WILD TROUT TRUST
wildtrout.org

Advisory Visit
Bradshaw Brook

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River	Bradshaw Brook
Waterbody Name	Bradshaw Brook
Waterbody ID	**GB112069064580**
Management Catchment	Irwell
River Basin District	North West
Current Ecological Status	Moderate (Good for Fish)
U/S Grid Ref inspected	SD73338 12681 (53.610000,-2.4044444)
D/S Grid Ref inspected	SD73499 11877(53.602778, -2.4019444)
Length of river inspected	1.2 km

1 Summary

- *Some excellent habitat was noted during the walkover survey – particularly in the lower reaches visited*
- *The club has a valuable policy of retaining naturally arising large woody material and woodland/understory vegetation features which is contributing to the resilience of self-sustaining trout populations in their waters*
- *The importance of tackling fine sediment inputs is stressed – along with potential mechanisms to seek effective solutions*
- *The likely negative effects of a low weir are characterised along with recommended mitigation*
- *Opportunities to augment in-channel structural diversity, canopy light/shade regime and native riparian understory vegetation are identified*
- *Invertebrate monitoring could provide useful quantification of potential impacts – as well as establishing a baseline for unimpacted conditions (useful in demonstrating damage in the instance of any future severe pollution)*
- *Ongoing control of invasive, non-native plants by the club is extremely valuable and the importance of continued vigilance and action where possible is emphasised*

2 Introduction

The Wild Trout Trust (WTT) were invited to visit the Bradshaw Brook by members of the Bradshaw Brook Fly Fishing Club. Throughout the report, banks are designated as right (RB) and left (LB) while facing downstream. Locations are specified using Decimal Degrees format in the main report text – enabling co-ordinates to be pasted directly into common mapping platforms (including Bing and Google Maps). The summary table at the start of this report contains both Decimal Degrees and National Grid Reference formats to enable cross-referencing between reporting systems.

3 Habitat Assessment

For this report the visited sections of the Bradshaw Brook spanned between a downstream limit at 53.602778, -2.4019444 to an upstream limit at 53.610000,-2.4044444. Observations are reported in a downstream to upstream sequence to aid clarity.

Abundant gravel deposits, in the form of a point-bar deposited on the inside of a bend, were noted at the downstream limit (Fig.1). A significant proportion of those gravel particles were in the 20-50 mm diameter range that trout prefer for spawning (e.g. Fig.2).

This, coupled with the depth and pace of the current at normal flow, suggests there is good potential for wild trout to spawn within the reach controlled by Bradshaw Brook Fly Fishing Club. Although sometimes described as “riffle-spawning” species, brown trout tend to select clean gravel sites where the flow is consistent but not too turbulent. An important factor determining hatching success is the ability of clean, well-oxygenated water to be drawn through (and not only flow over) gravel beds. In

Figure 1: Gravel point bar and diverse riparian woodland habitat.

situations where fine sediment clogs the gaps between gravel particles, eggs can suffocate when not sufficiently irrigated by oxygen-rich water.

Figure 2: Point bar gravel particles in the 20-50-mm diameter range.

Securely-lodged large woody material helps to maximise spawning success – as well as providing habitat for both juvenile and adult trout and a wide range of aquatic species. The localised bed scour promoted by large limbs and trunks of trees helps to create pool habitat and sorts gravel deposits into similar size fractions to keep them free of silt.

A particularly high value (in ecological terms) example of naturally occurring large woody material was noted at 53.603012, -2.401373 (Fig.3).

Figure 3: Apparently lodged at both ends, the complex trunk shape is promoting undershot scour and is not impounding the flow. This is an extremely valuable habitat feature.

Typically in peat stained, rain fed rivers there is a significant reliance on leaf litter at the base of aquatic food chains. The dark brown nature of the riverbed also means that solar heat gains can be more problematic in low-flow/hot summer conditions (compared to pale riverbeds). In combination, the need for deciduous leaf litter and sufficient shade tend to greatly increase the value of riparian woodland on rivers like the Bradshaw Brook. As mentioned previously, having an abundance of naturally arising woody material is highly beneficial in shaping complex habitat. In addition, wood and brashy material in the water will help to retain a higher proportion of leaf litter. River channels that lack this kind of hydraulic roughness tend to lose nutrients associated with leaf litter – as the leaves are exported out of the reach during spate flows.

