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Advisory Visit
Upper Rea Catchment
Fish Re-establishment Overview

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Rivers	Rea, Bourn Brook, Griffins Brook/Bourn, Callow Brook, Stonehouse Brook, Wood Brook
Waterbody Names	Rea Source to Bourn Brook, Rea from Bourn Brook to River Tame, Bourn Brook source to River Rea, Griffins Brook source to River Rea
Waterbody ID	**GB104028042510** **GB104028042550** **GB104028042540** **GB104028042520**
Management Catchment	Tame Anker & Mease
River Basin District	Humber
Current Ecological Status	Poor
U/S Grid Ref inspected	SO9835578360 SO9927383091 SP0073379554 SP0110881760 SO9839877550 SP0303681981
D/S Grid Ref inspected	SP0640683661 SP0573381599 SP0630583523 SP0250682857 SP0110481762 SP0368681243
Length of river inspected	20 km

1 Summary

- *Historic pollution has eliminated the majority of fish species (beyond stickleback) from the upper Rea catchment*
- *Restoring connectivity to the next-nearest population of wild trout will not be feasible within the foreseeable future owing to currently intractable man-made barriers*
- *If suitable conditions can be found or created, it may be appropriate to attempt to reintroduce self-sustaining fish populations (including salmonid species such as brown trout) through translocation from thriving populations elsewhere*
- *Relative to many urban river systems, the potential for poor water quality to eliminate recovering fish populations is significantly elevated in the upper Rea catchment*
- *A lack of headwater refugia with reliably clean water, coupled with no viable routes for recolonisation from downstream, makes it essential to maintain water quality within any reaches targeted for reintroductions*
- *With core habitat requirements being met in several areas of the upper catchment, there is a potential to establish sufficient water quality and connectivity to once again sustain wild fish populations*
- *A cost-effective strategy is proposed whereby invertebrate sampling can be used to judge likely* ***suitability*** *and* ***stability*** *of water quality across candidate sites*
- *This should be combined with qualitative scoring across parameters that include in-channel and riparian habitat structural diversity, connected reach length, low-flow resilience, custodianship and potential to contribute to downstream fish populations*
- *The shortlist of sites will include each site judged to meet minimum criteria across biological parameters*
- *The highest priority sites will be selected from those qualifying sites according to the highest total scores across all categories*
- *At that point, it may be deemed appropriate to attempt a phased reintroduction of fish from the most (nearest?) local wild population(s) living in the most similar conditions to the candidate recipient sites, where they have been judged to be harvestable stocks*
- *It is suggested that juvenile fish, spanning up to three year classes from donor population(s) may give the optimum combination of retaining donor population health while maximising chances of successful ark site establishment*
- *Supportive breeding methods or use of any wild brood stock approaches are not recommended in this instance*

2 Introduction

The Wild Trout Trust (WTT) was invited by the Environment Agency to assess habitat quality, over five days of visits, across a network of watercourses that make up the River Rea catchment in Birmingham. Wild fish populations are severely depleted in the visited reaches. Outputs from this visit-programme should inform feasibility appraisals and priority approaches to re-establishing self-sustaining fish populations. Throughout the report, banks are designated as right (RB) and left (LB) while facing downstream. Large Woody Material is abbreviated to a standard convention (LWM). The summary table at the start of this report contains National Grid Reference formats for mapping locations in order to maintain compatibility with Environment Agency records.

3 Habitat Assessment and Appraisal of Key Issues

The surveyed reaches were walked over a period of five days. Observations and photographs of salient features were noted and photographed individually. Those records will be presented as a separate series of reach-specific report documents upon completion. Conversely, this report aggregates observations across all visited reaches into an overall appraisal of key issues. This allows strategic recommendations to be made for the Upper Rea catchment as a whole. Separating reports in this manner will also limit the amount of repetition needed when addressing the specific examples photographed.

