River Trym and Hazel Brook, North Bristol

Wild Trout Trust report following an Advisory Visit, January 2019

Executive Summary

Habitat quality in the River Trym and its tributary, the Hazel Brook, is limited by numerous historic channel modifications including hard engineering, artificial weirs and other modifications that suppress natural channel morphology and limit the abundance and diversity of habitat niches. Additionally, both waterbodies show signs of significant water quality problems originating from urban run-off, and household/industrial mis-connections.

Nonetheless, the river can support wild fish and has great potential for improvement. Engaging with water companies, the Local Authority, Environment Agency, and local communities will be key to identifying and addressing sources of pollution. Local NGOs such as Avon Wildlife Trust and Bristol Avon Rivers Trust will be invaluable sources of information, advice and support for improving habitat quality and connectivity. The Wild Trout Trust can also provide further specialist advice and support going forward.

Setting achievable short-term goals will be important in progressing improvements within the catchment but it will also be important to establish ambitious, long term goals to work towards. There is no reason why the Trym couldn’t one day be a well-connected, well-protected and biodiverse ecosystem with the habitats, plants and invertebrates required to support a self-sustaining wild trout population.

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Introduction

This report is the output of a visit undertaken by Theo Pike and Mike Blackmore of the Wild Trout Trust on approximately 9 km of the River Trym from Southmead to Sea Mills, North Bristol, and the Hazel Brook (Figure. 1). A walk-over of the catchment was requested by Sustainable Westbury-on-Trym (SusWoT), the Friends of Badocks Wood (FBW), and Friends of Blaise (FB). The visit was primarily focused on assessing habitat for wild brown trout *(Salmo trutta)* and biodiversity in general.

Comments in this report are based on observations on the day of the site visit and discussions with personnel from SusWoT, FBW and FB. 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.

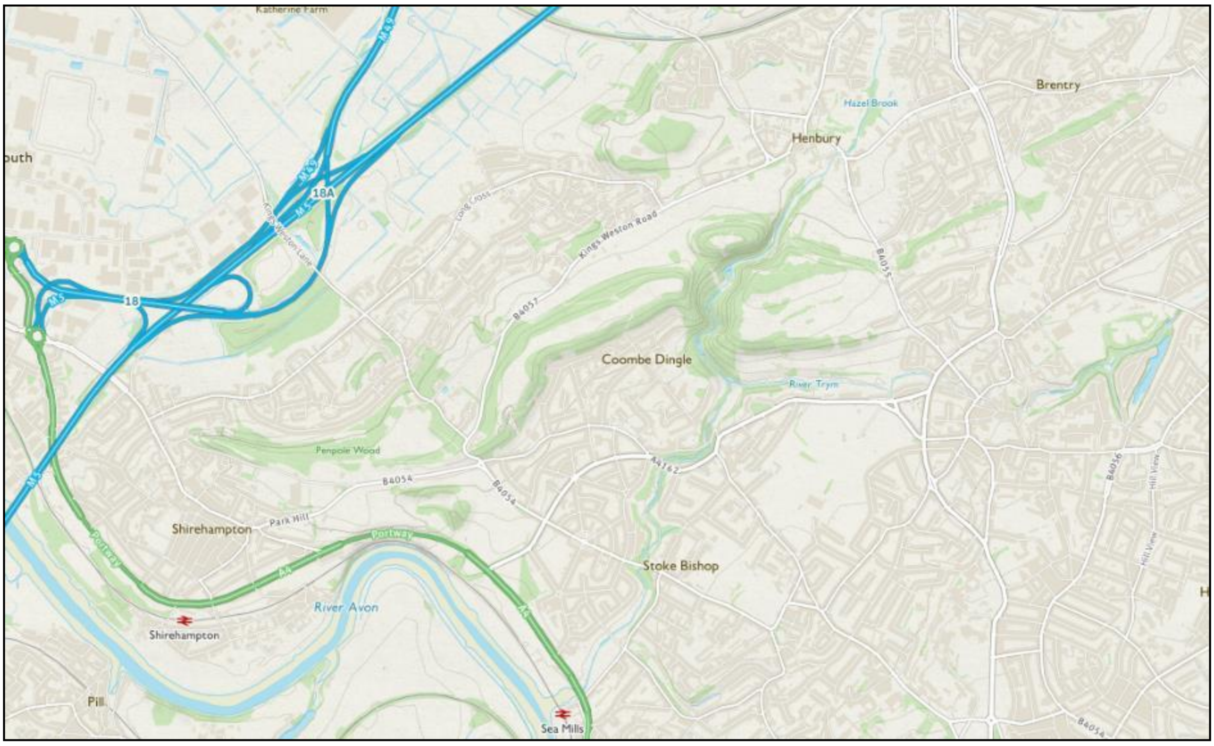

Figure 1: Map showing the location of the River Trym and Hazel Brook

River	River Trym
Waterbody Name	Trym – source to confluence with R Avon (Bristol)
Waterbody ID	GB109053027530
Management Catchment	Avon Bristol and Somerset North Streams
River Basin District	Severn
Current Ecological Quality	Moderate (as at 2016)
U/S Grid Refs inspected	ST 58679 78247 (R Trym – Southmead) and ST 56384 78704 (Hazel Brook – Henbury)
D/S Grid Ref inspected	ST 54889 75897 (Sea Mills)
Length of river inspected	c9 km

Classification Item	2013	2014	2015	2016
Overall Water Body	Moderate	Moderate	Moderate	Moderate
Ecological	Moderate	Moderate	Moderate	Moderate
Chemical	Fail	Fail	Good	Good
Priority substances	Good	Good	Does not require assessment	Does not require assessment
Other Pollutants	Does not require assessment	Does not require assessment	Does not require assessment	Does not require assessment
Priority hazardous substances	Fail	Fail	Does not require assessment	Good
Brominated diphenylether (BDPE) Calc	-	-	-	Good
Cadmium and Its Compounds	Good	Good	-	-
Di(2-ethylhexyl)phthalate (Priority hazardous)	Good	Good	-	-
Nonylphenol	Fail	Fail	-	Good
Tributyltin Compounds	Fail	Fail	-	-

Table 1: Water Framework Directive information for the River Trym

Catchment and Fishery Overview

The River Trym, together with its own tributary the Hazel Brook, is a small but highly-urbanised tributary of the Bristol Avon. The River Trym rises in the northern suburbs of Bristol, in an area of mixed geology which includes areas of the famous Clifton Down limestone as well as other limestones and mudstones of the Carboniferous, Jurassic and Triassic periods, often laid down in shallow seas and desert lagoons between 199 and 360 million years ago.

Despite its massive and intractable appearance, limestone is largely composed of the mineral calcite, and is soluble by rainwater, which is slightly acidic as a result of carbon dioxide absorbed from the atmosphere. Over geological time, faults within limestone and other calcite-rich rocks can be readily dissolved and weathered into dramatic gorges – such as those at Badock's Wood and Coombe

Dingle. These gorges have become natural focal points for human settlement, industry, and aesthetic interest, and the high-energy streams within them have been subject to much modification.

Located in an area where the steep gorge of the upper Trym breaks out into gentler contours, Westbury-on-Trym's history predates that of Bristol, and the river may already have been modified to some degree by 1086, with one mill listed in the Domesday Book. At the other end of the Trym, its confluence with the Avon had previously been developed as a Roman port. Tide mills were operating at Millpill in the 15th century, and the 18th century saw an attempt to establish a whaling station. Traces of other industries like limestone quarrying can also be seen, for instance at Henleaze Lake, and probably on exposed rock faces along the course of the river.

In the 20th century, the upper Trym catchment was heavily impacted by the exponential growth of the city of Bristol – not just residential development, but also large industrial areas like Filton airfield, and retail parks like Cribbs Causeway. The proliferation of impermeable surfaces has resulted in a typically flashy, urban-runoff-dominated hydrological regime, with attempts to mitigate this including the Catbrain attenuation reservoir on the Hazel Brook:

https://web.archive.org/web/20110520045642/http://www.bristol.gov.uk/ccm/content/Environment-Planning/Pollution/bristol-living-rivers--watercourses.en?page=3

Under the Water Framework Directive (WFD: the scheme currently used to assess Ecological Status and Ecological Potential of surface waterbodies in Britain), the Trym is classified as a 'Heavily Modified Water Body' (HMWB) as a result of high levels of historic modification, particularly for the purposes of urbanisation and flood defence.