In areas where the channel is able to meander naturally, the combination of bankside trees (and their root systems) with processes of erosion and deposition can create ideal scour pool habitat and cover for adult trout (e.g. Fig.4). The significance of deeper pool habitat containing complex submerged cover such as tangled tree roots is often underestimated. As well as the more obvious times adult trout use these areas as feeding habitat – such habitat also tends to greatly increase overwinter survival of wild trout. Whether trout are hidden away, lying dormant among the complex cover – or actively bolting into that cover to escape predation – tree roots and submerged branches help avoid over-exploitation of prey by predators. The function of this habitat is particularly important during harsh winters when nearby stillwaters become frozen and force piscivorous birds to hunt in rivers and streams.

Figure 4: Leaning trunks and submerged roots on the outside of this scour pool on a bend in the river. Although a mature specimen has been felled – the associated root wad and nearby trunks have been left in place. Ideally, the full tree would have been left in place.

As with many post-industrial rivers, the Bradshaw Brook shows signs of historic straightening of the channel in places (e.g. Fig. 5). In those areas, there is a corresponding reduction in habitat complexity. Lower structural diversity makes habitat suitable only for smaller subset of species.

Figure 5: This section appears to have been straightened in the past. Rock revetments are often stabilised by the roots from a line of riparian trees, as is the case here. However, this does create opportunities for stable, cross-channel large woody material features similar to the naturally arising example shown in Fig.3

The single row of trees of the same age can be used to diversify habitat in two main ways. Firstly, the uniform canopy could be staggered via very light rotational coppicing. Only a very small proportion of trees would be felled at each well-spaced rotation (e.g. taking 5 to 10% of trees once every two to four years). Secondly, trunk and crown material arising from each coppice could span the channel and be lodged on both banks for high stability. Having the trunk and/or limbs only touching the bed at points over the cross-section ensures undershot scour along with space to allow water and a proportion of debris to pass. Thirdly, hanging the v-shape union between main trunk and major limbs around remaining trees would also create stable “tree hanger” habitat features.

The rigorous and extensive Japanese knotweed control undertaken by the club is extremely valuable (e.g. Fig.6). Re-establishment of a more diverse understory of native vegetation may be helped by extending light rotational coppicing beyond the immediate bankside. Recovery may also be assisted via supportive planting of locally appropriate plug plants.

Although by no means a perfectly consistent pattern, there is a general trend towards more negatively impacted habitat when moving from downstream to upstream through the visited reach. The highest quality habitat was observed within the lower reaches of the Brook covered in this report. Modifications to the course and dimensions of the channel broadly increase in frequency towards the upstream limit – with notable exceptions in the area of the upstream limit itself.

Figure 6: Extensive area of Japanese knotweed treatment along a historically straightened section of channel a short distance downstream of the A676.

Owing to access, a short section of the Brook from just below to just above the A676, Bolton Road was not surveyed. Upstream of Bolton Road, behind the tennis club around 53.606230, -2.404347, the Brook is more constrained on both sides by riparian land use and infrastructure. However, varied habitat still exists with particular benefits arising from a lack of excessive pruning or removal of riverside trees (e.g. Figs. 7 and 8).

Figure 7: Marginal vegetation on the near bank and valuable overhanging branch cover on the far bank. The combination of fishable water with the probable elevation of fish numbers due to overhanging cover matches with club member reports of good dry fly fishing here.

Figure 8: Complex submerged cover on the far bank creating ideal adult trout habitat.

Retaining cover such as the examples shown in Figs. 7 and 8 is extremely important for high quality trout fishing. Pressure and temptation to excessively tidy up this type of habitat can sometimes be hard to resist. However, without enough of these types of features, there would be far fewer fish to cast a fly at. The presence of these features is a strong sign that the club waters are well managed. Continuing the policy of retaining important structural habitat – including woody material in the channel - is essential for robust, self-sustaining trout populations.

