WILD TROUT TRUST

wildtrout.org

River Yeo, Cheddar, Somerset

Wild Trout Trust report on a walkover survey carried out on 17 October 2020

Written by Theo Pike: tpike@wildtrout.org

Contents

1. Key findings

1.1. Water quantity, 'slowing the flow' and flood risk

- The natural flow of the Cheddar Yeo is affected by large-scale abstraction at a point very high up its course in Cheddar, with a hands-off flow which probably reverses the river's natural summer and winter flows.
- Conversely, Cheddar is vulnerable to flash flooding: both from rainfall funnelled down Cheddar Gorge and other slopes, and from urban runoff associated with hard surfaces in the town
- Opportunities to reduce local flood risk have been identified, including repurposing former mill ponds as SuDS and blue-green recreation spaces.
- River restoration to add sinuosity and flow diversity within the planform of the existing straightened post-industrial river channels could also help to 'slow the flow' on one hand and make the most of low flows on the other.

1.2. Water quality and habitat improvement

- Water quality in the Cheddar Yeo appears generally good.
- The river has abundant gravels, with high spawning potential for trout and other fish. Spawning success could be improved by adding woody material to increase complexity and reinvigorate natural processes.

1.3. Barriers to fish passage

- The Cheddar Yeo is notably fragmented by several large milling impoundments, plus a number of smaller weirs. Most of these are now redundant, and should be removed because of their negative impact.

1.4. Opportunities for community engagement

- Long stretches of the Cheddar Yeo flow between private gardens, so there are significant opportunities to engage local residents with 'river-friendly gardening', leaving 'shaggy edges' to increase habitat complexity and biodiversity – instead of clearing vegetation and woody material from the channel, which is detrimental to wildlife.
- Local residents could also take part in river-based citizen science programmes, such as riverfly monitoring and Westcountry CSI, as well as habitat enhancements and guarding against the arrival of invasive non-native species such as Himalayan balsam.

2. Introduction

This report is the output of visits undertaken by Theo Pike of the Wild Trout Trust on approximately 1.5 km of the River Yeo in Cheddar, Somerset.

This initial visit was undertaken on 17 October 2020 to provide a baseline habitat assessment of the urban reaches of the River Yeo as part of the TWIST (Transforming Waterways In Somerset Towns) pilot project – understanding pressures on the urban water environment, as well as investigating opportunities for physical enhancements and engaging urban dwellers with their local river. Particular attention was paid to:

- identifying opportunities to 'slow the flow' and reduce flood risk
- identifying and prioritising barriers to fish migration
- identifying opportunities to improve water quality and habitat
- identifying opportunities and locations for community engagement

At the time of the walkovers, the River Yeo was judged to be at moderate autumn / early winter flow, and water clarity was very good.

Comments in this report are based on observations on the days of the visits and brief discussions with local residents. Throughout the report, normal convention is followed with respect to bank identification i.e. banks are designated Left Bank (LB) or Right Bank (RB) whilst looking downstream. The Ordnance Survey National Grid Reference system is used to identify specific locations.

Figure 1: A map showing the course of the River Yeo through Cheddar, Somerset

3. Catchment and location overview

The upper River Yeo is an urban watercourse in the Somerset town of Cheddar.

This small limestone river rises at Charterhouse on the heights of the Mendip Hills, and quickly disappears underground into what is said to be the UK's largest 'karst' cave system, before resurfacing in Gough's Cave at the foot of Cheddar Gorge. Downstream from Cheddar, the Yeo flows into the highly modified Old River Axe, which runs broadly north-west along the foot of the Mendips to meet the Bristol Channel at Weston Super Mare.

River	Cheddar Yeo
Waterbody Name	Cheddar Yeo – source to conf Stubbington Rhyne
Waterbody ID	GB109052021540
Management Catchment	Somerset South and West / Brue and Axe
River Basin District	South West
Current Ecological Quality	Moderate (as at 2019)
U/S Grid Ref inspected	ST 46650 53910
D/S Grid Ref inspected	ST 45429 52746
Length of river inspected	1.5km approx

Table 1: Water Framework Directive (WFD) information for the Cheddar Yeo

The town of Cheddar is located on a sediment fan at the lower end of Cheddar Gorge – an impressive limestone ravine eroded by Ice Age flows of periglacial meltwater at times when subsurface channels through the bedrock were still blocked by permafrost.

Under current geological conditions, as a result of the extended residence time of water in their underground aquifers, limestone streams like the Cheddar Yeo are typically somewhat more stable in temperature and flow regime than rain-fed systems. When combined with calcium-rich and slightly alkaline water chemistry, these conditions can promote highly productive ecosystems, comparable in many ways to chalk streams.

Water can flow surprisingly quickly through subterranean channels dissolved by acid rain in limestone. Dye tracing suggests that water from the Charterhouse 'swallets' can take up to 14 days to reach Cheddar, having travelled underground for up to 10 miles (17km). (However, despite their reputation for pure, rock-filtered water, karst systems are vulnerable to pollution via sinkholes, swallets and quarrying activities, and such contamination may also be long-lasting).

Thanks to its reliable flows from the largest resurgence in the Mendip Hills, the Cheddar Yeo has been historically exploited for milling purposes. In 1527, the Bishop of Wells owned 6 watermills on the Yeo, 5 of them used for fulling wool, and Saxton's 'Atlas of England and Wales' c1588 notes that the (Cheddar) 'spring driveth 12 mils within one quarter of a myl of his head' (although the precise locations of these are not known). Upper Mill became the Yeo's first paper mill in

1765, pioneering a profitable local industry which was based on the purity of water filtered through the Mendips' Carboniferous limestone. Cloth making and clothing production also continued into the modern era: the last mill, used as a shirt factory, closed in the 1950s. By the end of the 20th century, the show caves and associated attractions meant that tourism had become Cheddar's major industry, and most of the former milling sites have been converted into retail premises and car parks.

Since 1937, a significant proportion of flow from the Gough's Cave springs has been abstracted for public water supply. Bristol Water currently holds an abstraction licence to take 22k megalitres per year from the Lower Pond in Cheddar, via a 54-inch (1.4m) pipe to Cheddar Reservoir: actual take averages at 40 megalitres per day, with proportionately more being taken in winter than in summer. Below the abstraction point, the river is protected by a hands-off flow set at 11.4 megalitres per day between May and November, and 6.8 megalitres per day at other times. However, it is understood that these levels were set in the 1970s, and depending on other inputs (from rainfall, runoff etc) may actually reverse the river's natural hydrograph, with higher flows in summer and lower flows in winter (pers. comm. with Bristol Water, Nov 2020).

On the other hand, as a result of local hill slopes, as well as the pinch point for overland runoff created by Cheddar Gorge, the town has occasionally suffered from flash flooding. One notable flood occurred on 10 July 1968, when 4 inches (10cm) of rain fell over the area, and many premises were flooded by water 3 to 5 feet (1 to 1.5 metres) deep. More recently, in November 2016, the B3135 through Cheddar Gorge was closed for a week while rocks and debris deposited by heavy rain were removed, and the road was repaired. Other floods occurred in 1995, 1996, 2003, 2008, 2012 and 2018.