For HMWBs like the Trym, the classification of Ecological Potential (rather than Ecological Status) is applied. The Environment Agency (EA) data held for this waterbody indicate that it has an overall classification of 'Moderate' for Ecological Potential according to the most recent assessment in 2016 (Table 1).

Taken at face value, it is encouraging to see that previous failures for chemical criteria ('priority hazardous substances' in 2013 and 2014) improved to 'Good' status in 2016: however the intervening 'Does not require assessment' classification in 2015 suggests that the improved designation may be the result of erroneous data or a change in monitoring practice. As such, the Trym's WFD classifications may warrant further investigation with the EA.

According to the EA's data, reasons for the Trym not achieving 'Good Ecological Potential' (GEP) include physical modification for transport and flood protection, point source pollution incidents from discharges of sewage as well as more general (household) foul water misconnections, and barriers to fish migration. Many of these typical urban pressures were evident during the walkover survey. It is interesting to note that phosphate enrichment from agricultural and livestock management sources has also been identified as an impact, although livestock and/or their potential presence was not readily evident on the day of the visit.

Further details of the Trym's WFD classifications can be found at:

https://environment.data.gov.uk/catchment-planning/WaterBody/GB109053027530

Many limestone streams in the Bristol area support healthy populations of fish, including trout, and it would be reasonable to suggest that a wide range of fish species could thrive in the Trym if water quality, fish passage and habitat issues were successfully addressed.

Thanks to their need for clean, well-oxygenated water, structurally-varied habitat and free movement between different habitat types, the UK's native wild brown trout makes an ideal indicator or sentinel species for the general health of rivers.

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 habitat quality (Figure. 2). By identifying the gaps (i.e. where crucial habitat is lacking: Figures. 3-5), it is often possible to design actions to overcome habitat bottlenecks.

This means it is useful to examine a river like the Trym for habitat bottlenecks that would prevent self-sustaining trout populations from existing. Even where there is little or no chance of wild trout colonising a stream, those requirements listed above for trout are all good yardsticks for assessing the general health of a stream and its wider ecology.

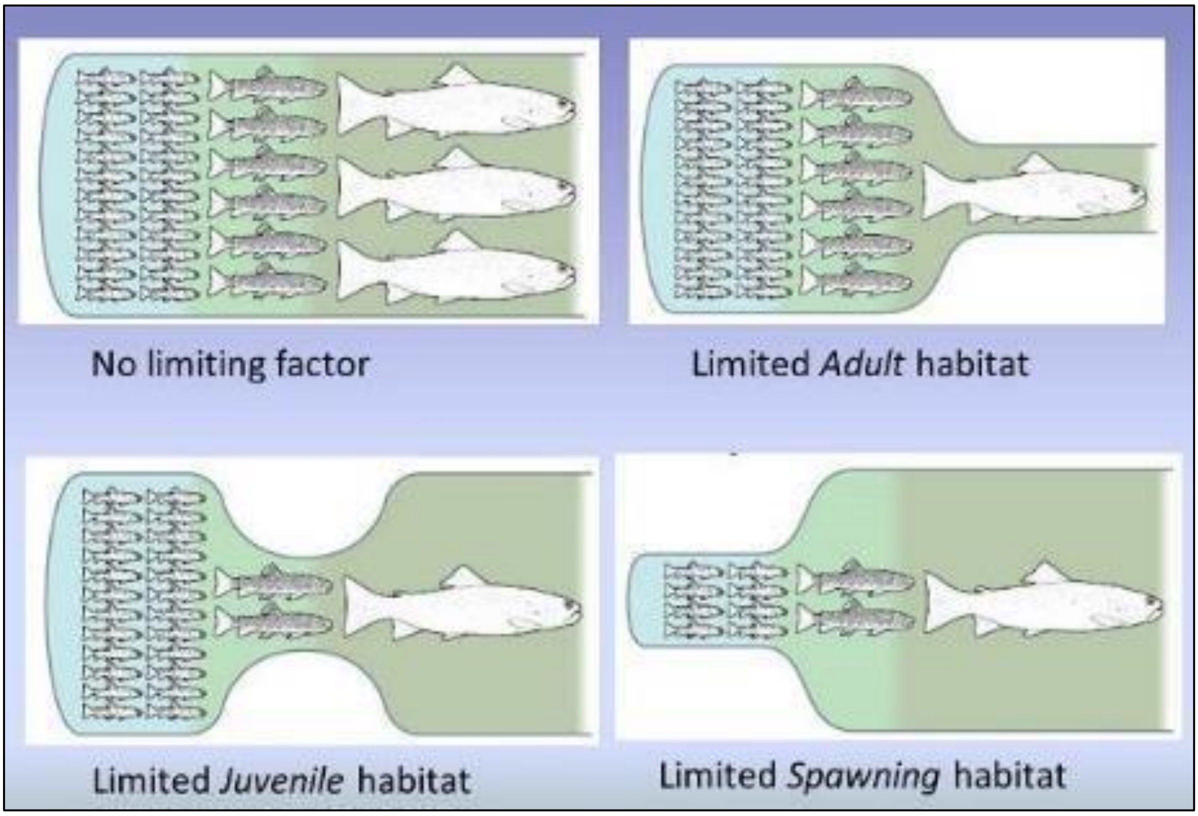

Figure 2: An illustration showing how a 'weak link' in habitat availability can cause population 'bottlenecks' at different life stages. Spawning trout require oxygenated water flowing through clean gravel. Juveniles need complex cover/refuge habitat. Adults favour pools (usually > 30cm depth) with nearby structural cover such as undercut banks, sunken trees/ limbs and/or low overhanging cover (ideally trailing on, or at least within 30cm of, the water's surface).

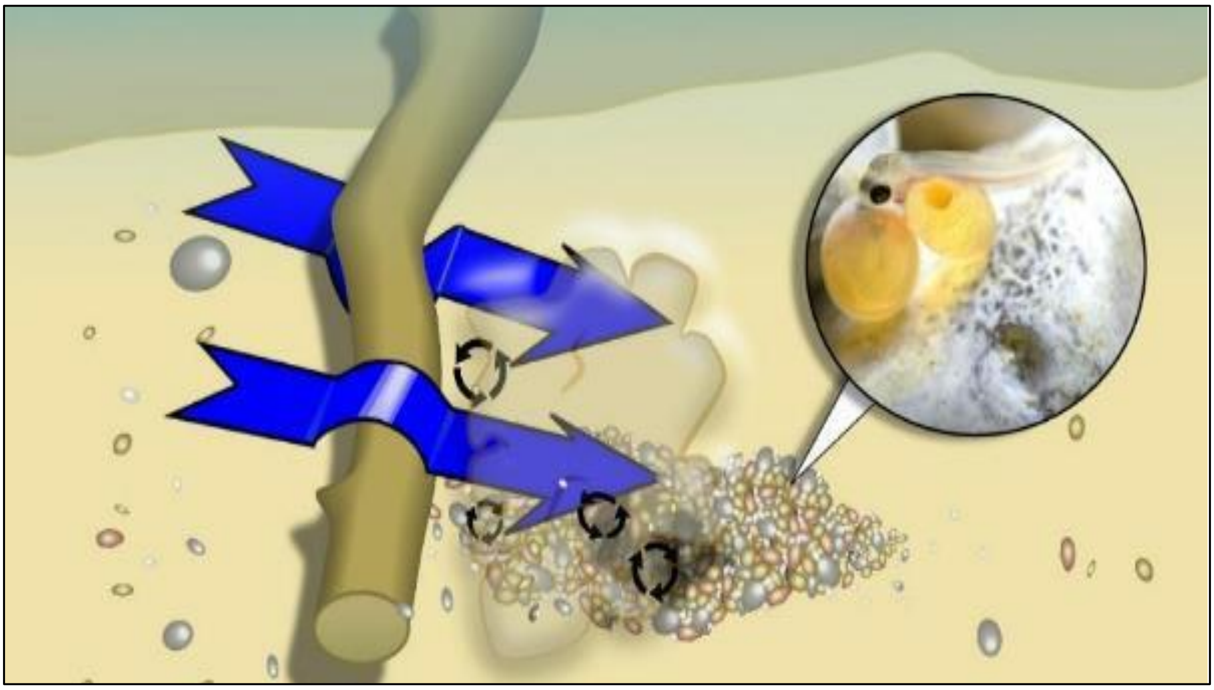

Figure 3: Trout eggs require clean, relatively silt free gravel. Here, a fallen tree limb is focusing flow to scour away silt from between gravel grains. Such sites are often selected by trout to dig a 'redd' (nest) for spawning. This cleansing flow of oxygenated water will help keep developing eggs and newly-hatched 'alevins' (inset) alive until they emerge in spring.