Figure 9: Native vegetation mixed with scattered, individual Himalayan balsam plants.

As with the Japanese knotweed control measures mentioned previously, the club are doing a good job by reducing and controlling Himalayan balsam cover. While in some areas (e.g. directly behind the cricket ground; Fig.9) there are still scattered balsam plants, the benefits to marginal vegetation cover of balsam control are evident (Fig.10).

Figure 10: A lack of balsam has allowed native marginal vegetation cover to develop and persist. This helps support healthy aquatic and terrestrial invertebrate populations as well as improving survival of trout fry after they emerge from the gravels in spring.

In common with the club's beneficial policy of woody material retention, efforts to control invasive non-native plant species are extremely important. Such efforts will protect the river corridor food chain and habitat, with many of the invertebrate species that rely on diverse, native riparian vegetation providing food for trout. Physical cover created by trailing/submerged plant material supports increased survival of juvenile and adult trout. Consequently, habitat and food chain effects compound to multiply the benefits of invasive plant control.

A potential point source of pollution was noted from the previously reinforced drain access shaft shown in Fig. 11. The flattened grass indicated a pathway for overflowing drain material to enter the river and the amount of concrete poured on top of the original structure suggests a known and apparently ongoing problem. If not already known, identifying ownership of this asset and giving the owners an opportunity to fix the leak before seeking a prosecution through the Environment Agency could, potentially, yield a quicker solution. The urgency of any repairs will depend on the nature of material transported by the drainage system. If there is confidence that only surface water with low levels of particulate and dissolved contaminants are ever present in the drainage system, this would have a lower priority compared to severely contaminated material.

However, the ability to confidently rule out contamination is difficult; particularly in cases of intermittent problems and/or unusual pollutant sources.

Figure 11: Raised drain cover with apparent split in the concrete casing. Note flattened grass below the concrete mound indicating a recent overflow into the river (which is just outside the frame, below the lower edge of the picture).

Setting up invertebrate community monitoring (e.g. following the Riverfly Partnership methodology) at comparable reference sites just upstream and downstream of this point-source is recommended. This would provide valuable insights into the likely severity of pollution, without needing to know in advance what substances to try to detect within the runoff.

Figure 12: Vertical toe boarding at the edge of a lawn in the background (centre/upper left of frame). The simplification of that section of bank appears to be adequately offset by surrounding, structural complexity on both banks. However, a vegetated buffer would be a positive benefit to wildlife in the garden and on the river.

A short section of riverside lawn and associated vertical toe-boarding represents poorer habitat (Fig. 12). While, in isolation, this isn’t a serious ecological impact – it would be far better to allow a vegetated buffer strip to develop. This would avoid the need for revetment, particularly on the inside of a bend, and create a wildlife haven within the garden.

Closer observation of the leaning tree shown in Fig.12 reveals additional complexity and ecological value to this structure (Fig.13). A cluster of large and coarse woody material is complemented by the trailing marginal vegetation resulting in an effective refuge from predation.

Figure 13: Lodged trunks and limbs associated with the rooted, living trees. Under different flow levels these should perform a variety of functions from simple overhead and submerged cover through to flow baffling and shaping the riverbed.

The reduced ground level behind a marginal strip of vegetation in some areas (e.g. Fig.14) may be a result of footfall compacting the ground and inhibiting vegetation growth. Alternatively, this could be the result of scour created during or after high flow events. The marginal plant growth here is, again, providing valuable cover. It appears that, running along the margin of the river, a single row of trees on both banks have quite a uniform age structure. Moving the informal path (or desire-line) further away from the river could be coupled with selective coppicing of a small number of trees. Felled trees could then be wedged (or cabled as required) to create cross-channel trunks – with much of their mass sitting on the riverbanks.

The staggered canopy structure along with reduced erosion due to foot fall should allow a wider buffer strip of vegetation to form. Rerouting the usual path a few metres further away from the river could help promote the recovery of understory and wetland vegetation. However, to set expectations, this area may experience episodic flooding and associated scour as water re-enters the channel following flooding. With that said, developing a wider buffer strip over time would make it easier to accommodate felled tree trunks within revegetated areas without creating an obstacle to riverside walkers. Access for anglers into the river channel could be maintained at the most appropriate points.

