Advisory Visit

R. Wharfe, Myddleton Angling Club

16/06/2017

1.0 Introduction

This report is the output of a site visit to the River Wharfe undertaken by Prof Jonathan Grey of the Wild Trout Trust at the request of Robert Jordan (representing the collective Riparian Owners). The rationale was to assess current in-river and riparian habitat quality, and the potential implications to the fishery from proposed bank revetment works to protect the Ilkley Lawn Tennis & Squash Club (ILTSC). Documentation regarding the proposed works was provided by Stephen Hepplewhite, who also gave a brief tour of the ILTSC bank that is most affected by river erosion; Robert Jordan and Steve Garner (Secretary, Myddleton Angling Club) accompanied on the walkover.

Normal convention is applied with respect to bank identification, i.e. left bank (LB) or right bank (RB) whilst looking downstream. Upstream and downstream references are often abbreviated to u/s and d/s, respectively, for convenience. The Ordnance Survey National Grid Reference system is used for identifying locations.

River	River Wharfe
Waterbody Name	Wharfe from Barben Beck/River Dibb to Hundwith Beck
Waterbody ID	GB104027064257
Management Catchment	Wharfe and Lower Ouse
River Basin District	Humber
Current Ecological Quality	Overall status of **Moderate** ecological potential based upon an overall ecological status of **Moderate** and overall chemical status of **Good**
U/S Grid Ref inspected	SE 09594 48439
D/S Grid Ref inspected	SE 11686 48005
Length of river inspected	~2500m in total

Table 1. Overview of the waterbody. Information sourced from:
http://environment.data.gov.uk/catchment-planning/WaterBody/GB104027064257

Under the Water Framework Directive, the Environment Agency consider the Wharfe from Barben Beck/River Dibb to Hundwith Beck as a heavily modified waterbody (HMWB). Through two cycles of assessment, it has achieved *Moderate Ecological Potential* overall. It is important to note that five ecological classes are used for WFD Water Bodies: high, good, moderate, poor, and bad. These are assessed against 'ecological status' (or 'ecological potential' in the case of HMWBs), and that anything ranked below good is classified as a failure.

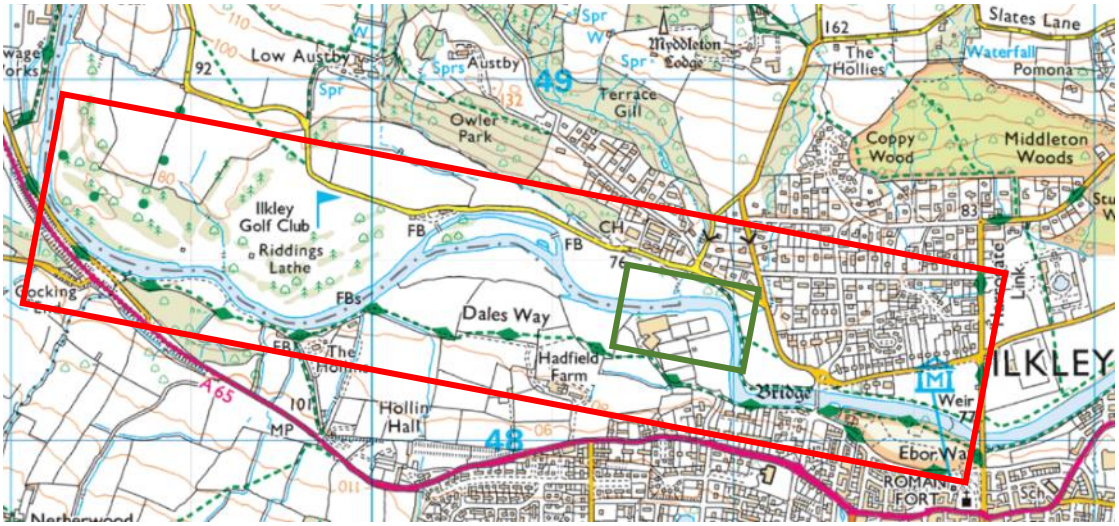
The status (or potential) of a waterbody is derived through classification of several parameters: water quality, physical condition and barriers, invasive non-native species, fish, and flows and levels. The overall status is then dictated by the lowest score amongst those parameters. However, it is important to note that, in the case of HMWBs, the status of fish (and benthic invertebrates) are often discounted as the HMWB designation already highlights a potential impact on those biological indicators, but as these are of the greatest immediate importance to angling clubs, they should not be overlooked.