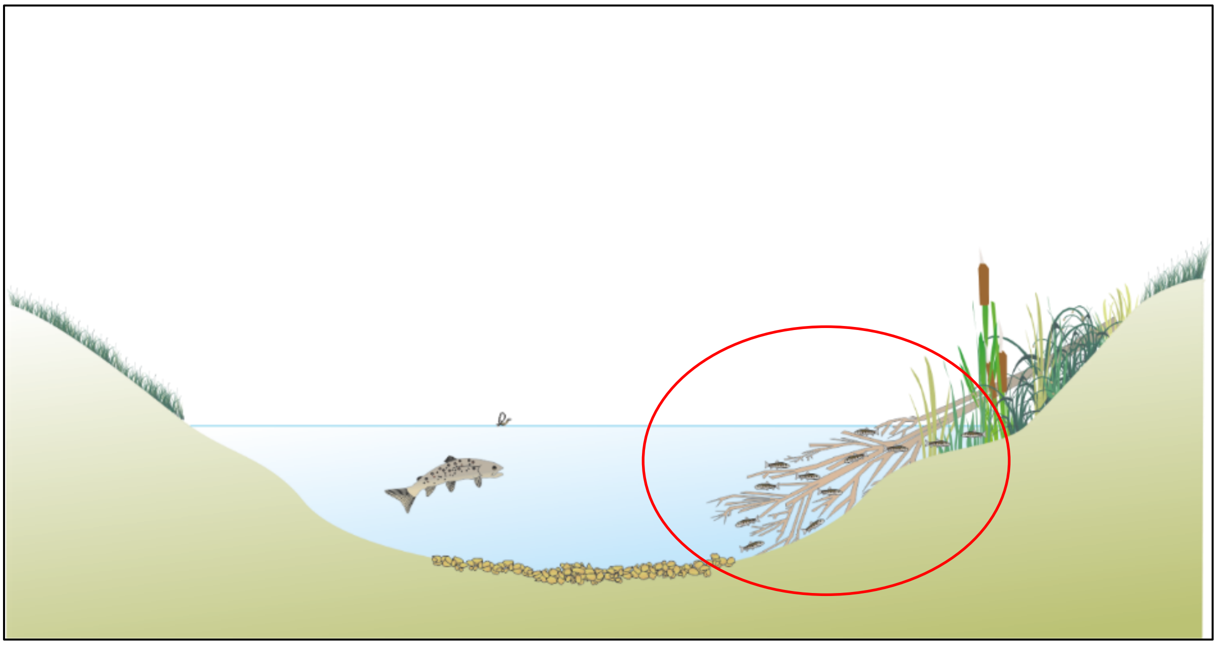

Figure 4: Submerged 'shaggy' vegetation and/or exposed fronds of tree roots (red oval) provide vital refuge from predation and spate flows to tiny juvenile fish. Trailing, overhanging vegetation also provides a similar function, and has many benefits for invertebrate populations.

Figure 5: The availability of deeper water (>30cm) bolt holes, low overhanging cover and/or larger submerged structures such as boulders, fallen trees, large root-wads etc. provide ideal adult trout habitat.

Habitat Assessment

Upper River Trym

At the upstream limit of the River Trym, at ST 58679 78247 in Southmead, the river emerges from a culvert and flows broadly west across a large area of open green space, bisected by Trowbridge Road.

Somewhat unusually in such an urban area, significant stretches of the channel appeared to meander naturally through the contours of the green space – suggesting that the stream was only partially straightened from its original course, while intensive 20th century residential development took place all around (Figure. 6).

Figure 6: Scoured but still sinuous: the upper River Trym in Southmead

This is confirmed by laying modern satellite imagery over early 20th century maps (OS 25 inch: 1892 – 1914): the channel now lacks some of its sharper meanders, but still appears to retain the general course of an upland limestone stream (Figure 7).

Figure 7: Laying modern satellite imagery over an early 20th century map enables comparison of the historic and contemporary courses of the River Trym through the Southmead green space (Mapping via National Library of Scotland)

On the ground, however, a wide range of other urban impacts was evident (Figure. 8). Although base flows were minimal (a frequent indicator of an unnaturally flashy catchment), the predominant profile of the banks (even on the inside of bends) was vertical and eroding, rather than shallow and gradually shelving – suggesting that the channel is subject to dramatic fluctuations in flow.

Figure 8: Very low base flows expose unsorted gravel and cobbles in the upper Trym. Sorting could be improved by introducing Large Woody Material: further gravel will be supplied by more controlled erosion from seams in the banks.

These fluctuations will include violent, scouring episodes of urban runoff when rainfall 'flashes' rapidly off large areas of roofs and roads, where the upper catchment of the Trym is now culverted under Filton and other areas upstream. Also, it is probably exacerbated by the current management regime for the Southmead green spaces. Tree root systems are an essential structural component of stable river banks, but very few trees were present on this stretch, and even riparian plants like sedges seemed to have been heavily strimmed. Regular cutting, strimming or grazing force plants to direct available energy into re-growing leaves. This in turn limits the energy divested into growing root mass, weakening banks and leaving them vulnerable to erosion.

Perhaps because of the time of year, no invasive non-native species (INNS) were observed, but it is understood from SusWot, FBW and FB personnel that the green space is heavily infested with Himalayan balsam *(Impatiens glandulifera)*, which is likely to be worsening the scouring effects of urban runoff along these upper reaches of the River Trym.

Himalayan balsam is a tall, shallow-rooted INNS, which grows in dense monoculture stands that shade out native plants 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, Himalayan balsam 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. In conjunction with thick beds of stinging nettles, with which it happily cohabits on nitrogen-rich soil, it also restricts access for local people and prevents beneficial engagement with small streams which should be a focal point of such public areas.

At several points along the course of the stream through the green space (and indeed all down the river), surface water outfalls were observed (Figure 9). These would have been installed to carry rainwater from surrounding residential areas into the river, but over time it is likely that many have been mistakenly 'misconnected' to pipes from kitchens and bathrooms - leading to some of the sewage litter which was apparent on structures like the trash screen at the lower end of the green space (and indeed to one of the reasons why the Trym is failing its WFD target). Tracing the source of misconnections is a time-consuming task for water companies, but it can make a very tangible difference to the chemical and biological health of such a small urban stream.

Figure 9: Bare, eroded and slumping banks suggest invasion by Himalayan balsam. Also note the surface water pipe on the left-hand side of this photo: almost certainly a source of water quality issues for the Trym.

At Trowbridge Road (ST 58480 78093) and again at Doncaster Road (ST 58316 77985), the natural flow of the river is interrupted by culverts (e.g. Figure 10). Both structures will present impassable obstacles to all species of fish, including European eels *(Anguilla anguilla)* which are globally threatened.

Figure 10: The trash screen over the deep culvert at the lower end of the Southmead green space, after clearance by SusWoT volunteers. The line of concrete bollards was probably installed to stop larger items of fly tipping and other urban debris from blocking the screen after being swept downstream by high runoff. (Photo: SusWoT)

In general (and by contrast to some areas further downstream), the Southmead stretch of the Trym appeared overlooked and undervalued by many local residents. However, this offers huge opportunities for community groups like SusWoT. Working with residents to clear litter and INNS, campaigning for better water quality, and raising the profile of areas like this can create a real sense of local ownership, fostering surprising levels of community cohesion and turning environmental eyesores into sources of pride for everyone concerned.