Figure 14: Single row of mature trees lining the near bank (RB) and compacted/lowered area behind the marginal wood rush understory.

The low weir across the river just upstream from the reach shown in Fig. 14 is likely to represent a complex, negative impact (Fig.15). Although not particularly high relative to many run of river weirs, it will still interrupt both upstream and (equally importantly) downstream movements of fish.

Figure 15: This weir apparently exists to stabilise and protect the services pipe which crosses the river at this point.

Bed scour directly below the weir will promote a slight increase in depth, over perhaps a one to two metre reach length. However, this is still a relatively short vertical swimming depth for fish. In species that are able to leap obstacles, water depth is vital for them to build up enough vertical speed (and hence momentum) to carry them over the obstacle. Consequently, particularly at lower flows, even this low weir is likely to prevent upstream movement of many fish. It may also cause injury or significant depletion of energy reserves for those fish that do make the leap. Even short delays can also lead to increased mortality, since fish accumulate in artificially elevated densities and predators can take advantage.

Any reduction or prevention of free movement up and downstream results in smaller effective breeding population sizes. Trout that would, otherwise, be able to combine their genetic material with particular members of the wider population have their options limited. That reduction in available mates can lead to reduced resilience and adaptability in wild trout populations. It is for this reason that free passage is important for all species of fish that travel between different habitat types to complete their lifecycle (including “resident” trout). Fish migration is certainly not just an issue for iconic marine migratory species such as salmon.

Another, less frequently discussed, impact of run of river weirs is the interruption of riverbed material being transported downstream. The shape and dimensions (bank full width and depth over a range of cross-sectional profiles) of a river channel are set during bank-full spate flows. This is when the shear velocities acting on the riverbed are greatest and when the largest volumes of bed material are shifted and re-deposited. As the spate flows recede, successively finer particles will settle into the overall topography created from deposits of larger gravels, cobbles and boulders.

Initially, installing an impounding structure (e.g. a weir) will create a deeper pool on its upstream side. However, over successive spate events, riverbed material is likely to build up and tends to reduce the average depth of water. As mentioned previously, the turbulent zone just below the weir may create a localised increase in depth due to the focussing of bed scour. Such areas can be known as good fishing hotspots. However, they are typically created at the expense of a much larger area of good fishing that would otherwise exist.

In the case of the Bradshaw Brook, a relatively high longitudinal gradient combines with a fairly wide, shallow channel and low weir crest to limit the “ponding” effect. As long as flow levels are high enough to easily pass over the weir crest, noticeable current velocities are maintained over the full cross section of the channel (e.g. Fig. 15, left of frame). For this specific structure, it is likely that the barrier to free fish movement is the most significant factor. This is not to say that the habitat and bed transport material are not negatively impacted. It would still be better on all fronts for the weir to be removed. However, in light of the costs of creating an alternative solution for the service pipe crossing the river, the best return on investment is likely to be an intervention that focuses predominantly on effective improvement to fish passage.

Notching the weir and combining with a sufficiently shallow gradient rock ramp on the downstream side (5% slope or less - ideally 1-3%) could be a good compromise if weir removal is unfeasible. Designed correctly, this may also aid in reconnecting at least some downstream transport of riverbed material.

It is important to consider riverbed material transport in terms of variation over time, as well as structural complexity. Physical complexity in habitat is vital for species-rich, healthy river corridors - the more structural variety in a habitat, the higher the number of species that can find their ideal conditions.

Stable, physical complexity is not the end of the story though. If habitat structure is locked in place over time, then competition between species can potentially play out to a definitive conclusion. Upon reaching that final state, certain species may suffer a decisive loss and become locally extinct. However, the presence of occasional disturbance (e.g. spate flows turning over and redistributing bed substrate) can periodically re-set that competition. Starting again from a more equal footing should maintain higher biodiversity over time. Some species will do well earlier in the rebuilding process while others may eventually win out given a long enough timeline in a stagnated/unchanging environment.