In 2016, the classification of *Moderate Ecological Potential* was based upon an ecological quality of moderate, and a chemical quality of good. Chemical quality has improved from fail in 2013.

2.0 Catchment Overview

The River Wharfe is a gravel bed river in a glacial valley, rising on Camm Fell in the Yorkshire Dales National Park and flowing for ~115km to join the Yorkshire Ouse near Cawood. The physical characteristics of the Wharfe and hence the potential of the fishery, by the time it reaches Myddleton AC waters, are influenced strongly by processes and interventions occurring upstream. Most Yorkshire Dales' rivers have been affected by drainage and intensive stock grazing in both the catchments and floodplains, resulting in rapid transit of water and flashy hydrographs with narrow, high peaks and troughs of flow, excessive erosion, and a scarcity of floodplain wetland features. These flashy flows and excessive erosion typically produce an over-supply of cobble and gravel to the river, resulting in pools filling in to become uniformly shallow, especially where natural geomorphology is constrained by bank revetment and channel realignment, or interrupted i.e. behind weirs.

The Wharfe from Barben Beck/River Dibb to Hundwith Beck is linked to several Protected Areas under the Conservation of Wild Birds Directive, and the Habitats and Species Directive (North & South Pennine Moors), as well as being a Drinking Water Protected Area in its own right.

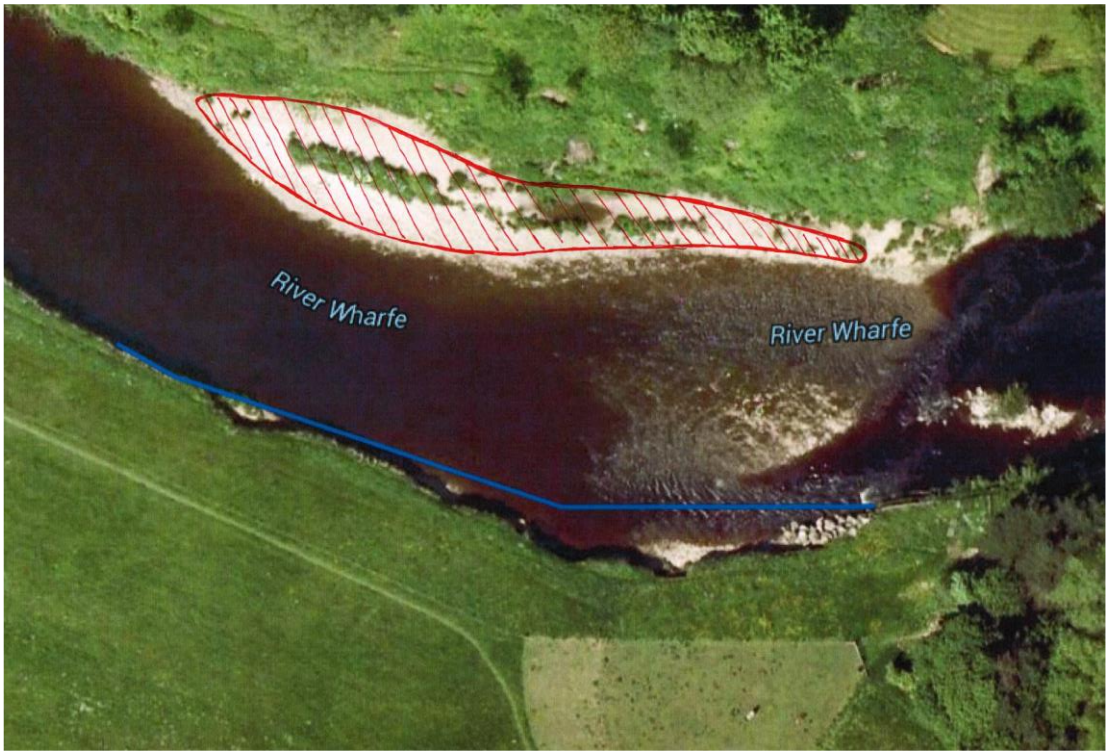


Map 1. Extent of Myddleton AC waters walked for this report (bounded by red) on the River Wharfe, and the focal area surrounding Ilkley LTSC (bounded by green).