Current climate change predictions include an increased intensity of rainfall and other weather events (which may also be borne out by the pattern of events noted above) so it would be prudent to anticipate recurring future events of this nature. In 2019, Somerset Rivers Authority and Somerset County Council commissioned a local flood risk study, including flow pathways and possible mitigation strategies, via JBA Consulting:

https://www.somersetriversauthority.org.uk/flood-risk-work/sra-annual-report-2019-20/cheddar-flood-risks-study/

At the time of writing this report, the public launch of this study's results has been delayed by the Covid-19 pandemic, but the author of this report is very grateful to Somerset County Council for making an early copy available to study. Key findings include:

- Cheddar is vulnerable to periodic flooding from rainfall runoff and effects on the upper River Yeo's underground sources
- Fluvial flooding is comparatively rare, although certain properties may be vulnerable. River dredging or desilting is not considered to be cost beneficial.

- Overland flow pathways for surface water flooding have been identified in several areas, often related to a combination of hill slopes and hard urban surfaces (e.g. in The Cliffs, Redcliffe Street and Felsberg Way areas)

Other relevant findings from the Cheddar Flood Risk Study have been woven into the narrative of this report.

Classification Item	2013	2014	2015	2016	2019
Overall Water Body	Moderate	Moderate	Moderate	Moderate	Moderate
Ecological	Moderate	Moderate	Moderate	Moderate	Moderate
Supporting elements (Surface Water)	Moderate	Moderate	-	-	Moderate
Biological quality elements	Good	Good	Good	Good	Moderate
Hydromorphological Supporting Elements	Supports Good	Supports Good	Supports Good	Supports Good	Supports Good
Physico-chemical quality elements	-	Moderate	Moderate	Moderate	Moderate
Specific pollutants	Moderate	Moderate	High	Moderate	Moderate
Chemical	Good	Good	Fail	Fail	Fail
Priority substances	Good	Good	Fail	Fail	Fail
Other Pollutants	Does not require assessment	Good	Good	Good	Good
Priority hazardous substances	Good	Good	Good	Good	Fail

Table 2: Water Framework Directive (WFD) details for the Cheddar Yeo: for full details see https://environment.data.gov.uk/catchment-planning/WaterBody/GB109052021540

According to the Environment Agency's assessment of the Cheddar Yeo under the Water Framework Directive (WFD: the scheme currently used to assess the Ecological Status or Ecological Potential of our surface waterbodies in Britain), the river is not designated as 'artificial or heavily modified'. This certainly seems to understate the actual levels of historic modification which are evident, particularly through Cheddar, where many typical pressures of urbanisation were noted during the walkover survey.

Having avoided classification as a 'Heavily Modified Water Body' (HMWB) under WFD, the Cheddar Yeo is currently subject to the target of 'Good Ecological Status' (GES) in spite of the clear urban and other pressures upon it: a more ambitious target than 'Good Ecological Potential' (GEP) which is usual for urban HMWBs.

Reviewing the EA's ecological data, it is concerning to note the river's biological quality elements have declined from 'Good' in 2013 – 2016 to 'Moderate' in 2019 (fish and invertebrates are still classified as 'High', but macrophytes have declined to 'Moderate'). It is possible that this decline is linked to the impact of abstraction on the river's flow and general hydrological regime, leading to siltation and other deleterious effects. At present, other reasons for not reaching GES include physical modification for flood protection, lead and zinc pollution from mining and quarrying (including both active and abandoned operations, as well as natural

mineralisation), and phosphate pollution (from agriculture and sewage treatment works, thus most likely affecting areas below the town).

Moving on to the EA's chemical data, most chemical elements are classified either as 'Good' or 'Does not require assessment'. The exception is priority hazardous substances, including Polybrominated diphenyl ethers (PBDE) flame retardant and Benzo(g-h-i)perylene, as well as mercury and its compounds.

This is a situation which applies to a very high proportion of the UK's rivers, following new standards applied to chemical assessments in the 2019 round of WFD classifications. Under the 'one out, all out' rule, the Cheddar Yeo now fails the EA's tests for chemical quality (whereas it passed them before). Since the newly-measured chemicals are now considered to be chronically present in almost all of the UK's fresh waters, it is not currently known how this situation can be improved. However, since the Cheddar Yeo's other chemical classifications are listed as 'Good' or 'Does not require assessment', this still implies considerable opportunities to enhance fish populations if historic fish passage and habitat issues can be addressed.

One of the major threats to urban rivers is the presence of sewage treatment works (STWs) which are liable to underperform or even fail catastrophically, resulting in fish kills such as on the Sheppey in August 2019). This means that it is vitally important to optimise habitat and water quality in the 'safe' areas of catchments upstream of STWs – since these areas serve as vital refuges for populations of fish and other species which may be uniquely genetically adapted to the characteristics of their river, and therefore irreplaceable.

In the case of Cheddar, the local STW discharges south west of the town, well downstream of the urban areas discussed in this report. This does not preclude the possibility of combined sewer overflows (CSOs) as mapped in Figure 2 below, misconnections or faulty septic tanks contributing to chronic pollution on the Cheddar Yeo, but it does fortunately remove the threat of STW pollution from the river, and highlights the importance of improving the upper Yeo as a vital reservoir of biodiversity for the whole catchment.

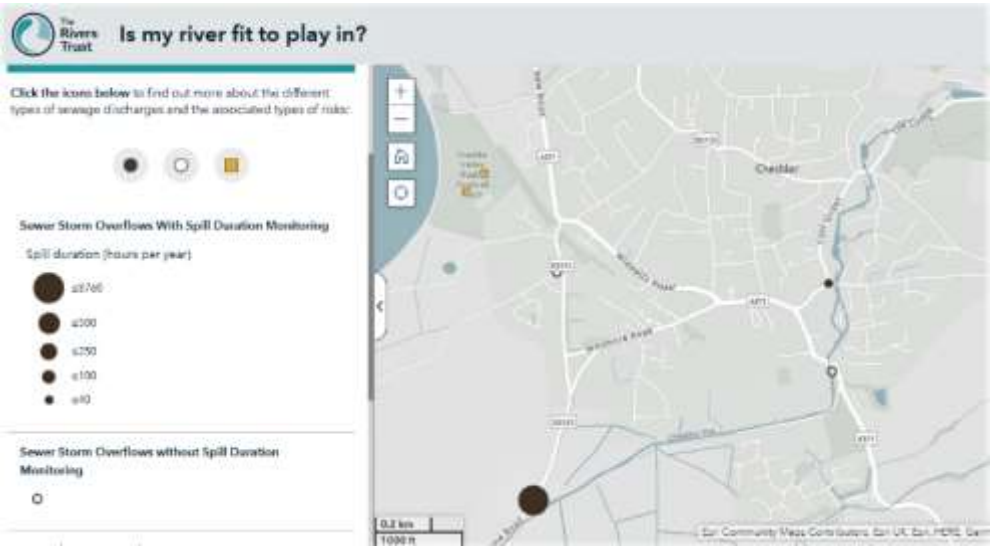

Figure 2: A map of CSOs on the Cheddar Yeo (data from 2019)

According to the Rivers Trust's interactive map of sewage outfalls (Figure 2 - available via https://www.theriverstrust.org/what-we-do/is-your-river-fit-to-swim-in/ - most recent data from 2019, as above) the River Yeo in Cheddar may be affected by 2 CSOs operated by Wessex Water:

- ST 46054 53295 (approx.): Cliff Street / Redcliffe Street: in 2019 this CSO spilled 25 times for a total of 37 hours
- ST 46039 52999: Froglands pumping station: spill durations are not currently monitored

The Environment Agency carries out monitoring of fish, invertebrates, macrophytes and diatoms on all rivers in England and Wales: these results are available in 'explorer' format at:

https://environment.data.gov.uk/ecology-fish/

The monitoring points for the Cheddar Yeo are some distance downstream of the urban areas of Wells: macroinvertebrates at ST 45837 52812, and fish at ST 45963 52842.

