Catchment Restoration Fund (CRF):

Diffusing the Issue in Rural Ribble

Outcomes and achievements






REDRESSING REASONS FOR WFD FAILURE

Department for Environment Food & Rural Affairs

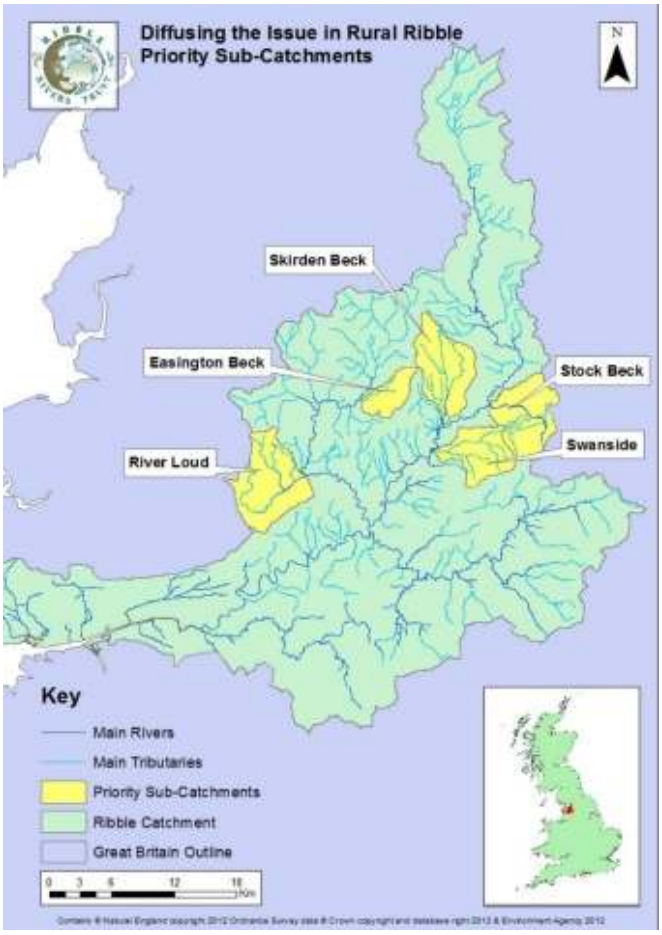
Ribble Rivers Trust

Environment Agency

Contents

Project Summary

The Diffusing the Issue project targeted five sub-catchments located throughout the centre of the Ribble catchment. All are rural and intensively farmed. Livestock grazing has posed an organic nutrient and sediment burden upon these water courses, many of which have become disconnected by the creation of crossing points and redundant weirs. This project set out to redress these issues that were causing the watercourses to fail to meet the standards required by the Water Framework Directive (WFD). This project has placed great emphasis upon working with farmers and landowners over how to maximise productivity from their land and have a conservation benefit - an ethos that has been championed to a high degree of success. A focus was placed upon bringing local farming communities together to adopt a broader outlook towards their practice. This was delivered through well attended farm events and individual farm assessments culminating in quick action on the ground. By delivering tangible results soon after consultation, the cumulative appeal of participation grew amongst these communities. Diffusing the Issue now leaves a legacy of improved riparian habitat and fish passage by having capitalised on an innate desire in the rural community to undertake land practice in an environmentally sympathetic manner. The project has led to calls for more work to be undertaken from adjacent rural areas in future.



Map of the 'Diffusing the Issue' areas of the Ribble Catchment.

Acknowledgements

We would like to thank the volunteers whose passion and enthusiasm made the delivery of the CRF projects such a success, as well as the funders who have made CRF a reality. We would also express our appreciation to our project partners who have helped to deliver the various components of the CRF project in Diffusing the Issue.

CRF project partners include: -

- Durham University
- DEFRA
- Environment Agency
- Forestry Commission
- Riverfly Partnership
- United Utilities
- Woodland Trust

1.0 Project Background

The Ribble Rivers Trust (RRT) is an environmental charity first initiated by a group of concerned angler volunteers who delivered practical river improvement projects from 1997. Traditionally, its involvement focussed upon the improvement of rural watercourses to the benefit of local fish populations and working with local farmers and landowners. Since its inception, the organisation has subsumed more professional expertise through the development of strong academic links.

The Diffusing the Issue project provided a continuation to the works delivered by RRT under the previous WFD "River Improvement Fund" (RIF) and the local Environment Agency project funding that had begun to address the poor habitat in the catchment. The failure of water courses to meet the necessary standards under the Water Framework Directive (WFD) provided a statutory driver for change. By coupling these factors, an opportunity was created to extend the RRT's practical delivery. Recognising that much work was still to be done to redress the area's WFD status, RRT has advanced its coverage and effectiveness in delivery.

1.1 Catchment Restoration Fund

The aim of the Catchment Restoration Fund project was to address "reasons for failure" or prevent deterioration in WFD water bodies to achieve GES. The Environment Agency awarded funds from DEFRA to the Ribble Rivers Trust to deliver three projects over the course of 2012 to 2015 to tackle key water resource issues across the Ribble catchment. The associated projects were entitled, 'The Colne Water Catchment Restoration Project', 'Diffusing the Issue' and 'Limestone Ribble'. The projects were holistic and based on working with nature and local interests to address all issues, from habitat fragmentation, diffuse and point pollution to poor habitat in contribution to failing to meet WFD standards. Of the awarded funds, £459,700 were spent in delivering the Diffusing the Issue project.

Diffusing the Issue in Rural Ribble

"This project has placed great emphasis upon working with farmers and landowners over how to maximise productivity from their land and have a conservation benefit - an ethos that has been championed to a high degree of success".

1.2 Brief history of the Diffusing the Issue areas

Representing the rural heartlands of the catchment, the area covered by this project has a long held tradition of farming that remains at its core today. Five water courses draining a largely grassland landscape are grazed by dairy, beef and sheep, presenting the types of challenges that the RRT built its foundations upon through working closely with landowners and farmers. The drive for greater yields through intensive land practice has led not only to local water courses failing to meet the desired quality standards set out by the WFD but a reduction in soil quality and productivity. Land has been extensively drained to make it available for agriculture to culminate in the increased loss of sediment and conveyance of organic nutrients.

Silage making at Sawley, mid-Ribble in the 1950s.

Modern day slurry spreading

Previous ecological monitoring informs the potential for improvement that remains within these sub-catchment areas. Many of the country's rarest aquatic species persist here, albeit within isolated pockets that are threatened by poor land practice and climate change. The pockets provide critical spawning and rearing habitat for salmon and sea trout and on two of the systems, white-clawed crayfish. Their status remains in the balance and with further deterioration stand to be permanently lost.

The five sub-catchments that comprise the Diffusing the Issue area encompass the River Loud, Easington, Skirden and Swanside brooks plus Stock Beck. The River Loud and Easington Brook flow into the River Hodder whilst the remaining three reach the River Ribble above Clitheroe. The **River Loud** is the largest and most threatened system of them and was highly accessible to livestock. Prior to the last ice age, the Loud flowed out to the Fylde coast directly. The last ice age carved a new river channel away from the coast, draining the Loud into the Hodder. The River Loud was later diverted following the recession of the glaciers towards its current course. Flowing off Parlick Hill within the Forest of Bowland Area of Outstanding Natural Beauty, the river traces Longridge Fell west and into the River Hodder through good quality pasture grassland. Chipping and Leagram brooks form its major tributaries coming off the Wolf and Burnslack Fells from 500m above sea level. The former runs through the old village of Chipping, which founded as a meeting point for local farmers and derived its name from the old English word "Cepping" by the same meaning (http://www.chippinghistory.co.uk/page2.html). Seven mills were built during in the mid-nineteenth century that saw the village develop, augmenting the brook. Whilst most of the mills do not remain, the impacts upon Chipping brook prevent fish from ascending it.

Easington Brook is situated further east into the catchment flowing off Easington and Harrop fells via a series of four farms down to the Hodder above the picturesque village of Newton-in-Bowland. Comparatively, the brook does not receive the same sediment inputs as the Loud but was openly accessible to mainly sheep grazing pressure. The brook is recognised locally [anecdote] by its strong run of sea trout returning to spawn.

Continuing east, **Skirden Beck** is possibly the most mobile water course and has a highly erosive capability that has resulted in the foot of the beck changing form about its confluence with the Ribble above Sawley. Its formative tributaries, Bond beck and Holden beck, drain off Gisburn Forest and Holden Moor respectively. The beck runs through the village of Bolton by Bowland where it poses a significant flood threat owing to the speed at which it rises and falls.

Flowing into the Ribble downstream of Skirden Brook close to Chatburn is **Swanside Beck**. Swanside beck's formative tributaries run off Downham, Twiston and Rimington Moors located north of Pendle Hill and also Crag Clough off Weets HIll. The area comprises a number of small hamlets and picturesque villages formed around its agricultural community. As with all of the sub-catchments the agricultural theme with localised development of textile based industry precludes the modern era. Remnant structures from this past lie derelict, such as Twiston Mill on Twiston beck. This was initially built by Cistercian monks to grind corn, later converted to run cotton in 1792.

Stock Beck runs off Weets hill to the east of Swanside through the town of Barnoldswick. This represents the largest urban area of any of the five mini-catchments with a population of 11,000 (2011 census) and formed through rapid development of the textiles industry and was originally founded as a rural settlement. Heavy industry in the town had severely impacted the water course in the mid-latter half of last century. The last ice age created the iconic drumlins through which the beck flows. The resulting geology created the perfect conditions for intensive agriculture particularly dairy farming.

