Advisory Visit
River Derwent, Bubnell

Advisory Visit by Paul Gaskell (pgaskell@wildtrout.org)

24/08/2021

River	River Derwent
Waterbody Name	River Derwent from Westend to Wye
Waterbody ID	**GB104028057880**
Management Catchment	Derwent Derbyshire
River Basin District	Humber
Current Ecological Quality	Good
U/S Grid Ref inspected	SK2468274470
D/S Grid Ref inspected	SK2509572376
Length of river inspected	2.6 km

1 Summary

- *The report centres around a heavily-modified section of powerful spate river in the heart of Derbyshire, the management of which has recently become part of Waltonians Angling Club*
- *Large-scale impoundments limit the formation of varied, high-quality habitat over the majority of the inspected reach*
- *Gaining additional understanding around stock fish, supportive-breeding and wild fish populations is important for informed management of the fishery*
    - *Genetic and behavioural effects of supportive breeding tend to reduce local adaptation compared to in-stream recruitment of offspring*
    - *Adding significant biomass in the form of stock fish can attract mobile predators to an easy food source in impounded habitat (as well as causing problems of territorial competition for resident fish)*
- *Areas where stock fish gather in slow water often coincide with poor wild trout habitat (and are consequently associated with poor wild-trout capture-rates for anglers); however UK case-studies of clubs which stop stocking and fish the habitat which wild trout prefer typically see increased numbers of fish caught over time (as long as catch and release is practiced)*
- *Modified methods to control signal crayfish may result in more extensive population reductions of this invasive species*

2 Introduction

The Wild Trout Trust were invited by representatives from Waltonians Angling Club to give advice on the management of their trout fishery. Throughout the report, banks are designated as right (RB) and left (LB) while facing downstream and locations are specified using the National Grid Reference system.

2.1 Background

A recent merger of contiguous clubs on the River Derwent has seen Waltonians welcome committee and angling members belonging to the section of river between Calver and Bubnell in the Derbyshire Peak District. The newly-combined clubs' wishes are to benefit from an assessment of their fishery and associated advice.

3 Habitat & Fishery Assessment

Before discussing structural habitat features, it is useful to outline the broader background and choices relating to the management of the fishery. Historically the reaches visited for this report have received plentiful stock fish inputs. Discussions during the visit highlight the desire for club members and committee to understand and assess considerations pertinent to fishery stock management. In particular:

- Stocking impacts and characterising cost/benefit
- Supportive breeding (through wild brood-stock schemes)
- Whether rainbow trout are appropriate stock fish

As well as the "background-reading" in articles on the WTT website (including:
https://www.wildtrout.org/assets/files/library/Stocking_position_2012_final.pdf

and

https://www.wildtrout.org/content/trout-stocking). The latter page also links to several UK case-studies of clubs who ceased stocking. Drawing out a number of key issues related to stocking trout as the first part of this report will aid interpretation of the recommendations which follow.

3.1 Important Issues with Stocking

When the decision is taken to add stock fish to a river, there are unavoidable, negative impacts. Due to being imported from a hatchery and fish-farm environment (and being the product of selection for good survival in that domesticated setting); stock fish invariably show *reduced local adaptation* compared to resident, wild fish. Those adaptations to your particular section of river give wild fish a significantly greater ability to survive and thrive in your fishery. However, forcing those wild fish into conflict/competition for “enemy or disease-free space” with significant biomass of stocked trout has inevitable consequences.

For stock fish, reduced adaptation could be due to “**epigenetic**” factors resulting from the hatchery/fish farm environment (i.e. lack of opportunity to fully learn foraging, predator-avoidance and territory-selection behaviours in the recipient river). There is also significant mismatch between “**genetic**” adaptations suitable for surviving and thriving in the fish farm versus genetic adaptations **honed by natural selection in the river**.

Note that individual stock fish cannot become “better adapted”. Instead poorly-adapted fish die. Artificial selective line-breeding compounds that effect because stock fish start out with a much-reduced selection of versions of each gene compared to wild breeding populations (and there are often multiple distinct breeding populations in rivers receiving stock fish).

The fish living and successfully reproducing in your river have already gone through a complex selective process (leaving the ones which thrive in those exact conditions). In contrast, the stock fish are adapted for a completely different environment and have reduced genetic diversity from which to adapt. The replenishment of farmed fish by repeated stocking events means that their presence in the river (and the competitive pressure they apply to wild fish) is disproportionate to their poor suitability/performance.

Familiarity with calm, slow flows will usually, over time, lead to stock fish congregating in impounded sections of river (i.e. on the upstream side of weirs). The barrier to fish movement also leads to fish congregating in these areas. In that simplified, pond-like habitat they are much more vulnerable to predators. By concentrating in those areas – and by being so available to mobile predators – stock fish are more likely to entice fish-eating birds with the reward of easy and plentiful meals.

While looking for holding lies, stock fish may come into territorial conflicts with resident wild fish. Continually forcing wild fish to defend (even when they don’t vacate) their territories imposes a significant drain on their reserves. Any feeding that stock fish undertake puts pressure on food reserves that may support wild fish (whether or not that feeding includes direct predation on wild fish).

All additional burdens on the watercourse receiving those stock fish should be appreciated in the context of your river’s carrying capacity. Carrying capacity means that, even in fantastic, productive habitat – there is a maximum biomass of adult trout (and grayling) that can be supported.

Adding extra stock fish biomass over and above that capacity is wasteful and damaging to wild fish populations. Yet the difficulty and expense of *obtaining a good estimate of carrying capacity means it is not done in UK river trout fisheries.*

These observations possibly make it less surprising to hear of numerous case studies where ceasing to add stocked trout resulted in huge improvements to grayling catches. An excerpt from 1 min 40 seconds onwards in the video below details the experiences of clubs on the River Ribble (and an explosion in their grayling fishing after stopping trout-stocking):

https://youtu.be/zYX6woFOWa4

The take-home message is angler-initiated stocking puts inevitable pressures on the river ecosystem (including on the populations of resident, wild fish). A classic study, of what happens to populations of wild rainbow and wild brown trout when stocking is ceased, measured significant increases in the number and biomass of both wild brown and rainbow trout (Vincent, E R (1987) *Effects of Stocking Catchable-Size Hatchery Rainbow Trout on Two Wild Trout Species in the Madison River and O'Dell Creek, Montana* **North American Journal of Fisheries Management** 7 (1) pages 91-105). With the introduction of live fish, despite stringent procedures, there is also always a risk of introducing disease along with stock.

3.2 Challenges of Wild Brood Stock & Supportive Breeding

Intuitively, the opportunity to improve a fishery through supportive breeding (e.g. via eggbox schemes) seems an appealing solution to some of the hatchery issues noted above. However, these schemes are fraught with complex and under-appreciated difficulties.