3.1 Issues and Implications Overview

A walkover survey of the upper and middle River Rea catchment lying to the southwest of Birmingham city centre was carried out to assess the potential for re-establishing self-sustaining fish populations, including trout, lost to historical pollution incidents. The investigation encompassed three sections of the River Rea itself along with Bourn Brook, Wood Brook, Griffins Brook (also known as The Bourn), Stonehouse Brook and Callow Brook. The driver for this overall investigation stems from a fundamental limitation of natural recolonisation. Recovery of self-sustaining fish populations is critically constrained by a series of impassable barriers to migration that exist downstream of the Rea (several of which remain unidentified and are located underground). These barriers cut off the habitat of the upper Rea catchment from the nearest wild populations of trout, found in the River Cole. For further context, the foot of the River Rea lies 8km below the downstream limit of the reaches surveyed for this report. It enters the River Tame approximately 12km upstream of the confluence of the Blythe and the Tame. Tracing the Blythe upstream to its confluence with the Cole adds another 0.7km to the total separation.

The cost and technical difficulty of removing those barriers imply huge financial commitments and a very long timescale before connectivity could be achieved. Consequently, to determine how best to mitigate the ongoing presence of those barriers, it is necessary to assess the potential for the upper Rea catchment to support self-sustaining fish populations in the absence of recolonisation from downstream sources.

Understanding the current status of the habitat, as well as identifying key actions that may be required to create a sufficiently diverse and connected network of habitat corridors, are essential to judge the viability of any reintroduced fish populations. In keeping with the Wild Trout Trust's typical assessment approach, the watercourses were visually appraised for structural habitat diversity, riparian zone conditions, connectivity and available evidence of water quality. Photographic records with explanatory notes are supplied as separate reports for each individual watercourse. This report therefore presents the overall findings regarding the potential to restore fish populations to the upper River Rea catchment, along with recommended actions to that end.

In all the investigated watercourses, examples of good habitat for a variety of fish species were noted. With specific reference to brown trout, all investigated watercourses apart from the Wood Brook appeared to possess the range of habitat characteristics required to support the full lifecycle at key stages including spawning (which requires loose gravel 10-40mm in diameter), juvenile survival (necessitating shallow areas with dense and complex cover from predators and high flows), and adult habitat (pools greater than 30cm deep with robust and complex cover from predators in the form of vegetation, large rocks and fallen woody material). The two downstream sections of the River Rea (e.g. Figs.1-3) and reaches of the Bourn Brook upstream of heavy channel modifications (e.g. Figs. 4 & 5) seemed to have the best variety and most extensive quantity of habitat suitable to support full trout lifecycles.

Figure 1: River Rea at SP0623183269 upstream of recent weir-removal, with structurally-diverse riparian vegetation, good floodplain connectivity and exposed coarse sediment demonstrating the presence of potential salmonid spawning substrate

Figure 2: River Rea at SP0596481890 – overhanging LWM providing valuable aerial cover in combination with diverse flow depth and velocities over the cross-section

Figure 3: River Rea at SP0575381568, where high quality large woody material and variety in depth was present, but excess fine sediment was observed

Figure 4: Bourn Brook at SP0320983145 with active geomorphology and varied riparian vegetation combining to create structurally-diverse habitats

Figure 5: Bourn Brook at SP0090683386, where natural gravel accumulation was helping to focus flow alongside diverse root structure – a great lie for adult trout

Notably high structural quality of trout habitat was also present in sections of the Griffins Brook/Bourn as well as parts of the Callow Brook. The detailed findings and photographic records of each of the surveyed watercourses are supplied as separate, individual reports. The purpose of this synthesis is to convey overall findings that encompass all of the separate reaches visited and to suggest a potential strategy to make best use of the existing conditions.

The core finding across all surveyed watercourses is that there is visual evidence of nutrient enrichment. Filamentous green algae growth (e.g. Figs. 6 & 7) was frequently noted at elevated levels in all of the visited watercourses, indicating excess nutrients (typically nitrogen and phosphorus compounds) in the water column.

Figure 6: Filamentous algae growing on the bed of the Rea in relatively shaded, early spring conditions at SP0219078738

Figure 7: Indications of nutrient enrichment at SP0235178761

When present in moderate amounts, algae forms part of the natural food web, but excessive growth can be problematic. Dense algal mats can reduce dissolved oxygen levels during night-time respiration and particularly during die-off and decomposition. It was also quite common to see evidence of misconnected domestic drainage and discharges resulting in sewage fungus around outfalls (e.g. Figs. 8 & 9).