Figure 16: Mid channel cobble bar formed in response to large woody material input.

This is why it is still a positive outcome if certain pools change or infill with substrate over time, as alternative pool habitat areas are created in different locations. Similarly, having the position and size of point bars (e.g. Fig.1), mid-channel bars (e.g. Fig.16) and riffles (e.g. Fig.13) shift in size, shape and location is also a good thing. Note, however, that this is different from situations where an imbalance in land-use in the headwaters of a river can lead to a massive oversupply of, for instance, cobble material. In those situations a river system may struggle to redistribute that oversupplied substrate into complex habitat. This is particularly true if the downstream watercourse has also suffered impacts that simplify a channel. A potential example of this is the likely impact of moorland grips/drains and the supply of cobble material into heavily grazed/unfenced reaches of the River Ure.

The natural ebb and flow of the habitat features that dominate reaches of river over longer timescales will probably be reflected in variation in the strength of different age-classes and size of trout. For a period of years, juvenile recruitment and survival may be particularly successful. At other times, overall numbers of fish could be lower but the average size of adult fish may be a little larger. In the absence of significant anthropogenic impacts creating bottlenecks in any of the key lifecycle stages of trout (i.e. spawning, juvenile and adult; Appendix 1); this natural variation should be embraced. It is the sign of a healthy and resilient self-sustaining trout population.

In addition to examples of historic straightening observed further downstream (e.g. Figs.5 and 6), remnants of stone revetment and signs of channel modification were also noted in the upper visited reaches (Fig.17). Consequently, the channel is a little less sinuous than would be expected.

Figure 17: Low blockstone revetment visible on the opposite bank. This will eventually erode away and the growth of bankside trees indicates nature is in the process of colonising these remaining structures.

Retaining a riparian woodland buffer strip around the channel will promote the formation of diverse root structures varying in depth and resistance to erosion. Tree roots, in particular, act to significantly reinforce banks against being washed away. This will help to avoid uncontrolled and rapid erosion associated with the shallow root horizon of short (grazed or mown) grass turf.

Probably the most significant challenge to overcome will be the degradation in recent years of the riverbed towards the upstream limit of this visit. A shallow gravel and cobble glide area which would otherwise be a potentially valuable spawning area has become clogged with fine silt (Fig. 18).

Figure 18: Cobble and gravel glide which has become clogged with fine silt in recent years.

There is also a lack of low level cover and in-channel large woody material that would be beneficial to reshape the bed and maximise the potential value as spawning habitat. However, the stand of trees on the LB in the background of Fig.18 provides ample opportunity to introduce stable cross-channel tree structures (wedged or cabled in place as required). Although it falls short of a true solution to the problem of eggs being suffocated by silt, large woody material may provide a small amount of mitigation. Undershot flows beneath logs and eddying flows around the edges of structures can create some localised flushing of fine sediment from between gravel particles. Furthermore, even clean gravels may be underutilised for spawning if there is insufficient cover to protect breeding adult fish from the threat of predation.

Consequently, installation of large woody material in this reach should create compounding benefits. With that said, those potential benefits will be relatively superficial if the oversupply of silt cannot be significantly reduced or eliminated. Existing pollution legislation regulates the release of polluting materials into rivers. Establishing whether sediment released from privately owned reservoir assets contravenes legislation an important step. The images shown in Figs. 19 and 20 show sediment releases from Jumbles Reservoir into the Bradshaw Brook during low summer flow conditions. A combination of higher temperatures and also low available dilution is likely to make such releases particularly damaging to the ecology of the river.

Figure 19: Sediment photographed below Jumbles Reservoir dam wall.

Figure 20: Fine sediment carried downriver in low flow conditions – magnifying likely ecological damage and photographed during summer 2023.