First and foremost is the lost contribution those fish **would have made had they not been captured**. This is another example of an unavoidable loss (and which, as explained subsequently, is unlikely to be offset by the negligible potential gains).

Furthermore, the parental combinations giving rise to in-stream breeding may look (at first sight) to be a totally-random scramble, but are in fact part of a deliberate selection process. Extensive studies show that various (important) aspects of a wild fish's genetic make-up **differ significantly from what would happen under random mixing**.

Female choice of male mates is, therefore, an incredibly important aspect of wild trout reproduction. For species (like trout) that tend to home to where they were conceived, there is always a risk of inbreeding (i.e. completely random mating carries a significant risk of reproducing with siblings or even parents). Mate choice not only avoids inbreeding, but also confers significant advantages in areas such as disease and parasite resistance.

An excellent example is the use of scent to identify the ideal amount of difference between the Major Histocompatibility Complex (MHC) make-up of two potential mates. The MHC is involved in the creation of the immune system in offspring. If parents have MHC characteristics that are either too similar OR too different – then the immune systems of their offspring are weaker than those with more moderate differences.

In contrast to in-stream spawning where the female selects a mate; supportive breeding cannot recreate the benefits of mate choice. However, to avoid inbreeding, a high degree of randomised fertilisation must take place. This places a huge cost of lost in-stream reproduction – since so many breeding individuals must be removed from the wild and stripped for eggs or milt. That impact is magnified since so many of those wild individuals become ill, die or otherwise refuse to come into breeding condition while being stressed in captivity. Consequently, there is a compounding impact of:

1. Needing to catch more brood stock to offset losses in captivity
2. Unconscious bias in the selection of breeding individuals (since these must be the fish which happen to be more tolerant of captivity)

Those effects mean that the system is forced down to a more disadvantaged starting condition. It also perfectly describes the experience of the very well-resourced Wilton Club and their 9-years of efforts at a brook-stock scheme; with captured brood stock refusing to come into breeding condition and showing poor survival. Despite adding 100,000 fry per year, less than 2% of fish from a sample caught by anglers came from the supportive-breeding scheme. At its worst, the loss of in-stream breeding required to produce almost a million fry, and the many unintended potential genetic impacts, could result in your fishery becoming dependent upon supplementary stocking or other artificial interventions.

The seductive thing about supportive breeding is the visual impact of hundreds of thousands of fry being produced and introduced into the river. However, the big problem is that many studies also show terrible (frequently almost undetectable) rates of captures of fish derived from expensive and labour-intensive supportive breeding.

One of the most important reasons that trout produce so many eggs and offspring is to allow for **selective mortality of poorly-adapted individuals**. The juveniles that remain are the ones that are best at surviving in that specific environment (through a combination of behaviour and innate characteristics including disease-resistance). However, as noted already, the juveniles produced by supportive breeding are (by definition) less well adapted than those from successful mate-choice-driven pairings.

3.3 Suitability of Rainbow Trout

There is a natural appeal of using stock fish that are the same species as resident wild fish. It provides a closer simulation of the experience of catching native fish. However, if the reason for stocking is to allow members to take fish for the table, it is necessary to reliably distinguish stocked from stream-bred fish. For brown trout in the Derwent, this implies fin-clipping, dye-marking or even tagging. Each process is relatively laborious and may also incur fish-welfare costs. *Catching an effectively-marked stock fish also greatly diminishes the impression of having caught a native fish (one of the main drivers for stocking with brown trout rather than rainbow trout)*.

Once the decision to add farmed stock-fish to a river is taken, from the biological perspective of the river there is unlikely to be any meaningful difference between the impact of **native** vs. **non-native** trout. Each impose the inevitable, negative impacts outlined previously. One possible advantage of using rainbow trout in that role is that they are at least readily distinguished from resident, wild fish – without enduring further marking or clipping.

Nevertheless, resistance to accepting that as a role for rainbow trout is entirely understandable on the basis of aesthetics. At the same time, marking stocked brown trout also tends to similarly spoil the illusion. If the only reason to favour brown trout stock fish is to maintain an illusion of catching wild fish, then that may not be sufficient justification for the extra expense and potential stress involved in marking them. In short if stocking rainbow trout is deemed unacceptable, it is hard to find a biological justification for stocking brown trout.

3.4 Structural Habitat Assessment

The reach assessments are reported, sequentially, in a downstream progression from the road bridge at SK2468274470 (Fig.1). At that point, the river benefits from a degree of shading by riparian (bank-side) tree cover. For rivers with dark substrate and water – such as the gritstone bed and peat-stained waters of the Derwent – the potential for warming in low flow/hot summer conditions is amplified. Rivers with less-coloured water and more reflective substrates will not absorb the same amount of heat. For cold-water specialist species (including trout and many species of invertebrate), availability of shade as well as open water is incredibly important. The lack of impoundment (holding back of water – for instance by a weir) in this section also allows a variety of water depths and velocities to develop. That variation in flow maps onto variety in the sizes of substrate particles forming the riverbed . Greater structural variety of this kind creates more micro-habitat niche opportunities for a wider variety of flora and fauna. As well as supporting a wider diversity of fly hatches, that structural variation also provides opportunities for more fish at each stage of their lifecycle. The additional complexity of current pace/turbulence, depth and sizes of rocks makes it much more difficult for fish-eating birds to forage and over-exploit fish populations.

Figure 1: The Derwent below Calver Bridge showing a variety of cover and open water as well as a range of depths and current speed (with correspondingly-varied substrate-sizes)

The combined existence of cobbles/small boulders with undercut edges (creating nooks and crannies in the riverbed) and low, trailing branch cover around shallow water (Fig. 2) helps maintain high natural survival rates of juvenile trout.

Figure 2: Note the low, overhanging branches and also shadows along the edges of cobbles and small boulders (indicating the presence of places for small fish to hide).

Note that branches more than around 12” above the surface of the water do not provide effective cover. However, they will still provide shade and subsidies of terrestrial invertebrates (directly eaten by fish) as well as leaf litter (consumed by a significant proportion of the invertebrates which trout subsequently eat). The existence of low, trailing (and ideally including submerged portions) tree-branches are extremely valuable to improving survival of both adult and juvenile fish. The lack of this kind of cover on grazed or otherwise intensively-managed sections of river will limit the holding-capacity of fish in such sections.

The free-flowing character of the river continues down to around SK24587 74321 (Fig. 3) and this section was notable for producing around four times as many fish to participants during a recent club fishing event than the typical impounded reaches.

Figure 3: This region appears to represent a border between the free-flowing reach upstream and modified/slower flows downstream.