Macroinvertebrates

The EA's most recent survey of macroinvertebrates, in October 2018, shows a good count of freshwater shrimp (448), indicating good chemical water quality. Among many other pollution-sensitive species, blue-winged olives (312), large dark olives (124) and rhyacophila caddis (18) were also found, suggesting consistently reasonably high water quality. However, only 1 stonefly specimen was noted, indicating either that the substrate at this point of the river is less favourable, or that intermittent pollution may be present that this genus cannot tolerate.

Fish

The EA's most recent fish survey, in September 2012, shows a high diversity of fish species, including brown trout (18), dace (56), roach (53), chub (25), perch (24), ruffe (1), bullhead (50), flounder (2), eel (21), rudd (1) and pike (1). These data suggest a typical assemblage of species at the point where upland 'trout zone' populations of bullhead and trout shade into lowland river fish populations.

Trout were found in a range of year classes, from 39 – 246mm, such as one might hope to encounter in a productive limestone stream. During this walkover survey, adult trout were seen at several points further upstream within Cheddar's urban reaches: however it is likely that fish passage issues such as weirs are currently limiting the population, and would make recolonisation difficult or even impossible, if isolated upstream populations became extirpated by low flows or pollution incidents.

The UK's native wild brown trout are noted for their genetic variability and potential to produce (over the course of generations) locally-adapted strains and cope with specific challenges posed by their particular environment. As such, it is very

probable that Cheddar's trout population is uniquely adapted to surviving elevated levels of lead and zinc pollution from historic mining which might kill trout which have not evolved to survive the River Yeo's particular cocktail of heavy metal contamination. Cheddar's trout are therefore potentially irreplaceable, so it would be highly beneficial to help their population to become as successful and resilient as possible.

Bullheads are also an indicator of clean water and high-quality habitat, with tolerances very similar to trout. European eel are now regarded as a threatened species, so their appearance in sizes from 130 – 430mm is a positive sign.

It would be reasonable to suggest that a wide range of fish species should thrive in the urban reaches of Cheddar if water quality, quantity, fish passage and habitat issues were successfully addressed.

4. Habitat assessment

Figure 3: The River Yeo between Gough's Cave and the Upper Pond in Cheddar

The Cheddar Yeo emerges from Gough's Cave and flows briefly above ground in a torrential rocky and gravelly channel before diving under the road through three box culverts, into the large online impoundment of Upper Pond.

Good macrophyte growth, including water crowfoot, is present in both the stream and the mill pond. However, the bed of the pond is very silty, suggesting that it acts as an informal silt trap for runoff from Cheddar Gorge, as well as sediment carried out of the Gough's Cave system: previous observations suggest that it can become very weedy and eutrophic in summer.

Water quality in this impoundment (as well as those further downstream) may also be affected by solar thermal heating, particularly in the summer months. In turn, this may lead to elevated temperatures and reduced dissolved oxygen in stretches of the River Yeo downstream of each of these impoundments.

Figure 4: The gauging weir and cascade at Cox's Mill

At Cox's Mill, the longitudinal connectivity of the Cheddar Yeo is severely interrupted as it flows over a gauging weir, down a multi-stepped stone or concrete cascade (as shown above in Figure 4), and into a culvert under a car park. Both the gauging weir and cascade are considered to be completely impassable to fish at any height of water.

At present these structures may be delivering a marginal benefit by oxygenating water flowing out of the eutrophic environment of the impoundment: however it would be far better to remove them completely renaturalise the river through this area, with multiple benefits including biodiversity and reduction of local flood risk. As discussed in more detail with reference to Figure 9 below, the current mill pond area could also be repurposed as a flood attenuation area.

Adjacent to the weir, the Cox's Mill buildings are derelict and apparently scheduled for demolition and / or redevelopment by the Longleat Estate. As part of this project, or in its own right, consideration should be given to removing the gauging weir and replacing it with modern ultrasonic gauging.

Such technology would still allow essential flow measurement to take place, without the weir's contribution to solar thermal heading and other destructive impacts on river function (as described in *Appendix 3: Weirs and their impacts*). In turn, this would also allow this stretch of the River Yeo to be renaturalised, including restoring fish passage for a full range of species.

Figure 5: The Middle Pond, with hands-off flows discharging into the river from structures at its downstream end

The river now enters a second large online impoundment: the Middle Pond, which serves as Bristol Water's abstraction point for Cheddar Reservoir and subsequent public water supply.

Hands-off flows (plus any surplus high flows) are discharged via a sluice system at the lower end of the impoundment. At present, the weir may only be passable to fish at the very highest flows: due to the abstraction infrastructure, removal may be unlikely, but future options for modification could include a rock ramp or technical fish pass in order to make this area passable for all fish species.

Immediately downstream of these structures, the channel is artificially straight and fast, but gravelly, and may be worth investigating further as fish spawning habitat. Adding Large Woody Material (LWM) flow deflectors in this area could help to add some much-needed sinuosity, and restart natural processes of scour and deposition. Associated marginal planting of wetland plants like iris could add additional diversity and low-level cover for adult and juvenile trout alike. By increasing channel roughness, these improvements could also help to 'slow the flow' into areas further downstream.

Figure 6: Braided but vertical, hard-sided channels at the Island Beds

In this area known as the Island Beds, the Cheddar Yeo is braided through narrow, stone-walled channels which are apparently historic formalisations of earlier natural gravel bars (as shown in Figure 6 above).

Although sediment supply from upstream must be very limited, deposits of gravel and cobbles are still present on the bed of the river, and several adult trout were observed, for the first time in this walkover (for public awareness, it was also good to see trout pictured on the adjacent information board!)

Thick stands of water crowfoot help to mitigate the armoured channel sides and lack of marginal vegetation, but adding LWM and associated marginal planting in low level berms or pool and riffle sequences (perhaps created by redistributing existing substrate within the channel as part of the weir removal works suggested below) would help to add valuable habitat complexity, and improve trout spawning and survival. Such soft, graduated habitat near the water level will also benefit water birds and many species of insects.

Figure 7: A weir impounding the Cheddar Yeo though the Island Beds reach

At the downstream end of the Island Beds, the Cheddar Yeo is impounded by a small two-stage weir which is shown in Figure 7 above. Although this weir is much smaller than the large structures further upstream, barriers like this can still be disproportionately damaging to the health of the river ecosystem (as discussed in *Appendix 3: Weirs and their impacts*).

In this case, as in so many other instances, the best option would be to remove the weir completely, allowing this whole stretch of river to be restored to more natural sinuosity within its existing planform. It is likely that the weir has been constructed from individual boulders of local limestone, so these could be retained and redistributed, with addition LWM, as habitat features – all helping to restart the natural processes of scour and deposition which have been suppressed by the presence of the weir. Removing this weir could also help to reduce flood risk in this area.

Figure 8: Surprisingly good habitat under a partial box culvert, which could be further enhanced by creating a soft vegetated toe along the RB

A short distance further downstream, as shown in Figure 8 above, the river is pinched into a partially covered box culvert. This constriction of the channel seems to have forced the river to scour downwards, and several more trout were observed in this deep pool with overhead cover and trailing beds of water crowfoot.

Additional habitat and aesthetic value could easily be created by softening the hard vertical edge of the depositional area on the RB with LWM and /or brashy material, plus plantings of marginal vegetation, to provide low and trailing cover for insects, birds and fish.

With landowner permission, easy access to the river at this point could also make it a suitable location for riverfly monitoring by members of the local community.