Figure 8: White areas of streambed are sewage fungus colonies at SP0060577644

Figure 9: Probable misconnected drainage outfall at SP0391481278

Sewage "fungus" (e.g., but not limited to, *Sphaerotilus natans*) is a bacterial growth that appears as white or grey filamentous material and develops in response to elevated organic matter and nutrients, indicating intermittent or continuous high nutrient inputs, often from sewage.

However, turning stones within the watercourses generally revealed *Baetis* spp. nymphs (mayfly larvae; e.g. Fig.10) as well as *Gammarus* sp. (freshwater shrimp), *Hydropsyche* sp. (caseless caddis; e.g. Fig.11), *Ancylus* sp. (freshwater limpets; e.g. Fig.12) and *Simulium* sp. pupa (blackfly; eg. Fig.13) in many of those watercourses. These invertebrates have intermediate sensitivity to organic pollution and represent an important finding. It is certainly possible to find salmonid fish populations

Figure 10: *Baetis* nymphs found in the Bourn Brook

Figure 11: *Hydropsyche* larva found in the Bourn Brook

Figure 12*: Ancylus* sp. freshwater limpet (circled) found in Bourn Brook

Figure 13: *Simulium* pupae (circled) found in Bourn Brook

in watercourses that do not have much in the way of more sensitive indicator species such as stoneflies or certain caddisfly families. The presence of these moderately tolerant taxa suggests that water quality, while clearly compromised, may not be at levels that would absolutely preclude salmonid fish populations. However, the prevalence of invertebrates such as *Asellus aquaticus* (water hoglouse, notably more tolerant to low dissolved oxygen) in several locations indicates that a careful appraisal of water quality is essential before any significant reintroduction efforts. This is a key finding of the overall appraisal. It is essential to understand episodic and chronic water quality issues when considering whether to proceed with reintroductions. It is equally salient when deciding on factors used to prioritise potential sites.

Most importantly, there was never a point during any survey where it was possible to find an upstream limit of apparent enrichment. This represents a significant concern and differs markedly from the situation in many post-industrial rivers that have their sources, for instance, in the Pennine chain. In that part of the UK, upper reaches of even heavily industrialised rivers often provide refugia from poor water quality that characterises lower sections. In those systems, clean headwater reaches can serve as source populations that gradually recolonise downstream as water quality improves. The absence of any apparent upstream refugia from poor water quality in the upper Rea catchment suggests that the entire system might be affected to some degree. It is, therefore, imperative to undertake a pragmatic level of water quality testing within each of the surveyed watercourses to establish where conditions may be adequate (or could be made adequate through targeted interventions) to support fish populations.

3.2 Defining Core Decision-making Criteria

Relative to the overwhelming majority of Wild Trout Trust surveys, water quality is disproportionately influential in assessing viability for population re-establishment in the absence of natural immigration to the Rea. In systems where natural recolonisation can occur from nearby source populations, temporary or localised water quality issues may be less critical because immigration can compensate for periodic mortality events. In an isolated system such as the upper Rea catchment, there is no such safety net. Any reintroduced population would need to persist through all seasonal variations and occasional pollution incidents without external recruitment. This places much greater emphasis on ensuring that baseline water quality conditions are adequate throughout the year and that the risk of catastrophic pollution events is minimised.

Probably the most cost-effective way to gain an overall impression of water quality, mapped onto geographic distribution, is via macroinvertebrate sampling. Benthic (bottom-dwelling) invertebrates experience exposure to all chemicals found in the water over the period they are present at a site. They also have much higher fidelity to a specific site compared to fish, which may move substantial distances and therefore provide less spatially-precise information about local conditions. Unlike chemical analysis, it is not necessary to know the specific pollutant to test for in advance. Different invertebrate species have different tolerances and sensitivities to a wide range of pollutants including heavy metals, pesticides, organic matter, ammonia and other compounds. Surveying invertebrate communities also removes the need to know exactly when to take a water sample in order to catch a pollution event in action. Chemical samples provide a snapshot of conditions at the precise moment of sampling but may miss intermittent discharges or diurnal variations in parameters such as dissolved oxygen. Aquatic invertebrates are present continuously and their community composition reflects the integration of conditions over weeks or months depending on the life cycles of the species present. That combination of integrating exposure over time and also reacting in characteristic ways to different contaminants makes them a very useful indicator of water quality.