1.3 Diffusing the Issue in Rural Ribble: What did it set out to achieve?

The objectives for Diffusing the Issue were shared across all CRF awarded areas within the Ribble catchment. These were to redress the reasons for failure under the Water Framework Directive by improving natural hydrology, the riverine habitat and its connectivity. To encourage a sustainable return to natural river processes improvements, the re-connection of fragmented habitats and reducing diffuse pollution were also targeted. Changes in the initial roll out of the 'Diffusing the Issue' plan stemmed from the delayed receipt of funding relaying onto the practical delivery elements. To minimise this impact an initial focus was placed upon riparian habitat improvements leading into the wider educational, community and other practical aspects. Furthermore, the preliminary monitoring of the works was ranked below practical delivery leading to the loss of a pre-works data set. The monitoring component of the project was re-established and results from this evaluation consider these limitations.

Direct faecal matter inputs and severe poaching leading to excessive sedimentation

As a secondary driver to the project, a reduction in faecal matter entering water courses was adopted. Incoming EC Bathing Waters regulations tighten the microbial safety standards, in anticipation this project encouraged the exclusion of livestock from water courses within targeted areas.

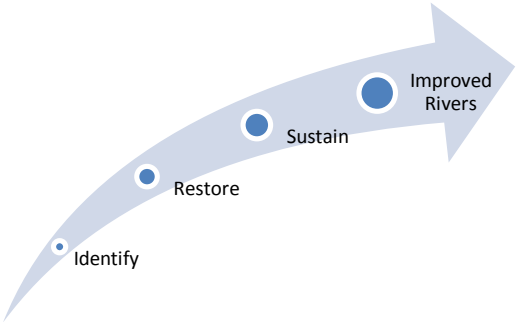
The Diffusing the Issue project sought to achieve its aims through the delivery of physical off-channel works delivered in partnership with local (mainly rural) communities and delivery organisations designed to raise public awareness of rivers.

A programme of activities was devised: -

- Fish easements
- Tree planting
- Riparian fencing
- Farm visits (PINPOINT)
- Farmer workshops
- Farming infrastructure upgrades
- Walkover surveys
- New crossing points
- Woody debris addition
- Monitoring and research
- Site tours and presentations

1.4 Strategic Documents

Ribble Rivers Trust's Business Plan



The RRT business plan recognises the importance of involving local people in the conservation and restoration of local rivers and streams and clearly sets out the commitment of RRT, to involving people in all stages of project delivery, including the planning and development of riverine restoration projects.

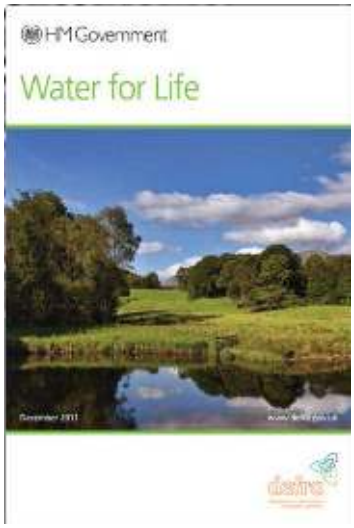
The Water Framework Directive (Directive 2000/60/EC) is a European Union Directive which commits European Union member states to achieve good qualitative and quantitative status of all water bodies by 2027. The Directive aims for good ecological status for all ground and surface waters. It is designed to:

- enhance the status and prevent further deterioration of aquatic ecosystems and associated wetlands which depend on the aquatic ecosystems
- promote the sustainable use of water
- reduce pollution of water, especially by 'priority' and 'priority hazardous' substances
- ensure progressive reduction of groundwater pollution

EU Bathing Water Directive (Directive 2006/7/EC) is a European Union Directive which commits European Union member states to reach sufficient microbiological standards for inland, coastal and transitional waters. The Directive's aim is to increase the number of bathing waters achieving 'excellent' or 'good' status. The purpose is to protect human health from the hazard posed by poor standards through the identification of such watercourses and their subsequent management.

EU Eels Directive (Council Regulation No 1100/2007) is a European Union Directive which member states to protecting the common eel and attain management targets for the seaward migration of silver eels.

EU Habitats Directive (Council Regulation No 92/443/EC) is a European Union Directive which commits European Union member states to protect specified habitats and rare species via the delivery of Biodiversity Action Plans. The plans identify local areas set out the local habitats siting aquatic species to be protected and known to be present locally that include otters, salmon, white clawed crayfish and brown trout.



National Policy

The Government's Water White Paper – Water for Life makes clear that we must halt and reverse the damage we have done to water ecosystems, and ensure that they can continue to provide essential services to us and the natural environment more generally. The White Paper highlights we have been damaging rivers and other water bodies in two ways. We have been polluting them and we have been taking too much water out of them (over-abstraction).

It proposes a new 'catchment-based approach' to water quality and diffuse pollution which includes working at a catchment level, making use of local networks, tapping into local enthusiasm and addressing local concerns. Working at a catchment level enables all those with an interest to see how they can tackle water issues together, in a way that not only improves water quality but also delivers benefits to the whole area, including financial benefits. The CRF project demonstrated this approach, working at a local level and with local people to address local concerns.

Forestry Commission 'Woodlands for Water' Plan states its aims to draw together existing scientific literature on how woodlands can help to improve water quality and management to attain 'good ecological and chemical statuses under the WFD.

1.5 Who was involved?

Ribble Rivers Trust staff directly employed by the CRF project: -

- Sarah Bolton, Agricultural Project Officer
- Jack Spees, Director
- Richard Atton, Volunteer Coordinator
- Catherine Birtwistle, Office and Publicity Manager
- Adam Walmsley, Invasive Species Officer
- Gareth Jones, Scientific Officer
- Paul Peters, Assistant Fisheries Scientist

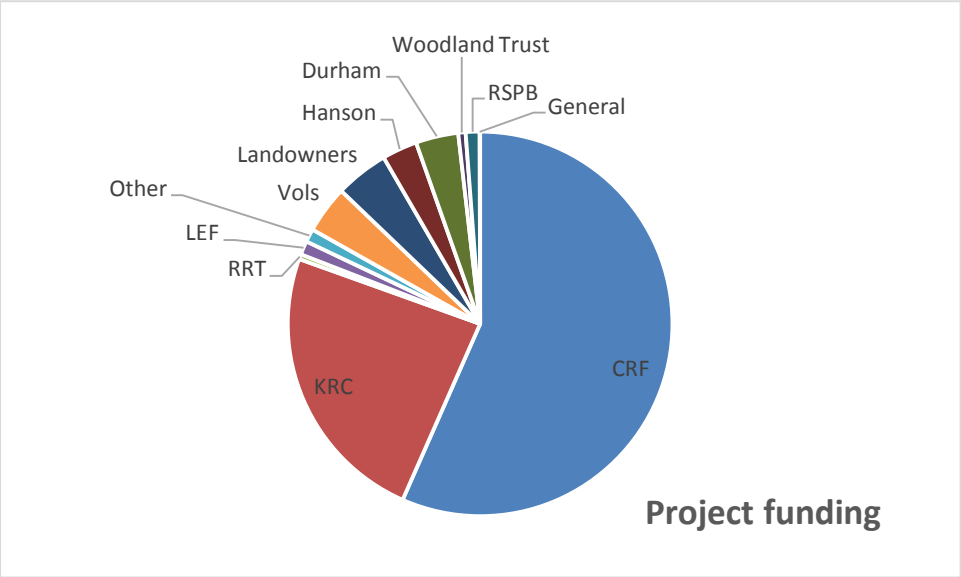
Representatives from academia, local authorities, governmental organisations, third sector organisations and local stakeholder groups all provided an input into informing or the undertaking of practical works as part of the project, to include: -

- Dr Martyn Lucas, Professor at Durham University
- Mike Forty, PhD Researcher at Durham University
- Dr Karen Potter, Professor at Liverpool University
- Thea Wingfield, PhD researcher at Liverpool University
- Pete Leeson, Woodland Trust
- United Utilities
- Dr Holly Shiels, Professor at Manchester University
- Karlina Ozolina, PhD researcher at Manchester University

1.6 Funding the project

The Diffusing the Issue project was developed and delivered over a period of three years and in that time, over £810,000 has been invested, with £459,700 awarded from the CRF. Funding was awarded as three yearly payments. Owing to initial delays in the release of the awarded funds due to contractual matters, practical works were unable to commence until August 2012. The knock-on effect led to bottlenecks in delivery up until these issues were resolved.

Other contributions towards the value of the project included £36,375 from local landowners, £24,000 from Hanson Cement contribution in kind, £9,500 from the RSPB, £5,000 from the Woodland Trust and other significant amounts of gift in kind from project partners at Durham and Lancaster Universities and our local volunteers. All reported values are as of March 2015.



2.0 Overall achievements and impact

Diffusing the Issue in Rural Ribble comprised five main activities aimed at improving river habitat, connectivity and water quality, engaging farmers and the public to increase awareness of local issues and monitoring the impacts of these activities.

1. ACTIVITIES

Riparian habitat improvement: 32 sites were selected from the 5 sub-catchments for improvement. 18,067m of riparian fencing was installed and 13,268 trees were planted, improving a total of 21.2 hectares of BAP priority habitat. In addition, 230m of watercourse over 3 separate reaches was furnished with large woody debris comprising 153 tree root plates.

Reconnecting habitat: 8 fish easements were constructed of varying design, including low-cost baffles, pool & traverse and rock ramps. In addition, one pipe bridge was replaced with a clear-span bridge and one weir was removed completely. These works unlocked over 100km of watercourse to migratory fish, 22km of which

was specifically focused on eel and elver migration.