Figure 9: The drained-down former mill pond for Cheddar Flour Mills, suggesting the potential to restore the river and renaturalise this area for flood alleviation

After flowing down a fast, straight channel between private properties on the site of the former Upper Paper Mill, where access for detailed assessment was not possible, the Cheddar Yeo enters a large former mill pond which previously served Cheddar Flour Mills (also known as Newspaper Mill). This is a typical post-industrial area which has now been converted to retail, offices and car parks, where rain falling on hard, impermeable surfaces quickly generates high volumes of urban runoff, increasing the risk of flash flooding from overland flow in the immediate area, and fluvial flooding further downstream.

In 2019, the Cheddar Flood Risk Study identified an overland flow pathway along The Cliffs, over the bridge to The Bays, and into St Andrew's Road. Illustrating this point, sandbags were still present near the doors of several neighbouring properties at the time of the walkover, as well as along the edge of the mill pond (as shown in Figure 9 above).

At the time of this survey, the mill pond had been drained down, perhaps for desilting or other maintenance, suggesting the possibility that this area could be creatively used as an urban flood storage area to protect surrounding properties from overland as well as fluvial flooding. Converting the pond into a permanent blue-green 'pocket park', with one or more sinuous river channels winding through it at low flows, would boost local biodiversity and add aesthetic and recreational value for residents and visitors alike. At times of heavy rain and runoff, suitable outflow controls could allow the area to function as a temporary wetland and Sustainable Drainage Scheme (SuDS), 'slowing the flow', improving water quality and reducing flood risk locally and further downstream.

To optimise habitat gains, an important part of the functionality of this concept would be to minimise the throttle on the downstream end, so that the SuDS fills only on the highest flows. Too much of a throttle could result in excessive deposition of fine sediment, leading to maintenance and habitat issues, particularly if subsequent flushing of that sediment occurs (including algal blooms downstream in following years). Full fish passage through this area should also be restored.

Alongside these improvements, it would be worth investigating replace all of the impermeable care park surfaces in this area with permeable paving, promoting infiltration of rainfall and reducing flood risk by preventing flashy runoff into the river.

Figure 10: Part of the possible fish pass channel (dry at the time of this survey) downstream of the mill pond

Flows from the mill pond under the remains of the former Cheddar Flour Mills (now an ornamental garden) are controlled by two sluice gates. These structures are most likely to be impassable for fish, although the channel below them offers plenty of excellent habitat features, including small rocky cascades, deeper pools and overhanging marginal vegetation.

However, a separate, adjacent ornamental rocky channel (shown in Figure 10 above - dry at the time of the walkover due to the mill pond having been drawn down) has some of the appearance of a nature-like fish pass, and it would be interesting to study this possibility further. The top of the channel is currently obstructed by a metal grille with narrow set bars, perhaps designed as a weed rack or trash grid. This would need to be removed or modified in order to let the channel function properly as a fish pass, and flows into the channel would need to be adjusted to create a suitable attraction flow to help fish to locate it.

Figure 11: The head race for the former tannery: very straight, with hard vertical sides, but showing abundant growths of water crowfoot

Between the road bridges at Cliff Street and Redcliffe Street, from ST 46169 53668 to ST 46061 53303 (approx.), the Cheddar Yeo disappears behind fences and private properties, where it was not possible to assess it in detail.

Historic maps show a tannery and grain mill in this area, and it is likely that the river retains plenty of previous modifications, including possible barriers to fish passage: for example, Ordnance Survey mapping suggests that the stretch shown in Figure 11 above was the head race for the former tannery. A weir can also be heard behind the Riverside Inn car park at ST 46174 53611 (approx.)

Aerial photography suggests that long stretches of the channel in this area are heavily tunnelled with trees, although water crowfoot will be present where overshading is reduced. Although some selective tree management could be implemented to let more light into the channel (and also generate woody material for adding LWM) it could be argued that these shaded reaches of the river help to mitigate the solar thermal heating from impoundments further upstream in the summer months.

In this whole area, as well as further downstream, it would be beneficial to engage with local residents and encourage river-friendly gardening practices - including replacing hard, vertical banks with sloping edges fringed with 1 – 2 metres of softly trailing waterside plants, to increase biodiversity and habitat for birds, fish and insects.

Figure 12: The river upstream of the Redcliffe Street bridge

At Redcliffe Street, the Cheddar Yeo emerges from a tunnel of trees at ST 46061 53300, and is briefly accessible before flowing under the bridge and into the former mill pond of the Middle and Lower Paper Mills – an area which has now been redeveloped for residential purposes.

Water crowfoot is growing healthily on good gravels in the unshaded channel: it would be beneficial to address some of the very heavy tunnelling upstream if possible, and use the arisings as LWM to diversify flow and promote localised scour and deposition. The hard edge of the RB could also be softened with low level berms and marginal planting.

Downstream of the bridge, the river is briefly split into two channels on either side of a small ornamental island: adding flow deflectors in this area is also recommended. The river then becomes impounded by weirs associated with the former Middle and Lower Paper Mills.

With landowner permission, easy access to the river at the Redcliffe Street bridge could make it a suitable location for riverfly monitoring by members of the local community. It would also be useful to monitor this area because of the presence of a CSO discharging intermittently into the river at 46054 53295 (approx.). In 2019 this CSO spilled 25 times for a total of 37 hours: regular kick-sampling above and below the outfall would produce better understanding of the impact of this intermittent pollution on the river environment.

Figure 13: The stepped weir structure seen from Felsberg Way

In the former Middle and Lower Paper Mills area, the flow is split around a substantial island, perhaps by an impassable structure between private properties at ST 46066 53237 (approx.)

From Felsberg Way, at ST 46084 53209, it is just possible to see a stepped weir structure (pictured in Figure 13 above): it appears to feature stilling pools, but may not have been properly designed with fish passage in mind, and is likely to be impassable to most species in most flows.

In 2019, the Cheddar Flood Risk Study identified overland flow pathways towards this stretch of river along Redcliffe Street, Union Street, Mason's Way, Symons Way, Felsberg Way and Fairlands Way. High volumes of runoff water have also been seen re-emerging from road drains, and possibly overcharging manhole covers, along Felsberg Way.

As discussed above in relation to the redundant Cheddar Flour Mills mill pond, it would be worth studying the potential of both restoring a natural river channel and providing high flow flood storage in the present Felsberg Way impoundment area, at the same time as restoring fish passage for a full range of species.

Figure 14: A small concrete weir impounding a short section of the western channel adjacent to Sainsbury's supermarket and car park

Beside Sainsbury's supermarket, from ST 46066 53237 to ST 46076 53118, the western channel of the river around the island is deeply incised below the floodplain, with occasional small weir structures, such as the example pictured in Figure 14 above, which should be removed if possible to restore full fish passage and natural river processes. (If it proves to have a function such as protecting a utility pipe, it could be modified with a rock ramp or low-cost baffles).

A further small weir, 50 metres downstream, has already been notched, and trout were seen in one or two of the pools. Improvements in this area could include adding LWM to the channel to improve habitat complexity for fish at all life stages

Figure 15: A shallow stretch of channel between high walls adjacent to Fairlands Way

Downstream from the Felsberg Way bridge, the eastern arm of the river is tunnelled with trees, before emerging at ST 46096 53146 into a short reach of well-lit gravel and healthy water crowfoot growth between high vertical walls (as shown in Figure 15 above). Several trout, including juveniles, were seen in this area: with the addition of flow deflectors and other LWM to increase scour and maintain pool depth, plus additional LWM in the shaded stretch upstream, this area could be enhanced as spawning habitat for trout and other species, as well as generating obvious aesthetic benefits for members of the public.