Below Doncaster Road, the stream drops rapidly into a limestone gorge through Badock's Wood (an area of ornamental woodland laid out in the early 20th century and managed as a Local Nature Reserve since 2008) where it is joined by another small tributary.

Figure 11: Two of the weirs in Badock's Wood. Possibly installed to 'keep water in the river' in this area of natural sinkholes, they are now doing more ecological harm than good. Removing the weirs and introducing natural woody features would create a healthier and more varied channel structure.

The river in this area is fragmented by around a dozen ornamental weirs and sluices (Figure 11), with others believed to be present further downstream in private woodland which could not be accessed at the time of this visit. Between these sequences of weirs, a high proportion of the Trym's flow seemed to disappear into an interesting area of natural sinkholes – a typical feature of 'karst' limestone landscapes – before reappearing an unknown distance down the catchment. It is possible that many of the weirs were originally constructed with the aim of 'keeping water in the river'. However, they are more likely to be doing the river's ecology more harm than good.

Weirs of all sizes are often significant barriers – or even complete obstacles – 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. This suppresses natural geomorphology (the process by which natural habitat features such as pools and riffles form) and can cause the river downstream to become depleted of coarse sediment, increasing rates of erosion as the river adjusts to the reduced gravel supply; see Figures 12 & 13.

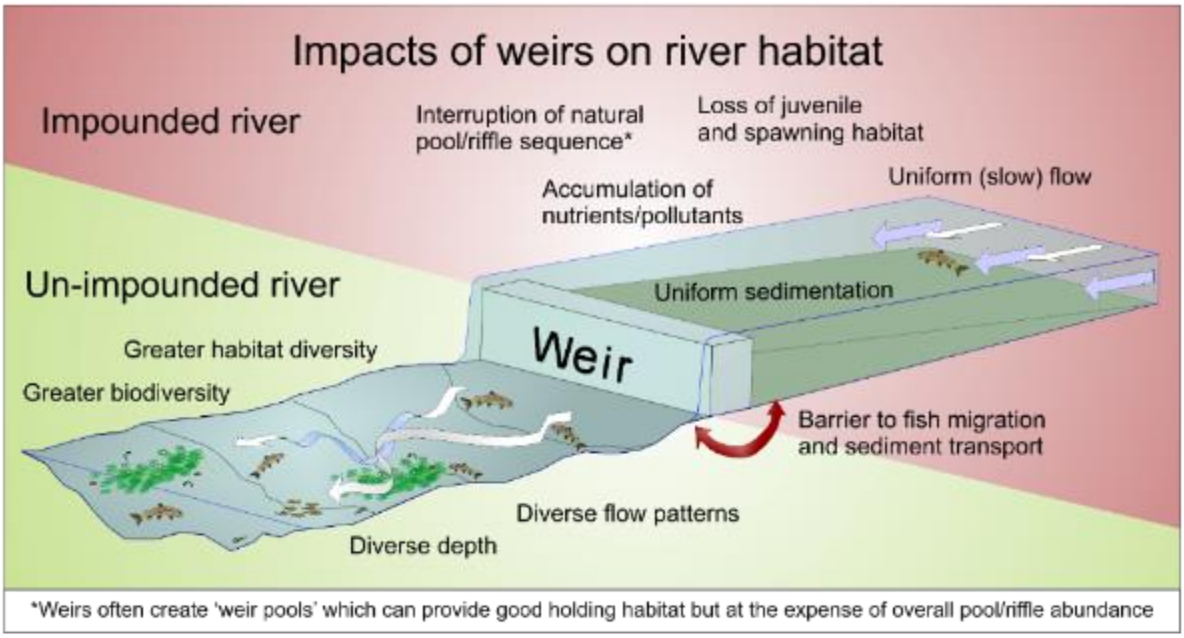

Figure 12: An illustration showing the impacts of weirs on habitat quality.

In the slow-moving water above a weir, fine sediment readily drops out of suspension and deposits uniformly across the bed. This severely degrades habitat quality and diversity. Such conditions can sometimes provide sufficient deep-water habitat for small numbers of adult trout, but are unsuitable for spawning, fry or juveniles. They can also result in fish populations becoming fatally isolated and very vulnerable to predation.

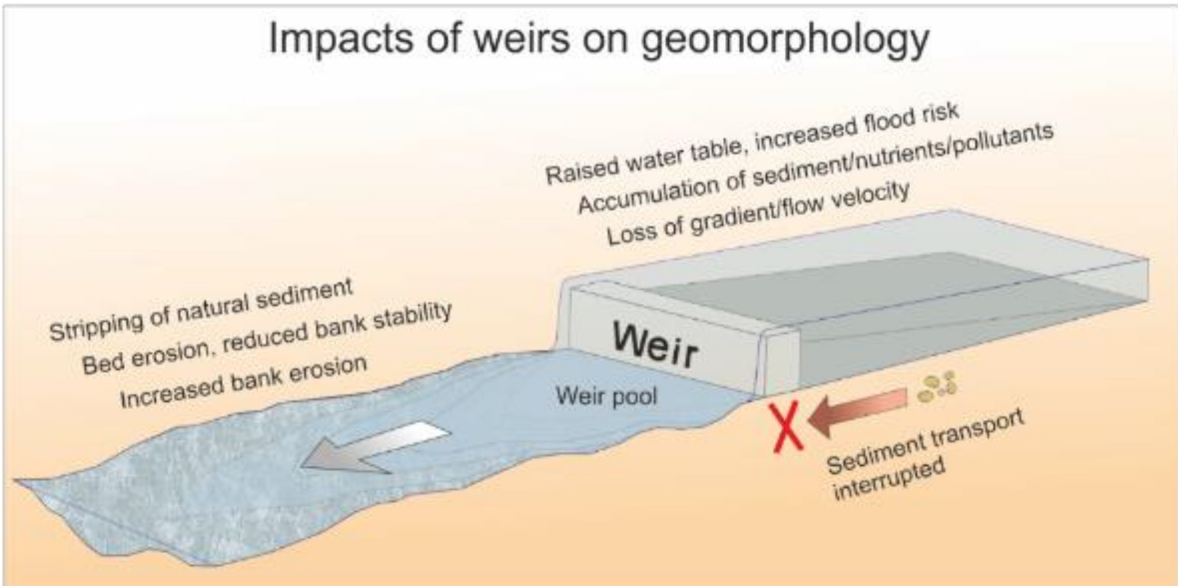

Figure 13: An illustration showing the impacts of weirs on river geomorphology.

Between Badock's Wood and the private woodland below, a high metal fence extends the full width of the valley, crossing the river with a gate set a short height above a concrete sill (Figure 14). With a shallow laminar flow of water spread across its width, this structure is likely to be a further obstruction to fish passage for all species and age classes.

Figure 14: Water gate between Badock's Wood and private land. Removing the concrete sill would restore fish passage and downstream sediment movement at this point.

Just above this point, another pathway for urban runoff was observed, in the form of a steep concrete and rock armoured chute down the RB of the gorge, which is understood to convey runoff from infrastructure including a leisure centre. A better approach would be to divert this rainwater into sustainable drainage solutions (SuDS) such as swales or rain gardens, promoting natural infiltration into the aquifer (thus reducing flood risk further downstream, and conversely boosting base flows in the river in times of drought).

As it flows through the historic village centre of Westbury-on-Trym, the river is alternately fully culverted and enclosed between high retaining walls (Figure 15). For much of this length the river bed has been simplified and armoured with poured concrete or 'crazy paving' slabs – offering very little habitat for fish, invertebrates or any other aquatic life.

In one or two areas, however, bedrock emerges as natural outcrops. These have been colonised by sedges and other emergent plants, and the stream appears to flow at a more natural width and depth, exhibiting sequences of pools and riffles, and providing a healthy mosaic of habitats for different species.

Figure 15: Some stretches of the Trym through Westbury still retain a reasonably natural morphology considering its constrained nature.