Farmer engagement: 57 PINPOINT farm assessments were made resulting in 47 farm infrastructure improvements and 51 farms have changed their working practices to incorporate more sustainable methods that aid protection of the water environment. 16 farmer workshops and educational visits were hosted, engaging an audience of over 500 people.

Increasing public awareness: 5 evening presentations were delivered to local community groups with a total of 160 people in attendance. Project reports were delivered to RRT members at 3 AGMs and via RRT's annual newsletters. 6 local agricultural shows were attended. Publicity was generated through 2 features in a local newspaper and RRT's social media pages (Facebook, Twitter and YouTube).

Monitoring: 68 different sites were electrofished across the 5 sub-catchments over the course of the project (Appendix E) and 10 sites were kick-sampled annually to monitor invertebrate populations by volunteers. A more focussed invertebrate study was undertaken at 4 additional locations (Appendix D). 5 walkover surveys were undertaken in 2 of the 5 sub-catchments by reassessment of those delivered by APEM in 2010 (Appendix H).
A PhD study assessed the efficiency of 3 fish easements constructed in 2 sub-catchments (Appendix C). Each of the studies have shown a positive ecological response to riparian habitat and river connectivity works. Salmon are now found in sections of river they have not been previously seen subsequent to these.

2. VOLUNTEERS

139 volunteer days were held resulting in over 3,000 volunteer hours with a value of over

£28,000 contributing in kind to the project value. Volunteer activities included ecological surveying, harvesting willows, installing fencing and water troughs for livestock, invasive

species control, fencing and tree planting. General awareness of rivers has been increased through volunteer activities and their associated publicity.

3. TRAINING AND EDUCATION

3 PhD research studies, 2 BSc dissertations and several work experience weeks were linked to the project. A farm demonstration event educated approx. 50 farmers from the 5 sub-catchments about ways of reducing soil compaction and aeration techniques.

4. STAFF

One new full-time post was created to manage the project and co-ordinate activities and another part-time post was created to assist with the practical delivery and monitoring components of the project. A further 5 existing members of RRT's staff worked ad-hoc on the project.

5. LOCAL ECONOMY

The project sought to utilise local contractors and organisations where possible (and within procurement guidelines), which has supported the local economy. A total of 10 local contractors were employed utilising skillsets including: civil engineering; farm infrastructure improvements; fencing; ecological monitoring; tree planting.

The Diffusing the Issue project aimed to redress reasons for failure under the WFD and bring significant ecological benefits to our watercourses and their natural hydrology. This achieved a measure of success further to a programme of practical works, monitoring studies and community engagement activities across the 5 sub-catchments. The main areas of impact were: -

1. Improved riverine habitat for wildlife and people, and increased resilience to pollution and climactic change.
2. Improved habitat connectivity for migrating fish
3. An advancement in farmer and public understanding of our local water resources
4. Investment in education, skills and training

An agricultural theme permeated the Diffusing the Issue project owing to the rural land usage of the targeted sub-catchments. Maps charting the full extent of the RRT's work during the funding period are provided in Appendix A.

3.0 Evaluation Methodologies

The Diffusing the Issue project had four main aims, to address barriers to fish migration, reduce diffuse pollution, improve habitat quality and engage with local communities to recognise healthy rivers. There were three elements to the evaluation process:-

1. Quantify the response of local fish, invertebrate and plant populations' pre and post works utilising academic and volunteer support.
2. Complete river walkover surveys for comparison with those undertaken pre-works in January 2015.
3. Collate engagement statistics and examine the impact upon those who participated upon events delivered through Diffusing the Issue by the end of March, 2015.

Data was collected over the course of the Diffusing the Issue project in the following ways: -

- Original grant bid documentation
- Mapping project delivery in terms of physical works.
- Fixed point photography before and after the works.
- Flood risk and stakeholder interviews
- Volunteer sign-in sheets
- Articles in the Ribble Rivers Trust newsletters
- Interim project reports
- Recording email enquiries and feedback
- Walkover surveys of river habitat features and drainage grips
- Website and social media activity analysis i.e. Facebook, Twitter and YouTube
- Ecological surveys of habitat, freshwater invertebrates and fish
- Active and passive monitoring of fish movements using radio tracking.

Pit telemetry assessed salmonids' ability to ascend a fish easement on Swanside Beck.

The Diffusing the Issue project aimed to improve riverine habitat quality, improve water quality by reducing diffuse pollution, improving farm infrastructure and prepare rivers and streams for the adverse effects expected to result from future climate change and rising temperatures. This was achieved through the delivery of practical improvements that encompassed: woody debris installation, riparian tree planting, and fencing. These works were completed in mainly rural spaces to the benefit of wildlife, landowners and the general public. The scale of the practical works resulted in the RRT's opting to monitor the ecological response through sub-samples of the works.

4.0 Evaluation Results

4.1 Achievements and Impact

4.1.1 Improved riverine habitat for wildlife and people, and increased resilience to diffuse pollution and climactic change

Diffusing the Issue aimed to improve riverine habitat quality, improve water quality by reducing diffuse pollution and prepare rivers and streams for the adverse effects expected to result from future climate change and rising temperatures. This was achieved through the delivery of practical improvements that encompassed: woody debris installation, riparian tree planting, fencing and farmyard infrastructure improvements. These works were completed in mainly rural spaces to the benefit of wildlife, landowners and the general public. The scale of the practical works was greater than the RRT's capacity to monitor the ecological response and so sub-samples of the works were investigated.

Woody debris addition: 230m of soft revetment was installed into the banks of Chipping and Leagram brooks within three separate sections. These comprise 153 root plates will create new, diverse habitat for aquatic species and dissipate the energy of water flowing though the exposed roots.

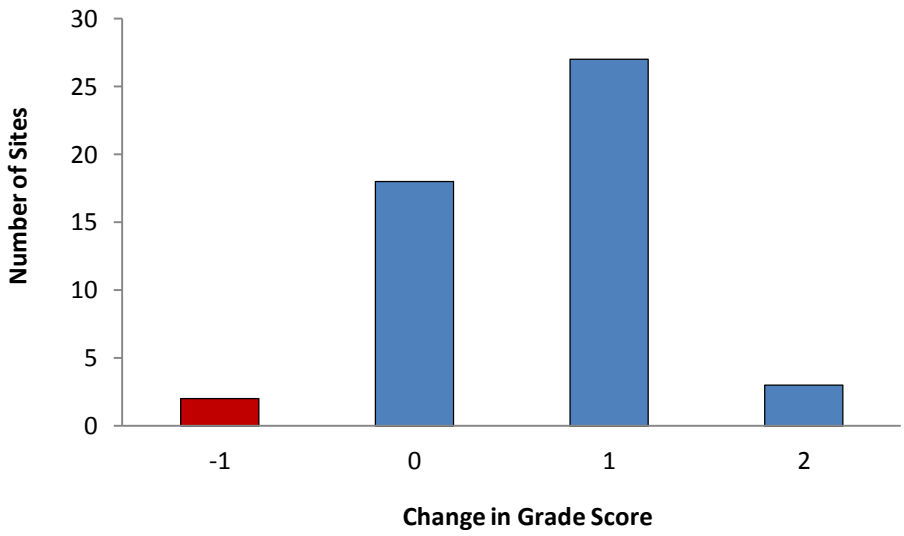
Woody debris addition as installed on Leagram Brook, before (left) and after

Farm infrastructure improved: Over 45 farm infrastructure improvements have been made further to 57 independent PINPOINT assessment visits made by the RRT Agricultural Projects Officer to reduce sediment flow pathways (see Appendix B).

Farm infrastructure improvements delivered under CRF - new manure store (left) and a gated crossing point.

Reduced diffuse pollution

The impact of livestock exclusion due to fencing was quantified through the before and after monitoring of riparian habitat. River walkover surveys were conducted by the Trust revealed a decrease in overland, sediment conduits (see Appendix F). Areas of poaching have re-vegetated across all surveyed brooks (see chart below). This most prominent improvements have occurred within old cattle drinking bays. Twenty-two examples of 'good practice' were recorded in the surveyed areas where there previously none. All sites previously assessed as being in a degraded state had improved.



Level of improvement resulting from pre and post works walkover assessments within the 'Diffusing the Issue' project area (to include Chipping Brook, Stock Beck, Brown brook and the River Loud). The blue bars indicate positive change to riparian habitat features whilst the red shows a negative.

Further assessment of the impact of the habitat schemes via an independent, academic investigation of the associated, riparian plant communities and their soils. Greater species richness and diversity availed within schemes where compared to those absent of a scheme upon Easington Brook (see Appendix F). Statistically, significant improvements in soil compaction were identified. The soil was also more compacted and less absorbent where livestock had retained their access to the water course.

The exclusion of livestock also now reduces the number of animals defecating into 32 reaches within the Diffusing the Issue area, reducing the loading of Faecal Coliforms and E. coli that can impact upon public health at bathing waters.

Maturing riparian habitat within a CRF delivered scheme on Leagram Brook.

Bankside habitat improved: Fences were erected along 18,067m of river restoring 21.2 hectares of BAP habitat with 13268 trees planted across 32 sites involving 152 volunteers. The fenced off areas now exclude stock from adjacent land offering shade over the selected water courses and buffering overland runoff. Before and after photographs for eleven habitat improvement schemes are showcased in Appendix 3. Two independent assessments of the aquatic invertebrate taxa within all of the project areas observed a positive impact. Kick samples taken from above, within and below habitat schemes consistently found a greater number of taxa and species richness within schemes opposed to outside of schemes upstream or downstream (see appendices D and G).