A legacy of extensive engineering interventions on these reaches of the Derwent have created some conditions that are relatively difficult to interpret. Of course there are many quite straightforward examples of large weirs and their associated impounded reaches upstream. However, as noted subsequently in this report, there may also be influences of artificially-increased channel capacity (i.e. digging out the channel) or perhaps redirection of the channel along lower-gradient contours. All three of those types of intervention can create long, uniform and slow-flowing sections. That habitat can have come utility for adult fishbut where slow, deep, uniform pool habitat becomes significantly over-represented it will create problems for species such as trout. An example of extensive slow-flowing habitat is shown at SK24584 74112 (Fig.4).

Figure 4: Slow-flowing and with bare LB, the low overhanging cover on the RB is consequently very valuable.

These types of pools can hold a lot of grayling when they shoal up for the winter – and when fish (trout or grayling) rise in this type of flat water they are easily spotted. At the same time, because trout are more prone to wander around in flat water, the number of those rises can give quite a boosted impression of the actual fish density. With that said, as mentioned in section 3.1, these slower flows can also accumulate stocked trout over time. One problem with that situation is the previously-mentioned risk of attracting predators for an easy meal (which can then secondarily impact on wild grayling and wild trout populations).

The reasons for the slower water and more simplified habitat creating that additional risk are illustrated in Figs. 5 and 6. Essentially, this concept boils down to the calories involved in avian predators chasing down and catching prey versus the calories needed to move to a new, productive feeding ground. The more complex the habitat, the less energetically profitable it is to chase down every last fish to eat. Conversely, the simpler the habitat, the easier it is for birds to herd up the fish against solid structures – and the more likely that they can continue profitably feeding until the prey are significantly depleted. This is just one (of many) factors that explain much higher variability in grayling population numbers (compared to trout) from year to year. In cold winters when stillwater hunting grounds are out of the equation, it seems that cormorants and goosander are more likely to appear on (unfrozen) rivers in higher densities.

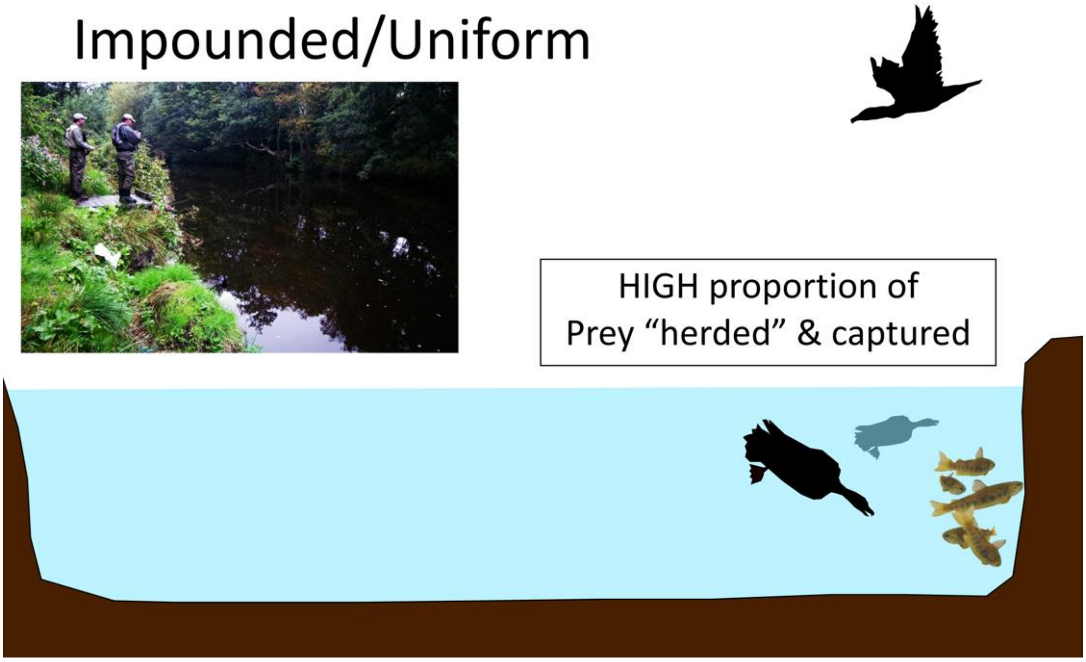

Figure 5: Simple habitat carries a greater risk of extensive depletion of fish populations due to avian predation

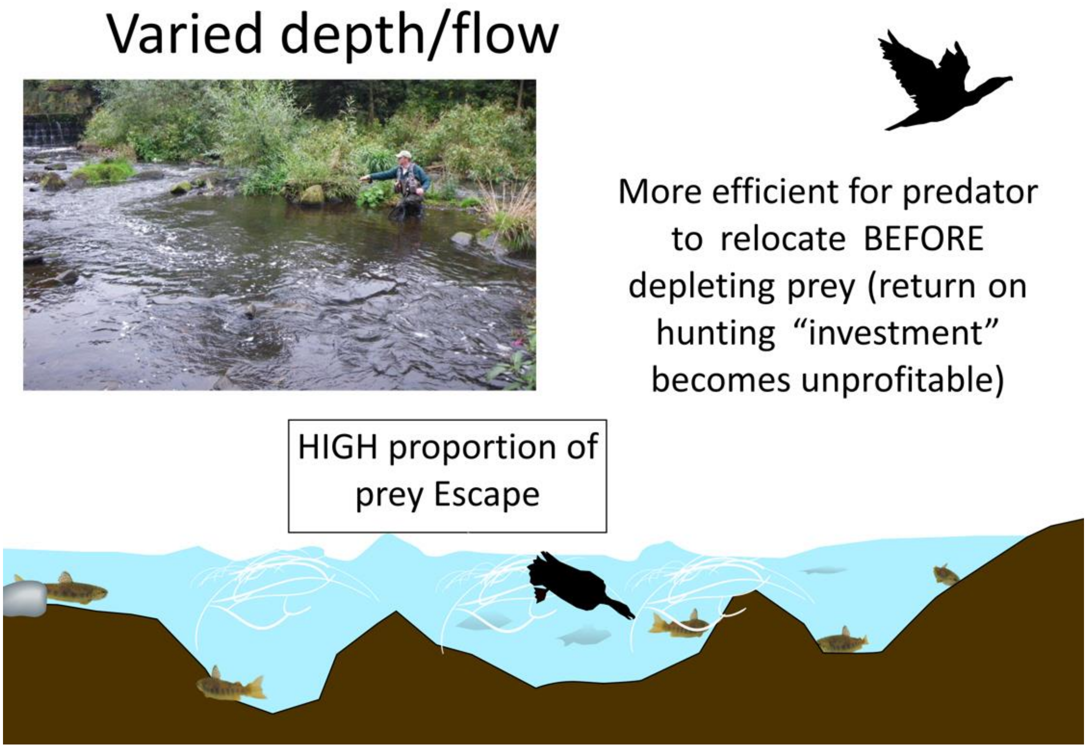

Figure 6: With greater complexity in the habitat, the predators' return on energy invested in hunting drops far earlier – causing them to relocate (or accept far fewer fish captures)

With such extensive reaches of simplified, slow-flowing habitat, additional structural variation of any kind could increase the survival prospects of a range of species; for example, the mid-channel island at SK24672 73943 (Fig.7).