Adjacent to the junction of Trym Road and Channels Hill at ST 57472 77451, a large culvert enters the river from the LB (Figure 16). At the time of this visit, the culvert was constantly discharging a milky liquid onto sewage fungus (colonies of tightly-sheathed filamentous bacteria), suggesting a long-term, severe misconnection problem. This was reported to the Environment Agency's pollution hotline as soon as possible, and it would be wise to maintain a watching brief on this clear source of water quality problems for the river.

Figure 16: A serious misconnection problem in Westbury.

Near Chock Lane in Westbury-on-Trym, the Trym disappears into extensive culverts under the town, including what appears to be a large-capacity subterranean flood defence scheme (Figure 17).

Flooding at urban pinch points is a common challenge for urban rivers, especially when their upper catchments are steep, or already developed in such a way as to accelerate flood flows downriver, converging at historic bridges, mills and culverts which were originally designed to cope with far lower peak flows.

'Slowing the flow' in areas like Southmead would almost certainly help to reduce flood risk further down the catchment. At the same time, significant over-capacity in Westbury-on-Trym's flood scheme may make it possible to re-naturalise and restore some 'roughness' to the simplified river channels through the town without adding to flood risk (though this would require very careful planning).

Figure 17: The throttled offtake to Westbury's large underground flood defence scheme.

The river finally resurfaces behind allotments off the A4018 (Falcondale Road), where it is intercepted once again by the flood defence scheme. This finally discharges into the river in Henbury golf course near ST 56653 77590, where the LB of the river has been hard-engineered to resist spate flows. By contrast, the RB has been softened with pre-planted coir rolls – most of which have established successfully, adding some welcome diversity, except at the very top of this stretch, where over-shading from trees on the LB has caused the plants to fail, and the coir roll to decay (Figure 18). In future, this open stretch of river could benefit from further softening/replacement of the hard revetment as well as an un-mown buffer of rough grassland/marginal wetland habitat.

Figure 18: Through Henbury golf course, the Trym's channel has been partly softened with coir rolls on the RB.

The base flow became more substantial in this area, further augmented by a spring from the foot of a rocky bluff on the RB.

From the edge of the golf course to its confluence with the Hazel Brook, the Trym flows though a woodland gorge, often well below the level of the public footpath, and exhibits increasingly natural hydromorphology – which may even suggest a 'target condition' for restoring other areas of the stream (Figure 19).

Figure 19:Excellent natural channel morphology on the Trym near its junction with Hazel Brook.

Also noticeable in this area was the effect of a large oak tree which had fallen into the channel and accumulated additional woody material of all sizes (Figure 20). Naturally-formed 'debris dams' like this are very effective for 'slowing the flow', promoting scour to create fish spawning areas, and providing a wide diversity of habitat niches for many species.

Figure 20: Naturally fallen woody habitat features are very important for 'slowing the flow' and generating habitat niches for many species. Note, however, that the cluster of holes circled in red may suggest the presence of American signal crayfish – a problematic INNS which is present throughout much of the Bristol Avon catchment.

Just upstream from their confluence, both the Trym and the Hazel Brook have been impounded by weirs crossed with ornamental bridges (Figure 21). Both of these structures represent fish passage problems. However, the Trym structure is smaller, and should be relatively easy to notch and / or pre-barrage with a rock ramp structure, providing easy fish passage from the pool below (which it is understood may recently have been deepened as a swimming hole for local children).

Figure 21: Just before its junction with the Hazel Brook, this weir is a significant barrier to migrating fish.

<u>Hazel Brook</u>

At the upstream extent of the Hazel Brook, a V-shaped and vertical weir impounds the river (Figure 22). The original purpose of the structure is unclear. It may have been installed for ornamental purposes, as part of a pumping system to send water to The Old House or Blaise Castle House, or possibly as a bed-check to constrain the brook and limit bank erosion or undermining of the nearby footbridge.

The water was turbid and exhibited a milky-blueish colouration. The weir was also coated with sewage fungus. These are both indicators of foul water pollution, likely originating from household misconnections.

The weir is a complete barrier to fish passage and interrupts natural sediment transport. It should ideally be removed but more investigation would be required to ascertain what (if any) function it serves and how feasible a removal (or significant lowering) would be.

Figure 22: The weir at the upstream extent of the visited section of the Hazel Brook is a barrier to fish passage. The brook shows signs of nutrient enrichment

Further signs of catchment run-off problems were observed downstream of the weir as the Hazel Brook flows into the grounds of the Blaise Castle Estate. Fine sediment was observed uniformly smothering the bed through shallower sections (Figure 23), and deeper parts were opaque with the same blueish, milky colouration as observed above the weir (Figure 24).

Figure 23: The bed is smothered in excess fine sediment (silt).

Figure 24: A cloudy, blueish grey colouration is suggestive of household misconnections

A small weir (possibly the remnants of an older and larger structure) was observed at the boundary of Blaise Castle House Museum on the RB (Figure 25). The structure was almost entirely buried in fine sediment and further investigation may be required to ascertain its purpose (if any) and condition. The structure is not a barrier to fish passage but is nonetheless an interruption to sediment transport and impounds the river, contributing to the excessive silt deposition

Figure 25: a weir (or the remains of one) is submerged but still impacts on habitat quality

Patches of pondweed (*Potamogeton* sp.) were observed nearby emerging from thick silt (Figure 26). As the name suggests, this is a species that favours slack flow conditions. It's presence in a stream is indicative of abnormally (and consistently) sluggish flows.

Figure 26: Pond weed in a river is indicative of abnormally sluggish flows

A little further downstream the remnants of another weir were observed. The structure has been almost entirely demolished but the footings are still present in the bed (Figure 27). It also delineates a significant change in the character of the brook. Above, the brook is sluggish and silty but below it is shallow and free flowing with very little fine sediment.

Figure 27: The remnants of another weir interrupt natural sediment transport and impact on habitat diversity

This may in part be due to a natural change in gradient here and it is quite possible that the weir was originally built on top of a natural limestone outcrop. Nonetheless, the footings of the old structure create an interruption to natural sediment transport and will be contributing toward the sedimentation upstream.

From here downstream the brook is very straight, in part due to the steep gorge through which it flows but historic management is likely to have contributed (Figure 28). The straightness of the channel increases an already relatively steep gradient and is compounded by its uniformity in width, resulting in a net loss of smaller gravel substrate and natural depositional features. Introducing some naturalistic woody features into the channel here could significantly diversify in-stream habitat. However, habitat connectivity issues (such as barriers to fish passage) would need to improve for such efforts to yield significant ecological benefits.

Figure 28: The channel is straight and steep, lacking in habitat diversity through the upper gorge

Progressing downstream through the gorge, the brook flows alongside Stratford Mill (Figure 29). The mill was originally constructed many miles away on the River Chew in Somerset and was moved brick by brick when part of the valley was flooded to form Chew valley Reservoir. The mill is essentially a folly (like Blaise Castle itself) and was not ever a functional building at its current location. The presence of the mill hints at the magnitude of aesthetical landscaping the Estate underwent in the 18th, 19th (and possibly 20th) century.

Figure 29: Stratford Mill is an ornamental feature, hinting at the efforts that went into landscaping the river corridor

Downstream of the mill, the brook is afforded a little more space and the banks are populated with sedges and small saplings. Natural woody debris in the channel helps to diversify flow patterns and promote the formation of small gravel bars, and any urges to remove these and 'tidy up' the channel should be resisted (Figure 30). The steep scree slopes (Figure 31), particularly on the RB are a natural source of stones and gravel which help to drive a degree of natural geomorphology despite the interruptions to sediment transport upstream.

Figure 30: Woody material in the channel helps to diversify habitat

Figure 31: The natural scree slopes provide a regular supply of gravel into the river system

There are many opportunities to introduce some additional woody habitat features into the channel, helping to increase friction and further improve habitat diversity. For example, laying some of the bankside hazel stems down along the channel margins (in a fashion similar to hedge laying), could provide good habitat for marginal plants and aquatic invertebrates. Were habitat connectivity better, such features would also provide excellent cover for fish. Unfortunately, a series of barriers fragment the brook and act as complete barriers to fish passage. The first barrier downstream consists of a long concrete basin above a tall block stone weir (Figure 32).