Proceeding downstream from this point, the two arms of the river re-join under a footbridge, and flows behind the supermarket for a short stretch before becoming inaccessible and heavily shaded again, reappearing briefly to view at Church Street.

Figure 16: Looking downstream from the bridge at Cheddar Bridge Touring Park

At Cheddar Bridge Touring Park, the river is wide and unshaded, with gravel, boulders, and healthy stands of water crowfoot. However, the channel has almost certainly been straightened at some point, and it would be beneficial to address this lack of sinuosity, perhaps with alternating marginal berms which could be planted with attractive native species such as flag iris and purple loosestrife. In addition to restoring natural processes of scour and deposition, this would also help to increase the aesthetic value of this stretch of river for guests of the Touring Park.

This is currently the site of the EA's fish surveys. Since it is situated just downstream of Wessex Water's Frog Lane pumping station, where a CSO is currently unmonitored for duration of spillages, it would be worth engaging with the proprietors of the Touring Park to explore the possibility of riverfly monitoring or other citizen science projects to understand the impact of the CSO in this area.

Figure 17: The very dark, overshaded channel at the downstream end of the Cheddar Bridge Touring Park

Further downstream, alongside Old Bridge Lane, the channel becomes narrower and even more uniform: tree cover on the south LB is dense, the vertical banks show signs of past dredging, and macrophytes like water crowfoot have disappeared (as shown in Figure 17 above).

Although the stretches upstream and downstream are completely unshaded, shade levels in this area are likely to be suppressing valuable in-channel plants, and it would be preferable to let more light into the river. Skylighting or other selective tree works in this area could help to recreate a better-proportioned patchwork of light and shade, in a ratio of 60:40, and the arisings could be introduced to the channel as LWM, perhaps including 'hinged' structures or tree kickers.

With better light penetration from the southerly LB, a more relaxed mowing regime could be implemented on the RB, allowing a beneficial 'shaggy' fringe of vegetation to develop: far better habitat for insects, birds and fish, and more attractive for guests of the Touring Park, as discussed above.

Figure 18: Well-scoured gravel channels between stands of water crowfoot and soft, trailing marginal fringes

Continuing along Old Bridge Lane below the railway bridge (which approximates to the EA's invertebrate sampling site at ST 45870 52815), tree cover on both banks of the Cheddar Yeo disappears again completely. The channel is still very straight and uniform, probably due to historic dredging: however, both banks remain softened by vegetation, and there is excellent 'messy' trailing cover on the RB, as shown in Figure 18 above. Water crowfoot growth is excellent. and trout were seen actively feeding in clean gravel runs between stands of weed.

It is recommended that any future management of this area should be undertaken with a very light touch: in particular, the shaggy riparian fringes should be left untidied for the benefit of many species of insects, birds, animals and fish. Future diversity of this stretch could be further enhanced by the introduction of LWM, perhaps by planting small trees such as goat willow, with the aim of 'hinging' them into the margins in due course as additional habitat features.

With landowner permission, easy access to the river at this point could also make it a suitable location for riverfly monitoring by members of the local community.

Figure 19: Recent evidence of unnecessary marginal 'tidying', with vegetation and substrate scraped out onto the bank

At the end of Old Bridge Lane, the river continues straight and uniform, but becomes more intensively managed. An EA notice (dating from 2018) on the gate at ST 45704 52784 announces the intention to use Roundup herbicide to control weed in the channel, and small piles of marginal vegetation appear to have been recently scraped out onto the LB (although the RB remains beneficially shaggy). The channel as a whole now becomes noticeably shallow, overwide and dominated by fine sediment, and the fish population changes from individual trout to shoals of juvenile cyprinids and perch.

Unless a clear local flood risk case exists for managing this stretch of channel for maximum conveyance, it is suggested that a less aggressive management regime would be ecologically beneficial, and could help to 'slow the flow' of flood water to more vulnerable areas further downstream. Indeed, it might even be possible to create a flood retention SuDS or wetland area on the LB at ST 45579 52755 (approx.)

Figure 20: A surface water outfall from the Cheddar Business Park, which flows into a short stretch of channel with much more complex habitat than the dredged areas up- and downstream

At ST 45435 52747, the furthest downstream point of this survey, a large surface water drain enters from the RB, presumably conveying runoff from the roofs and other hard surfaces of Cheddar Business Park directly into the river. In order to 'slow the flow' and reduce downstream flooding, this should have been buffered through a flood alleviation basin or similar form of SuDS. Retrofitting such an intervention should be considered, using adjacent land on either side of the Business Park.

In other respects, however, this short stretch of the Cheddar Yeo does exhibit many more natural characteristics than the intensively managed channel up- or downstream. Perhaps because of access issues related to the Main Sluice Rhyne and its headwall on the LB, trees overhang the river, reeds on both banks remain undredged (as shown in Figure 20 above), and the self-cleaning depth of the channel increases dramatically.

As such, it was no surprise to see shoals of large chub and perch in this small area of much more complex habitat, as well as one or two adult trout. This short stretch of river could provide an interesting insight into of the high ecological potential of the lower Cheddar Yeo, if intensive management could be scaled back, and more natural processes were encouraged.

5. Recommended projects and improvements

5.1. Citizen science: Riverfly monitoring

Riverfly monitoring is a tried and tested methodology which enables local volunteers to support the statutory agencies by checking the health of their neighbourhood river. Such citizen science activities also have a track record of enhancing community cohesion and sense of place – all of which will be particularly important as Somerset emerges from Covid-19.

Subject to landowner permission, easy-access potential locations for riverfly monitoring, and other citizen science projects like Westcountry CSI, have been identified at the following locations on the Keward Brook and St Andrew's Stream:

- ST 46260 53813: half culverted channel below Island Beds
- ST 46061 53300: Redcliffe Street bridge
- ST 45870 52815: near railway bridge alongside Old Bridge Lane

Additional CSO-related locations to monitor could include:

- ST 46054 53295 (approx.): Cliff Street / Redcliffe Street: in 2019 this CSO spilled 25 times for a total of 37 hours
- ST 46039 52999: Froglands pumping station: spill durations are not currently monitored

5.2. Habitat improvements

The ecological health and habitat value of the River Yeo could be enhanced with some or all of the following habitat and fish passage improvements.

Flow deflectors

Figure 21: A flow deflector log pinned at an angle, using rebar stakes, partially across the stream (split chestnut stakes can also be used). In order to create scour in the centre of the channel, the log is angled upstream. At lower flows, the stream width is reduced, keeping the gravels clean and helping to move mobile sediment downstream. Higher flows can run over the top with little impediment.

Hinged trees

Figure 22: To reduce overshading and increase habitat, bankside trees can be hinged into the edge of a river so that they can continue to grow (depending on species) and provide low-level cover for fish, insects and birds. For extra security, the branches can be staked, or the trunk can be cabled back to the stump.

Soft vegetated margins

Figure 23: Millais's 'Ophelia' was painted from life on the banks of the Hogsmill chalkstream, and is widely regarded as a portrait of a perfect, diverse assemblage of native riparian plant species.

6. Making it happen

The creation of any structures within 'Main Rivers' or within 8m of the channel boundary (which may be the top of the flood-plain in some cases) normally requires a formal Environmental Permit from the Environment Agency. This enables the EA to assess possible flood risk, and also any possible ecological impacts. Many watercourses perceived to be lower flood risk are not designated as 'Main River', in which case they are classed as 'Ordinary Watercourse' and the body responsible for issuing consent will be the Local Authority. In any case, contacting the EA early and informally discussing any proposed works is recommended as a means of efficiently processing an application.