Investigation into whether turbidity and/or suspended solid levels, Biochemical Oxygen Demand (BOD) or nutrient levels are covered by (or in breach of) consented levels for this asset is strongly recommended. Information available on the Environment Agency register of discharges to water and groundwater for the area around Jumbles Reservoir do not appear to include the reservoir itself: [Results of searching Discharges to Water and Groundwater (data.gov.uk)](). Confirming whether reservoir silt releases are currently covered under consented discharge legislation should be coupled with determining whether the release of silt and associated nutrients from water company assets would be covered under The Water (Prevention and Control of Pollution) Act, 1974 and related legislation. This will help to determine the available mechanisms for reducing or eliminating future releases of the material shown in Figs. 19 and 20.

4 Recommendations

Options for improving and protecting the Bradshaw Brook include:

- Determine the legal status of silt releases from Jumbles Reservoir into the Bradshaw Brook including:
    - Whether covered by consented discharge permit
    - Whether in contravention of existing water pollution legislation
- Seek proper control or elimination of silt releases – either through voluntary collaboration or enforced legal action
    - If the fishing club belong to the Angling Trust, there may be access to appropriate legal representation, if required
- Undertake Riverfly Partnership monitoring initiative training and adopt routine monitoring
    - Establish invertebrate monitoring stations in an effort to characterize the scale and extent of water quality impacts – particularly around suspected point sources (particularly the overflowing drain shown in Fig. 11)
    - If possible, identify all priority issues and sites for water quality problems
    - Campaign for improvements and solutions to ongoing water quality issues
- Continue to monitor and control stands of invasive plant species such as Himalayan balsam, Japanese knotweed and giant hogweed (while remaining vigilant to new infestations)
- Continue with the club's excellent policy to retain stable woody and vegetative cover
- Seek a costed design for a stable rock ramp utilising material that closely mimics the natural bed to improve fish passage and reinstate a proportion of riverbed transport at the weir pictured in Fig.15
    - Request confirmation of safe limits to the dimensions, location and long-term stability of the notch that may be required to enable successful rock ramp installation and performance
    - Obtain a cost for installation under the supervision of rock ramp design contractors
- Establish a very light coppicing regime and utilise arising trees to create stable, secure cross-channel large woody material

installations (e.g. Fig.21) and/or tree hanger features (e.g. Fig.22) particularly at points mentioned throughout this report
- Set back the informal footpath used by anglers by a few metres where possible (especially where notable erosion or compaction from foot fall is evident).
    - Combine with light coppicing to help reestablish a more densely vegetated riparian understory buffer strip
    - Path route could be defined via low dead hedge structures – but these may be periodically washed out and need repairing
    - Select access points to the river that promote sufficient protection and recovery of buffer strip vegetation

Figure 21: Wedged cross-channel tree habitat feature installed on the River Washburn – note the length and mass of main trunk remaining on the bank, lodged between standing, live trees (left of frame) as well as the space beneath the main trunk to allow flow to pass through for much of the full channel width.

Figure 22: Tree "hanger" with flow travelling from right to left.

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 local council as well as relevant departments within 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 rivers.

5 Acknowledgements

Wild Trout Trust would like to thank the Environment Agency for supporting the work in this report. The advice and recommendations in this report are based solely on the expert and impartial view of WTT's conservation team.

6 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.

NB. See Appending 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.