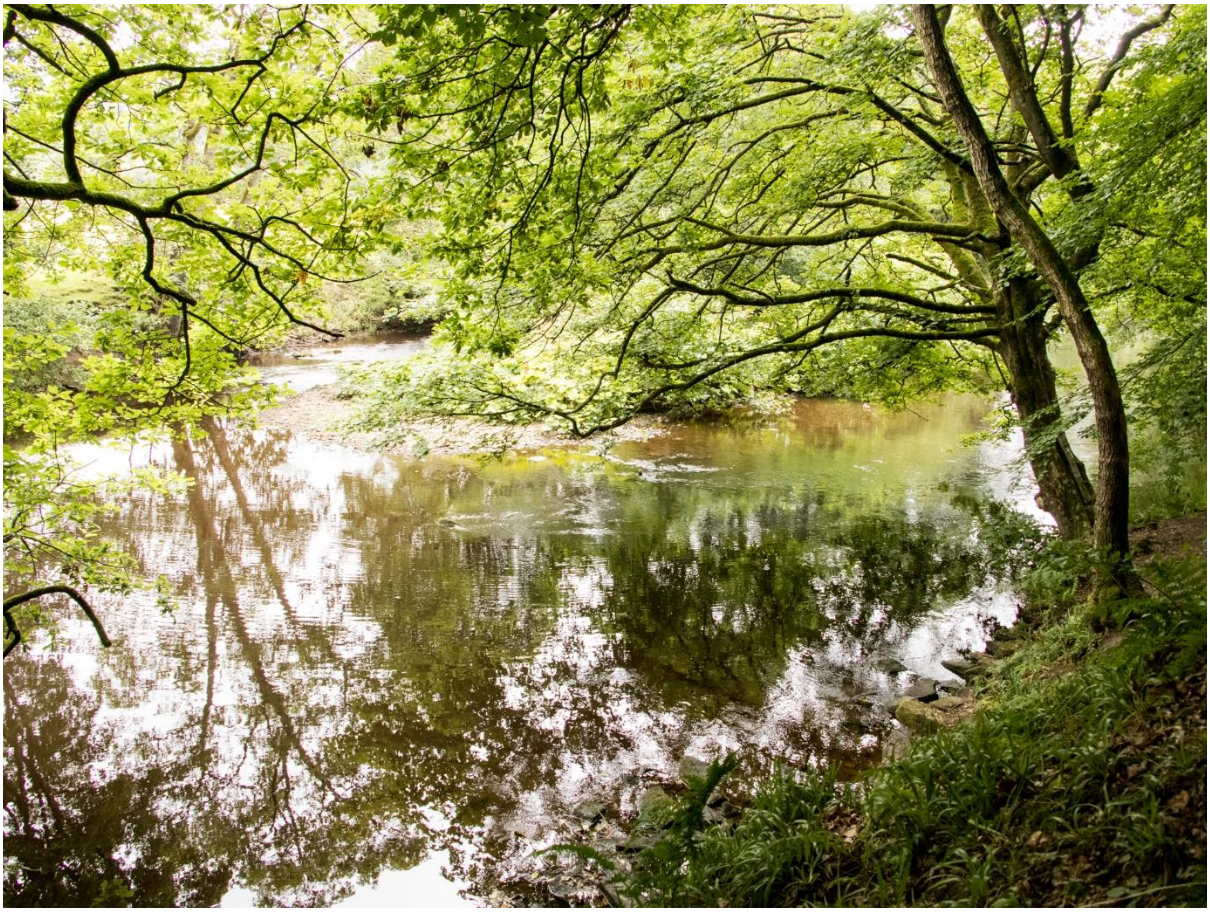

Figure 7: Mid channel island creating diversity by enabling pinched, shallower flows to co-exist with deeper pool and glide habitat – along with re-vegetation of deposited shoals of cobble and gravel.

Given the apparent artificial realignment and modification of the channel (typically maintained by a single line of riparian trees and stone bank revetments), the formation of this island is difficult to interpret. It is possible that either an increase in channel capacity or the loss/removal of a previous impounding structure promoted mid-channel deposition of substrate here.

Whatever the precise explanation, the island is an example of the river adapting to excess channel capacity and re-claiming some structural variation. At the same time, the generally slow, uniform flows both up and downstream still result in a lower overall degree of habitat diversity than would be expected in an unmodified channel.

The impact of a series of weirs on the Derwent is important to consider in the context of the supply of spawning gravels. Similarly, the river's capacity to reclaim habitat diversity via the emergence of depositional features such as mid-channel islands and point bars should also be noted. Figure 8 gives an indication of generalised impacts of weirs (or series of weirs) on the capacity of rivers to generate varied, high-quality habitat:

