WILD TROUT TRUST
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River Sheppey, Croscombe, Somerset

Wild Trout Trust report on walkover surveys carried out on 13 February and 5 March 2021

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Contents

1. Key findings

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

- The River Sheppey responds rapidly to rainfall, due to the steep topography of its upper catchment: this 'flashiness' has been exacerbated by historic urbanisation, and may be even more pronounced in the narrow Croscombe valley.

- Opportunities to reduce local flood risk have been identified, including removing impoundments close to residential properties.

- River restoration to increase sinuosity and flow diversity could help to 'slow the flow' of spates on one hand, and maximise environmental benefits of low flows on the other.

1.2. Water quality and habitat improvement

- The River Sheppey's limestone water chemistry should naturally support a rich ecology. However, water quality has historically been variable, with serious fish kills believed to have been caused by industrial effluents (and underperforming sewage treatment works downstream of Shepton Mallet which have seriously affected the Croscombe stretch of the river).

- Despite the pressures of urbanisation in the confined Croscombe valley, there are interesting opportunities to reverse historic habitat damage – particularly in terms of softening hard revetments, removing impoundments and adding habitat features to historically straightened river channels.

1.3. Barriers to fish passage

- The River Sheppey is notably fragmented by barriers to fish passage dating from the early industrial era – some of which are complex and highly integrated with other infrastructure in Croscombe. Removing or significantly modifying redundant weirs will be important for restoring the river's ecological connectivity – and thus the sustainability of future trout populations.

1.4. Opportunities for community engagement

- River habitat improvements in Croscombe could help local people to develop an enjoyable stake in their local environment, reduce flooding and pollution related risks for riverside residents.

- Long stretches of the River Sheppey flow alongside private gardens, so there are significant opportunities to engage local people with 'river-friendly gardening' to increase habitat complexity and biodiversity.

- 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 other river-based activities.

2. Introduction

This report is the output of visits undertaken by Theo Pike of the Wild Trout Trust on approximately 1.3 km of the River Sheppey in Croscombe, Somerset.

These initial visits were undertaken on 13 February and 5 March 2021 to provide a baseline habitat assessment of the urban reaches of the River Sheppey 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 Sheppey was judged to be at moderate winter flow, and water clarity was very good.

Comments in this report are based on observations on the days of the visits. 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.

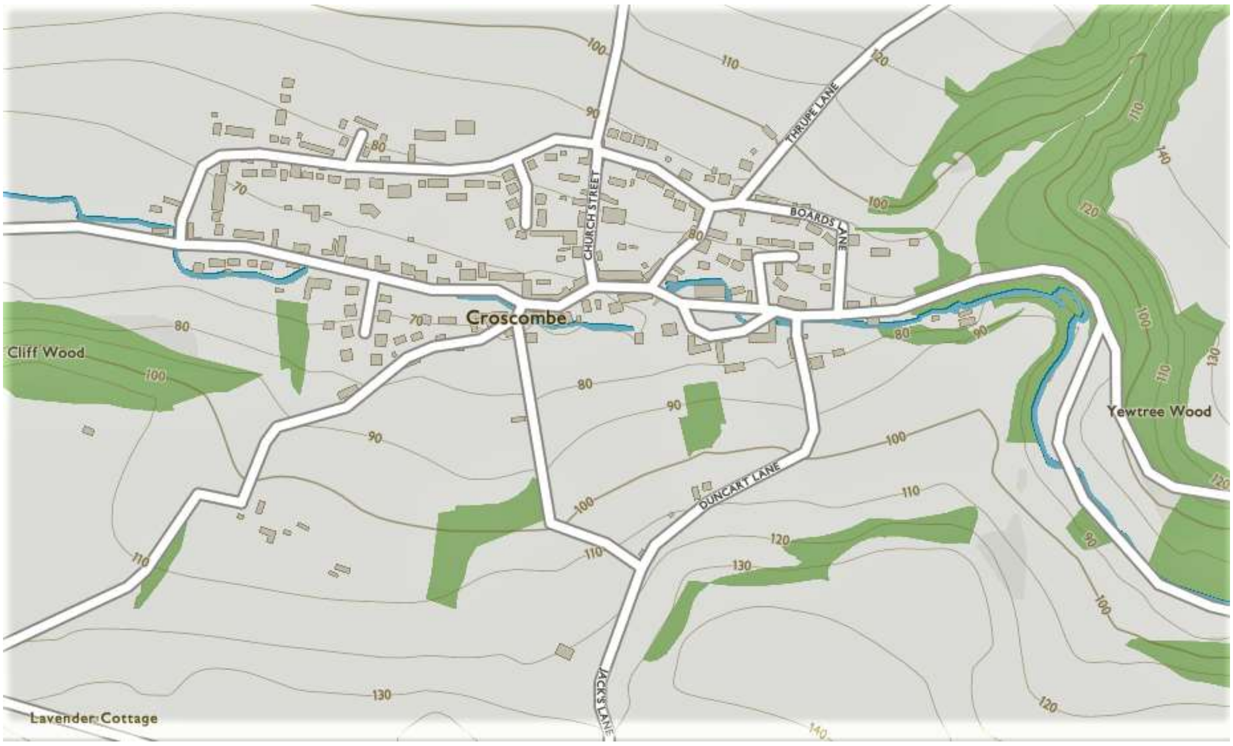

Figure 1: A map showing the course of the River Sheppey through Croscombe, Somerset

3. Catchment and location overview

The River Sheppey is a small watercourse which rises from a number of springs near Doulting, and flows west through Shepton Mallet, Croscombe, Dinder and Dulcote to join the Keward Brook at Coxley. From this point it follows a highly modified course across the Somerset Levels to join the River Brue at Westhay, and eventually the Bristol Channel at Burnham-on-Sea.

Owing to the Sheppey's reliable spring flows, it contributes an important proportion of the summer base flows of the lower Brue (Brue and Axe Local Environment Agency Plan 1997).