By gaining that understanding of where pollution levels are likely to remain acceptably low over the timescales to support a range of aquatic invertebrates (which can range from a few weeks for some taxa to over a year for others), it is possible to identify lower pollution risk areas. This should be the first step in an assessment of feasibility for self-sustaining salmonid fish population establishment. This may highlight that tackling poor water quality in key areas needs to be undertaken either before or in conjunction with improvements to connectivity and physical habitat. With that said, efforts to identify areas of existing sufficient water quality or priority areas for pollution reduction should favour stream reaches with the best potential habitat. For the specific purpose of this initiative, there lower value in investing resources to improve water quality in reaches that lack the physical habitat characteristics necessary to support fish populations, just as there is limited benefit to improving physical habitat in areas where water quality would prevent fish from thriving.

To this end, the most important areas to investigate water quality will be the lower two sections of the Rea, the middle and upper sections of the Bourn Brook (upstream of heavily-engineered channel sections) followed by meandering sections of the Bourn/Griffins Brook and Callow Brook. In these latter two watercourses, efforts to investigate water quality should be targeted around the areas of greatest geomorphological process and most structurally-diverse riparian vegetation. The caveat with all watercourses is sufficient longitudinal connectivity should exist to allow access to the full range of key habitat features. Areas where the channel is actively shaping itself through erosion and deposition tend to create the variety in habitat structural elements that support diverse fish populations. On the Rea in particular, it is a good opportunity to take advantage of recent improvements to connectivity and geomorphological process brought about by a programme of weir removals carried out by the Environment Agency. These removals have enhanced longitudinal connectivity within sections of the Rea and are also likely to have improved sediment transport and habitat diversity, making these reaches particularly valuable as potential core areas for population reinstatement.

Once priority habitat areas have been appraised for water quality via invertebrate sampling (with identification at least to family level, and where readily apparent, greater taxonomic detail such as genus or species), the sites should be ranked in terms of suitability for supporting self-sustaining trout populations. The aim of this ranking would be to produce a strategic distribution of potential ark sites. The concept of ark sites refers to locations that could sustain isolated populations that, in turn, might serve as sources for colonisation of adjacent reaches as connectivity improves or conditions ameliorate elsewhere in the catchment. One pragmatic way of creating such a ranking would be to plot radar charts for individual reaches with qualitative scores between 0 and 10 assigned to a range of relevant categories based on observations and measured parameters (e.g. Fig.14).

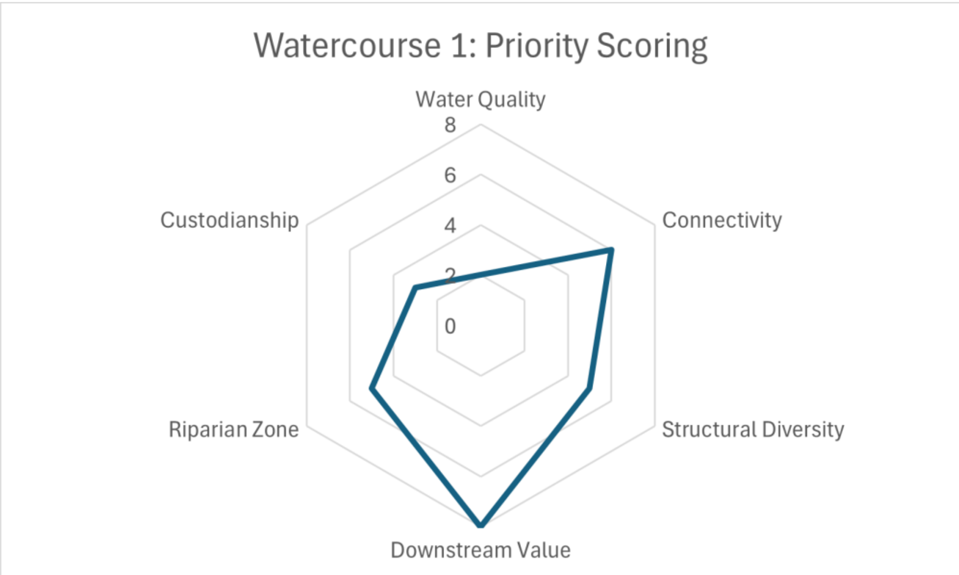

Figure 14: Example radar plot with random scores illustrated across a simple, "demonstration set" of categories.