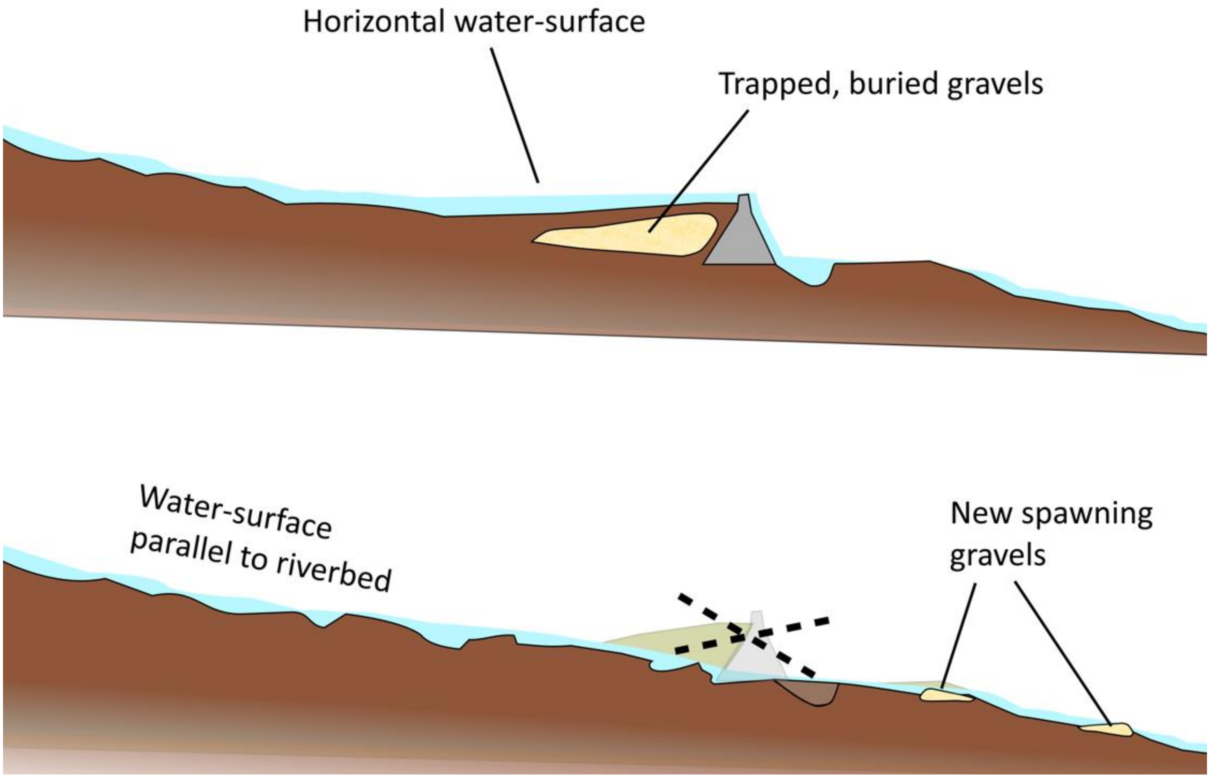

Figure 8: Impounded sections of river represent level "steps" in the longitudinal gradient. The interception of valuable substrate behind weirs interupts their supply to downstream reaches. Under natural conditions the water surface should be parallel to that longitudinal slope – whereas large impoundments create a horizontal water surface with little or no downstream current.

That interception of bed material - and the reduction in a river's potential to redistribute that material during spate conditions – are at least as significant as any "barrier-to-migration" impact of multiple weirs on a river system. Highlighting that (lesser-known, yet significant) impact does not diminish the serious problems caused by fragmenting breeding populations of fish and/or reducing the access to key habitat features utilised by trout to complete their lifecycles (see Appendix 1).

In order to capture a feel for that extensive habitat simplification which dominates the majority of river assessed, Figs. 9 - 12 show typical examples that account for hundreds, if not thousands, of metres throughout the 2.6-kms visited. During the visit, multiple rising fish were noted in slow water. While these clearly indicate the presence of those fish, it is difficult to assign strict numbers due to the wandering nature of trout in slow water. It is also very difficult to accurately compare to the numbers of adult fish in more varied water (other than by the snapshot of simultaneous captures on the fishing event mentioned previously). At the same time, as long as they were wild fish, the need for good spawning and juvenile habitat to be connected to the deeper pool habitat should not be underestimated in order for any of those adult fish to be present in slower reaches.

Figure 9: Slow bend pool

Figure 10: Slow glide

The value of areas with more varied depth, width and current speeds is highlighted by the need for accessible spawning grounds. Probably the best example of potential spawning habitat was noted at SK24780 73902 (Fig. 11).

Figure 11: Potential spawning gravels in the tail of a glide (above the head of the riffle).

Although often termed a “riffle-spawning” species, trout actually need a relatively smooth flow (as well as percolation of oxygenated water through the gaps between the gravel grains) for the best egg-survival. Where the water is too turbulent, the eggs are less likely to be properly deposited within a scraped out “redd” (nest) and/or successfully buried with gravel from directly upstream of the excavated hollow. By the same token, without that rising ramp of gravel at the tail of a glide, water is less likely to be drawn through the gravel-bed. This is the primary importance of the riffle – which always form on the steeper sections or gradient-breaks of the river. The mass of water drawing on the downstream side of the riffle pulls water from the glide through the gravels deposited at the tail of the glide and creates the supply of oxygen needed by the eggs.

The existence of good cover habitat adjacent to spawning gravels is also a big determinant of spawning success. While some low overhanging cover is present, at least on the LB in this section, an increased amount of submerged/trailing large woody material would improve the survival and success of breeding trout. Stable large woody material projecting from the bank down onto deposited gravel would also help to locally scour (and so remove silt from) potential spawning sites.

Something that was very notable for such a rich river was the hard work that has obviously gone into controlling Himalayan balsam infestations. In surrounding reaches of the Derwent, there would be far more extensive stands of this invasive, non-native plant. The club should be commended for their actions in creating biodiverse "fire breaks" free from large stands of balsam where native flora (and associated fauna) can thrive.

Examples of naturally-arising structural complexity (which the club is strongly encouraged to retain) includes large root-plates such as the one shown in Fig. 12.

Figure 12: Root plate, lodged into the bank – creating localised bed-scour and providing cover and substrate for a variety of species.

The temptation with material such as this (or large, fallen trees) is to remove them during work parties to keep things tidy. As an alternative that will directly improve the chances of wild fish populations, retaining (or if necessary re-positioning and securely-anchoring) woody material is recommended. With appropriate permissions in place, the deliberate lodging of fallen trees (for example using the "V" formed between the trunk and a major limb) around a standing tree can create extremely natural woody habitat. Such placements may significantly improve the overall survival rates of adult fish within a fishery. In some of the slower areas, this may add at least some protective effects against avian over-exploitation of fish stocks.

A notable exception to the slow/uniform habitat is the section around a stock drinking point (Fig.13). Here, there is much greater variation in structure, depth and flow velocity. The river runs off an extensive riffle (a great "food factory") into a long pool with multiple feeding lanes suitable for both trout and grayling. Fish will use the full range of available water over different times of the year – which is another advantage of varied habitat.

Figure 13: Head of the pool adjacent to the stock watering point. Livestock densities seem to be low and/or intermittent.

Although it is not ideal for livestock to have direct access to the river (and the associated faecal matter is *not* a positive contribution to water quality), the stocking levels seem relatively low and bank "poaching" is also surprisingly limited. The height of the sward in this field possibly indicates a more intermittent occupation by livestock. However, if stocking densities and/or occupation frequency increases, the impacts of fine sediment and nutrient-rich runoff may become a significant problem for the river.

Opportunities for the creation of large woody material cover in deeper sections were noted just downstream from the cattle drink around SK24805 73577 (Fig. 14). Here the water is very deep and the bed appears to comprise fractured seams of bedrock.

Figure 14: Slabs of bedrock visible at the toe of the RB dropping off into extremely deep water with a much greater density of tree cover on the LB.

A well-featured bend-pool (Fig. 15) with active erosion in the process of creating additional meandering and structural diversity is noted at SK24860 73462. To maximise the fishery potential, this area should be allowed to meander as much as will be tolerated by landowner(s).

Figure 15: Bend pool with high structural diversity – note the shallow, sloping point-bar (colonised/partially-consolidated by butter-burr) in the background; contrasting with the vertical cliff in the foreground. Such variation in cross-sectional bed-profile is lacking in the more uniform sections assessed for this report.

The value of a naturally meandering planform in terms of diversifying habitat structure is easier to appreciate with some explanatory diagrams (Figs. 16 & 17).