River	Sheppey
Waterbody Name	Sheppey
Waterbody ID	GB108052021221
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 59573 44270
D/S Grid Ref inspected	ST 58466 44424
Length of river inspected	1.3 km approx

Error! Reference source not found.*Table 1: Water Framework Directive (WFD) information for the River Sheppey*

The village of Croscombe is located about 7 km downstream from the headwaters of the River Sheppey, which runs through Shepton Mallet, Bowlish and Darshill to reach the village.

Downstream from its limestone springs, the Sheppey flows across Jurassic and Triassic deposits of mudstone, blue lias and oolitic limestone. At Croscombe, the mudstones are encountered on the lower valley sides and floor, while limestones of the Clifton Down formation are found higher up on the parallel ridges.

Owing to the extended residence time of water in their underground aquifers, limestone streams like the Sheppey 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. However, despite their reputation for pure, rock-filtered water, limestone karst systems are particularly vulnerable to pollution via sinkholes, swallets and quarrying activities, and such contamination can sometimes be long-lasting. The capacity or conveyance of local aquifers may also be adversely affected by wider limestone quarrying in the eastern Mendip area.

Croscombe developed at a point where the valley narrows and steepens around the river, and milling has been prominent in the village's history, from the booming wool trade in the 16th and 17th centuries onwards. By 1848, the Sheppey was providing water power for 2 corn mills, a silk mill, and a stocking factory, and relics of these industries are still influencing the course of the river, which threads tightly between buildings in the valley floor.

The River Sheppey responds very quickly to rainfall, and lower-lying areas of Croscombe are vulnerable to flash flooding, with river flows from higher up the catchment augmented by runoff in overland flow pathways including lanes running down the steep valley sides from north and south. During the winter of 2020 – 21, some residents noticed groundwater, or high flows in culverts, coming up through the floors of their homes. Drains also backed up into residential properties until non-return valves were fitted (pers. comm. Calm Engineering, February 2021)

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. As such, it would be prudent to anticipate recurring future events of this nature, and investigate any possible river restoration and natural flood management (NFM) measures to alleviate pressures on the village's infrastructure. On a wider upper-catchment scale, such interventions may also help to augment low flows at other times.

In 2016, a fisheries walkover survey by Westcountry Rivers Trust (WRT) and Bristol Avon Rivers Trust (BART) characterised most of the upper River Sheppey as dominated by parr-type habitat (suitable for juvenile salmonids, post-fry stage): 20-40cm deep, fast-flowing (60-75 cm/s), surface turbulent, with gravel/cobble/boulder substrate. This assessment is unsurprising in light of the river's long history of modification for industry: channel simplification and straightening, to deliver a smooth and consistent flow of water to mills, has also steepened the gradient of the river and shortened the length of its channel.

In order to recreate habitats for all life stages of fish in the Sheppey, hydraulic roughness, complexity and connection to the floodplain need to be reinstated on a catchment scale. Locally, this means making the river as sinuous as possible again, including within its existing planform in areas where it cannot be 'broken out' because of buildings and other infrastructure. In turn, this could also help to 'slow the flow' and reduce flood risk at unavoidable pinch points and other vulnerable areas.

In addition to lateral (floodplain) connectivity, strong consideration should be given to longitudinal connectivity. The Sheppey has been severely fragmented by weirs and other industrial structures (the WRT/BART survey identified 35 such structures downstream of Darshill alone) which are likely to make fish passage and/or recolonisation after pollution incidents very difficult or even impossible.

Natural recolonisation by native species is almost always preferable to reintroduction by humans (which may only serve to mask the pressures which contributed to the original decline or localised extinction). Under some circumstances, however, it is recognised that reintroduction is the only way to restore valuable populations to areas which might otherwise remain uncolonised for many years – thus also denying engagement opportunities for local people.

Due to the large number of weirs along the Sheppey, it would be beneficial to consider restoring trout populations to the upper river by translocation, when water quality and habitat are deemed to be suitable. However, this should not reduce the imperative to address fish passage issues strategically throughout the catchment, with the aim of maximising free migration for long-term resilience of all fish species.

In 2018, a catchment walkover by FWAG also identified a range of rural land management issues which are also likely to affect the River Sheppey (since rivers tend to aggregate the impacts of wider activities within their catchment). These challenges include excessive poaching around watercourses and ditches, plus runoff from farm tracks, maize cultivation, roads and blocked roadside ditches. FWAG's investigation was designed to help the Somerset Catchment Partnership to draft a work programme for a multiple-benefit project for the Sheppey catchment, and it is hoped that the particular urban focus of this WTT report will inform and support the wider strategy.

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	Poor	Poor	Poor	Moderate	Moderate
Hydromorphological Supporting Elements	Supports Good	Supports Good	Supports Good	Supports Good	Supports Good
Physico-chemical quality elements	Moderate	Moderate	Moderate	Moderate	Moderate
Specific pollutants	High	High	High	High	High
Chemical	Good	Good	Good	Good	Fail
Priority substances	Good	Good	Good	Good	Good
Other Pollutants	Does not require assessment	Does not require assessment	Does not require assessment	Does not require assessment	Does not require assessment
Priority hazardous substances	Good	Good	Good	Good	Fail

Table 2: Water Framework Directive (WFD) details for the River Sheppey: for full details see https://environment.data.gov.uk/catchment-planning/WaterBody/GB108052021221

According to the Environment Agency's assessment of the River Sheppey 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 classified as a 'Heavily Modified Water Body' (HMWB) as a result of much historic modification for milling, transport and general urbanisation. These typical urban pressures were very much in evidence on the days of these walkover surveys.

For HMWBs like the River Sheppey, the classification of Ecological Potential (rather than Ecological Status) is applied. The Environment Agency (EA) data held for this waterbody indicate an overall classification of 'Moderate' Ecological Potential, according to the most recent assessment in 2019. Reasons for not reaching 'Good' status are listed as physical modification for industry and transport, plus ammonia and phosphates from ineffective water treatment.

