present is toxic – then the fish don't get to benefit from them!

Figure 12: Substantial fallen tree - encouraging excellent fish-friendly habitat to develop in the form of more interesting current and riverbed features.

Further downstream, the benefits of even relatively modestly-sized woody debris were also evident. For instance a small tree stump at NZ 63493 18270 has created terrific habitat via the focussing of localised scour on the riverbed during spate flows (Fig. 13). The resultant scour pool, surrounded by gravel riffle, provides a feeding lie for much larger fish than could be supported by the depth of water present in the surrounding riffle.

Figure 13: Formation of a deeper holding spot promoted by scour resulting from small tree stump - great variety that increases the capacity of the stream to hold fish

Nearby, at NZ 63498 18292 there was also an excellent illustration of how bed scour processes generate – not only adult scour pool habitat – but also enhance egg survival within gravel beds. Figure 14 highlights the self-cleaning pool that is formed by the "blowing out" of material from the riverbed (in contrast to pools that are formed by holding back water; *which rapidly accumulate sediment and are filled in by the river*!). It also highlights how the material that has been blown out to form the depression in the riverbed is deposited downstream as a mound. The combination of lowered hollow/raised mound and the weight of the water pulling downhill forces water to flow *through* as well as *over* the loose gravel mound. It is this flow percolating between loose gravel grains that keeps eggs supplied with oxygen after they are laid and buried by spawning trout.



A B

Figure 14: Stump and debris causing scour pool formation - which contained several adult fish - (A) and the resultant gravel mound formed from the material arising from the scour pool (B). Note the smooth, upward ramp of gravel that gives way to more riffled/broken flow below. The ideal spawning spots will be on the upstream face of the gravel ramp in the smooth but fast water. Note also the high quantities of sand in the river bed and also entrained/aggregated within the dry gravel deposits – an indication of the large supply of fine material from the catchment upstream (which is reported to be higher now compared to when the river supported *Ranunculus spp*. growth)

Finally, a drive upstream to the Sandswath Beck rounded off the survey with a visit to the source reaches of the major slurry pollution incidents. Although small in size and discharge, the volumes of slurry entering this tributary high up in the system had effects that were registered on the coast at Saltburn-by-the-Sea. Clearly, the tackling of this issue – thanks in large part to the determined efforts of GAC – will be a significant boost to the future prospects of the whole catchment.

4. Recommendations

4.1 Retaining existing high-quality features

The first rule of ensuring the quality of fishing in our rivers is maintained is to recognise and avoid destroying valuable features. From this perspective, the general lack of impounding structures (such as weirs), the presence of varied bank-side vegetation and regular natural inputs of Large Woody Debris (LWD) and the ability of the channel to actively change shape through erosion and deposition are all huge plus points. Very commonly in our Advisory Visit reports we recommend (and describe methods for) the artificial introduction of LWD and/or structures that perform a comparable function. The Howl Beck would seem to be a rare case in which adding further artificial LWD structures would possibly be "gilding the lily". Of course, if there were other unvisited sections in which LWD inputs were rare – or if such inputs are commonly removed – then there may be value in prescribing appropriate introduction and stabilisation of such materials. It is important to note that any such work will be subject to obtaining permissions from regulatory authorities as well as land owners. Any installation works within the channel – or within 8-m of the channel boundary – is generally subject to consenting processes that take into account changes to flood risk as well as impacts on wildlife. An example of a potentially suitable technique for sections of the Beck which may lack in-channel LWD would be the anchoring of "tree kickers" similar to those demonstrated in this WTT video: http://www.wildtrout.org/content/how-videos#tree kicker

It is very important to avoid removing the valuable inputs of LWD that are currently benefiting the Howl Beck fishery.

4.2 Impacts and Stressors

4.2.1 Early stages of Himalayan Balsam colonisation (or recolonization)

Currently at a relatively low density, the presence of Himalayan Balsam plants amongst native bank-side vegetation is a potential future stressor to the Howl Beck catchment. Each individual plant is capable of producing up to around 800 seeds and their explosive seed pods can catapult them over 20 feet (7 m). They grow incredibly fast, are shade tolerant and will out-compete tree seedlings - which would eventually remove any of the great benefits that woodland is currently providing to the Howl Beck.

As illustrated in the following video and in section 4.2.2, below, the enhanced supply of fine sediment to river systems promoted by extensive infestation of this plant can contribute to poor egg survival in gravel-spawning fish species: http://www.wildtrout.org/blog/which-worse-himalayan-balsam-or-poachers.