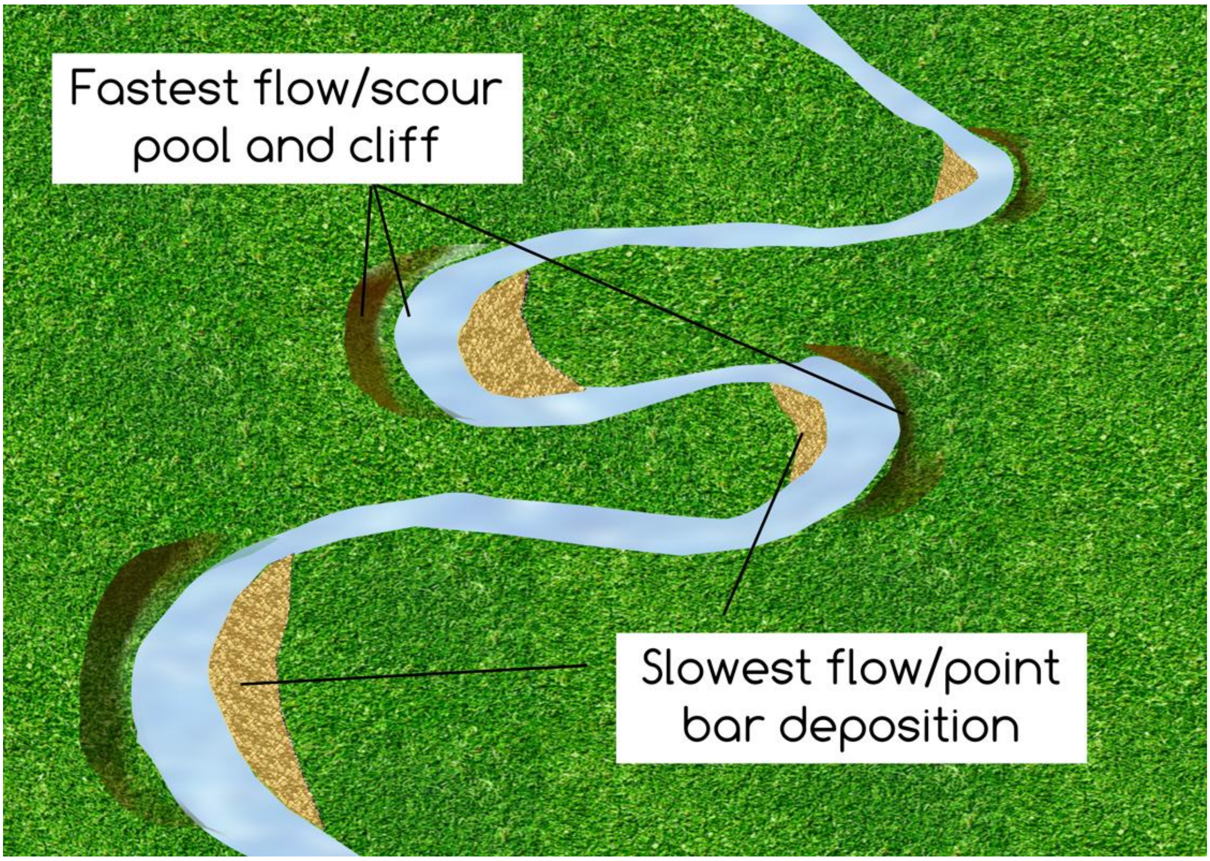

Figure 16: When meanders form naturally, the faster flow on the outside of the bend scours deeper pool habitat. The arising material is subsequently deposited downstream as point bars (and riffles) in the slower flows caused by friction between water and the riverbed.

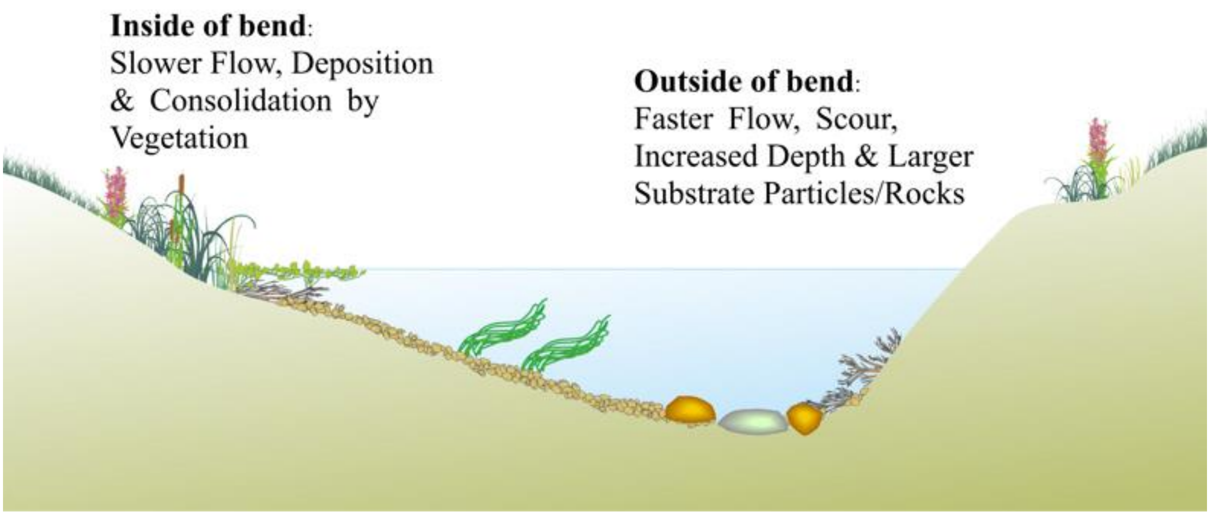

Figure 17: The benefits of natural river process can be seen in elevation-view of a typical cross-section through a bend. Each depth and velocity band over that cross-section will have its own characteristic flora and fauna. In contrast to pools formed by impounding water (which fill in with deposited material over time), sediment is continually scoured out of bend-pools.

Contrast the cross section shown in Fig. 17 with the trapezoidal cross-section shown in Fig. 5. Hopefully it is easier to see which has the greater diversity of micro-habitat niches to support more aquatic life (including fish populations which depend on the full food-web of a river). This is the reason that the (natural) instinct to "repair" natural rates of bank erosion and to lock a river in place is important to resist. Another, more subtle, reason is that the greatest ecological diversity – and hence greatest resilience – is maintained when habitat is allowed to change over time. Locking a river in place actually stifles biodiversity by favouring a smaller subset of species that are particularly adapted to those stabilised conditions. Periodic shifts and disturbances help to reset competitive interactions and allow more species to co-exist. However, if large magnitude disturbances occur too frequently, then this will also stifle biodiversity by disproportionately-favouring species that are adapted to extreme disturbance. Most rivers managed for trout fisheries suffer from the former "locking in place" problem rather than the latter – because anglers like the features named in membership booklets and beat-maps to persist from year to year (among other reasons).