Reviewing the EA's ecological data (Table 2**Error! Reference source not found.**), it is somewhat encouraging to see that the Sheppey improved from 'Poor' to 'Moderate' on biological measures between 2015 and 2016, and remained at this status in 2019. Within these measures, invertebrates have been assessed as 'High' since 2014, while fish improved from 'Poor' in 2015 to 'Moderate' in 2016 and 2019. At the same time, it is worth remembering (as discussed below) that the EA's monitoring sites are all located well downstream of the urban areas of Croscombe. It is also slightly anomalous to see the river's hydromorphological elements at 'Supporting good' despite the river's status as a HMWB and the clear issues that barriers create. On the other hand, this also suggests that tried and tested habitat improvement techniques may be able to improve the situation in simplified and highly modified urban channels.

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) and Benzo(g-h-i)perylene (PAH: polycyclic aromatic hydrocarbons), as well as mercury and its compounds.

This is a situation which now 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 River Sheppey 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 River Sheppey'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. This was grimly illustrated on the River Sheppey in August 2019, when an unknown substance overwhelmed Wessex Water's sewage treatment works between Shepton Mallet and Croscombe, causing a pollution incident that severely damaged fish and insect populations for 9 miles (15 km), including through Croscombe, and is still under investigation. (Effluent from industrial processes in Shepton Mallet is also believed to have caused pollution incidents on the Sheppey in the past).

This constant threat from STWs means that it is vitally important to optimise habitat and water quality in the 'safe' areas of catchments upstream of STW locations – 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 the Sheppey, this would correspond to the river upstream of the STW at ST 60032 44000 (approx.).

At the same time, it will be vital to restore longitudinal connectivity and habitat to the river downstream of the STW, particularly through Croscombe, so that fish can migrate freely up and down the river, and rapidly recolonise any areas which may be impacted by future pollution incidents.

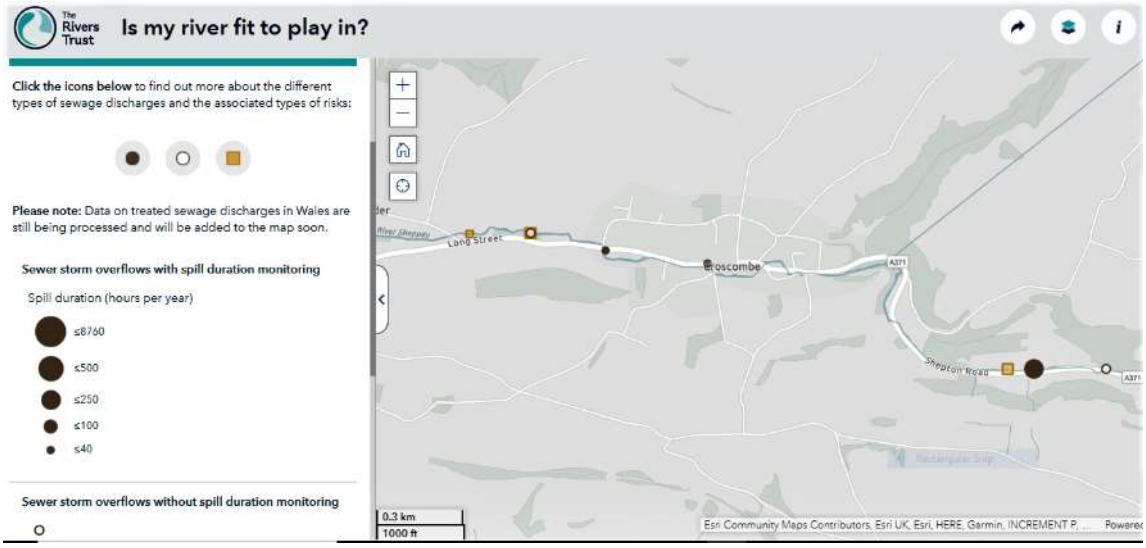

Figure 2: A map of CSOs at Croscombe on the River Sheppey (data from 2019)

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 Sheppey in Shepton Mallet may be affected by 4 CSOs operated by Wessex Water:

- ST 60058 43970 (approx.): Shepton Mallet STW: in 2019 this CSO spilled 36 times for a total of 228 hours
- ST 58929 44332: Croscombe opp Manor House: in 2019 this CSO spilled 1 time for 0 hours
- ST 58568 44401: Fayre Way / Long Street: in 2019 this CSO spilled 7 times for a total of 2 hours
- ST 58466 44424: Croscombe STW: spill durations are not currently monitored

The following 6 CSOs are also present further upstream at Shepton Mallet:

- ST 62856 43417 (approx.): Fosse Lane pumping station: spill durations are not currently monitored
- ST 62772 43538 (approx.): Victoria Grove: spill durations are not currently monitored
- ST 61829 43830 (approx.): Cat's Ash / Cowl Street: in 2019 this CSO spilled 22 times for a total of 5 hours
- ST 61152 44047: Sunny Mount / Ham Lane: in 2019 this CSO spilled 10 times for a total of 3 hours
- ST 61152 43987 (approx.): Sunny Mount: spill durations are not currently monitored

- ST 60298 43969: Shepton Mallet STW storm tanks: spill durations are not currently monitored

The Environment Agency carries out monitoring of fish, invertebrates, macrophytes and diatoms on 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 River Sheppey are all located some distance downstream of Croscombe: macroinvertebrates at ST 57599 44455 (Dinder), macrophytes at ST 56014 44820 (Dulcote) and fish at ST 53616 44062 (Woodford). However, some details are provided below for wider catchment reference.

Macroinvertebrates

The EA's most recent survey of macroinvertebrates, in September 2018, shows a good count of freshwater shrimp (c250), indicating good chemical water quality. Among other species, pollution-sensitive blue-winged olives were also found (c20).

Fish

The EA's most recent fish survey, in June 2018, showed the presence of brown trout (9), bullhead (54), European eel (9), and three-spined stickleback (2). Trout were found in a range of year classes, from 57 – 272 mm, such as one might hope to encounter in a productive limestone stream.