3.0 Information provided in advance

Certain documents were provided by Stephen Hepplewhite regarding the proposed bank protection measures to provide context for the discussions and walkover.

- Weetwood / Fluvio geomorphological assessment, June 2014
- Coxon Brothers Civil and Environmental Engineers letter, dated 21/03/2016
- Method statement from Coxon Bros.
- Two images of proposed gravel extraction and line of proposed revetment, one inserted here, below.



This image was taken in May 2009, prior to a line of willow trees being planted along the RB (bottom of photo), and the scour and erosion along the full length of the RB has extended considerably in an u/s *and* southerly direction.

According to the documentation supplied, Coxon Bros. proposed to reinstate a bank line (in blue, above), face it with 1-2 tonne rock armour for ~90m and backfill with gravel extracted from the opposite bank (red-hatched, above). Weetwood propose several options revolving around sheet piling along the former revetment bank line.

4.0 Habitat Assessment

Water quality, water quantity, and habitat make up the 'tripod' required to sustain viable fish populations. When assessing habitat for fish and fishery interests, it is important to look beyond the life-stage which is of a size typically of interest to anglers. For brown trout and grayling, this 'target size' is ~200-300mm and greater. However, all life-stages must be catered for and these have markedly different requirements: fish capable of reproduction require access to well oxygenated gravels within a particular size range in which to bury their eggs; swim-up fry require slower water with plenty of cover to protect them from spates and predators; juvenile parr can occupy relatively fast, shallow water which provides feeding opportunities and cover around rocks, and the adults themselves require relatively deeper water with refugia as they grow (see Appendix 1 – Life cycle of the brown trout). This is for context with regard to the following observations.

The focal erosion area affecting the RB immediately u/s of the ILTSC is a result of the Wharfe beginning to return to a more natural sinuous course across the floodplain. As such, the geomorphological processes of erosion and scour have produced great variability in depth profiles which provide some excellent habitat for brown trout and grayling. The depositional zone toward the inside of the bend (LB) provides shallow, well oxygenated water with many stones proud of the surface: this is good habitat for fry and juvenile parr stages (Fig 2). The scour pool created behind the failed bank revetments has created greater depth of water and varied flow for adult trout holding lies, as do each of the erosion cells further u/s on the RB (Fig 3). Recirculating flow, which is in part exacerbating the erosion of the RB, is indicative of a slower flow regime around the remainder of the RB d/s and this has led to localised deposition and sorting of gravels around larger boulders (Fig 4). If these short gravel beds are relatively stable under winter flow regimes, they could be a potential spawning site for smaller individual trout; they certainly provide high quality habitat for stoneflies, mayflies, and other flow-loving invertebrate species – i.e. good feeding for resident fish.

Fig 2. The main scour pool eating into the RB adjacent to the Tennis Club. The original bank revetment position is depicted by the red line. Willow has been planted along the bank top rather than bank toe – too little, too late to prevent any further erosion. Gabion baskets topped by large boulders (white arrow) from the original revetment have now entrapped the river, essentially exacerbating erosional scour (blue arrow) but creating excellent habitat features for wild trout (diverse flow / depth profile / boulder lies).

Fig 3. Looking u/s from immediately above the scour pool in Fig 2, demonstrating the extent of erosion along the RB. The original revetment position is roughly indicated by the red line and most bank protection options supplied propose that the bank be reinstated to this line; ~100m of relatively smooth faced rock armouring introducing a featureless sweeping curve.

The willows (visible to the left of Fig 3) planted along the RB top are a relatively recent addition (<8y). Their position on the bank top does little to alleviate erosion pressure as that is occurring at the toe of the bank and the soils above are cantilevering into the channel (block-failure). In their present state, some saplings overhanging and some slipping into the channel, they are providing some much needed

low cover to the water which is otherwise poor along this section of bank.