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

A focused Trout in the Town Urban River Toolkit is available at:

https://www.wildtrout.org/content/trout-town

There is also the possibility that the WTT could help via a Practical Visit (PV). PV's typically comprise a 1-3 day visit where WTT Conservation Officers will complete a demonstration plot on the site to be restored.

This enables recipients to obtain on the ground training regarding the appropriate use of conservation techniques and materials, including Health & Safety, equipment and requirements. This will then give projects the strongest possible start leading to successful completion of aims and objectives.

Recipients will be expected to cover travel and accommodation (if required) expenses of the WTT attendees.

There is currently a big demand for practical assistance and the WTT has to prioritise exactly where it can deploy its limited resources. The Trust is always available to provide free advice and help to organisations and landowners through guidance and linking them up with others that have had experience in improving river habitat.

7. Acknowledgement

The Wild Trout Trust would like to thank the Environment Agency and Somerset Catchment Partnership for funding this walkover survey.

8. 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.

9. Appendix 1: Summary tables of recommendations

Location	**Photo** (If required)	**Priority (1-3)**	**Grid reference**	**Proposed action**
Cox's Mill gauging weir		3	**ST 46465 53942**	Flood risk, fish passage and habitat: Investigate options for removing and replacing weir with ultrasonic flow gauging enabling fish passage and river restoration
Channel below Middle Pond		1	**ST 46381 53873**	Fish passage and habitat: add LWM to increase channel roughness, slow the flow and create habitat pockets. Also marginal planting to soften hard edges, plus potential future fish passage options for structures
Island Beds channels		1	**ST 46316 53849 (approx.)**	Habitat: add LWM to increase channel sinuosity, with redistribution of substrate to create low level berms or pools and riffles, plus marginal planting to soften and add habitat value to hard edges

Island Beds weir		1	**ST 46281 53837**	Flood risk, fish passage and habitat: remove weir to restore hydromorphological processes, ease fish passage, reduce flood risk and facilitate enhancement of Island Beds area just upstream
Half culverted channel		1	**ST 46260 53813**	Habitat: soften RB with LWM and/or brash berm, plus marginal planting, for habitat and aesthetic value
Former Cheddar Flour Mills impoundment		2	**ST 46157 53751**	Flood risk and habitat: 'slow the flow' and reduce flood risk in local properties by repurposing former mill pond as urban SuDS and blue-green pocket park; investigate permeable paving options to prevent runoff from all car parks in town
Ornamental channel		1	**ST 46147 53707 (approx.)**	Fish passage: investigate possibilities for easing fish passage (including removing weed rack at upstream end)

Cliff Street to Redcliffe Street		2	**ST 46169 53668 to ST 46061 53303**	Habitat and community engagement: add flow deflectors for sinuosity, and engage with residents to soften banks and promote river-friendly gardening. Also investigate fish passage issues
Redcliffe Street bridge area		1	**ST 54161 44911**	Habitat: soften edges and add LWM for extra habitat diversity
Middle and Lower Paper Mill sites		2	**ST 46084 53209 (approx.)**	Flood risk and fish passage: investigate fish passage options in this area; also investigate river restoration and SuDS creation in present impounded area
Western channel at Fairlands Way		1	**ST 46051 53139**	Fish passage and habitat: remove small weirs; add LWM for habitat value

Eastern channel at Fairlands Way		1	**ST 46096 53146**	Habitat: soften edges and add LWM to enhance spawning and juvenile habitat for trout and other species; also reduce overshading upstream, and downstream to Church Street bridge
Cheddar Bridge Touring Park		2	**ST 45978 52842 (approx.)**	Habitat: increase sinuosity of channel with alternating marginal berms and LWM, and marginal planting for aesthetic value; also investigate riverfly monitoring (re CSO just upstream)
Cheddar Bridge Touring Park		2	**ST 46042 52870 - ST 45882 52818**	Habitat: selective tree works to skylight heavily shaded areas, using arisings as LWM or hinging selected trees into the channel to reduce uniformity; plus a more relaxed vegetation management on RB to develop marginal fringe
Old Bridge Lane (below railway bridge)		1	**ST 45870 52815 - ST 45704 52784**	Habitat: continue light touch management regime, leaving prolific weed and natural 'shaggy edges'; add LWM, possibly including hinging trees pre-planted for this purpose

Green space between Old Bridge Lane and Cheddar Business Park		1 - 3	**ST 45704 52784 - ST 45435 52747**	Habitat and flood risk: initiate lighter touch management regime if possible; investigate possibility of wetland / flood attenuation area on RB

10. Appendix 2: Trout habitat

Due to their need for clean, well-oxygenated water, structurally-varied habitat, and free movement between different types of habitat at different life stages, the UK's native wild brown trout makes an ideal indicator species for healthy rivers. These characteristics mean that a simple and effective assessment for overall river health can be based around the life cycle requirements of brown trout.

As a result, identifying and noting the presence or absence of habitat features that allow trout to complete their full life cycle is a very practical way to assess overall habitat quality (**Error! Reference source not found.**). By identifying the gaps (i.e. where crucial habitat is lacking: **Error! Reference source not found.** to **Error! Reference source not found.**), it is often possible to design actions to solve those habitat bottlenecks.

To put all this into context, there are three main habitat types required for wild trout to complete each of their three key life cycle stages. This creates a demand for varied habitat, which is vital for supporting a wide diversity of other species too.