These data provide a snapshot of the lower River Sheppey at that time: however, it should be remembered that the river has been subjected to significant pollution events for at least 20 years (River Sheppey fisheries survey, WRT/BART 2016) and then suffered a major fish kill in August 2019. Unfortunately, no trout were seen in the course of these walkovers in Shepton Mallet and Croscombe: it is likely that that low flows and/or previous pollution incidents have extirpated trout from the upper River Sheppey, and impassable weirs and other structures have subsequently prevented them from moving upstream to recolonise those areas.

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 120 – 330mm is a positive sign (again, dated from 2018).

Despite all these caveats, it would be reasonable to suggest that a range of fish species (including trout) should thrive in the upper reaches of the River Sheppey through Croscombe if water quality, quantity, fish passage and habitat issues were successfully addressed.

4. Habitat assessment

Figure 3: A redundant weir impounding the River Sheppey upstream of Croscombe

Several hundred metres downstream of Shepton Mallet STW, the River Sheppey flows around the wooded edge of a grazing field. On the RB, a fence prevents livestock access to the river – a very important intervention which stops marginal poaching (in line with Defra's Farming Rules for Water) and allows a beneficial riparian fringe to develop.

At the north-western end of the field, the river's longitudinal connectivity is severely interrupted by a large redundant weir (as shown in Figure 3 above) at ST 59595 44305 – a relic of a long-vanished mill. As described in Appendix 3: Weirs and their impacts, such weirs have a very damaging effect on river ecology and natural processes, and options for removing this one should be investigated as soon as possible.

Figure 4: Looking downstream through an old milling site: the pinched channel widens out into a long riffle, where fallen trees could be dropped into the river and secured as beneficial woody material

Downstream of the weir, abundant gravel and cobbles can be seen in the channel through the remains of the old mill buildings. At one point, the river is pinched into a particularly narrow, deep channel (which may represent a pocket of good habitat for adult trout) before widening out into a long cobbly riffle.

Several trees have fallen across the river, and it would be beneficial to slew them round, so that they trail in the channel in a downstream direction, where they could also be secured with stakes in order to provide very beneficial Large Woody Material (LWM). Generous quantities of natural wood are an essential component of all healthy rivers: in this case, the fallen trees would kick-start local processes of scour and deposition, forming complex pockets of habitat for many species, and 'sorting' the substrate into different sizes of gravel and other sediments – a process which is vital for successful trout spawning.

Any cut-off arisings from this tree work could be staked into the river, creating a sinuous low flow channel though this wide pool which would provide fish passage and a variety of habitats, even in low flows. Additional trees could also be hinged into the channel, or secured as tree kickers, helping to slow the flow into flood-prone pinch points further downstream.

With landowner permission, easy access to the river at this point could make it a suitable location for riverfly monitoring by members of the local community – with particular reference to any impacts caused by the Shepton Mallet STW not far upstream.

Figure 5: Looking upstream across the old mill pond, from Duncart Lane bridge

As it leaves the long riffle shown in Figure 4, the River Sheppey flows through private gardens and commercial premises where it could not easily be assessed. However, the WRT/BART 2016 survey suggests that at least one fish passage barrier may exist at ST 59462 44315 (approx.) and this will require further investigation.

Approaching the Duncart Lane bridge, the river flows along the RB of what appears to be a former online mill pond (as shown in Figure 5 above). The LB has become well consolidated, with an abundance of established marginal plants in a soft fringe. Abundant gravel and cobble substrate is visible in the channel: however its present course is very straight and uniform, and it would be hugely beneficial to re-meander the channel extensively through the full area of the old pond (perhaps in conjunction with a project to improve fish passage through the weir just downstream, as described below).

In addition to increasing the length of the channel, thus reducing its gradient and 'slowing the flow' through this stretch, this extensive re-meandering would connect the river more fully to its floodplain, boosting flood storage at times of high flow, and increasing infiltration to ground water. A more sinuous channel, with greater complexity of depth and flow patterns, will also increase aesthetic benefits for local people, and provide many more habitat niches for different species and life stages of insects, birds and fish.

Figure 6: An impassable weir between Duncart Lane and Back Lane

Just downstream of the old mill pond illustrated in Figure 5, the River Sheppey reaches the mill pond's impounding structure – a large and complex weir shown in Figure 6 above, where the river flows through a narrow former sluice, and down a long lower weir face. This is considered to be completely impassable to fish of all species.

At present, the river's channel is artificially 'perched' in this area, probably increasing flood risk to local properties, until it plunges suddenly over the weir. For this reason, as well as all those discussed in Appendix 3: Weirs and their impacts, it would be advisable to renaturalise the river's natural gradient through this reach. As such, removing the weir would be the best option in ecological and hydromorphological terms. However, if this proves impossible, some benefits could also be achieved by deepening the notch through the old sluice and lower weir face to near natural bed level (possibly also incorporating a technical fish pass) and re-grading the channel through the short distance upstream to the concrete footings of Duncart Lane bridge. Alternatively, a rock ramp could be constructed from a lowered point in the upstream right bank (front right of photo) down to the bridge at Back Lane. It is suggested that a structural engineer should be consulted as part of this process.

At the time of these walkover surveys, no invasive non-native species (INNS) were noted, but in summer 2020, several Himalayan balsam (HB) plants were seen growing on the crest of the weir. HB is a tall, shallow-rooted plant which tends to grow in dense monoculture stands that shade out native species before dying back in winter, leaving bare soil without perennial root structure to help resist erosion. Riverbank erosion can contribute significantly to riverbed sedimentation (one recent study suggests a rate of 10 tonnes per km per year) smothering gravels, invertebrates and fish eggs. More generally, HB also reduces biodiversity by suppressing native plants with allelopathic compounds in the soil and attracting insects to pollinate its flowers preferentially with its strong scent and prolific nectar.

Best practice involves identifying the maximum upstream extent of the HB, and systematically (and repeatedly) clearing it downstream from the top of the catchment. In the meantime, it would be highly beneficial to engage with the landowner to arrange local eradication of this infestation of HB, perhaps by hand-pulling with the help of volunteers.