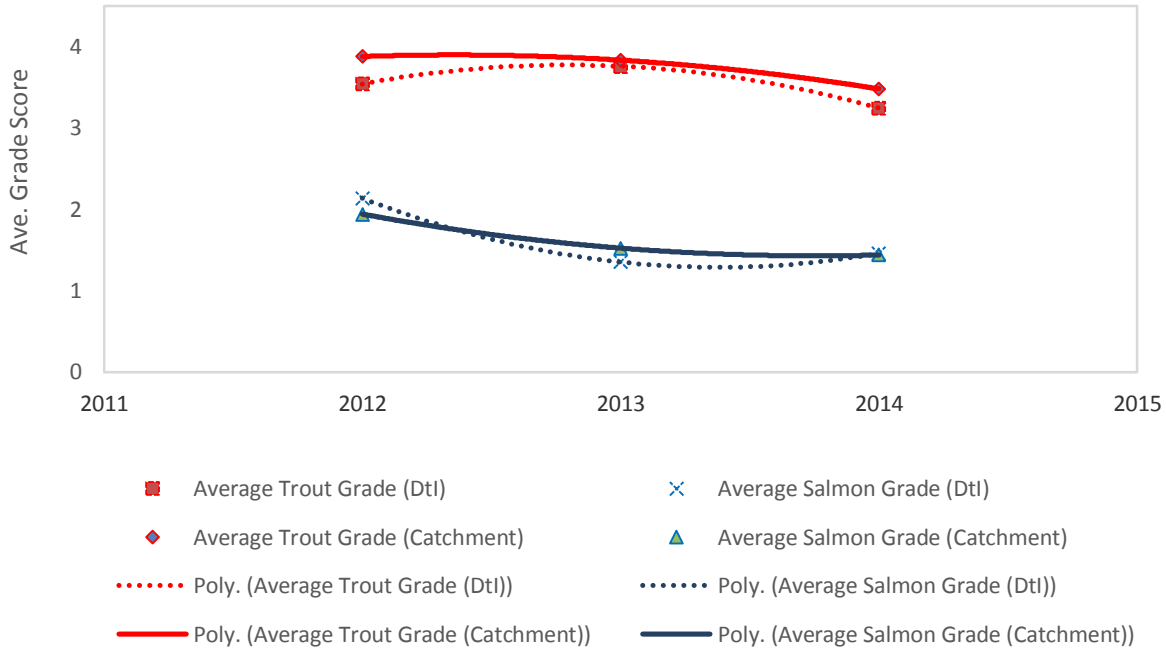
Electrofishing and invertebrate kick surveys conducted as part of the RRT's annual ecological programme of monitoring have provided a continuous catchment overview. This has enabled the RRT to build up a picture of local scale issues and improvements within CRF and non-CRF areas. Healthy assemblages of invertebrates, trout and salmon are discovered throughout of the 'Diffusing the Issue' areas of works, especially upon upper Chipping and Leagram, brooks, lower Easington and Swanside becks. The latter has historically proved the most productive for salmonids and white-clawed crayfish.

Volunteer kick-sampling for invertebrates

The average number of juvenile Brown trout present within habitat scheme water courses (over the three years) has remained at a stable level, consistent with that observed for the rest of the catchment

(see Appendix E). The overall level of response from the fish population has been challenging to quantify and is less defined than that of local invertebrate assemblages.

A reduction in the average number of salmon fry was observed in both the project areas and the catchment as a whole, between 2012 and 2014. The average grade score for project area sites was higher in 2013 than that for the rest of the catchment until 2014 where they overlapped. The decline in salmon fry across the catchment reflects the regional trend reflective of marine-based issues impacting mature salmon. By safeguarding the in river habitat for spawning fish and juveniles, greater opportunity for spawning and rearing success are afforded.



Average (National Fisheries Classification Scheme) grade scores for trout and salmon fry within electrofishing sites located in 'Diffusing the Issue' area compared to the whole catchment average.

In 2012, the RRT, in partnership with the Environment Agency and the Ribble Fisheries Consultative Association, began trapping and tagging 'spring-run' salmon. The run represents a small proportion of the overall number migrating the Ribble to spawn and the study has learnt of their favoured locations. Utilisation of the tributaries within the project area has proven to be vital to the sustainability of the catchment's population. Skirden and Stock Becks, were utilised by tagged fish and from the observations of our annual electrofishing programme, translates to successful spawning and rearing habitat. After learning of these becks' utility, the RRT and its partners have used CRF funds to exclude livestock and plant the enclosed banks with trees here.

A tagged spring run salmon ready for returning to the river (left). An angler volunteer searches for tagged salmon upon as part of an RRT-EA-RFCA partnership project (right).

Within the project's boundaries, each of the following water courses provide a nursery area for juvenile salmon: Easington Beck; River Loud (lower); Leagram brook; Chipping Brook; Stock Beck; Swanside beck; and Skirden Beck. The culmination of the tagging study and completion of the habitat works provides the foundation for monitoring the population response. Considering that some schemes were completed in 2015 and lifecycle duration of a salmon is of the order of upward of four years then the requirement for long-term monitoring is vital. A more detailed summary of the results pertaining to the CRF areas is provided in Appendix E.

4.1.2 Improved habitat connectivity for migrating fish

A total of eight fish easement and barrier removal projects were delivered (see images below) providing bespoke solutions to bolster fish migration. A novel, wooden baffle solution was retrofitted to the face of Newby weir on Swanside Beck, replacing the previously inefficient pass and also upon a slipway on the River Loud aided by a rock ramp at its foot. A pool and traverse pass was constructed to replace an old barrier on Agden Beck at the top of Swanside Beck. A rock ramp replaced an old weir on Chipping Brook within the Loud catchment.

Structures preventing the migration of fish were removed from two locations: A pipebridge that frequently blocked with debris was removed and replaced with an overarching, cantilever bridge across Leagram brook (R. Loud) that allows fish to swim through; and a 'pool and weir' fish pass on Cragg Clough. Together these in-river improvements unlock 100km of water to migratory fish species, of which 22km is specifically focused on facilitating juvenile eel and elver migration.



Swanside beck before, during works (in low flows) and after (high flows) photos, Sept 2012. Note: changes to the flows at the foot of the structure.

Leagram brook bridge upgrade. Before (left) and after (right).

Chipping brook weir easement (1). Before and after.

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River Loud two part fish easement: Wooden baffles above a rock ramp (Before and after).

Easement on upper Chipping Brook, at Wolfen Hall in June, 2014. Before and after.

Cragg Clough before and after photos, Sept 2012.

Howgill beck before and after photos, 2013.

Four of the easements were studied (on Swanside beck (2) and Chipping brook (2)) and evaluated as part of a PhD thesis undertaken by Mike Forty of Durham University (see Appendix C). The evaluations were conducted using Passive Integrated Transponder (PIT) tagging of brown trout to record their movements around the structures and to calculate the efficacy of the easements. This was achieved by recording the attempts of tagged fish to swim between two fixed points.

The comparison of pre- with post-works monitoring demonstrated an improvement in the migratory success of brown trout (see Appendix C). Swanside's low-cost baffle solution proved the most efficient pass amongst those studied, however all demonstrated good possibility (~80%) rates. The efficacy of the passes was also discovered to improve where annual flows/river levels were elevated and again, the same low-cost baffle solution provided the greatest attraction flow for fish passage. Previously, a standing wave had formed at the foot of the weir owing to the previous design. The wave caused fish to prematurely leap on to the foot of the weir face at Swanside. Further to the new design, the wave has dissipated.

New easements upon Chipping brook (2), Howgill, the River Loud and Swanside beck now reduce gradients for fish migration. The low cost baffle solutions installed on the barriers situated on the River Loud and Swanside beck now create diagonal flows with intervening resting pools on the face of the weir to aid ascendance. The original head height of the structure on the river Loud necessitated two adjacent structures were required. The construction represents the first compound easement installed within the Ribble catchment. Successful migration of Atlantic salmon was recorded in 2014

during the RRT annual electrofishing surveys when juvenile fry and parr where discovered above the easements on Swanside and Howgill.

On Leagram brook and Cragg Clough the complete removal of structures has directly aided the passage to migrating fish. Further migratory successes have been recorded above the easements on Swanside beck and Chipping brook. The identification of juvenile Atlantic salmon and eels above these works was made further to the RRT's annual electrofishing survey programme (see Appendix E).

Time lapse footage of the fish easement works on Chipping and the River Loud are available to view via the Ribble Rivers Trust YouTube channel at https://www.youtube.com/watch?v=i3HBpFpbRsg and https://www.youtube.com/watch?v=emLzZ2WrUOU

4.1.3 An advancement in farmer and public understanding of our local water issues

Sixteen rural-themed events and workshops were co-ordinated or contributed to by the RRT Agricultural Projects Officer mainly through presentations directed at conveying the principle aims of Diffusing the Issue in Rural Ribble. At the first workshop, delivered on 29th March 2012, the RRT presented to stakeholders on its ambition to increase river awareness and environmentally sound agricultural practice alongside its partners the Forest of Bowland AoNB, RSPB and Natural England. Since then, the events have drawn together the rural community in keeping with their past history of communal gatherings. Utilising local community halls and businesses to demonstrate farm equipment resulted in the most well attended agricultural events that the RRT has held.

Supporting presentations and monitoring displays were held for Bowland Young Farmers, Myerscough College and Bowland High School groups. The latter were invited to observe and participate in an electrofishing survey activity which drew to attention the productivity of local water courses and the need to consider sympathetic land practice.