Suggested categories for this scoring system include estimated water quality (based on invertebrate sampling, outfall surveys and any available chemical data), length of fully connected reach (the extent of stream that fish could access without encountering barriers), extent and connectivity to downstream habitat suitable for salmonid fish (relating to the viability of downstream connectivity to potential recipient sites that would benefit from downstream displacement of salmonids over barriers), habitat structural diversity (the variety of depths, velocities, substrates and cover types present), riparian vegetation and habitat quality (the condition and diversity of bankside vegetation and its contribution to in-stream habitat), summer low flow discharge, summer low flow temperatures and potential for local stakeholder custodianship (the presence of engaged friends-of groups, angling clubs, local community members or other parties who could provide ongoing stewardship). This last criterion is often overlooked but can be critical to long-term success. Sites with strong local engagement are more likely to benefit from ongoing monitoring, prompt reporting of pollution incidents, and sustained habitat management efforts. Further categories may also be appropriate to include, based on local insights and the potential to assess each criterion.

For ecological parameters, qualitative scores below 5 should be allocated where improvements would be necessary in order for long-term population viability to be reasonably expected. This threshold recognises that marginal conditions are unlikely to support thriving populations over multiple generations, particularly in the absence of immigration to compensate for periodic recruitment failures. At such a time that at least three sites meet all minimum ecological criteria requirements, the sites with the greatest combined totals when all criteria scores are summed would be put forward as potential ark sites. The requirement for multiple sites provides resilience against localised catastrophic events and increases the overall probability that at least some populations will persist through challenging periods.

Comparing the number of sites receiving the highest scores with available resources to protect and further enhance minimum ecological requirements would then allow a **prioritised, phased approach** to potential reintroductions. Resource limitations are a reality in most conservation projects, and a phased approach allows learning from early efforts to inform subsequent work.

No such reintroductions should be attempted if any of the core ecological criteria are unlikely to remain above minimum required levels over multiple years. Introducing fish into marginal habitat represents poor use of limited resources and risks creating a perception that restoration efforts are ineffective when, in fact, the underlying conditions were inadequate from the outset.

3.3 Rationale for Recommended Actions

In the event that no foreseeable connections to downstream wild populations in the River Cole could be achieved in the short-medium term, it may be justifiable to consider an assisted reintroduction programme for the highest-scoring sites that reach the required standards. However, if such a programme were to be considered, careful attention must be paid to the source and provenance of fish to maximise chances of establishing viable, self-sustaining populations while minimising risks to donor populations. The following guiding principles should be adopted in order to avoid common pitfalls that have undermined many well-intentioned reintroduction efforts.

Line-bred hatchery stock should be avoided due to lack of relevant and sufficient genetic diversity. Hatchery populations, even those originally derived from wild stock, undergo selection pressures that are fundamentally different from those in natural environments. Over multiple generations of captive breeding, traits that enhance survival in hatchery conditions (such as tolerance of high densities, aggressive feeding on artificial diets, and reduced predator avoidance) become more common while traits important for survival in the wild may be lost. Additionally, effective population sizes in hatcheries are often small, leading to inbreeding and loss of genetic diversity that can manifest as reduced disease resistance, poor growth rates, and reproductive failures.

Assisted breeding from wild broodstock should also be avoided due to the removal of in-stream mate choice and associated fitness benefits, as well as the loss of wild foraging and predator avoidance behaviours that are learned within wild cohorts. In natural spawning, female fish exhibit mate choice based on multiple cues including size, condition, breeding colouration, olfactory cues and behaviour. These choices are not random but reflect assessment of male quality and genetic compatibility. When eggs and milt are stripped from wild fish and combined artificially in a hatchery, these mate choice mechanisms are bypassed. The resulting offspring may carry combinations of genes that would not have occurred through natural mating. The artificial process may also cross fish destined for very different spawning locations/habitat. Furthermore, juvenile fish reared in hatcheries do not learn the complex suite of behaviours required for survival in the wild, including efficient foraging techniques, recognition of predators, and appropriate use of cover and flow refuges.