Figure 32: A large weir, part of the historic landscaping work, fragments habitat for fish and invertebrates

An off-take above the weir diverts a portion of the flow into an ornamental pond via another small basin, believed to be an engineered sediment trap (Figure 33). 'Online' (i.e. connected to the stream) ponds quickly accumulate fine sediment. Flows slow as the stream encounters a sudden increase in width and depth, causing fine sediment to drop out of suspension. Even with the small sediment trap at the in-flow, the pond will continuously accumulate fine sediment and associated pollutants. Taking the pond offline would improve its water quality, reduce the amount of maintenance it requires (de-silting etc.), and would also give rise to opportunities to improve fish passage at the weir.

Figure 33: The small sediment trap is not enough to prevent sediment and pollutants accumulating in the pond.

The component of the brook which is not diverted through the pond is directed around it in a flow-depleted but otherwise natural channel which then becomes culverted under the path around the pond (Figure 34). This culvert is flat-bottomed and is a barrier to fish passage. Below the culvert, the outflow from the pond re-joins the brook and the valley floor broadens out, becoming densely wooded. Geomorphology improves as the gentler gradient is combined with a greater diversity of sediment sizes (including small-medium gravels) and occasional natural woody features (Figure 35).

The channel could be enhanced further by allowing (or promoting) a greater volume of woody material in-channel. Naturally fallen trees/branches should be retained where possible and opportunities sought to introduce additional woody features.

The Estate is obviously a popular amenity attracting many visitors throughout the year. People and dogs walking on the paths and riverbanks are causing extensive erosion which in some places is quite acute. The tall gorge and wooded valley floor mean that much of the riverbanks are heavily-shaded, limiting vegetation growth and contributing to the rate of erosion.

Figure 34: The culvert under the path around the pond is flat-bottomed and a barrier to fish passage

Figure 35: Some natural morphology resumes below the pond

A programme of woodland management to thin out some of the trees would allow for better understory growth as well as providing space for some saplings to grow to maturity. An additional benefit of such works would be increased reliance against footfall erosion and the associated diffuse input of excess fine sediment. The riverbanks are dominated by shade-tolerant sedges (*Carex* spp.) and improved light conditions may promote additional marginal wetland plant species, boosting biodiversity. Woody material arising from such works could also be

utilised in-channel to provide habitat diversity and possibly natural flood management (NFM) benefits.
A little further downstream is another weir associated with another ornamental pond. In this case the weir is less substantial and the offtake to the pond is actually blocked with silt (Figures 36 & 37).

Figure 36: Another weir, presumably constructed to divert flow into the adjacent pond

Figure 37: The offtake for the pond is silted up and the pond is offline, suggesting the weir could be removed.

The fact that the pond is holding water despite being cut-off from the stream suggests that it could be taken permanently off-line, allowing for the removal or

significant modification of the weir. This could also improve water quality and reduce the future maintenance requirements for the pond.
Immediately downstream of the weir, high on the RB, is an outfall showing signs of nutrient enrichment (Figure 38). This is likely a misconnected stormwater drainage outfall from residential streets at Combe Dingle. Investigating potential household misconnections along Belleview Avenue and Chardstock Avenue could eliminate a point source of pollution.

Figure 38: Sewage fungus stains the outfall, suggesting misconnected foul water

Downstream of the pond, the brook exhibits some good quality habitat with a high diversity of coarse sediments, natural woody features and overhanging bankside vegetation. However, some dog slides (sections of acute bank erosion caused by dogs scrambling in and out of the river) are bare of cover and function as point-sources of fine sediment (Figure 39).

Excluding dogs from streams in popular, publicly accessible places is extremely difficult and it may sometimes be more practical to formalise such sites to facilitate dog access whilst also protecting the riverbank from further erosion. Examples of such works are outlined in the *Recommendations* section.

Figure 39: Severe bank erosion where dogs access the stream

Near its confluence with the Trym, the Hazel Brook flows over another weir (Figure 40). This is most likely a redundant structure which once diverted flow through a leat to Combe Mill (long since demolished). The abutments of the weir are in a state of disrepair and threaten the structural integrity of the footbridge above. These will need repairing soon and presents an excellent opportunity to improve fish passage and sediment transport between the Hazel brook and Trym. The best ecological outcome would be the removal of the structure, replacing it with a clear span footbridge.

Figure 40: The weir at the confluence of the Hazel Brook and River Trym

Lower River Trym

Supplemented with flow from the Hazel brook, the Trym starts to exhibit a greater diversity of depths and potential habitat for adult trout or other flow-loving fish species. As it flows out from the narrow gorge into a broad floodplain of the lower Blaise Castle Estate, footfall is less concentrated and so path and bank erosion are less severe. One potential point-source of excess sediment is the ford at ST558775 (Figure 41). This could be mitigated by the instatement of a crushed limestone hard-standing on the slopes of the ford.

Figure 41: The ford across the Trym at the downstream end of the Blaise Castle Estate

Toward the Combe Dingle car park at the downstream extent of the estate, a section of the LB is reinforced by a tall, block-stone revetment. It was most-likely associated with some aspect of Combe Mill and is near the point where the tail race (no longer present) from the mill would have re-joined the Trym. This limits marginal cover habitat and so any instances of low-hanging branches or trailing vegetation (such as ivy, sedge or ferns) should be retained (Figure 42). Naturally fallen woody features should also be retained wherever possible. Although depth variation is greater than upstream, the river still lacks well-defined deep pool habitat. Large, woody features can deflect flow into the riverbed, scouring deep pools and cleaning the riverbed of fine sediment. It is worth noting that in urban catchments, such features can also intercept litter and become unsightly. However, such 'litter traps' can be useful hotspots for organised river litter picks.

Figure 42: Trailing vegetation and woody debris helps mitigate the impact of hard-engineered bank revetment

A dramatic illustration of the benefits of woody habitat features was evident adjacent to the Coombe Dingle car park (Figure 43). Here, undershot scour below an accumulation of woody material has mobilised a very large plume of gravel and larger items of substrate to create a substantial riffle: potential spawning habitat for gravel spawning fish such as trout, in close proximity to high quality cover habitat in the deep pool.

Figure 43: How pools and riffles form: the accumulation of wood on the left of this photo has created powerful undershot scour, forcing the river to dig down into the bed and throw up the large gravel riffle downstream.

In the ordinary course of events, this is exactly the kind of dynamic process which should be encouraged all the way up and down the Trym and Hazel Brook. In this case, however, the debris dam should probably be carefully dismantled to prevent the risk of large sections breaking free and blocking the small-arched road bridge just downstream. At the same time, items of builders' waste including bricks and pieces of concrete could be removed from the new riffle in order to optimise its natural appearance, enhancing its perceived value to visitors.

Proceeding downstream through the valley, the river becomes increasingly uniform in profile, flowing between incised clay banks. This uniformity is possibly due to historic dredging to protect the sewer line that runs parallel to the river. However, repeated scouring by urban-runoff peak flows and lack of flow-deflecting woody material will also play a role. The character of the riverbed changes significantly; from gravelly, to smothered in silt. This may be further evidence of dredging, suggesting that either gravel has been removed, or the gradient of the bed has become abruptly shallower. It should also be noted that as the Trym flows down from the scree-strewn karst gorges and onto the alluvial floodplain below, the supply of gravel from the riverbanks is reduced. In a natural river this wouldn't be a problem as gravels should be continuously transported down from the headwaters. However, when natural sediment transport is interrupted by weirs (repeatedly on both the Trym and Hazel Brook), the lower river will experience a net loss of gravel, resulting in bed incision and increased habitat uniformity. The result is a channel lacking the natural variation in width and depth required to support a healthily functioning river ecosystem.

Figure 44: The character of the river changes as it progresses downstream.

The floodplain between The Dingle and Dingle Road would benefit from a programme of woodland management to improve light conditions, promote a more diverse understory, and improve biodiversity. Specifically, this would allow more light onto some bare sections of bank, promoting the establishment of riverbank plants.