One thing that was noted in the area of the bend-pool shown in Fig. 15 was a difficult-to-access stand of Japanese knotweed. Investing in some early treatment of this is likely to be beneficial in containing the infestation before it becomes a much more costly problem.

Continuing downstream revealed a good example of a single line of veteran bank-top trees, with little to no understory regeneration (Fig. 18).

Figure 18: A row of bank-top trees of uniform height.

The steepness of the bank below this row of trees is likely to protect any seedlings from grazing-pressure. Consequently, there may be beneficial effects from introducing a degree of age/size staggering into this (and similar) stands of trees. Employing some very light and occasional coppicing would achieve this aim and allow greater opportunity for successional growth of tree seedlings. For maximum benefits, securely-anchoring the arising material in the manner previously mentioned is a good strategy. At the same time, retaining well-shaded areas (e.g. Fig. 19) is important insurance against increasing maximum summer temperatures and more frequent extreme low flows.

Figure 19: Valuable low-level shading, cover and terrestrial-subsidies provided by the large area of low, overhanging branches in this reach. Removing/tidying such features is strongly discouraged.

A return to the highly uniform, impounded character is noted around e.g. SK24948 73224 (Fig. 20) and continues all the way down to a significant weir at SK24967 72528 (Fig. 22). All preceding comments relating to the problems of extensive impoundment apply throughout that section of river. In addition, the club's practice of crayfish-trapping in an attempt to control the invasion of American signal crayfish (*Pacifastacus leniusculus*) was observed. The large numbers of individuals trapped (Fig. 21) would seem to imply that the population has not, so far, been substantially-reduced by this significant dedication of volunteer resources. Assuming suitable permissions can be obtained, this trapping could potentially be combined with dominant-male sterilisation to achieve a greater degree of population control.

Figure 20: The slow, impounded character of the river continues down to a large weir downstream.

Figure 21: Crayfish trap contents for the Bubnell section of the club waters.

The format for a combined crayfish trapping and sterilisation programme would be to continue the removal of smaller individuals – while large (and territorially-dominant) males would be sterilised via pleopod removal. Sterilised males would then be returned, alive, to the river. Those large males tend to dominate the mating opportunities and deny the smaller males the opportunity to reproduce. At the same time, because their ability to produce viable, fertilised eggs from their mating attempts is reduced, fewer offspring should arise. An example of this protocol in action is linked below (the page also contains a useful video by way of illustration):

www.exmoor-nationalpark.gov.uk/Whats-Special/exmoor-non-native-invasive-species-ennis/about-the-ennis-project/river-barle-signal-crayfish-project

The weir at SK24967 72528 (Fig. 22) creates a huge, upstream, impounded reach under normal flow conditions – estimated by GIS mapping to be around 935m in length. Just the visible section of impoundment immediately upstream of the weir is shown in Fig. 23.

Figure 22: Weir impounding almost a kilometer of the Derwent.

Figure 23: Example section from within the impounded reach created by the weir at SK24967 72528.

Residential properties and gardens (including that of a recipient of this current Advisory Visit!) back on to the impounded section – with some residents utilising the slow water for boat-mooring. Below the weir, far more varied habitat is evident (as well as more riverside properties) – extending all the way to the downstream limit habitat surveyed in this report (Figs. 24 and 25).

Figure 24:Example of property backing on to far higher quality un-impounded river downstream of the large weir.

Figure 25: View upstream from the downstream limit - varied habitat with riparian cover, open water and a mixture of flow depth and pace.

4 Recommendations

Legal permissions must be sought before commencing work on site. These are not limited to landowner permissions but will also involve regulatory authorities such as the Environment Agency – and any other relevant bodies or stakeholders. Alongside permissions, risk assessment and adhering to health and safety legislation and guidance is also an essential component of any interventions or activities in and around your fishery.

Assuming that all legal requirements have been met for relevant activities, a summary of the recommended actions are:

- Use the contents of this report (and the recommended supporting content and references) to frame a committee and membership discussion on priorities for the management of the full Waltonians fishery – including:
    - The perceived and desired function of stock fish to club members (and particularly what level of catch-and-kill fishing is practiced by club members)
    - Objectively assess the costs and benefits of stocking to the club and to the wild fishery/associated ecosystem of the Derwent
- Explore opportunities in the challenging area of notching/lowering or complete removal of weirs so as to reduce the predominance of slow, impounded flows (and associated degraded river

habitat/increased mortality due to predation/reduction in effective breeding-population sizes of trout and grayling). Considerations include:
    - Local attachment to the familiar landscape
    - Specific heritage designations
    - Understanding and mitigating potential to impact properties or infrastructure (though detailed modelling to identify low-risk interventions is typically far, far less costly than the installation of a technical fish pass)
- In addition to above, incorporating into discussion and decision-making the concepts that:
    - If equivalent ecological impacts of weirs on aquatic species were, instead, caused by chemical pollution – prosecution could be sought
    - The costs of enhanced predation success (due to simplified habitat and slow flows) to the fishery will be severe, particularly during colder winters
- Seek a modification to the current crayfish-trapping licence agreement such that dominant-male-sterilisation (and release into the river) can be incorporated into current trapping protocols

5 Further information

The WTT may be able to offer further assistance such as:

- WTT presentation/Q&A session
    - Where recipients are unsure about the issues raised in the AV report, it is possible that your local conservation officer may be able to attend a meeting to explain the concepts in more detail.

In these examples, the recipient would be asked to contribute to the reasonable travel and subsistence costs of the WTT Officer.

The WTT website library has a wide range of free materials in video and PDF format on habitat management and improvement:

www.wildtrout.org/content/wtt-publications

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 material, enhancing fish populations and managing invasive species.

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

6 Acknowledgements

Wild Trout Trust would like to thank the Environment Agency for their continued support of the advisory visit service, in part funded through monies from rod licence sales. The advice and recommendations in this report are based solely on the expert and impartial view of WTT's conservation team.

7 Disclaimer

This report is produced for guidance; 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.

N.B. See Appendix 1, over.

Appendix 1: Key trout lifecycle stages and associated habitat

There are three main types of habitat that are needed in order for wild trout to complete each one of three key lifecycle stages (spawning, juvenile and adult; Fig. A1). The consequences to trout populations of a lack of each specific habitat-type are also illustrated in Fig. A1.

The basic process by which the Wild Trout Trust's advice is derived is to examine whether each of the key habitats are represented within a visited reach. Where those habitats do exist, there is then an assessment of whether trout can access those habitats to make use of them and successfully complete self-sustaining lifecycles. In this way, both habitat quality and habitat connectivity are assessed in order to judge whether wild trout populations could survive and thrive.

Because the habitats which support complete trout lifecycles meet a wide range of varied requirements, they are physically diverse (Figs. A2-A4). That structural variety is, in turn, vital for supporting a wide variety of species.