Such plants introduce:

- 'hydraulic roughness' – under higher flows, the water has to flow around and through the vegetation, thereby locally slowing the flow and trapping debris.
- trailing vegetation on the water surface which provides low cover and refugia for fish and invertebrates from predators and spate flow, some shading, egg-laying substrate for river fly species, as well as structure to help insects emerge from the water. Submerged and low growing willow branches may diffuse flow to such an extent as to encourage deposition of sediments downstream and hence diversify channel cross-section (unlikely here until the trees are very mature).
- diversity in rooting which will impart greater physical stability to bank soils and resilience to erosion during spates via a diverse root matrix 'knitting' the soils together (unfortunately too late and not in the right place in this instance).
- good feeding, reproduction sites, and shelter for a host of insect and other invertebrate life which may ultimately contribute to the diet of fish and birds, and contribute important ecosystem services such as pollination. Leaf litter deposited directly into the river provides sustenance for many shredding and filtering species such as *Gammarus* shrimp and caddis flies, respectively.

The Weetwood report does include a recommendation that any future management of this bank line must include vegetation to enhance bank shear strength, presumably to protect the edges of their engineered structures.

Fig 4. Gabion basket revetment that has failed immediately d/s of the scour hole from Fig 2 (position marked by white arrow) which will require repair and further disruption to the bank and bed characteristics. Note large boulder (to the left of image) and localised scour introducing depth variability, some gravel deposition and sorting.

The deflection of the main current out of the scour hole and across towards the LB has diversified the flow pattern to a more meandering course d/s as opposed to simply sweeping around the outside of the bend – see Fig 5. Such flow diversion is very valuable in what would otherwise be almost continuous glide habitat in a straightened section of river below the bend.

Fig 5. Looking d/s from Fig 4 at the riffles and shallow glides that currently provide good juvenile parr habitat for ~250m. The disturbance on the river surface gives some indication of the main flow patterns now meandering from the RB to the LB and back to the RB (blue arrow), as opposed to the main flow line (pale, dashed arrow) continuing around the outside of the bend along the RB which will likely occur following bank protection.

The LB is lined with low-growing, relatively young willow, providing excellent low cover via trailing and submerged branches, but only over water which is relatively shallow (so, good for juveniles but little worth for larger fish). The RB is lined with mature trees toward the

bank top; shade from these appears to have inhibited sapling growth at the waterline (Fig 5). Some judicious coppicing of one or two mature trees to diversify the canopy age / height structure, and allow more light in, plus providing opportunities for introduction of willow with its lower growing properties would be beneficial.

Approximately halfway along the RB (passing the ILTSC; Fig 6), there was evidence of grass cuttings and other cut plant material being dumped into the channel. Not only is this using the river as a waste disposal system, but potentially introduces viable non-native plants to the wider river ecosystem. The grass cuttings in particular begin to breakdown quite rapidly, leaching nutrient-rich liquor into the soil (which slows the colonisation of the bank by other plants, hence making it more susceptible to erosion when the cuttings are washed away in spates), and ultimately into the watercourse.

Fig 6. Grass cuttings and other plant materials from pruning at the Tennis Club that have been deposited directly onto the riverbank. This should be disposed of responsibly.

Downstream from the main buildings of the ILTSC, the Wharfe is forced to turn right and then left in relatively quick succession (Figs 7 & 8). The RB is still within the grounds of the ILTSC until the left hand bend and the bank riparian structure remains similar to that along the straight in Fig 5; generally mature trees with a dense canopy. A weir below the Old Town Bridge is responsible for impounding the river almost to the right bend in Fig 7, some ~460m.