Figure 7: Looking downstream from Back Lane bridge, with deteriorating retaining walls on the RB

Proceeding downstream from Back Lane bridge, the River Sheppey enters a semi-cultivated garden area, before flowing under the A371 Long Street in a deep culvert. It was noted that this culvert entrance is rather low and small, suggesting that it may act as a throttle on higher flows. As such, the stretch of river and its adjoining gardens immediately upstream may become a useful flood attenuation area.

This stretch of the river is still constrained between high walls, but some of the walls adjoining the RB gardens are visibly deteriorating - suggesting that it would be relatively easy as well as beneficial to remove them completely, and replace with a soft, well-vegetated bank toe. This would benefit many species of insects, birds and fish, by creating a more gradual transition between different habitats in varying high and low flows.

Adding LWM to the channel would also help to create a more sinuous channel with varied flow patterns and microhabitats, which is preferable to the relatively straightened, shallow profile of the river at present.

Finally, it was noted that sewer pipe also crosses the area: this would be threatened by any uncontrolled collapse of the existing stone revetments, so a bank softening project should include securing the integrity of the pipe (which should also be periodically inspected by Wessex Water in any case).

Figure 8: A mid-channel wall which is probably damaging the river's ecology in low flows

From a point just upstream from the A371 Long Street bridge, the River Sheppey continues to flow between high retaining walls, but is now also divided into two parallel streams by a central wall, probably designed to split and control flows over the weir system at ST 59131 44343.

Although the mid-channel walls are now deteriorating, this split of flows (as well as the weirs themselves) is redundant, and indeed may be causing quite significant environmental damage in times of drought - by artificially spreading available flow across the full, excessively uniform width of the channel, instead of allowing it to flow in a single naturalistic 'thalweg'.

As such, the central wall in this stretch should be removed, with rock arisings redistributed within the channel as low-level berms, and LWM introduced to promote a more natural, sinuous flow. With flows more focused in a single channel, marginal areas could also be softened with plantings of native vegetation, dramatically increasing total habitat benefits for many species.

Figure 9: A complex system of weirs beside the village school, with an arrow showing a potential fish passage easement route after removing modern weir sills

After flowing around the northern boundary of Croscombe Primary School, the River Sheppey reaches a complicated (and perhaps deteriorating) system of weirs which once supplied the Middle Mill factory area (as shown in Figure 9 above).

As discussed in Appendix 3: Weirs and their impacts, the effects of these structures are deleterious to the river's ecology, and fish passage (as a bare minimum) should be restored throughout this area.

Once again, removal of the weir would be the best option in ecological and hydromorphological terms. However, if this proves impossible, it should be feasible to remove what appear to be relatively modern sills on the western and northern side of the complex in order to achieve much better fish passage (as indicated on the image above). If necessary, a rock ramp could also be incorporated.


Figure 10: Small but potentially significant: a weir in the torrential bypass channel at Middle Mill

Alongside a small private access lane at ST 59107 44327 (approx.) the River Sheppey reappears briefly from a culvert below the A371 road, before plunging into another culvert, under part of the former Middle Mill area.

The flow through this short stretch is straightened and torrential, as befits what appears to have been a former bypass channel designed to carry unwanted water past the factory area as fast as possible: there is also a small but possibly significant fish passage problem in the form of a small weir.

This structure should be removed if possible, and the rest of this short stretch of artificial channel made more hospitable, for a range of species, by adding anchored boulders to create a more diverse and sinuous flow pattern.

Figure 11: A dog-leg culvert, with integrated weir(s), under Old Street Lane

At the downstream end of Middle Mill at ST 58958 44304, the River Sheppey re-emerges from private gardens, and plunges 90 degrees right into a deep culvert, including one or more small weirs, under Old Street Lane and possibly the corner of an adjacent building.

Due to the water levels impounded by this complex structure, nearby properties are likely to have some of the highest flood risk in the village, and could benefit from interventions to improve fish passage, and reduce the height of the impoundment and the pinch point created by the culvert: further investigation is recommended.

Figure 12: At Old Street Lane bridge, small marginal berms could be formalised, with small but significant habitat and visual benefits. In this area and further downstream, small perturbation boulders could also be added to increase habitat diversity

Downstream from Old Street Lane bridge at ST 58948 44318, the River Sheppey emerges into a uniform channel between stone retaining walls, which continue to pinch and confine the river as it flows west, parallel to the A371 road.

At the upstream end of this reach, at Old Street Lane (as shown in Figure 12 above) the existing small marginal low-level berms could be formalised and augmented by redistributing additional substrate from within the channel, before planting with attractive native flowering species such as purple loosestrife and hemp agrimony – increasing visual amenity and drawing attention to the river as a positive local asset, instead of simply a flood risk and possible source of pollution. On both sides of the river, soft berms like these could also help to pinch the channel slightly in low flows, creating a more dynamic and sinuous course within the existing hardened planform.

It is also worth noting that a CSO enters the channel at this point, and its impact would be worth investigating via regular riverfly monitoring. This would ideally be achieved with a site just upstream of the outfall and another 5m (ideally 10 - 20m) downstream in the same shallow riffle habitat, where the outfall water has been allowed an opportunity to mix with the river.

Further downstream, the channel continues to flow fast and straight with vertical armoured walls on either side, and offers very little habitat diversity for fish in its current condition. In limited depositional areas, some sediment has been colonised by emergent vegetation, and these softer pockets of habitat should be retained and formalised wherever possible. Consideration could also be given to introducing perturbation boulders to create low-level 'boulder gardens' where fish can take refuge from predators and high flows (while high flows can pass over them unimpeded).

Figure 13: A recent housing development along the A371, with the River Sheppey disappointingly still culverted under its front gardens – a major missed opportunity to reduce flood risk and increase the aesthetics of the village

Between ST 58887 44330 and ST 58739 44372, the River Sheppey disappears into a long culvert, mainly under private gardens, before it reaches the site of Croscombe's former corn mill at the lower end of the village.