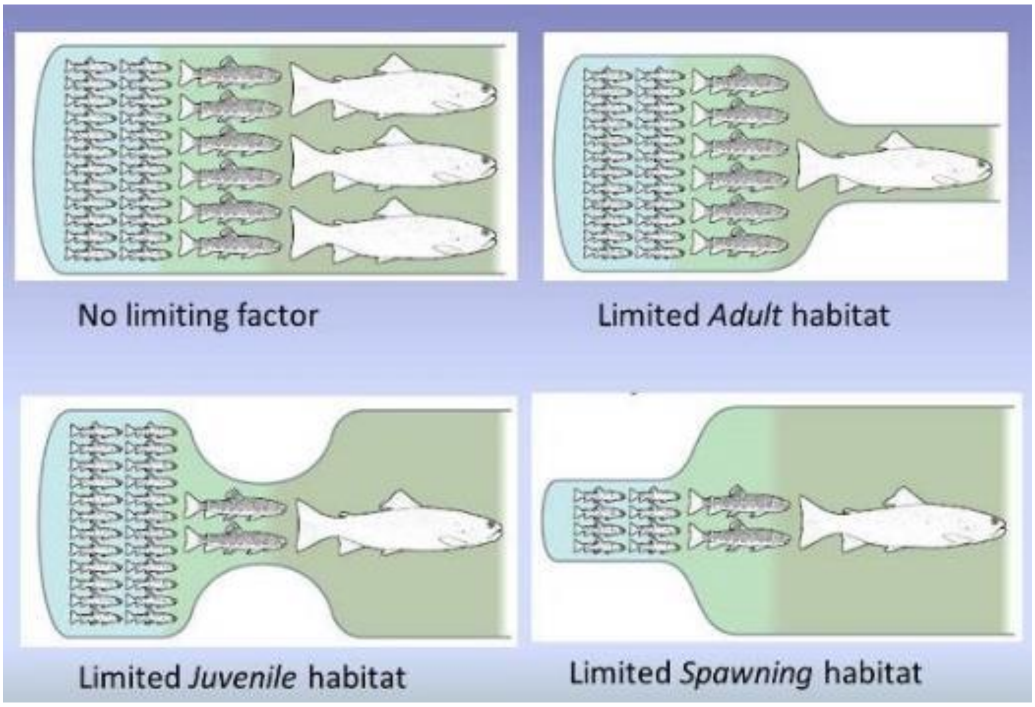

Figure A1: The impacts on trout populations lacking adequate habitat for key lifecycle stages. Spawning trout require loose mounds of gravel with a good flow of oxygenated water between gravel grains. Juvenile trout need shallow water with plenty of dense submerged/tangled structure for protection against 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.

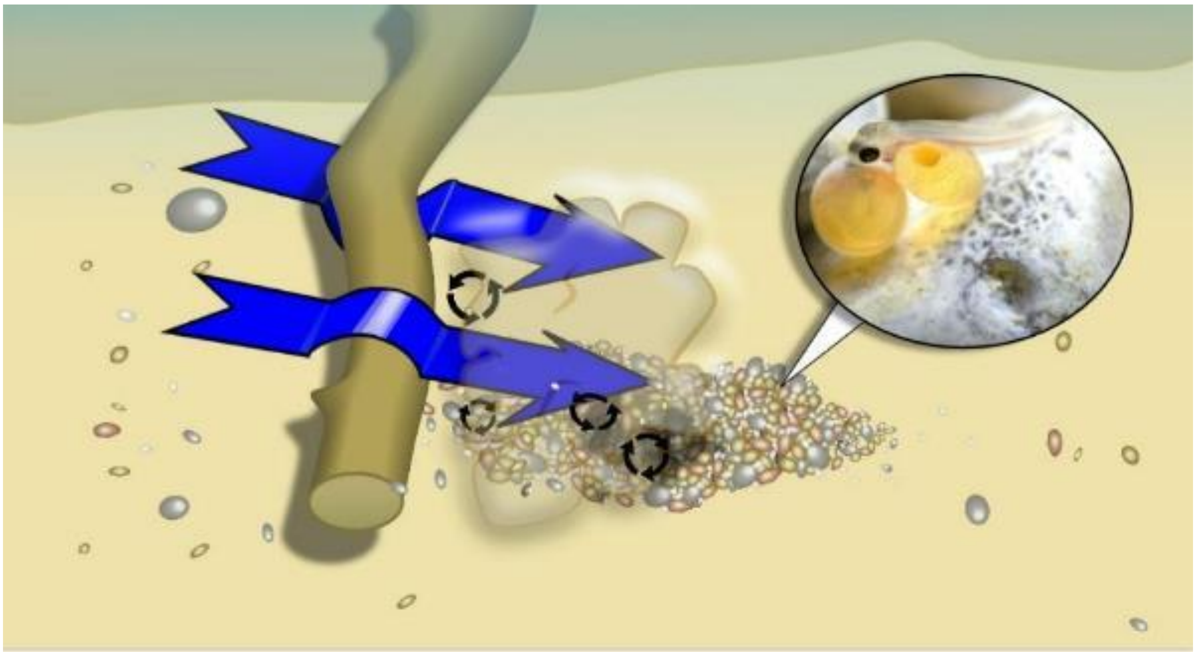

Figure A2: Features associated with successful trout spawning habitat include the presence of silt-free gravels. Here the action of fallen tree limb is focusing the flows (both under and over the limb as indicated by the blue arrows) on a small area of river-bed that results in silt being mobilised from between gravel grains. A small mound of gravel is deposited just downstream of the hollow dug by focused flows. In the resulting 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.