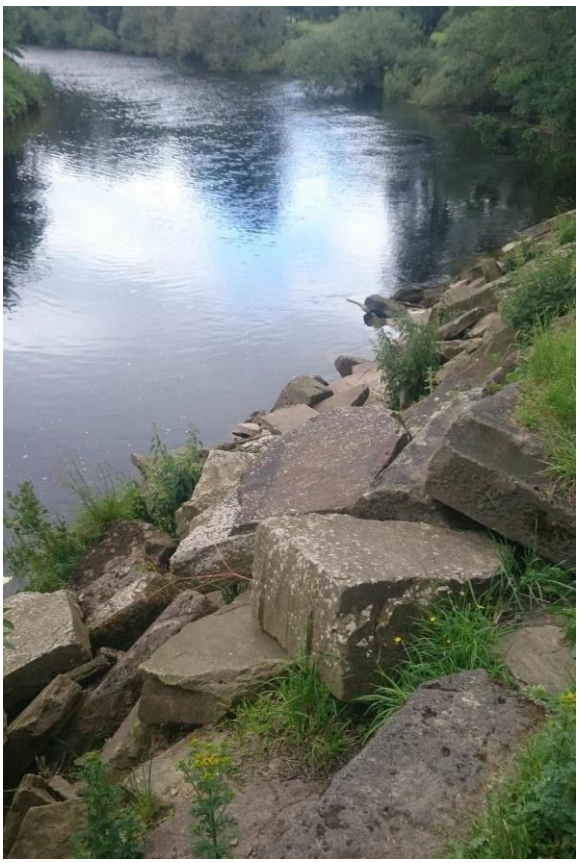


Fig 7. At the d/s end of the section depicted in Fig 5, the river is forced to turn right abruptly, and the scale of the armouring required to coerce it to do so is evident in the foreground. Note that the river is beginning to suffer from the impounding effect of the weir at Old Bridge, ~460m d/s.

The deeper glides and pools in this lowest section are less favourable habitat for wild trout and grayling, which will be better adapted to the faster water u/s. These pools may retain stocked trout for longer than they would otherwise persist in the reach.

Fig 8. A deep pool on another 90° bend to the left, with barely discernible flow caused by the weir impoundment ~200m d/s at Old Bridge.

The habitat was also assessed toward the top of Myddleton AC waters on a slightly more natural bend in the river (Fig 9). While the inside of the bend (LB) is still influenced heavily by revetment to protect greens and fairways on the golf course, the outside (RB) is butted up to a bedrock outcrop at The Hollins. Unmanaged native deciduous trees fringe the RB, with a diverse species composition and canopy structure caused by natural tree fall creating 'gaps' which have been exploited by self-set saplings. Many branches and some trunks were jutting over the channel, and low branches provided cover over deeper water, suitable for holding larger fish. There were also quite a few large boulders occurring naturally within the channel, again creating localised flow, scour and deposition around each to increase the channel habitat diversity. This is a useful exemplar stretch for more natural conditions along the Wharfe.

Fig 9. In the upper reaches between Riddings Lathe and The Hollins, the Wharfe retains slightly more natural characteristics, more so on the RB (lower panel) where the river is naturally tight to the side of the valley butting up to bedrock. Here, a combination of natural, low tree branches and large boulders in the river create habitat diversity and cover for fish.

5.0 Habitat projections

Rivers can be highly dynamic systems: Prof Richard Hey describes seven degrees of freedom for gravel alluvial rivers, since they can adjust their average bank-full width, depth, maximum depth, slope, velocity, sinuosity, and meander arc length through erosion and deposition. The variables controlling stable river dimensions are discharge, sediment load, calibre of bed material, bank material, bank vegetation structure, and valley slope. Change to any of these independent variables will result in development of a new regime of channel geometry which is in equilibrium with the changed conditions.

The proposed works will effect change throughout the reach directly adjacent to the bank protection, and downstream along the stretch past the ILTSC, and that change may develop over several years until equilibrium is reached. Indeed, there is ongoing and proposed work adjacent to the Golf Club upstream at Hawksworth Island that will also induce change. This WTT report does not include specific geomorphological expertise; however, from reading the proposals and evaluations to date (supplied), they all appear to be addressing symptoms and not identifying actual causes. All the proposals intend to realign the bank to a more hydraulically smooth profile, to reduce bend curvature and prevent erosion along the RB; any defences must be 'smooth' to reduce the likelihood of the introduced materials actually creating erosion cells which will jeopardise the future integrity of the works. To prevent the river 'outflanking' any defences, the works must extend a considerable distance up and downstream of the current eroded focal point, to tie in to the natural bank upstream, and mesh with the existing but currently damaged defences downstream. A conservative estimate of the total length of bank affected then is ~120-150m. None of the proposed solutions (gabion baskets, rock armour, or sheet pile) allow for significant vegetative growth from the waterline to the bank top (and most likely for some distance set back from the bank top too).

Thus, below the waterline there will essentially be a simplified triangular channel created by constraining the flow around a long sweeping bend (Fig 10). Above the waterline, vegetation will be so far removed as to have little direct benefit to aquatic organisms.