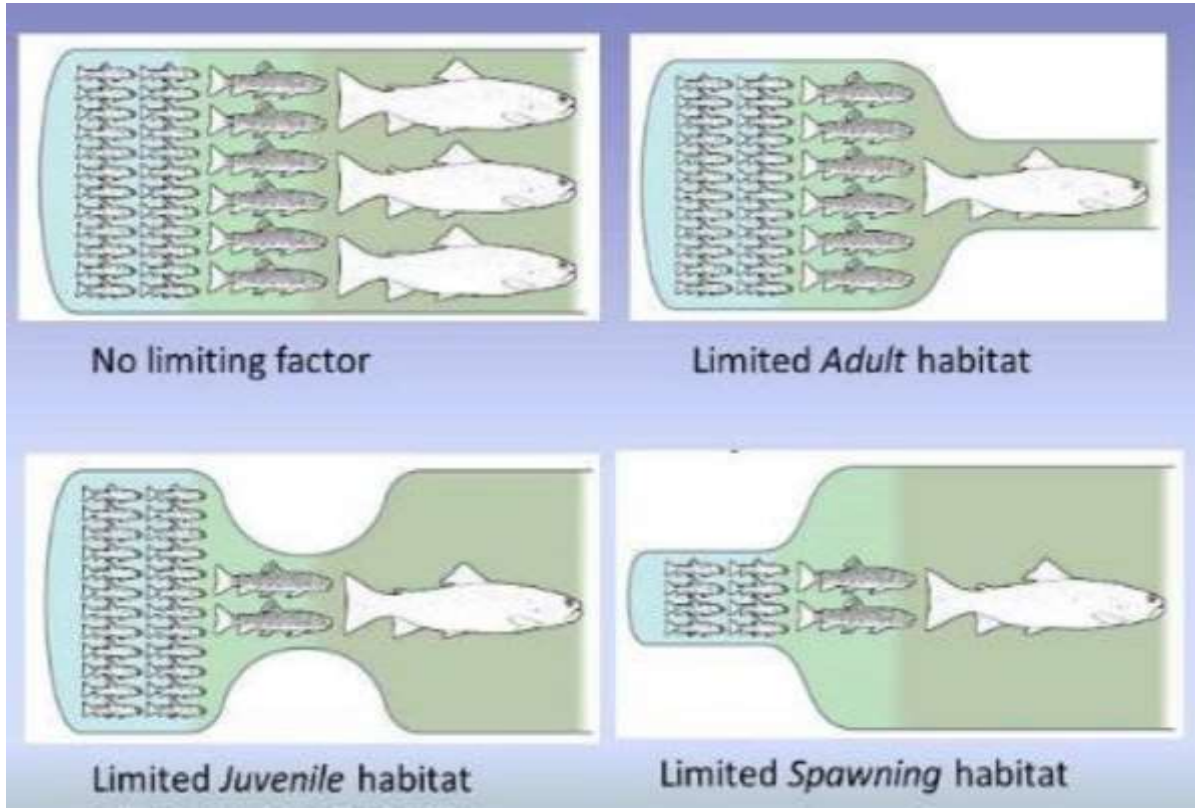

Figure 24: The impacts on trout populations lacking adequate habitat for key life cycle stages. Spawning trout require loose gravel with a good flow-through of oxygenated water. Juvenile trout need shallow water with plenty of diverse structure for protection against predators and wash-out during spates. 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 may not mitigate a 'weak link' in the remaining critical habitat.

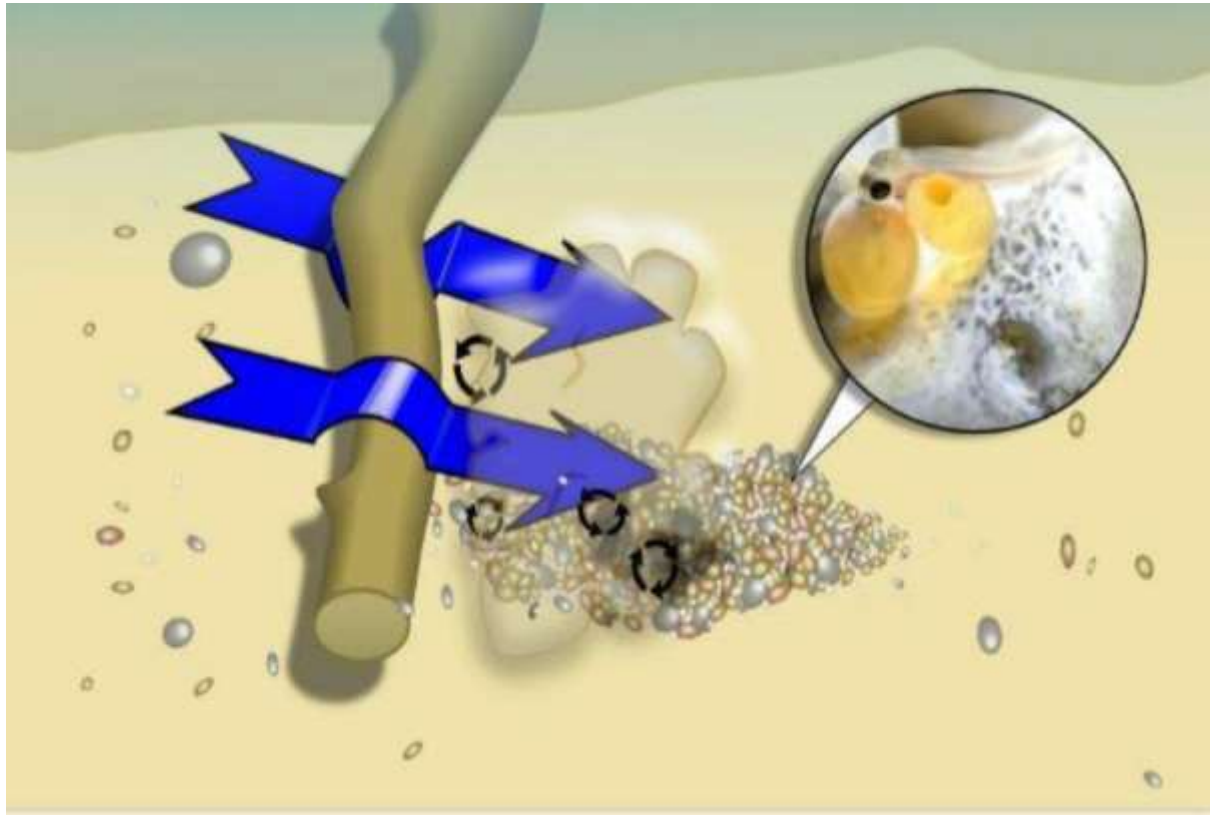

Figure 25: Successful trout spawning habitat requires relatively silt-free gravels. Here, the action of a fallen tree limb is focusing the flows (both under and over the limb as indicated by the blue arrows) on a small area of riverbed that results in silt being washed out from between gravel grains. A small mound of gravel is deposited just below the hollow scoured out by focused flows: this mound will be selected by trout to dig a 'redd' for spawning. In the 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 as they hide within the gravel mound (inset) until emerging in spring.

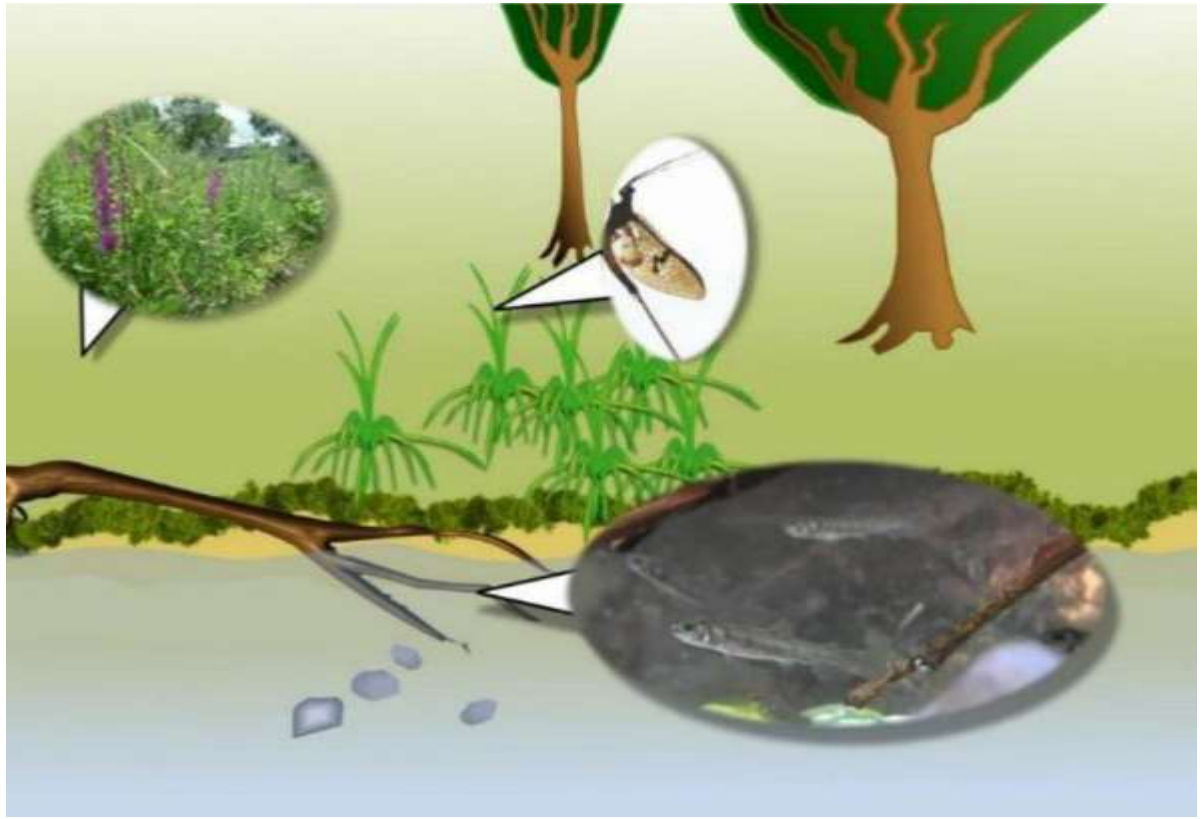

Figure 26: Larger cobbles and submerged 'brashy' cover and/or exposed fronds of tree roots provide vital cover from predation and spate flows for tiny juvenile fish in shallower water (<30cm deep). Trailing, overhanging vegetation also provides a similar function, and has many benefits for invertebrate populations (some of which will provide a ready food supply for the juvenile fish).