Very few fish were observed. However, a nice shoal of roach (*Rutilus rutilus*) and rudd (*Scardinius erythrophthalmus*) was found downstream of Dingle Road. A heavily-leaning sycamore was protruding into the flow, scouring a small pool surrounded by and roots and other woody material, creating a small oasis of diverse habitat features (Figure 45). At least one trout has apparently been seen in this area.

Figure 45: An area of complex structure, in an otherwise featureless stretch of channel, provides a pocket of habitat for fish.

Especially at times of low flow, complex natural structures like this, offering both depth of water and overhead shelter, are important refuges for fish of all species – and well worth attempting to replicate along the full length of the Trym and Hazel Brook.

As the river flows through the narrow woodland parallel to Combe Bridge Avenue, the riverbed becomes less silty and is instead strewn with larger stones (Figure 46). Some appear to be natural, but many are engineered blocks and bricks. There is a high volume of litter and other urban detritus, but also a few valuable woody features. This is a good reach for organised river clean-ups but care should be taken to ensure that valuable habitat features (such as fallen wood) is retained in-channel.

Figure 46: River clean-ups should focus on removing human-made materials, leaving woody features in the river.

As the Trym approaches Sea Mills and its confluence with the Avon, the channel becomes even straighter and more uniform, while the flow is increasingly sluggish: impounded by a weir immediately upstream of the A4 viaduct (Figures 47 & 48). The tidal sluices positioned on top of the weir do not appear to be in active use. Further investigation is required to ascertain their current status and what options may be feasible to improve fish passage at this site.

Figure 47: The lower reaches of the Trym are impounded by the weir at Sea Mills.

Interestingly, the 'two-stage channel' intermittently lined with poplars above the weir, may be the remnants of mud banks, similar to those in the channel of the

Avon, but now consolidated and cut off from the river's estuary by the presence of the weir.

Between Trym Cross Road and the A4, the Trym flows through an area of public green space. This section of the river is lacking in tree cover and is devoid of marginal habitat. There are several potential options to improve habitat diversity in this reach, including tree planting and the introduction of some shallow, marginal habitat. However, habitat quality will always be limited so long as the river is impounded by the tidal weir/gates.

The weir may over-top during particularly high tides, but it is still a significant fish passage issue at all other flows. It is also a barrier to downstream sediment transport, as described above, impounding the river and promoting uniform deposition of sediment across the river bed for a very significant distance upstream.

Figure 48: The weir and tidal sluice gates at Sea Mills

Recommendations:

In order for the River Trym and Hazel Brook to achieve their full potential for biodiversity and good quality habitat, capable of supporting healthy, self-sustaining populations of wild brown trout, the following actions are recommended:

1. *Urban runoff and natural flood management*

Despite their very pleasant sense of isolation in wooded gorges for much of their length, the Trym and Hazel Brook are heavily impacted by urban pressures – particularly runoff from surrounding urban development.

Misconnections and water quality: Improving water quality will likely be a slow (and sometimes painstaking) process. However, engaging with local sewerage providers to investigate misconnections (where kitchen and bathroom pipes have been mistakenly plumbed into surface water drainage) will generate immediate water quality improvements for the Trym. There are cost-effective public engagement and awareness tools, such as the 'yellow fish scheme' which is a simple way of labelling drains that connect to the river
https://www.gov.uk/government/publications/avoiding-pollution-yellow-fish-scheme
Other options to mitigate water quality problems include breaking out drainage pipes into reed beds, or even fitting specially-commissioned 'Downstream Defender' silt traps to intercept fine sediment from urban run-off (Figure 49).

'Slowing the flow' through Southmead: Re-meandering sections of scoured and straightened channel, breaking out other sections into low-lying wetland / flood plain areas, and improving natural flood management (NFM) by increasing in-channel roughness with woody material, should all be investigated.
The overall aim would be to increase the 'lag time' of water in this green space, increasing infiltration of rain into the limestone aquifer, and helping to smooth the flashy hydrograph of the river. Tree planting with species like goat willow *(Salix caprea)* will help to stabilise banks, and their root structures will add natural complexity to the channel, as well as introducing hydraulic roughness.
Other areas of the Southmead open space could also be used for initiatives like community orchards. Tree roots can greatly increase rain infiltration into compacted soils, and reduce overland flow after heavy rainfall. Local residents could also be encouraged to install their own rain gardens and water butts – a real benefit in times of low rainfall, as well as helpful for attenuating storm flows.

Figure 49: Downstream Defender hydrodynamic vortex chamber silt traps, originally designed for very high volumes of motorway runoff, being installed to intercept sediment in surface water drains in south London (Photo: South East Rivers Trust)

Sustainable Drainage Solutions (SuDS): engaging with local planning authorities to mandate permeable paving, rain gardens, swales and green roofs for all new developments will help to future-proof the catchment of the Trym from becoming even harder and 'flashier' in years to come (Figure 50). In the meantime, such interventions can often be retrofitted into urban areas when redevelopment takes place, or when local streetscapes are periodically upgraded.

Figure 50: Rain gardens in south London have helped to attenuate urban runoff into the nearby River Wandle. Retrofitting these structures in the urban parts of the catchment could help to reduce scouring flows in the river (Photo: One Planet Sutton).

2. *Woody habitat features and woodland management*

Many stretches of the River Trym and the Hazel Brook, including Southmead, Badock's Wood, Blaise Castle Estate and Coombe Dingle, would benefit from retention and further introduction of woody material in the channel. The naturally complex structure of fallen trees/limbs promote localised scour and deposition, driving the creation and development of natural habitat features such as pools and riffles. Such features also help to 'slow the flow' and attenuate flood risk at hard urban pinch points further downstream.

Introduced woody features provide the best habitat and function if they are kept in as natural a condition as possible. The goal should be to mimic the type of habitat that would be created when a tree naturally falls into the river. However, in urban catchments it is sometimes necessary to be a little more prescriptive. Securing small tree limbs or logs to the riverbed with wooden stakes (ideally sustainable, untreated sweet-chestnut) is a good way of ensuring such features do not increase flood risk. One of the most naturalistic ways of securing woody features is 'hinging'. This involves cutting partially through a tree or limb and laying into the river in a fashion similar to hedge laying. Bankside willows, hazel and younger alders are suitable for hinging (Figures 51 & 52).

Figure 51: Bankside hazels ‘hinged’ into the channel margins to provide habitat on a Bristol Avon tributary

Figure 52: Bankside willows hinged into a river in Dorset

3. Fish passage issues

Numerous weirs, sluices and other structures present serious fish passage issues along both the Trym and Hazel Brook, and it will be necessary to address these strategically to enable fish of many species to migrate between different areas of habitat and complete their life cycles successfully.

Due to their location just above the point where the Trym and Hazel Brook join to form the mainstem of the lower Trym, two of the most damaging obstructions are likely to be the weirs shown in Figures 21 and 40.

Full weir removal, with associated works to re-establish the natural gradient of the channel, usually produces the best ecological effects. However, should such options prove unfeasible, some combination of weir notching and the construction of 'rock ramps' will significantly ease fish passage.