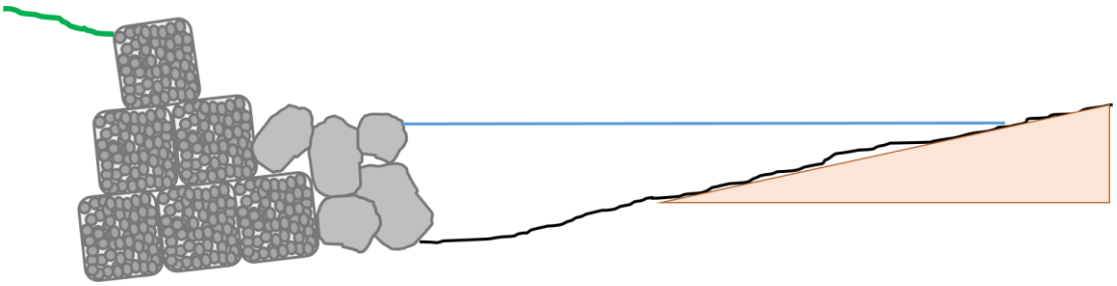


Fig 10. Schematic of potential bank protection solution, here gabion basket and rock armour modified from the Weetwood report, and the likely simplified channel cross-section resulting from helical flow continuously applied to a long sweeping bend of low curvature. The red triangle depicts the gravel deposition bar that is potentially to be removed for infill behind the gabion baskets

At least one proposal implies removal of the gravel deposition bar from the LB to provide infill behind the defences – see Fig 10. Obviously, this would be highly disruptive to the bed of the river, disturbing all links in the food chain to trout and grayling. It would further simplify the trapezoidal channel cross-section by making the depth more uniform. It will also inevitably increase local conveyance and accelerate erosion and transport of new material from upstream to resupply the void left behind; i.e. to reinstate equilibrium. Depending upon where this material comes from, there may be noticeable changes to habitat structure u/s in Myddleton AC reaches. The uniformity of channel and lack of any natural cover above the water will leave the whole reach vulnerable to increased rates of predation, especially from avian predators such as goosander and cormorant.

How the straightened reach immediately downstream (adjacent to the ILTSC buildings) will respond, and for what distance, is difficult to predict. Channel flow pattern will change from that evident currently (Fig 5). However, situated below the proposed works (which will therefore be unaffected), it is ideal for rehabilitation techniques such as tree kickers or boulder installation to diversify the habitat and essentially recreate a more natural channel similar to that found u/s (see Fig 9). It must be stressed that no specific recommendations can be made until the proposed bank protection works have 'bedded in' and the river has approached equilibrium, probably after several winter seasons.

6.0 Making it Happen

The WTT may be able to offer further assistance:

- WTT Project Proposal
  - Further to this report, the WTT can devise a more detailed project proposal report. This would usually detail the next steps to take and highlight specific areas for work, with the report forming part of an Environmental Permitting Regulations application. NB the caveat regarding allowing the river to attain equilibrium, post works.
- WTT Practical Visit
  - Where recipients are in need of assistance to carry out the kind of improvements highlighted in an advisory visit report, there is the possibility of WTT staff conducting a practical visit. This would consist of 1-3 days work, with a WTT Conservation Officer teaming up with interested parties to demonstrate the habitat enhancement methods described above. The recipient would be asked to contribute only to reasonable travel and subsistence costs of the WTT Officer. This service is in high demand and so may not always be possible.