Other public and private groups engaged with over the course of the project included; Bowland Farmers; Longridge Young Farmers; Imperial College London; EA North West Catchment Co-ordinators; Slaidburn Young Farmers; Clitheroe Young Farmers; Royal Agricultural Benevolent Institute; Burnley Lady Farmers; Bolton by Bowland Young Farmers; Ribble Catchment farmers; the Ribble Life catchment partnership; River Loud Catchment Farmers; and the NFU. The events attracted a total of over 500 people directly.

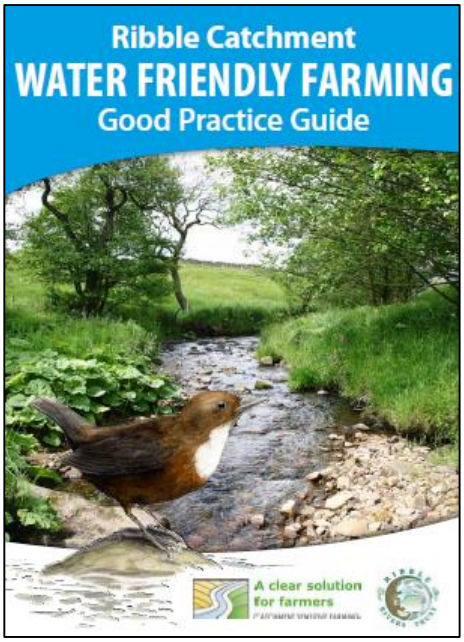
Ribble Rivers Trust exhibiting at the Hodder Valley Show in September, 2014.

The RRT has held exhibition stands at the Chipping, Great Harwood, Goosnargh & Longridge and Hodder Valley agricultural shows and delivered five evening

presentations to over 160 local stakeholders. Furthermore, the outcomes of the project have been relayed to the RRT membership and trustees via the RRT AGM over the duration of the project.

To promote good practice amongst the farming community and attendees at farm shows and events the "Water Friendly Farming: Good Practice Guide" and "Funding Opportunities for Farmers" were published and distributed to over 300 individuals and organisations. The guide documents detail good practice for the protection of water courses flowing through rural environment providing an illustration of the contrasting impacts agricultural practices. The guides also signpost individuals to the Ribble Rivers Trust for advice.

Soil structure training event held for farmers



Front cover of the Water Friendly Farming guide

The Diffusing the Issue project has received additional coverage through the RRT annual newsletters, the draft consultation document for the Flood Risk Management Plan and also through RRT social media channels (Twitter, Facebook and YouTube).

Work on the River Loud was showcased in the EA consultation document, the "North West River Basin District: Challenges and Choices" published in 2013 and available online from https://consult-cy.environment-agency.gov.uk/portal/ho/wfd/water/choices?pointId=ID-2437430-QUESTION-VIEWS-ON-THE-NORTH-WEST-RIVER-BASIN-DISTRICT&do=view

4.1.4 Investment in education, skills and training

Practical sessions and farm events have educated the local farming community to gain a wider understanding of soils science and environmentally sympathetic land management practices, for example showcasing ways of reducing soil compaction and aeration as a means of reducing soil loss and slowing run-off. Such events have provided a unique two-way forum for farmers to express their own desires and the barriers towards attaining their goals.

Fifty-one farms have changed their working practices to incorporate more sustainable methods that aid protection of the water environment. This is in addition to positive feedback received from farm events pertaining to influencing change (see Appendix I).

To deliver the monitoring aspects of the CRF, volunteers and staff have been trained in the delivery of electrofishing, invertebrate monitoring and river walkover techniques. The outcomes of these studies have also contributed to the annual survey reports that have informed RRT members and angling clubs in the behaviour, presence and whereabouts of local fish populations.

409 individual volunteers have contributed over 3,000 hours of their time to aid the RRT in delivering the Diffusing the Issue project. 139 volunteer days were offered in aid to a range of tasks that included ecological surveying, harvesting willows, installing fencing and water troughs for livestock, fencing and tree planting. General awareness of the river has been increased through publicity of the project and activities. It has also stimulated volunteer involvement from other areas, which we believe, adds to health drivers. The project is also delivering on the directives and management plans as outlined in section 1.4.

Students from Manchester University, Liverpool University, Durham University, York University, Lancaster University and Burnley College have all benefitted from the project funds through link-ups that enabled them to complete their research studies (at PhD, postgraduate and undergraduate levels – see appendices F and G) whilst working with the RRT. Farm infrastructure visits, walkover training and electrofishing tasks have been performed with groups from Imperial College London, Burnley College and Myerscough College. Two students also completed their Duke of Edinburgh awards having assisted the Trust with tree planting and fencing. A three-year fish telemetry study was also delivered in partnership with the EA and local angling clubs.

4.2 Who benefitted from the Diffusing the Issue project?

4.2.1 Local Residents and Visitors

The Diffusing the Issue project engaged with local residents in a variety of ways, including agricultural and public shows, farm events, workshops and presentations. The aim was to draw locals' attention for the rural community towards their local rivers and reduce pressures of farming practice impacts. The shows have provided a good opportunity to showcase the work of the Trust in relation to the CRF and historically. In support of the show events the RRT has introduced a newly developed river simulator which enables visitors to the stand to get a hands on feel and understanding of river geomorphology. This has proven very successful with drawing visitors, particularly families, to the stand and improving understanding of the impacts of bank modifications on natural processes.

The River Simulator table in use at the Chipping Show, 2014.

The support of volunteers in the delivery of practical improvements has not only spread knowledge in how to apply practical skills but a wider understanding of the RRT, its partners and their objectives to improve river habitat and farming practice. Visitors to the area further benefit from the practical improvements to the river aesthetic, improvements to water quality and more diverse wildlife. Concurrent work upon the 'Keeping Rivers Cool' initiative has brought attention to the local area through documentation in the national media.

4.2.2 Schools and Colleges

Groups of students from Myerscough College, Imperial College London and Bowland High School have participated upon workshops and received presentations educating them in responsibly managing land and a wider knowledge of aquatic ecology. The varying academic level of the students that attended these events represent the next generations of farmers and decision makers. It is envisaged that through these educational routes, sympathetic management practices will be selected in the future.

The RRT partnered the EA and Malcolm Handley, of Croasdale House farm to deliver a presentation and river walkover of Croasdale beck on the 3/3/13 to students of Bowland Highschool.

4.2.3 Volunteers

The installation of fence lines, drinking troughs and tree planting has taught those engaged not only how to perform the practical tasks but the reasons behind undertaking the action. General awareness of the river, its properties and the threats to its overall condition has been propelled by wider publicity of the project and its activities. This has contributed to the direct knowledge of rivers as understood by those who have participated. It has also stimulated volunteer involvement from other areas outside of the immediate vicinity, which we believe adds to health drivers.

Volunteers assisting with the installation of a new fence line

The installation of new drinking water troughs supplemented the ambition of the RRT in delivering its goals for fencing and tree planting. The troughs, powered by a combined battery and solar panel control system, were a new technology for the Trust that were initially developed in house, then installed and later maintained by a group of four volunteers led by Vince Edmondson and latterly, Dave Smith. The process has benefitted those trained volunteers in how to now install, operate and upkeep a new technology.

A cattle drinking trough fed by a solar powered pumping unit provides an alternative drinking source to livestock excluded by riparian fence lines.

4.2.4 Community and Interest Groups

The Diffusing the Issue project placed focus upon working with and influencing farmers over the loss of soils and nutrients resulting from unsympathetic agricultural practices. Throughout of the dialogue a rapport has been established with the farming community to the mutual benefit of both farmers and their environment. Success was notable from the feedback responses from these events (see Appendix I) and through the uptake of schemes with notable room for future improvements being identified (Appendix J).

"We have worked with the Ribble Rivers Trust on various projects since the initial PINPOINT visit. The project funded quick fixes in the farm yard including guttering to prevent clean roof water entering the slurry pit, increasing our storage capacity. Stone was also provided for us to stone out gateways to reduce dirty water run off.

Since delivering the yard works we have planted 1ha of broadleaved trees utilising a Forestry Commission Woodlands for Water Scheme.

The events organised by the Trust have been very useful and the soil demonstration resulted in us hiring an aerator in 2013 to address surface compaction"

Simon Stott, farmer at Laund Farm, Chipping (R. Loud).

The meeting have drawn the agricultural community together outside of their usual routines to place rivers and the environment on the agenda.

A joint RRT/CSF delivered farmer/contractor meeting, held at Waddington Hall 12/11/14.

The following is a quote received by the Head of the Bowland Young farmers group, further to our support of evening workshops,

"I am a second year Environmental Geography student, studying at the University of York. I got in touch with the RRT after they had been doing work on my family's beef and sheep farm, in the Easington sub-catchment. The RRT contributed to guttering, stoning out gateways and a riparian habitat scheme. Sarah organised for me to do work experience with the trust throughout summer 2013. This allowed me to develop a more practical knowledge of the issues surrounding water quality and what measure can be put in place to alleviate them.

I asked Sarah to give a talk to Slaidburn Young Farmers Club in September 2013, she talked about diffuse pollution and what we could do to help the problem. I have kept in touch with the RRT since last summer and will be returning in summer 2014 for more work experience and to do my university dissertation. Sarah and the RRT have been extremely useful to me in helping me decide what I want to do in the future by giving me invaluable experience."

4.2.5 Local Business and Organisations

Farm events were also supported by local businesses who have contributed farm equipment towards the live demonstration of soil aeration techniques. Townson tractors were actively involved in delivering and showcasing of equipment.

4.2.6 Partner Organisations and the Wider Sector

The Diffusing the Issue project has partnered with several organisations to deliver farm events and visits. Contributions with match funding or practical delivery have been made by Natural England, the Forest of Bowland AoNB, the Farm Advice Service, Myerscough College, local Environment Agency, and the Campaign for the Farmed Environment over the course of the project. Further to the organisation of events and their content these groups in addition to the NFU, CLA and Livestock Northwest have advertised the events to attract unprecedented attendance number for the events.