The good news is that the level of infestation is currently such that it can be realistically controlled by hand-pulling (essentially weeding!). A stitch in time may well save 9000…

Hand-pulling by the roots or strimming stems below the first "node" needs to be done when the plants are already quite well-developed and are flowering – but before they start to set seed. In both cases, the best way to deal with the pulled/cut plants is to pile them up in as few (and as large) heaps as possible to rot down on site. Do not remove the plants from the site as they become classed as biologically hazardous waste. Our free guidance sheet gives some pointers on how to tackle balsam:
http://2ww.wildtrout.org/sites/default/files/library/Invasive_Plants_Apr2012_WEB.pdf

Be sure of your plant identification – since it would be disastrous to attempt hand pulling or strimming of e.g. Japanese Knotweed or giant hogweed!

4.2.2 Increased fine sediment supply

Although difficult to definitively assign cause(s) to the loss of *Ranunculus spp*. from the system, it is certainly true that this aquatic plant cannot tolerate chronically-elevated levels of suspended solids. Additionally, the flow ranges that it requires are relatively narrow (so wash-out or drought years can cause it to be lost). There may be some merit in attempting trial replanting in some test areas (the WTT can give guidance on how this can be done on upland rivers).

However, on the subject of chronic sediment inputs, *Ranunculus* foliage accumulates these particles and the weed eventually starts to die off and rot. Additionally, the suffocating impact of chronically-increased fine sediment loadings on river beds (as indicated in section 4.2.1 above) is clearly undesirable from a salmonid fishery perspective. Consequently, in addition to Himalayan Balsam control, it would be extremely valuable to explore possible impacts (and associated appropriate remedial measures) arising from forestry activity in the catchment. Poor design of forestry drainage – especially when combined with clear-felling events – can increase the "flashiness" of surface water runoff. This can dramatically increase the erosive power of spate flows as well as directly supplying huge volumes of "wash-load" fine sediments to the watercourse. Ensuring that forestry activities comply with best practice for controlling runoff should be combined with confirmation that suspended solids inputs do not exceed levels consented by the E.A. *Creating a large (at least 20-m or more than 50-m ideally) buffer strip of deciduous forest* between coniferous plantation and watercourses >2-m wide and *decreasing the amount of drainage* are both ways of reducing the impact of coniferous forestry on watercourses. More information can be found in the UK Forestry Standard guidelines here:
http://www.forestry.gov.uk/pdf/FCFC001.pdf/$FILE/FCFC001.pdf

As a "helping hand" measure, it may be useful to undertake some localised gravel-cleaning towards the end of summer; prior to when fish start moving onto their spawning grounds. Guidance is given in the video here:
http://www.wildtrout.org/content/how-videos#gravel

4.2.3 Risk of decreasing viability of wild stocks through stocking of fertile, farmed stock fish AND sea trout fry

There are many instances in fishery management and biology in general where fact is stranger than fiction. The findings of objective investigations can often run completely counter to what our individual experiences tell us to expect. For example, it would seem perfectly reasonable to expect that stocking rivers with fish that are physically capable of reproducing would be a way of increasing the chances of fish to breed independently in the wild.

However, the findings of a very large body of studies (explored and interpreted here:
http://www.wildtrout.org/sites/default/files/library/Stocking_position_2012_final.pdf) *unequivocally indicate the serious risk of reducing the viability of self-sustaining trout populations when domesticated-strain stock fish are given the opportunity to hybridise with wild fish*.

These issues are summarised in two short videos here:
https://vimeo.com/63397187 and https://vimeo.com/63397188
The risk of fertile stock fish is due to the difference between characteristics that allow fish to thrive in captivity (which selects and produces fish carrying those heritable characteristics) versus those characteristics vital for completing a full lifecycle in the wild. The crucial observation is that those sets of characteristics are very different from each other. In the same way, dairy cattle are brilliant at thriving in farmed conditions – but would fare much worse in the wild than their feral ancestors (aurochs) which, in turn, were nearly impossible to domesticate! Interestingly, the proportion of wild trout that are able to thrive in captivity is also low – resulting in a heavily-skewed selection of genetic traits that are

passed down domesticated breeding lines. In contrast, individuals that exist in a specific wild habitat are only there because they (and all of their ancestors) managed to stay alive until they were old enough to breed in that habitat. Consequently, the degree of adaptation to surviving in the wild of hybrids between wild and domesticated parents will inevitably be poorer than the adaptations displayed by the offspring of two wild parents from a local wild breeding population.