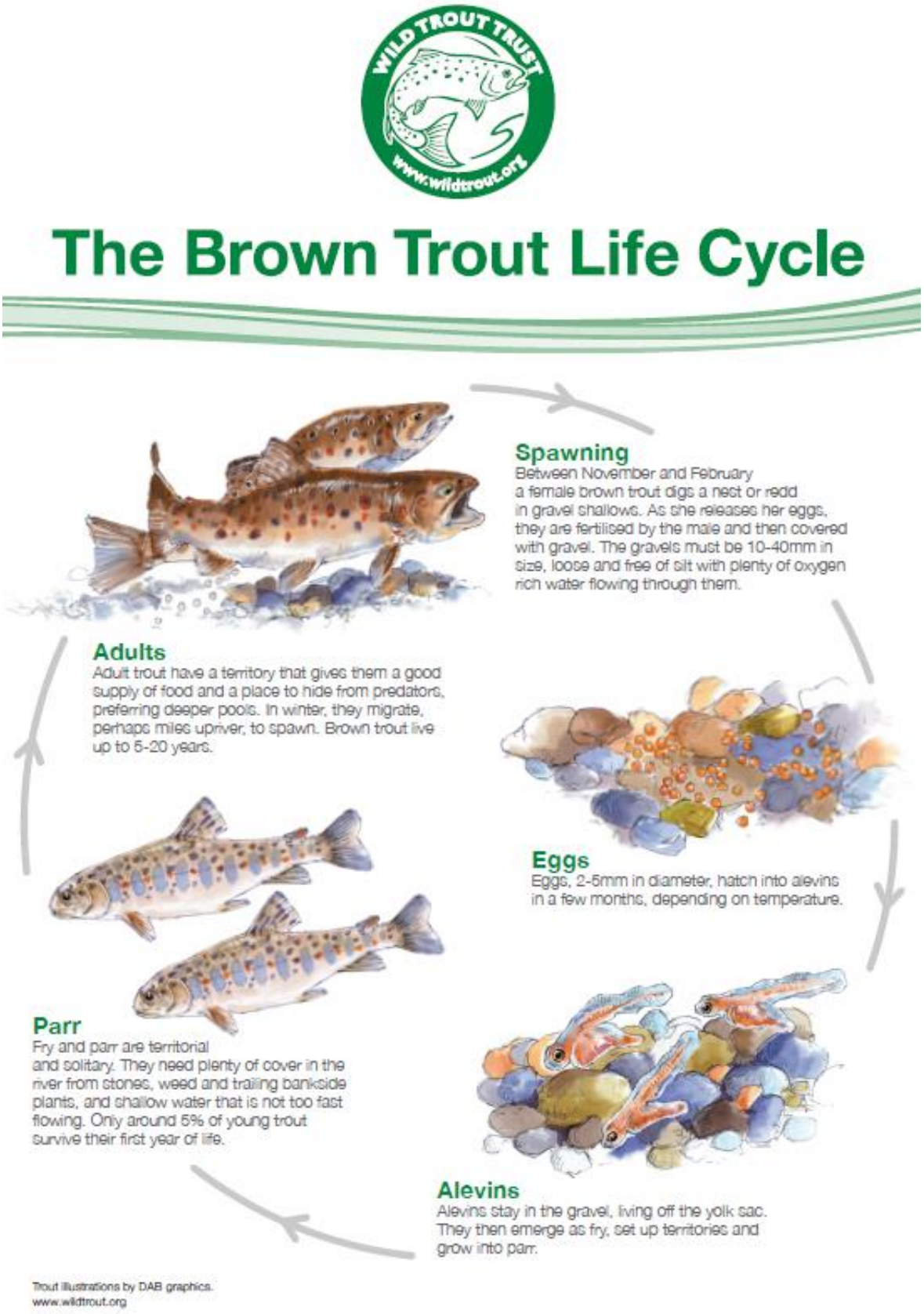
In addition, the WTT website library has a wide range of free materials in video and PDF format on habitat management and improvement:

http://www.wildtrout.org/content/index

7.0 Disclaimer

This report is produced for guidance only; no liability or responsibility for any loss or damage can be accepted by the Wild Trout Trust as a result of any other person, company or organisation acting, or refraining from acting, upon guidance made in this report.

8.0 Appendix


WILD TROUT TRUST
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The Brown Trout Life Cycle
Spawning
Between November and February a female brown trout digs a nest or redd in gravel shallows. As she releases her eggs, they are fertilised by the male and then covered with gravel. The gravels must be 10-40mm in size, loose and free of silt with plenty of oxygen rich water flowing through them.
Eggs
Eggs, 2-5mm in diameter, hatch into alevins in a few months, depending on temperature.
Alevins
Alevins stay in the gravel, living off the yolk sac. They then emerge as fry, set up territories and grow into parr.
Parr
Fry and parr are territorial and solitary. They need plenty of cover in the river from stones, weed and trailing bankside plants, and shallow water that is not too fast flowing. Only around 5% of young trout survive their first year of life.
Adults
Adult trout have a territory that gives them a good supply of food and a place to hide from predators, preferring deeper pools. In winter, they migrate, perhaps miles upriver, to spawn. Brown trout live up to 5-20 years.
Trout illustrations by DAB graphics.
www.wildtrout.org