Throughout of the project, particularly during its first year, the RSPB have provided agri-environmental advice on farms and signposted farmers towards the RRT for delivery of practical improvements. The Forestry Commission have aided with the sourcing of root balls that were added to the banks of Chipping and Leagram brooks as woody debris to provide additional refuge for aquatic species and reinforcement to eroding banks.

5.0 Legacy

5.1 Legacy for Natural River Heritage

The project has successfully delivered a significant range of river improvement projects. These will continue to develop and provide greater benefit to the river (and the wider environment) beyond the end of the project. For example, immediate benefits have been identified from the exclusion of livestock from watercourses reducing faecal matter and allowing vegetation to naturally recover. Longer term, the maturation of trees planted will see increases in shade, habitat and buffering of diffuse pollution. The fish passage works have reconnected localised populations of fish and increased the availability of habitat indefinitely.

Subsequently, the legacy of the project is such that improvements will continue to be achieved and experienced long after the end of this project.

Although many actions were targeted at riverine species, particularly salmonids, the numbers of species that have and will continue to benefit include dippers, kingfishers, aquatic invertebrates and otters to name but a few.

It is hoped that the activity of this project and the delivery of multiple benefits with demonstrable and continuous improvements to be seen, will aid in inspiring and encouraging the participation of landowners, partners and communities in further improvement projects to benefit the Ribble and the catchment as a whole.

5.2 Legacy for people

The Diffusing the Issue covered traditional core areas for the RRT, having delivered previous river improvements locally. The positive response of the rural communities and previous successes have fostered personal relationships and strengthen links with angling and farming groups in the area, not to mention instilling a greater understanding of what the Ribble Rivers Trust wishes to achieve in these sub-catchments.

By forging strong links with local farming communities, the RRT has built the relationships to deliver mutually beneficial works and create the capacity upon neighbouring farms. The realisation of the impacts amongst the community will promote more sustainable management and practice.

Health and wellbeing has also been encouraged through the project by generating opportunities for local people to volunteer, undertaking simple, physical tasks like fencing and tree planting. Volunteering also helps to increase people's understanding of the issues that rivers face and the importance of carrying out restoration projects. Volunteers gained new practical skills through volunteering on the Diffusing the Issue project and some gained nationally recognised qualifications, allowing them to chemically eradicate invasive plants adjacent to watercourses.

The increased habitat that resulted from the project is envisaged to improve the connectivity and availability to some of the Ribble catchment's most important Salmon spawning areas, leaving a more prosperous environment that can be enjoyed by all.

As a result of the fish passage works, the farmed areas are now at less risk of flooding than it was prior to the capital works taking place. As a result of this project, the RRT has greater support from the farming community towards making further improvements to rivers in the future.

5.3 Legacy for Partnerships

The existing partnerships within the project area have been strengthened and new partnerships developed which leaves a positive lasting partnership legacy. As demonstration to this, new projects are currently being developed and it is hoped that the actions of this project and the sharing of evidence and outcomes will result in delivery by other groups, such as, the Bowland AONB, Forestry Commission, Natural England and the RSPB, to name but a few and all of which will support the continuation of the Catchment Based Approach and increased delivery of Water Framework Directive objectives.

5.4 Legacy for the Ribble Rivers Trust

The Diffusing the Issue project represents significant impacts upon the rural landscape of the mid-Ribble and Hodder areas. This has brought the RRT into contact with additional delivery bodies, landowners and agencies on a local scale. The wide-scale of delivery represented a challenge at a time where new working relationships had to be forged. These challenges have been positively addressed and created a positive legacy for RRT. To maintain this legacy, the momentum generated by the project needs to be maintained and continued activity in the area is vital. RRT will continue to seek resources to achieve this, as well as to support the ongoing monitoring and maintenance requirements of the project outcomes to ensure that the decadal timespan over which full realisation of the work and legacy is achieved bolstering support for the RRT and its partners.

6.0 Lessons Learned

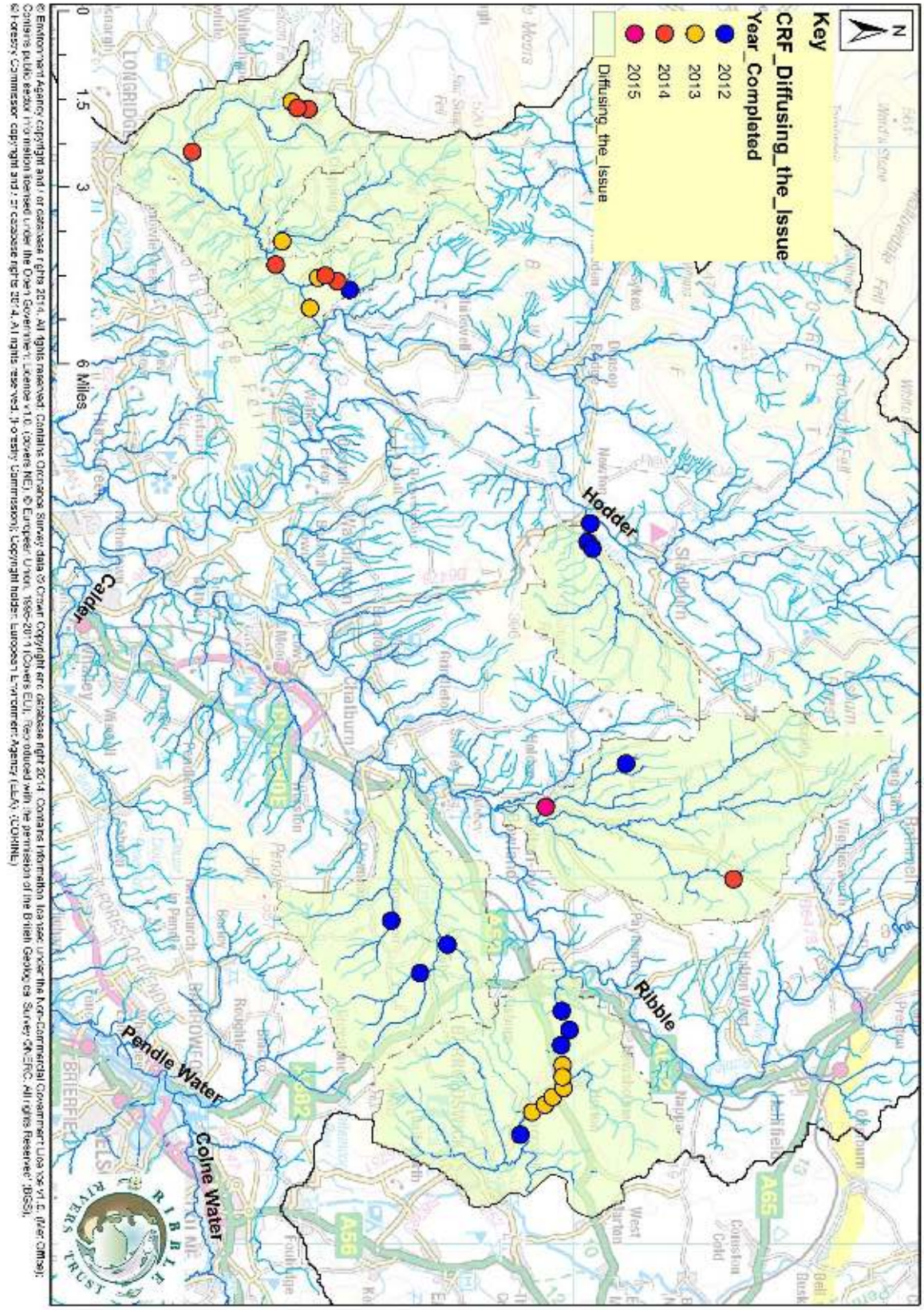
The improvement to riverine habitat will likely take decadal time spans meaning that the planting of trees and changing of mind-sets will be achieved over a time frame that extends well beyond the timeframes set out in this report. As 90% of the Ribble catchment is of rural land use, the coverage of this project represents only the smallest of fractions towards overcoming the true extent of agricultural impacts.

Whilst the receipt of CRF funds has allowed the much good work to happen within the project area, the outputs could have been further reaching if time had not been lost in the first year due to delayed receipts of funds. Future financial structuring that expedites the release of funds earlier would undoubtedly aid delivery on the ground to achieve more practical improvements in future. The experience has taught the RRT to be flexible and reactive in its approach towards funding.

The CRF evaluation has presented a significant challenge in capturing the ecological and hydrological data prior to and shortly after works had begun. The scale of monitoring, influence of environmental variables and resource availability provided a steep learning curve on capturing accurate information about the project. The RRT will maintain its long term baseline monitoring programme by which to establish the true impacts of the work as the river responds to them over time scales that overrun the availability of funding. At best, the locations of the programme provide some pre-works monitoring outcomes. In reality detailed pre-works surveying is required and time be afforded to complete this. In future, improved reporting mechanisms are sought that provide good quality pre-works monitoring that can be easily interrogated with cross organisation data sharing. The latter could provide the mechanism for enhancing practice and knowledge for stakeholders or identifying knowledge-gaps in the early stages of new projects.

Appendix.

Appendix A. Map of habitat improvement works completed under the Diffusing the Issue project.



Appendix B. Before and after photographs of farm improvements and riparian habitat schemes delivered in the Diffusing the Issue area, 2012-2015.