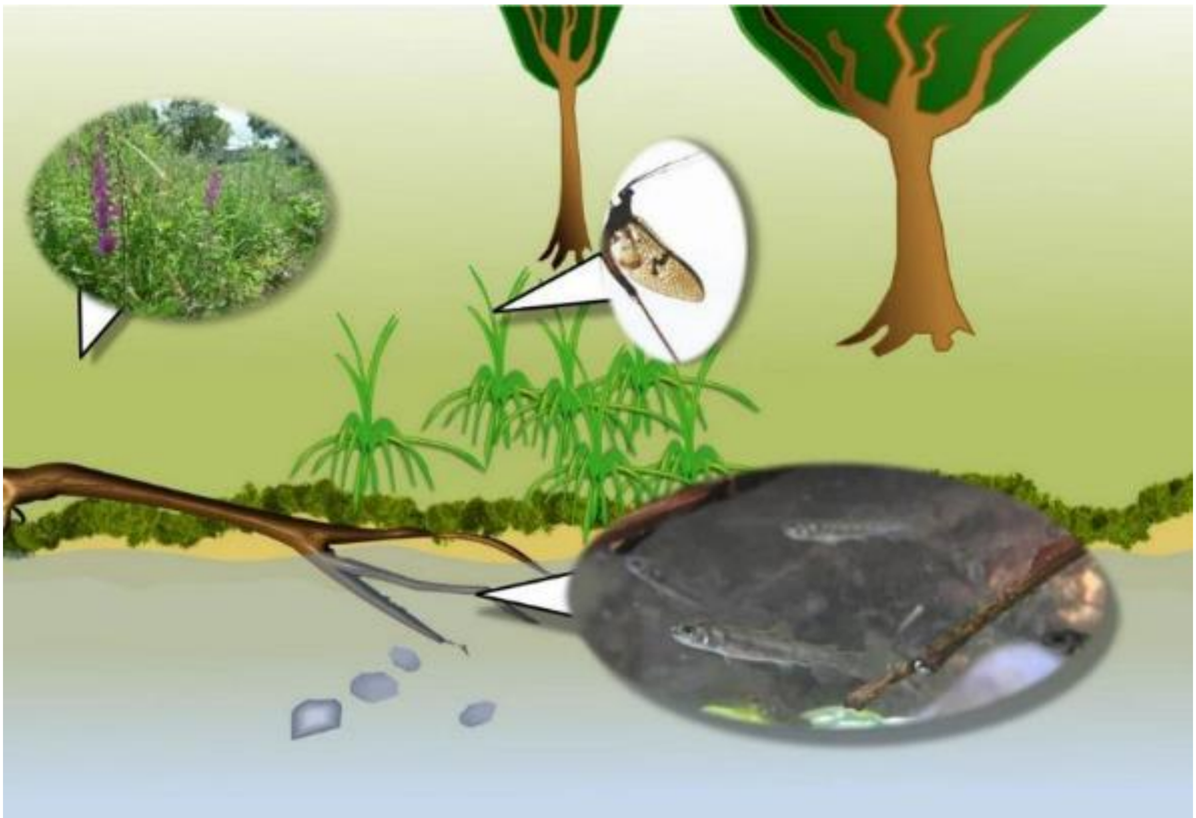

Figure A3: Larger cobbles and submerged "brashy" cover and/or exposed fronds of tree roots provide vital cover from predation and spate flows to tiny juvenile fish in shallower water (<30cm deep). Trailing and overhanging bank-side vegetation also provides a similar function and has many benefits for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