In this way, assessing habitat for a trout provides a means of identifying how to improve and/or protect wider river-corridor biodiversity

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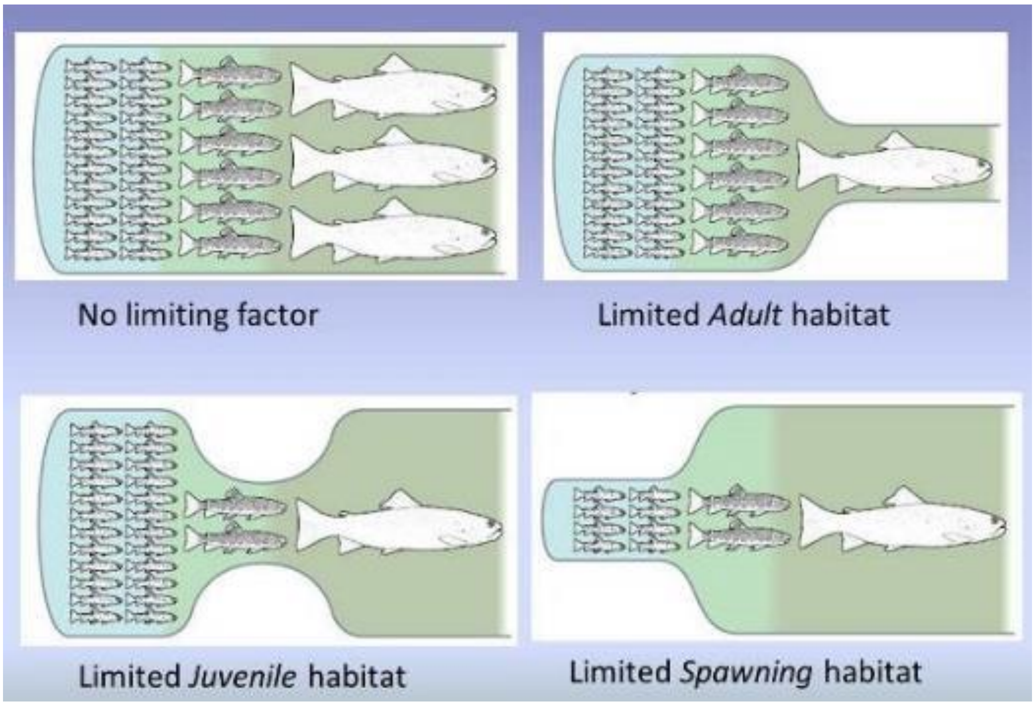

Figure A1: The impacts on trout populations lacking adequate habitat for key lifecycle stages. Spawning trout require loose mounds of gravel with a good flow of oxygenated water between gravel grains. Juvenile trout need shallow water with plenty of dense submerged/tangled structure for protection against predators and wash-out during spates. Adult trout need deeper pools (usually > 30cm depth) with nearby structural cover such as undercut boulders, sunken trees/tree limbs and/or low overhanging cover (ideally trailing on, or at least within 30cm of, the water's surface). Excellent quality in one or two out of the three crucial habitats cannot make up for a "weak link" in the remaining critical habitat.

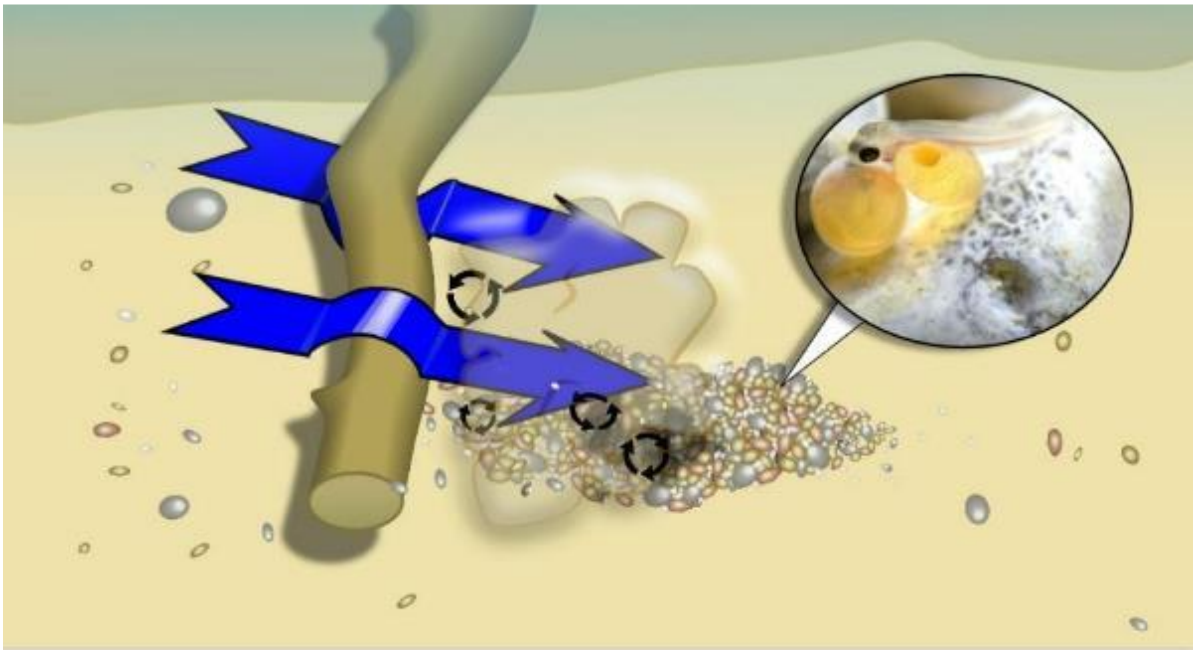

Figure A2: Features associated with successful trout spawning habitat include the presence of silt-free gravels. Here the action of fallen tree limb is focusing the flows (both under and over the limb as indicated by the blue arrows) on a small area of river-bed that results in silt being mobilised from between gravel grains. A small mound of gravel is deposited just downstream of the hollow dug by focused flows. In these silt-free gaps between the grains of gravel it is possible for sufficient oxygen-rich water to flow over the developing eggs and newly-hatched "alevins" to keep them alive within the gravel mound (inset) until emerging in spring.

Figure A3: Larger cobbles and submerged "brashy" cover and/or exposed fronds of tree roots provide vital cover from predation and spate flows to tiny juvenile fish in shallower water (<30cm deep). Trailing, overhanging vegetation also provides a similar function and diverse bank-side vegetation has many benefits for invertebrate populations (some of which will provide a ready food supply for the juvenile fish).

Figure A4: The availability of deeper water bolt holes (>30cm to several metres), low overhanging cover and/or larger submerged structures such as boulders, fallen trees, large root-wads etc. close to a good food supply (e.g. below a riffle and with prey likely to fall from overhanging tree canopy in this case) are all strong components of adult trout habitat requirements.