The situation with domesticated breeding lines of stock fish is relatively easy to appreciate and accept – but it is more difficult to understand how taking two wild parents as brood stock and using them to produce hatchery-reared juveniles could also reduce the viability of offspring in the wild. The crux of the matter centres round the removal of choice of mate from wild breeding partners. In the wild, trout (including sea-trout) unconsciously select their ideal mating partners based on a number of criteria. They also "choose" breeding site and the timing of breeding efforts – which can further control which males mate with which females within a single river system. When artificial fertilisation and hatchery-rearing take place, those choices cannot be mimicked and the genes from each parent are mixed together essentially at random. The consequences of those random combinations (versus the "selected" combinations guided by visual and scent cues utilised in the wild) include poorer performance in first-generation hatchery-bred fish from purely wild parents in critical traits such as:

- Disease resistance
- Predator avoidance

As well as the literature described in the WTT stocking position rationale (on previous link) there is an extremely elegant study carried out in Atlantic salmon that shows exactly this effect by examining combinations of immune system genes achieved through mate choice versus artificial hatchery-mating. The especially neat thing about this study is that the researchers subsequently went on to compare how well the offspring produced under those different regimes could rid themselves of parasites. They found that the random combinations resulting from hatchery mating produced offspring that suffered significantly higher parasite loads than those found in stream-spawned offspring of natural mate-choice breeding (http://rspb.royalsocietypublishing.org/content/275/1641/1397.long).

It is useful to explain why this should be of concern. In river systems (such as the Howl Beck) where there is access to in-stream spawning, the stream-spawned fish are more likely to be better adapted to surviving through all stages of their lifecycle when compared to the offspring of randomised artificial mating. In addition, many of the individuals that would die as juveniles in the wild will survive in hatchery conditions. This could have significant implications if the introduction of large numbers of (ultimately less-viable) juvenile fish were found to compete with the (better adapted) wild juveniles. The highlighted case study, over the page, shows that contesting for the acquisition and retention of juvenile "cover" habitat is an arduous and draining undertaking.

Case study:

Harwood, A.J., *et al*., "Intra- and inter-specific competition for winter concealment habitat in juvenile salmonids". **Canadian Journal of Fisheries and Aquatic Sciences, 2002. 59(9): p. 1515-1523.**

This study found that aggressive competition (both within and between Atlantic salmon and brown trout) for overwintering refuges in juvenile fish is observed to be highly intense when refuges are in short supply. Existing residents are less likely to leave a refuge than an intruder when disputes arise and competitive interactions are reduced when refuges are plentiful. The intense struggle to oust a competitor when refuges are in short supply is likely to make especially severe demands on the energy reserves of juvenile fish who are not the first to locate a particular refuge.

Random parental combinations produce offspring that are more likely to have poorer immune systems/predator avoidance etc. than those offspring produced by directed wild mate-choice. Consequently, a simple analogy can be made to describe fishery management options. The journey of migratory fish to and from the marine environment is extremely demanding – a little like a marathon. By taking your elite marathon runners and making them fight several rounds in a boxing ring with lower-ranked runners before running the race, you reduce everyone's chances of making it around the course. In the same way, adding large numbers of hatchery fish to (finite) juvenile habitat imposes an additional strain on the wild fish (which are actually better equipped to complete the full task of running to sea and returning to produce similarly-viable offspring). The outcome of this strategy is likely to be one (or even both) of two scenarios:

- Continued reliance on pumping enough hatchery-produced juveniles to compensate for their poorer fitness and produce some returning adult fish
- The hamstringing of the natural increase in recruitment and population size to a higher level that the best-adapted fish could achieve without the additional strain of competing with hatchery juveniles

Furthermore, if the argument for introducing elevated numbers of hatchery juveniles from wild brood stock is to mitigate the impacts of poor water quality or marine mortality, then there are some important considerations to take on board. First of all, there is the removal of the contribution of better-adapted juveniles that those brood-stock parents would otherwise make through being allowed free mate choice in the river. Secondly, all fish (whether stream or hatchery spawned) will still face those environmental stresses – it is just that the hatchery-derived fish are less capable of overcoming them. Taken together, when there is the potential spawning habitat within the river system, a much more reliable approach than stocking of juveniles will be:

- Protect and enhance spawning habitat AND juvenile/nursery habitat
- Ensure best possible water quality (including suspended sediment criteria)
- Provide best access to habitat through all reaches from spawning grounds to the sea

4.3 Recommended action list

- Retain naturally-occurring LWD
- Explore potential for increased submerged brash/coarse cover directly downstream of observed spawning redds (WTT can support with further advice)
- Control Himalayan Balsam
- Carry out some trial *Ranunculus* replanting (WTT can guide)

- Tackle potential forestry-derived elevated sediment inputs
- Continued vigilance for water quality problems (suggest establishing Riverfly Monitoring programme with GAC members via http://www.riverflies.org/rp-riverfly-monitoring-initiative).
- Explore the potential to remove or notch the remaining weir on the system to improve access for migratory fish (and improve overall habitat quality in surrounding reaches)
- Discontinue stocking of juvenile sea trout
- If anglers are unwilling to move to catch and release, stock a small number (<500) of sterile 7 to 9 inch fish that are marked to distinguish them from wild fish (marked fish only to be killed)…
- …otherwise, adopt catch and release for wild fish and utilise the savings on stock fish costs to fund other listed actions (e.g. Riverfly Partnership training)

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Disclaimer