Expected higher percentage chances of success would be associated with translocation of juvenile fish from the nearest wild populations in structurally and chemically similar streams. This approach addresses many of the concerns associated with hatchery-origin fish while working within the constraints of available resources and the need to minimise impacts on donor populations. Using juvenile fish that result from natural, assortative mating in ecologically-relevant habitats conveys multiple benefits. First of all, juvenile fish naturally experience a very highpercentage mortality in their first year of life, often exceeding 95 or 98 percent depending on conditions. Translocating a portion of a donor stream's juvenile output is less likely to damage that source population than taking individuals that have survived to breeding age and are making active contributions to the reproductive output of their natal stream.

Additionally, the immunocompetence of offspring produced via natural, assortative mating has been shown to be greater than that achieved via random combinations in hatchery settings. Mate choice in fish is partly mediated by assessment of genetic compatibility, including major histocompatibility complex (MHC) via olfactory cues. Offspring from naturally-paired parents tend to have more effective immune responses to pathogens they are likely to encounter. Taking fish from suitably-similar donor streams is also likely to confer appropriate situation-specific, heritable adaptations that should improve the viability of self-sustaining populations in the recipient sites. Fish populations become locally adapted to the specific conditions of their home streams over many generations. While trout from any source might initially survive in the Rea catchment, those from streams with similar temperature regimes, flow patterns, and water chemistry are more likely to thrive and reproduce successfully long-term.

By contrast, to avoid known in-breeding risks for supportive breeding programmes using wild broodstock requires a large number of breeding-age fish from the donor population. Further allowing for the high mortality rates of wild fish in hatchery conditions (due to stress, injury during handling, and disease exposure in confined spaces), this places an unsustainable burden on the wild populations close to the Rea catchment. Mortality in captivity and the necessary random combination of eggs and milt inevitably create offspring with genotypes that diverge from locally-adapted wild individuals. At the same time, the in-stream contributions that those broodstock fish would have made to their native streams has been lost. Each adult removed represents lost spawning potential and the possible loss of particular genetic lineages that may be important for population resilience.

In the instance that collection of juvenile fish from several year classes are deemed to not pose a risk to donor populations, then this may be a justifiable part of an ethical reintroduction strategy. Taking fish from multiple year classes helps to capture genetic diversity associated with different parental cohorts and environmental conditions during spawning and early rearing. It also reduces the risk that a single translocation event might coincidentally sample an unusual or unrepresentative subset of the genetic variation present in the donor population.

In synthesising the findings from across the surveyed catchment, several overarching themes emerge that should guide strategic planning for potential fish population restoration. The upper Rea catchment possessessubstantial areas of suitable physical habitat that could support various life stages of brown trout and other fish species. This is an encouraging baseline finding and suggests that, with targeted interventions to address water quality concerns, the system has genuine potential to support self-sustaining populations. However, the pervasive evidence of nutrient enrichment and organic pollution throughout the catchment represents a fundamental constraint that must be addressed before reintroduction efforts are likely to succeed.

The absence of any apparent refugia from water quality degradation means that a catchment-wide approach to pollution source identification and mitigation will be necessary. Priority should be given to identifying and rectifying misconnected drainage that is allowing sewage to enter the watercourses, as this should be a practically-addressable source of organic pollution and nutrient enrichment. Working with water companies, local authorities and householders to identify and correct these misconnections could yield significant water quality improvements relatively quickly and at moderate cost compared to the re-establishment of connectivity to the River Cole, which will remain the longer term goal.

The systematic approach proposed, involving invertebrate sampling to identify reaches with the best existing water quality, coupled with multi-criteria scoring to rank potential ark sites, provides a rational framework for prioritising limited resources. Focusing initial efforts on reaches that combine good physical habitat with acceptable water quality and strong potential for local stewardship gives the highest probability of establishing successful populations. As these initial populations become established and demonstrate viability, lessons learned can inform expansion to additional sites and potentially provide a source of locally-adapted fish for translocation to newly-improved reaches.