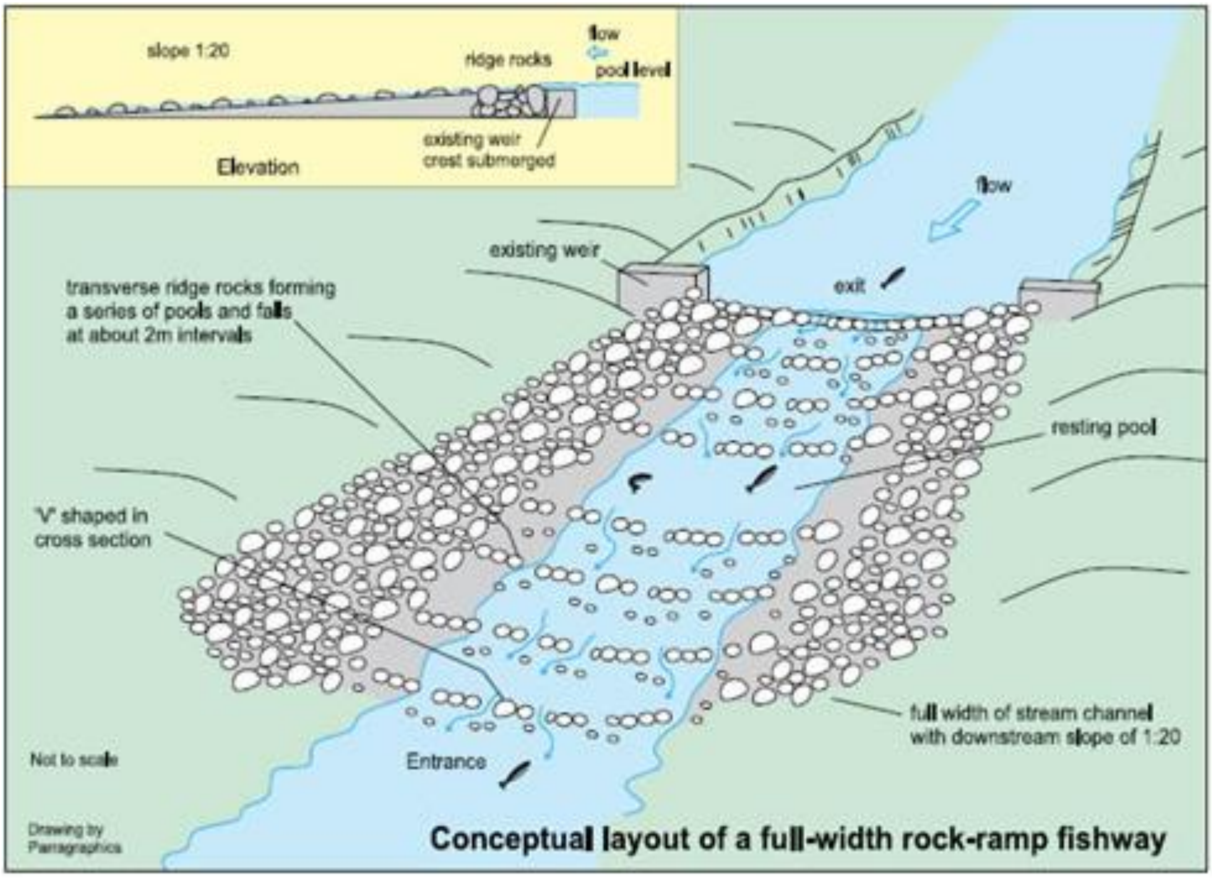

Figure 53: Structure of a rock ramp (Source: Thorncroft & Harris, via SERT: https://www.southeastriverstrust.org/of-rock-ramps-and-fish/)

If natural recolonization by wild trout is to be achieved, the tide weir near the mouth of the Trym will also need to be addressed. Once again, complete removal would undoubtedly produce the best results in terms of restoring fish passage, sediment transport and other natural processes, but some form of technical fish passage easement (such as a 'Larinier' fish pass) may be a useful interim solution. Taking the ponds on the Hazel Brook offline may simultaneously improve the ponds and allow facilitate improving fish passage at the associated weirs. Even the culvert under the path at the upstream pond (Figure 34) could be improved for fish passage by installing low-cost baffles to slightly raise the water level within. However, all such actions will require community support, landowner permission and a degree of funding.

4. Armoured channels

Radically simplified channels like those in the village of Westbury-on-Trym can provide interesting opportunities to restore straight, featureless flood defences to something approaching their original functioning ecology – not just creating connectivity between other areas of habitat, but actually providing good quality habitat in their own right.

In the case of Westbury-on-Trym, the combination of efforts to 'slow the flow' through Southmead and Badock's Wood, and the existing high-capacity flood defence structure under the village, means that it may be possible to add much more roughness to the simplified channels without increasing flood risk.
Suitable solutions could include reinstating a more sinuous flow path within the existing retaining walls by creating alternating berms to define a low-flow channel; see Figure 54.

Figure 54: Backfilled and planted rock berms create a meandering channel for the River Somer in its armoured channel through Midsomer Norton, Somerset.

Alternatively, cobbles and small boulders of local limestone could be secured in place with steel rods or threaded bar chem-fixed with water-safe resin into pre-drilled holes in the stone and bed (Figures 55 & 56). These could then be used to retain introduced gravel, creating an artificial but naturalistic riverbed with a significantly broader diversity of habitat.

Figure 55: Resin, Purbeck stone and rebar: raw materials for adding roughness to the Hogsmill River in south London: see https://www.southeastriverstrust.org/first-class-degree-in-fish-passage-at-kingston-uni/ for the full case study (Photo: SERT)

Figure 56: Introduced rocks and gravel create a range of habitats and flow dynamics in what was once a smooth concrete channel in the Hogsmill River (Photo: SERT)

5. Invasive non-native species

Because their natural ecological balance has already been disrupted by urban pressures, urban river catchments are especially vulnerable to invasion by INNS like Himalayan balsam and American signal crayfish.

In the case of the Himalayan balsam, which is believed to be present near the top of the Trym in Southmead, it would be beneficial to get the local community involved in eradication efforts as soon as possible. Pulling Himalayan balsam is a very satisfying form of community engagement, suitable for young and old alike, and is also very appealing to gardeners who might not normally have become engaged in river-related projects.

Himalayan balsam is easy to address by means of hand pulling before it has set seed, either piling up the plants in a shaded area to desiccate or arranging for it to be taken away by the local council for composting. It is important to ensure that pulled plants are broken between the root and first node of the stem, to prevent them from re-sprouting from this point. After the first work parties of the year in May or June, sites should be revisited on a monthly basis until the first frosts, to catch plants which will germinate later and flower without growing to the height of the early-season specimens.

Himalayan balsam seeds can float downstream, so it is advisable to clear this plant from a catchment from the top down: determine the highest point of infestation in the catchment (which may in practice be even further upstream than Southmead) and focus extra efforts here, with the relevant landowners' permission. Consistent pulling for 3-4 years in succession at any given site should be sufficient to exhaust the seed bank in the soil.

Also, be aware of the chance of seeds being spread by car tyres or the treads of people's shoes: Himalayan balsam plants may consequently appear or reappear where they are least expected. For this reason, careful biosecurity measures are recommended for river restoration personnel and volunteers when moving around the catchment: adopting and promoting the 'Check, Clean, Dry' protocol is highly recommended:

http://www.nonnativespecies.org/checkcleandry/

Much further downstream, near ST 56081 77585, half moon shaped holes were seen in a sandy bank: further investigation will be required, but it is possible that these were created by invasive American signal crayfish.

Invasive crayfish are one of the worst invaders of freshwater ecosystems worldwide: having been introduced to English fish farms in 1975, American signal crayfish are now driving our native white-clawed crayfish into extinction through disease (crayfish plague) and competition.

Signal crayfish also cause severe damage to the wider environment, reducing overall invertebrate biomass in infested waters by more than 40%. By undermining banks with tunnels up to 2m long, they increase erosion and dump silt into gravels, which inhibits successful spawning by native fish. Signal crayfish may also be responsible for the decline of many amphibians.

Trapping signal crayfish usually requires a licence, to help prevent inadvertent targeting of native white-clawed crayfish (and trapping has only proved to be effective in very specific circumstances). However, river restoration groups can still help to spread the word about biosecurity, both in theory and practice, since stringent biosecurity is still the only effective means of preventing the spread of American signal crayfish.

It should also be noted that, if an alien crayfish is caught, the law forbids releasing it or allowing it to escape. Crushing is usually the easiest and most humane means of dispatch.

For more information about controlling Himalayan balsam, American signal crayfish and other INNS, see 'The Pocket Guide to Balsam Bashing': http://www.merlinunwin.co.uk/bookdetailse.asp?bookId=152

Making It Happen

The creation of any structures within most 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. The headwaters of many rivers are not designated as 'Main River', in which case 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

Local NGOs such as Bristol Avon Rivers and Avon Wildlife Trust may be able to help with much of the actions outlined in the *Recommendations* section. They may also be able to provide additional advice and support. Connecting with these organisations may also make it easier to attract funding for river improvements going forward.

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.

A PV 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.

Disclaimer

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