Old maps offer no hints as to the purpose of this 180 m long culvert, and it is disappointing to note that a very recent housing development on this stretch (as shown in Figure 13 above) seems to have missed the opportunity of deculverting the river through three new front gardens. Future development plans in the village should be scrutinised carefully for any opportunities to reduce flood risk (by removing the 'throttle' of potentially undersized culverts) and restore the river as a positive landscape asset that could also increase property values. It would be worth engaging with landowners in this area to consider options for deculverting in any future garden designs.

Downstream from this culvert, the river disappears again behind private properties on the former corn mill area, where the old mill pond has been filled in as part of previous redevelopment. Although detailed assessment was not possible, experience suggests that river channels in residential areas like these have often been simplified and hardened, and ornamental lawns may be mowed right down to the water's edge, leaving little marginal vegetation as habitat for birds and fish. Runoff from roofs and paved areas is likely, and misconnections are possible.

As in all urban and semi-urban areas, it would be beneficial to engage with local residents to highlight these potential issues and communicate the benefits of 'river-friendly gardening': solving misconnections, and promoting use of water butts, rain gardens, and permeable paving, as well as softening banks and improving in-channel habitat along individual lengths of stream. This could include replacing any 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 14: The River Sheppey downstream of Ham Mill

After skirting the former corn mill area, the River Sheppey flows under the A371 once again, and enters another area of private gardens at Townsend Farm (as shown in Figure 14 above).

As previously discussed, the river's hardened channel offers ample opportunities for 'river-friendly gardening', including softening the banks with shaggy, trailing vegetation.

It is also noted that a CSO enters the river in this area, and the periodic impacts of this could be assessed by regular riverfly monitoring. Subject to additional landowner consent, the impacts of Croscombe STW further downstream could also be monitored.

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 upper River Sheppey in and around Croscombe:

- ST 59525 44329: riffle at old milling site

Additional CSO-related locations to monitor could include:

- ST 58929 44332: Croscombe opposite the Manor House
- ST 58568 44401: Fayre Way / Long Street
- ST 58466 44424: Croscombe STW

5.2. Habitat improvements

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

Anchored rocks and boulders

Figure 15: In hard-sided artificial channels, anchored rocks or boulders can sometimes be a more suitable solution than than LWM, with a much longer (indefinite) lifespan than wood, which will degrade over time and require maintenance. In low flows, the rocks create habitat pockets for many species, while higher flows can run over the top with little impediment.

Hinged trees

Figure 16: 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.

Weir removal and regrading

Figure 17: Before and after: an impounded and ecologically impoverished stretch of river (left) can be renaturalised by removing or reducing the weir, before re-grading and re-meandering the channel through the site (right). Connectivity, sinuosity and natural processes have all been restored to this stretch of the River Wandle in Carshalton, south London.

Rock ramp

Figure 18: A rock ramp is an effective fish passage solution when a culvert cannot be modified with baffles or other easements, and a step up into it may need to be 'drowned out'. This example uses a series of erratic perturbation boulders to baffle the flow and ease fish passage.

Soft vegetated margins

Figure 19: 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 for funding this walkover survey.

8. Disclaimer

9. Appendix 1: Summary tables of recommendations

Location	Photo (If required)	Priority (1-3)	Grid reference	Proposed action
Weir upstream of Croscombe		1	**ST 59595 44305**	Fish passage and habitat: remove weir and re-meander to allow fish passage and restore natural processes
Riffle at old milling site		1	**ST 59525 44329**	Habitat and community engagement: add LWM to channel by reducing existing fallen trees / hinging others; investigate possible weirs further downstream; possible site for riverfly monitoring
Channel upstream of Duncart Lane bridge		1	**ST 52988 44298 (approx.)**	Habitat: create more sinuous channel by re-meandering through footprint of old mill pond

Weir downstream of Duncart Lane bridge		1	**ST 59251 44299**	Flood risk and fish passage: reduce height of impoundment and ease fish passage through weir (possibly by deepening notch or constructing a rock ramp along the RB)
Channel downstream of Back Lane bridge		2	**ST 59213 44301 (approx.)**	Flood risk and habitat: 'slow the flow' and reduce flood risk by breaking out hard wall on RB and adding LWM in conjunction with a soft vegetated toe; also secure the integrity of the sewer pipe crossing this area
Channel behind school		1	**ST 59189 44333**	Habitat: remove central dividing wall, redistribute rock arisings within channel and create single sinuous low flow channel; add LWM
Weirs beside school		1	**ST 59131 44340**	Fish passage and habitat: investigate options for fish passage (perhaps removing modern weir sills and regrading through the area)

Channel downstream of A371		3	**ST 62220 43717**	Fish passage and habitat: remove small weir and add anchored boulders for habitat value
Weir(s) and culvert under Old Street Lane bridge		1 - 3	**ST 58958 44304**	Flood risk and fish passage: investigate reducing impoundment and easing fish passage
Channel downstream from Old Street Lane bridge		1	**ST 58947 44317 to ST 58888 44330**	Habitat: retain and enhance existing marginal berms; add low level boulder gardens; monitor impact of CSO with riverfly monitoring
Old culvert under gardens and recent development		2	**ST 58887 44330 to ST 58739 44372**	Flood risk, fish passage and habitat: remain alert for future opportunities to daylight redundant culverts

Channel through gardens at western end of village		1	**ST 58713 44361 to 58459 44422 (approx.)**	Habitat and community engagement: engage with residents to implement 'river-friendly gardening'; also monitor impact of CSO (and STW further downstream) with riverfly monitoring

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 required for trout to complete their full life cycle is a very practical way to assess overall habitat quality (Figure 20). By identifying the gaps (i.e. where crucial habitat is lacking: Figure 21 to Figure 23), 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.