Swanside (or Howgill Beck) before

Swanside (or Howgill Beck) after

Stock Beck 1 before

Stock Beck 1 after

Stock Beck 2 before

Stock Beck 2 after

Stock Beck - Painley before

Stock Beck - Painley after

Hollings Farm (Ings beck) Before

Hollings Farm (Ings beck) After

Higher Gills Farm (Ings Beck) before

Higher Gills Farm (Ings Beck) after

Leagram Mill (Leagram Brook) before

Leagram Mill (Leagram Brook) after

Leagram Brook – Pale Farm Before

Leagram Brook – Pale Farm After

Eel Beck (or Thistleber Beck) before

Eel Beck (or Thistleber Beck) after

Greaves Farm (Bleara Syke) before

Greaves Farm (Bleara Syke) after

Wood Top Farm (River Loud) before

Wood Top Farm (River Loud) after

Clean and dirty water separation, before bunding

Clean and dirty water separation, after bunding

Clean and dirty water separation. Heavy sediment run off (before)

Hard standing area (after)

New hardstanding, drinking point for livestock adjacent to a new riparian habitat improvement scheme, delivered in conjunction with the Forestry Commission. Chipping Brook, 2013.

Poached gateway with heavy sediment runoff, before

Reduced sediment load, reinforced gateway, after.

	
Broken Guttering	*Guttering repaired and protected from livestock*

Manure stored on the flood plain, before

Manure stored in a bunded area away from the water course, after

Stoned out farm track – reduced sediment entering the watercourse

Appendix C. Evaluation of the efficacy of fish passage measures installed on Swanside Beck and Chipping Brook, by Mike Forty (Durham University)

Introduction

The impact of impoundment by in-stream structures such as dams, weirs and culverts on river systems can be extensive, especially upon fish populations, creating upstream and downstream barriers to migratory movement (Lucas and Baras, 2001; Aarestrup & Koed, 2003). Loss of free passage due to artificial barriers can lead to habitat fragmentation and limit distribution in water courses by reducing access to spawning grounds (Dynesius and Nilsson, 1994; Nilsson *et al*. 2005). River systems are particularly susceptible to fragmentation as one barrier has the potential to isolate large sections of river from one another (Jager *et al*., 2001).

In order to mitigate the negative effects of barriers on upstream migration fish passage technologies have been developed, many within the last sixty years, such that there is now a wide variety of designs, categorised as either technical (vertical slot, pool and weir, baffle-type) or nature-like (by-pass channels and rock ramps) (Clay, 1995; Katopodis and Williams, 2012). Evaluation of the performance of fish passage structures has indicated that whether they are successful and the degree of success can be very variable and site specific (Kemp, 2012). Despite the efforts to provide passage assistance there are still negative impacts incurred by multiple species at these structures including migratory delay with fish attempting to pass structures on multiple occasions (Laine, 1995; Lucas and Frear, 1997; Hasler *et al.*, 2011). With 25,000 known man-made barriers on UK Rivers and an increased ambition to provide free passage it is important to determine the functionality of fish passage designs (Gough *et al*., 2012).

As part of grant issued by DEFRAs Catchment Restoration Fund the Ribble Rivers Trust addressed the issues of poor fish passage and its associated impacts through the construction fish easements under the Diffusing the Issues in the Rural Ribble project. This report aims to measure the efficacy of fish passage solutions installed by the RRT as part of this project.

Methodology

This study was conducted on two streams on the River Ribble catchment (1133 km ^{2}), one of the main basins in northwest England. The River Ribble drains limestone bedrock in its headwaters as well as areas of outstanding natural beauty in the Yorkshire Dales and the Trough of Bowland, running south and then west before flowing in to the Irish Sea. The two study streams were Swanside Beck (~100 m.a.s.l.), a minor tributary of the Ribble, and Chipping Brook (~150 m.a.s.l.), and a minor tributary of the River Hodder (Figure C1). Both streams have riparian landscapes that predominantly consist of grassland which is subject to intensive dairy and sheep farming. Normal pH for both rivers is between 8-8.5, while the conductivity is typically lower in Chipping Brook (100-200 µS) than Swanside Beck (300-600 µS). The substratum is predominantly composed of gravel, pebbles and cobbles in both streams. Swanside Beck runs for 6 km with moderate gradient (c.a. 12.2 m km^{-1}) impeded by three low head barriers (< 3 m) while Chipping Brook runs for 4.5 km with a higher gradient of c.a. 42.6 m km^{-1} and has six low-head barriers. A total of 6 structures were assessed across the two years, three

on Swanside Beck and the first, second and fifth on Chipping Brook (Figure C1). Of these, four were recently constructed fish passage structures: two pool-weir traverse fish passes, one embedded rock ramp, and one low-cost baffle pass (Servais, 2006; Table C1). The other two structures were culverts with contrasting physical characteristics where Culvert 1 was used as a control as water velocities were within expected swimming performance of salmonids, and represented a man-made structure which appeared to pose minimal barrier impact to upstream passage and Culvert 2 representing a more formidable barrier to upstream passage in terms of length and water velocities (Table C1).

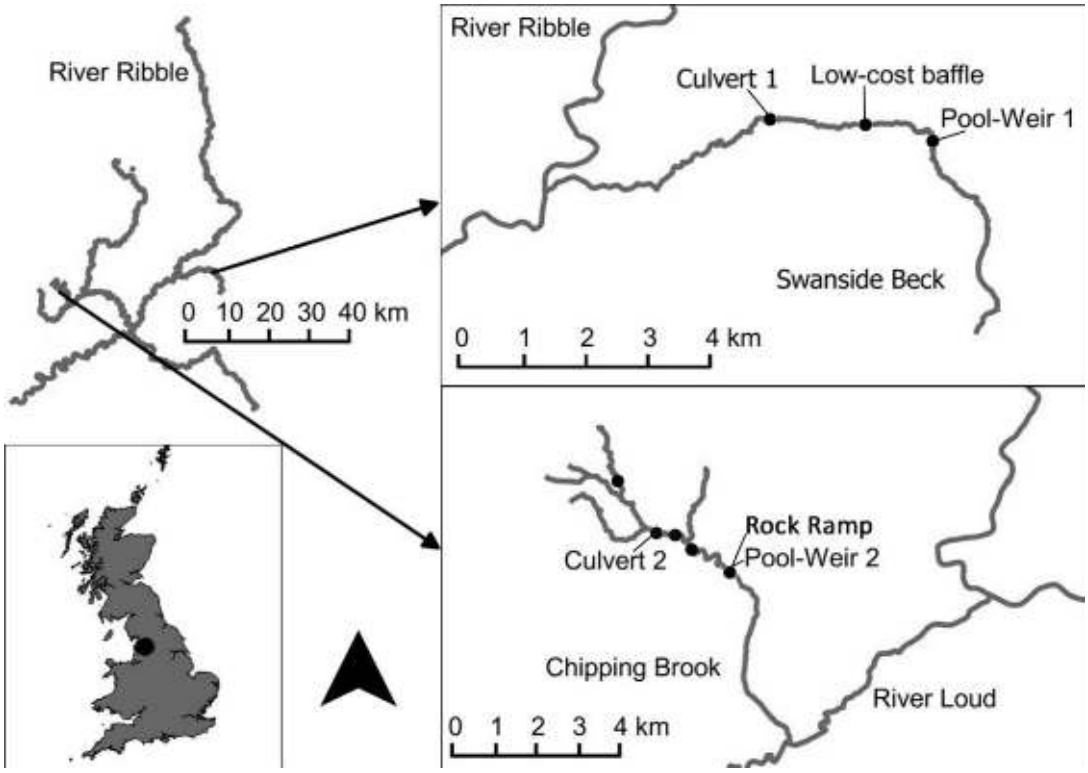


Figure C1. Map of study area with in-stream structures shown as black circles (top and bottom right).

Table C1. Physical characteristics of studied structures

			Fish passage structures				
	Culvert 1	Culvert 2	Low-cost baffle	Pool-Weir 1	Pool-Weir 2 (2013)	Pool-Weir 2 (2014)	Rock Ramp
Length (m)	20	63.5	6.7	8.43	7.2	7.2	4.57
Width (m)	0.5	2.15	7.6 - 9.7	6.2	8.65 - 10.50	8.65 - 10.50	6.8

Head loss (m)	0.8	3.32	1.6	1.16	0.84	0.84	0.55
Slope (%)	4%	5.2%	24%	14%	12%	12%	12%
~ Base flow velocity at entrance (m/s)	0.7	3	1.85	0.5	1.92 - 2.26	1.80-2.20	1.28
Entrance depth at base flow (m)	0.12	0.05-0.15	0.15	0.06	0.1	0.1	0.3
Open/Closed culvert	Open	Closed	-	-	-	-	-
Notch width (m)	-	-	0.35	0.6	0.6	0.6	-
Baffle height (m)	-	-	0.2	-	-	-	-
Pool step height (m)	-	-	-	0.25-0.33	0.49, 0.23, 0.12	0.25	-
Number of pools	-	-	-	3	3	3	-
Number of notches	-	-	16	4	4	4	-

Passive integrated transponder (PIT) logging stations

Passive integrated transponder (PIT) telemetry was used to measure passage efficiency and delay before passage of *Salmo trutta* at in-stream structures. Each site was monitored using a logging station comprising either a half-duplex (HDX) reader (Texas Instruments S2000) and data logger (Flinka Fiskar) set up in a master-slave configuration (Castro-Santos *et al.*, 1996), or an Oregon RFID HDX multiple antennae reader and data logger (Oregon RFID, USA). These configurations interrogated each antennae loop 8 and 6 times per second respectively via a PIT tuning box (RFID Tuner, Texas Instruments, and Dallas, USA) connected to the logger using shielded coaxial cable. Two antennae loops (6 mm multi-stranded high quality copper speaker cable, 777 x 0.1 mm strands) were constructed horizontally across river at the downstream and upstream extents of each structure such the direction and success of passage by individuals could be identified. Antennae were affixed to the bottom and sides of in-stream structures in most cases with the exception of the upstream loops for the LCB and PW1 sites which were 1 m upstream of each structure and affixed to the banksides and then weighed down on the stream bottom using large cobbles.