Figure 27: The availability of deeper water bolt holes (>30cm), 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 in this case) are all strong components of adult trout habitat requirements.

11. Appendix 3: Weirs and their impacts

Urban rivers usually exhibit a typical mixture of challenges, including weirs, hard/revetted banks, culverts, impoundments, and straightened/modified channels.

Among these modifications, weirs are perhaps the most damaging. Many of these are likely to have been constructed to provide a head of water for milling purposes: more recently, others may have been installed with the aim of 'keeping more water in the river' – in reality, an intervention which always does more harm than good.

Weirs tend to create extended stretches of slowly-moving water, where sediment carried in suspension drops out of the water column uniformly across the stream bed, and habitat quality and diversity are severely degraded (*Figure 28*). Such conditions can sometimes temporarily provide sufficient deep water habitat for small numbers of adult trout and other species (until the deep water inevitably fills with sediment) but are generally unsuitable for many beneficial invertebrates, and gravel spawning fish, fry and juveniles.

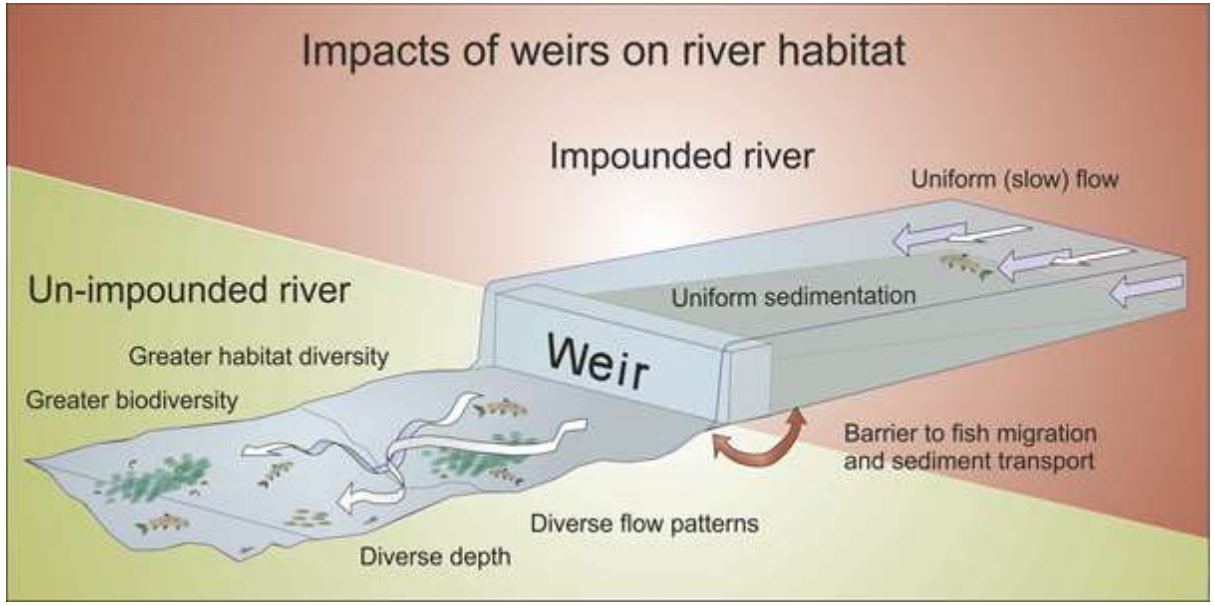

Figure 28: An illustration showing the impacts of weirs on habitat quality

Weirs of all sizes are often significant obstacles – or even complete barriers – to fish passage, preventing many species from moving up and down rivers freely to fulfil the different stages of their life cycles. Weirs also interrupt the natural transport of river sediment (*Figure 29*). This can cause the river downstream to become depleted of coarse sediment, and increase rates of bed and bank erosion as a result of the interrupted supply of suitable gravel and cobbles from upstream.

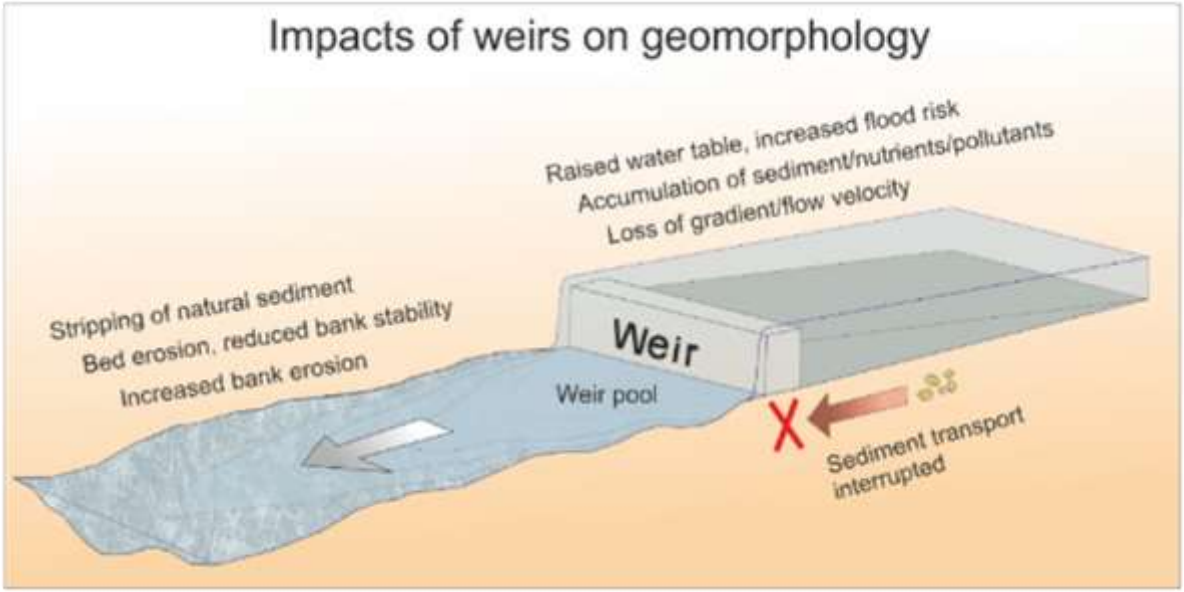

Figure 29: An illustration showing the impacts of weirs on river geomorphology

Weirs and other modifications also produce cumulative effects in terms of their impact. More information about weirs, and the benefits of removing them, can be found on the following links:

https://www.wildtrout.org/content/weirs-culverts-and-barriers

http://urbantrout.blogspot.com/2018/02/why-presume-to-remove-weirs-with-river.html

https://www.americanrivers.org/threats-solutions/restoring-damaged-rivers/how-dams-damage-rivers