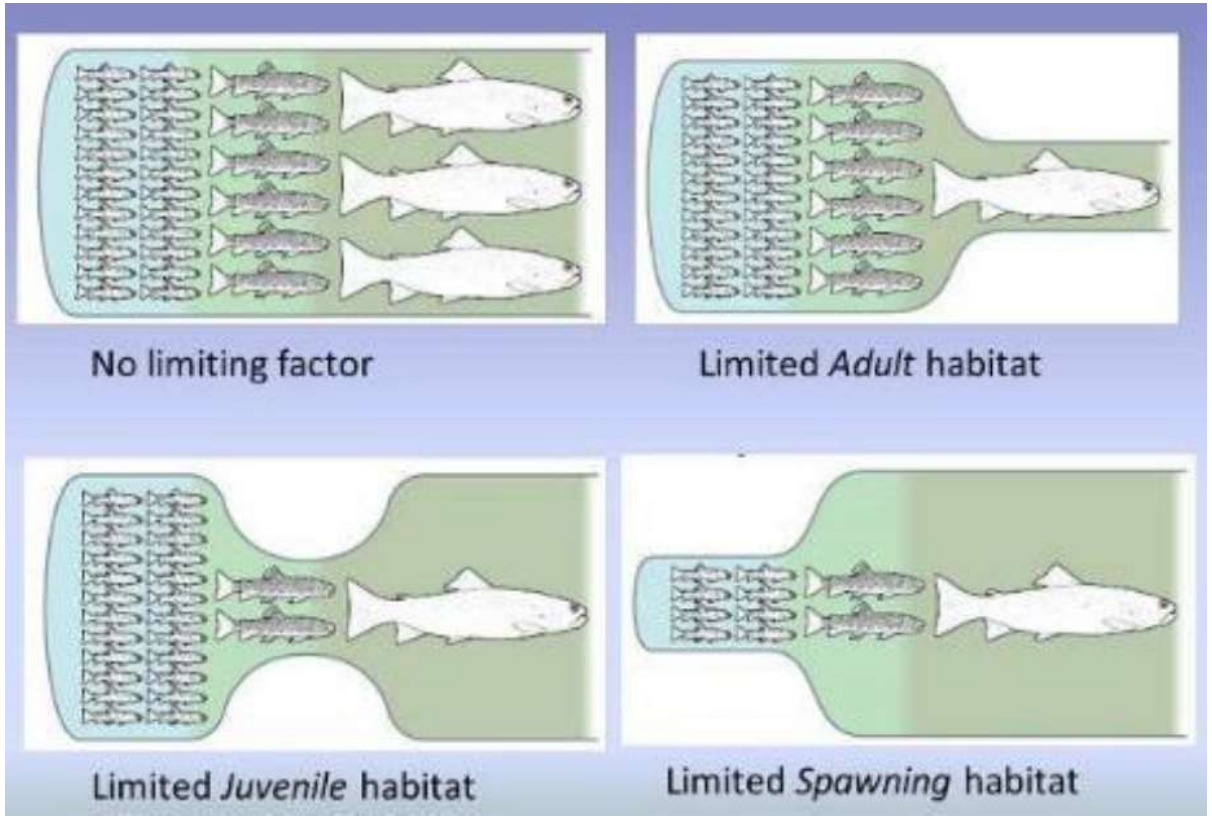

Figure 20: The impacts on trout populations lacking adequate habitat for key life cycle stages. Spawning trout require loose gravel with a good flow-through of oxygenated water. Juvenile trout need shallow water with plenty of diverse structure for protection against predators and wash-out during spates. 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.