The phased approach also allows for adaptive management, wherein monitoring of initial reintroduction sites can reveal unforeseen challenges or opportunities that can inform subsequent work. This is particularly important given the uncertainties inherent in working within an urban catchment where multiple, diffuse and point-sources of pollution and habitat degradation may interact in complex ways. The emphasis on juvenile translocation from wild donor populations in similar systems is a strategic approach that balances conservation ethics with practical constraints. It avoids the well-documented problems associated with hatchery fish while limiting impacts on donor populations and increasing the likelihood that translocated fish will be adapted to conditions similar to those they will encounter in the Rea catchment.

Ultimately, the feasibility of restoring self-sustaining fish populations to the upper Rea catchment will depend on sustained commitment to both water quality improvement and habitat protection over a timeframe of years to decades. The physical habitat framework is largely present and recent improvements in connectivity through weir removal provide a strong foundation. However, without parallel progress on water quality, particularly through identification and remediation of point sources of pollution such as misconnected drains and illicit discharges, the prospects for long-term population viability remain uncertain. The strategic framework outlined here provides a pathway forward that acknowledges both the potential and the constraints inherent in this urban catchment system.

4 Recommendations

A concise list of recommended actions includes:

- Shortlist priority sites to **test for water quality** based on:
    - In-channel and riparian habitat structural diversity
    - Longitudinal connectivity between habitat suitable for spawning, juvenile and adult trout

    - Estimated summer low-flow resilience
- Suggested initial reaches to investigate include (but are not limited to):
    - Rea downstream of Wychall Reservoir
    - Bourn Brook between Water Mill Primary School and new trash screen at junction of Northfield Road and Wentworth Way
    - Bourn Brook between new trash screen and confluence with small tributary at SO9953383488
    - Griffins Brook between SP0343481130 and weir at SP0311680962
- According to available resources, assess macroinvertebrate taxonomic diversity and relative sensitivity to organic pollution in priority sites
    - In most cases identification to family level will still yield useful information
    - Any available resources that lead to greater levels of taxonomic resolution will add to the interpretive power of associated traits
    - It is recommended to identify macroinvertebrate samples to the best, practical taxonomic resolution but to balance this with the coverage/number of surveys required to gain sufficient insights into each candidate reach
- Determine whether any investigated sites already meet minimum criteria for habitat (in-channel and riparian), water quality and connectivity. Subsequently:
    - Add any qualifying sites to final list of candidate ark population sites
    - Identify water quality and connectivity failure points for remaining sites and cost required remediation
    - Remediate failing sites in sequence according to strategic spread of risk and benefit to downstream reaches
- Identify appropriate wild trout donor population(s) from which to source juveniles (encompassing up to three year-classes), based on:
    - Proximity to recipient ark site
    - Similarity in geology, water chemistry/quality, spawning substrate and channel size
- With three suitable recipient ark sites identified, undertake phased reintroductions that avoid depleting donor population(s)
    - Carry out juvenile translocations into each ark site over a minimum of three years
    - Initiate translocations at a single site to allow troubleshooting over first two years

    - With suitable adaptations made, perform translocations in parallel to as many separate, qualifying ark sites as can be sustained by donor population(s)
- In the absence of more formal guidance, initial (precautionary) principles for sourcing juveniles from suitable wild population(s) are suggested to include:
    - Find a minimum of 50 suitable individuals per translocation effort as long as the following criteria are met
        - The total number of individuals per translocation should not exceed 25% of the source-population fish caught during sampling
        - More than one year class are represented within translocated individuals
    - In the event that an abundant source population is identified, numbers of individuals can be raised as long as they stay within the limit of not exceeding 25% of individuals captured
    - The above parameters should be subject to adjustment and further iteration based on practical experience during early translocation efforts

5 Acknowledgements

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

6 Disclaimer

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

Legal permissions must be sought before commencing work on site. These are not limited to landowner permissions but will also involve regulatory authorities such as the local council as well as relevant departments within the Environment Agency – and any other relevant bodies or stakeholders. Alongside permissions, risk assessment and adhering to health and safety legislation and guidance is also an essential component of any interventions or activities in and around rivers.