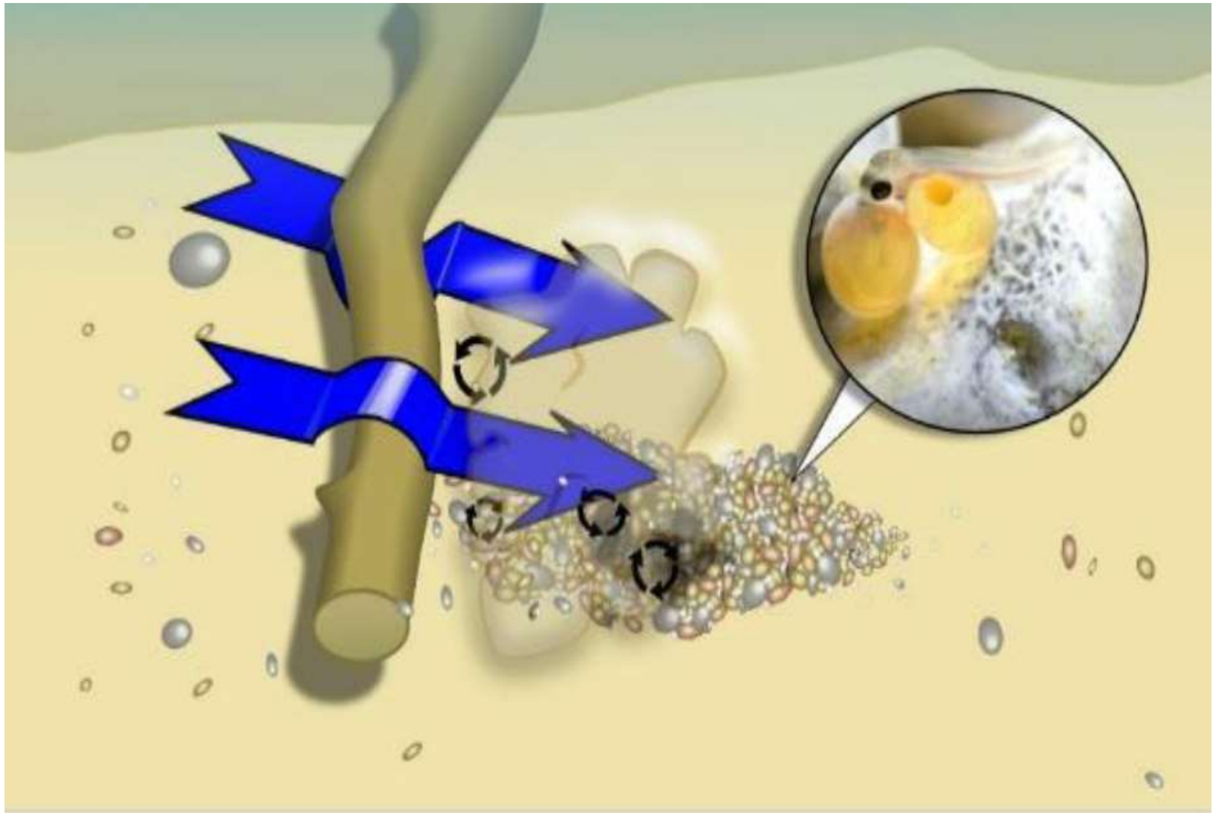

Figure 21: Successful trout spawning requires relatively silt-free gravels. Here, the action of a fallen tree limb is focusing the flows (both under and over the limb as indicated by the blue arrows) on a small area of riverbed that results in silt being washed out from between gravel grains. A small 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 22: 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 23: 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 24). 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.

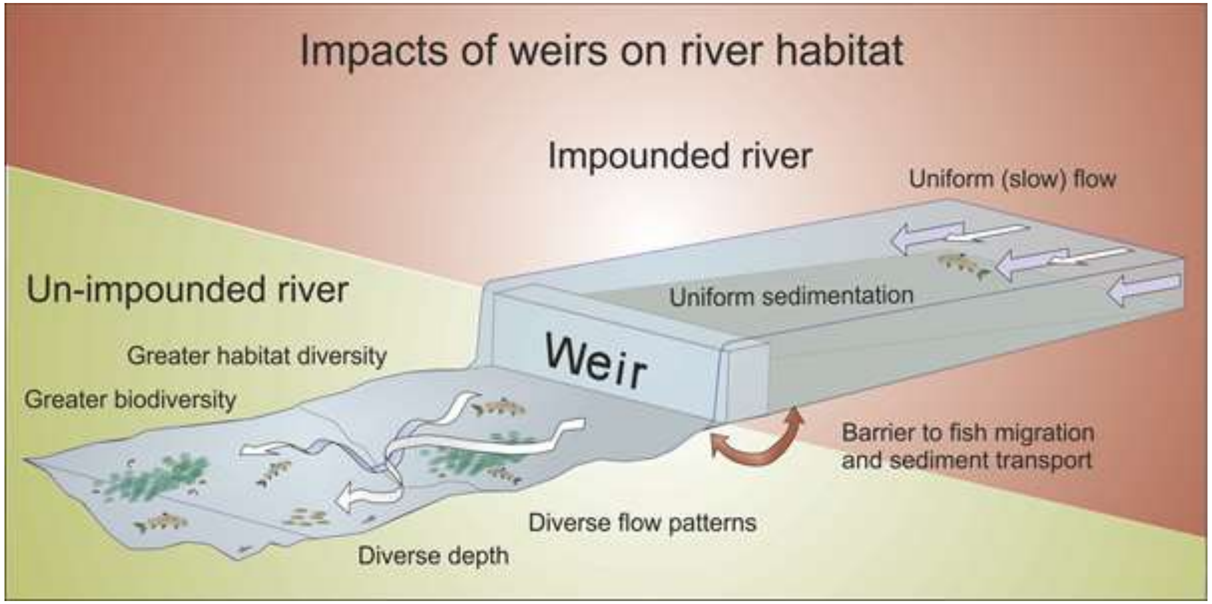

Figure 24: An illustration showing the impacts of weirs on habitat quality

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 25). 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.

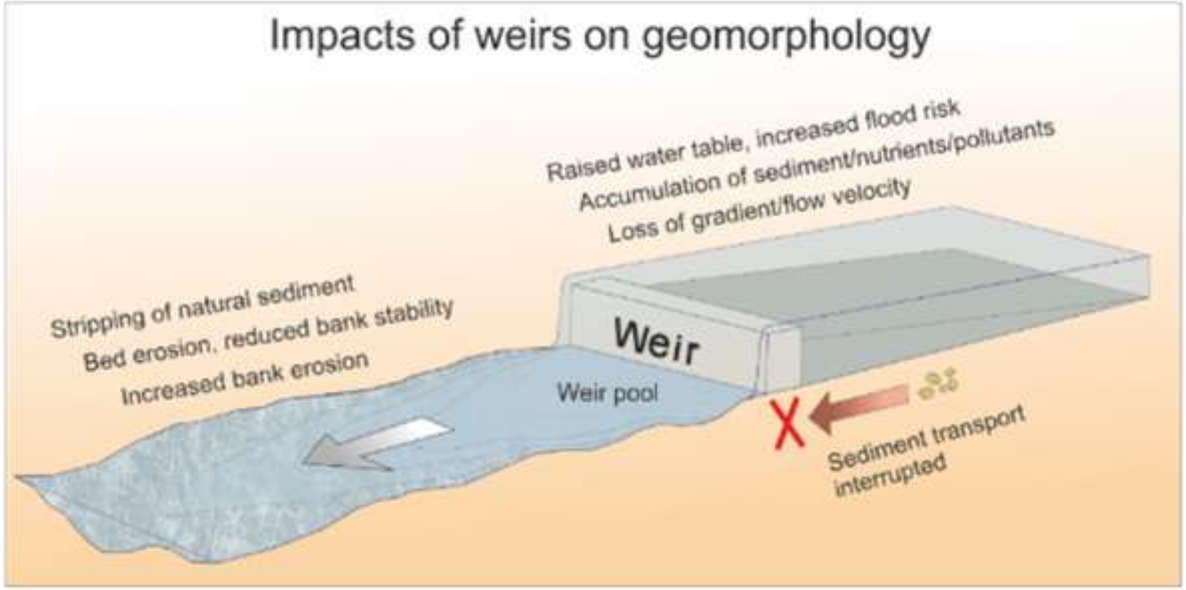

Figure 25: An illustration showing the impacts of weirs on river geomorphology

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