Low-cost Baffle

Pool-Weir 1

Pool-Weir 2

Culvert 1

Culvert 2

Embedded Rock Ramp

Figure C2. Images of evaluated structures

Each loop was thoroughly tested ensuring they were tuned to maximum detection range and efficiency by drawing a PIT tag through the loop at small (< 0.25 m) intervals across the width and height of the loop at a slow speed so as to determine detection range and identify any holes within the field and then at a faster speed to simulate burst swimming of a fish. Logging stations were powered using two 110 Ah deep cycle leisure batteries run in parallel which were changed every 3-4 days to avoid power supply failure. Data was downloaded at each battery change and the antennae loops tested using a PIT tag attached to a pole to ensure they were functioning correctly.

A pilot study was initially conducted between 9th October and 8th November 2012 in order to gauge how successful this methodology could be in evaluating fish passage. This was conducted at the Low-cost baffle structure pre-restoration while it was still a flat faced weir. The low sample size used in this pilot (20 sea trout and 11 brown trout) and shorter duration of monitoring mean that this was not a true pre-restoration assessment of the efficiency of this structure but does give an indication of what that may have been.

Five structures were assessed during the autumnal migration in 2013 using a two part methodology investigating passage for naturally migrating *Salmo trutta* in addition to utilising the homing instinct of individuals through displacement experiments. At each structure, fish were first captured downstream in a three-pass depletion quantitative survey, of which the upstream extent was 100 m from the structure, or in a single pass of the section between the quantitative survey and the structure completed on the same day. These fish were then tagged and returned to where they originated and the logging stations monitored for between 5 and 19 days (Table C2). Following this fish were captured in the first 100 m upstream of the structure, tagged and subsequently displaced 100 m downstream of the structure. In addition fish were tagged on the same day in a three-pass depletion quantitative survey whose downstream extent was 100 m upstream of each structure. Logging stations were then kept running until mid-December (Table C2) by which time naturally migrating individuals were expected to have completed spawning.

Improvement works were conducted on P-W 2 in early summer 2014 to improve the original construction which meant the head-drop between pools in the fish pass was incorrect leading to a 0.37 m difference in the head drop at the first notch and that at the most upstream notch of the pass (Table C1). A new embedded rock ramp was also constructed on a flat faced weir 20 m upstream of P-W 2 at the same time. Both of these structures were investigated in summer 2014 along with repeat assessments of LCB and Culvert 1 on Swanside Beck. All sites monitored in 2014 were subject only to short term displacement experiments conducted using the same format as in 2013 but with monitoring of the logging stations for the first 15 days following displacement. As Pool-Weir 2 and the Rock Ramp were in close proximity fish were captured from above the Rock Ramp and then displaced 100 m below Pool-Weir 2 using the same displacement group to test both structures.

Experimental fish

Fish used in the study were captured by an electric fishing team of one or two assistants using hand nets and an anode operator using a pulsed DC bank-side electric fishing kit (Electracatch WFC4, Wolverhampton, UK and 1 KVA Honda generator). Captured fish were placed in to covered reservoirs providing aeration and circulation by means of a 12 V submersible aerator pump (1732 L hr^{-1}). Trout were PIT tagged with one of two tag sizes depending on whether their fork-length was between 70 and 130 mm (12 x 2.12 mm, 0.1 g) or greater than 130 mm (23 x 3.65 mm, 0.6 g). Prior to tagging fish were immersed individually in to an anaesthetic bath of 2-phenoxyethanol (250 µL L^{-1}) until they reached stage III anaesthesia. Fish were then removed from the bath, had their fork-length recorded before having a PIT tag inserted in to the peritoneal cavity via a 3-5 mm incision on the ventral surface anterior to the pelvic girdle. The incision was left un-sutured as studies have indicated this not to be necessary (Jepsen *et al*. 2002; Bolland *et al*., 2009). Individuals were then placed in a separate recovery reservoir of aerated fresh water for observation ensuring they were able to maintain equilibrium and were responsive to external stimuli before release.

PIT logging stations ran continuously during monitoring periods with the exception of Pool-Weir 1 (12/09/2013 13:00 – 16/09/2013 18:00) Pool-weir 2 (12/09/2013 12:00 – 16/09/2013 18:30) which both experienced equipment failure at the beginning of displacement experiments (Table C2). PIT antennae were washed out of Culvert 1 on 21/10/2013 and water levels then remained too elevated to re-install loops within reasonable time so monitoring was ceased at that point.

Environmental data

Stage and temperature were recorded during the study on Swanside Beck and Chipping Brook in pool habitat 5 m upstream of the Low-cost baffle and Pool-Weir 2 structures respectively. These were measured at 15 minute intervals using an automatic logger (HOBO U20-001-01-Ti; accuracy: 0.05 cm, 0.044°C from 0°-50°C) placed in a stilling well affixed securely upright at the bank. Water level was then calibrated using a single point reading of depth at the data logger and hourly mean sea level pressure readings from a weather station at Bingley (53.81 N 01.87 W).

Data analysis

In order to assess performance for fish passage each structure was subject to a number of metrics. *Passage efficiency* was defined as the percentage of fish which successfully ascended a structure compared to those which were detected at the downstream antennae loop attempting to ascend. *Attraction efficiency* was defined as the proportion of fish which attempted to ascend a structure compared of those which were displaced below it. *Delay* experienced by fish was measured using two metrics; firstly by calculating the time between first detection at the downstream loop and the first detection at the upstream loop of a structure in hours. Secondly, by calculating the *number of attempts* made by a fish before successful passage where an attempt is defined as a detection at the downstream antennae which is not within 5 minutes of a previous detection. *Delay* for unsuccessful fish was a minimum delay and calculated as the time difference between the first detection at the downstream antennae and the end of monitoring on that structure. Data presented is only based on the first ascents of individuals and does not take in to account repeat ascents from fish which fell back of a structure after successfully passing it.

The effect of length on the passage success of trout at structures was tested using binary logistic regression. This provides a useful method for modelling a binary response variable (successfully or unsuccessfully ascending a structure) based on a predictor variable (length) (Bewick *et al*., 2005; Starrs *et al*, 2011). Models were constructed based on the observed data collected during 2013 and tested for significance against the Null model. Displaced fish at Pool-Weir 2 were not included in that model due to the equipment failure experienced in the period following their displacement. Logistic regression was not fitted where complete separation arose due to 100% passage efficiency (Field, 2005). All analyses were conducted using R version 2.15.2 (R Core Team, 2012) and graphs made using the ggplot2 package (Wickham, 2009).

Table C2 – Summary of experimental groups of *Salmo trutta* PIT tagged during 2013 and 2014

Group	Year	Number tagged	Fork-length [mean SD (range), mm]	Date displaced	Monitoring period
Culvert 1 displaced	2013	68	119.7 ± 34.8 (82 - 191)	04/09/2013	19/08 – 21/10/2013*
	2014	53	152.4 ± 42.4 (80 - 294)	24/07/2014	24/07 – 08/08/2014
Culvert 2 displaced	2013	49	127.7 ± 35.8 (74 - 206)	30/09/2013	25/09 – 16/12/2013
Low-cost baffle displaced	2013	118	148.2 ± 28.9 (83 - 298)	05/09/2013	20/08 – 14/12/2013
	2014	101	154.5 ± 34.1 (112 - 293)	30/07/2014	30/07 – 14/08/2014
Pool-weir 1 displaced	2013	72	130.8 ± 29.7 (80 - 208)	11/09/2013	23/08 – 14/12/2013
Pool-weir 2 displaced	2013	141	159.0 ± 51.6 (109 - 443)	12/09/2013	02/09 – 12/12/2013
Rock ramp displaced	2014	179	145.0 ± 40.6 (102 - 326)	12/09/2014	12/09 – 27/09/2014
Total Swanside Beck	2013	582	141.7 ± 42.1 (80 - 450)	-	
	2014	158	156.0 ± 39.3 (80 - 294)	-	
Total Chipping Brook	2013	646	149.3 ± 49.1 (74 - 443)	-	
	2014	178	156.9 ± 40.6 (102 - 326)	-	

*PIT antennae washed out in high flow event

Results

2012 Pilot study

Of the 31 tagged fish 14 (45%) were detected attempting to ascend the weir of which 8 were sea trout and 6 brown trout. Fork-lengths of tagged fish ranged from 248 – 542 mm for sea trout and 186 – 337 mm for brown trout. Attempting fish had fork-lengths ranging from 265 - 505 mm for sea trout and 186 – 337 mm for brown trout. Three fish successfully ascended the weir (passage efficiency = 21 %), two were sea trout and one a brown trout with fork lengths of 263, 505 and 312 mm respectively.

Water level during the study ranged between 0.512 and 1.095 m with a mean of 0.813 m (σ=0.093; Figure C3). Fish were observed to attempt the weir at water levels between 0.673 and 1.069 m with successful fish ascending the weir at water levels between 0.706 – 0.908 m. Water temperature during the study had a mean of 8.9°C (σ=1.36°C), ranging between 4.4 and 11.2°C. Attempts to ascend the weir were observed between 8.1°C and 11.0°C with successful fish ascending the weir between 9.8 and 10.9°C.

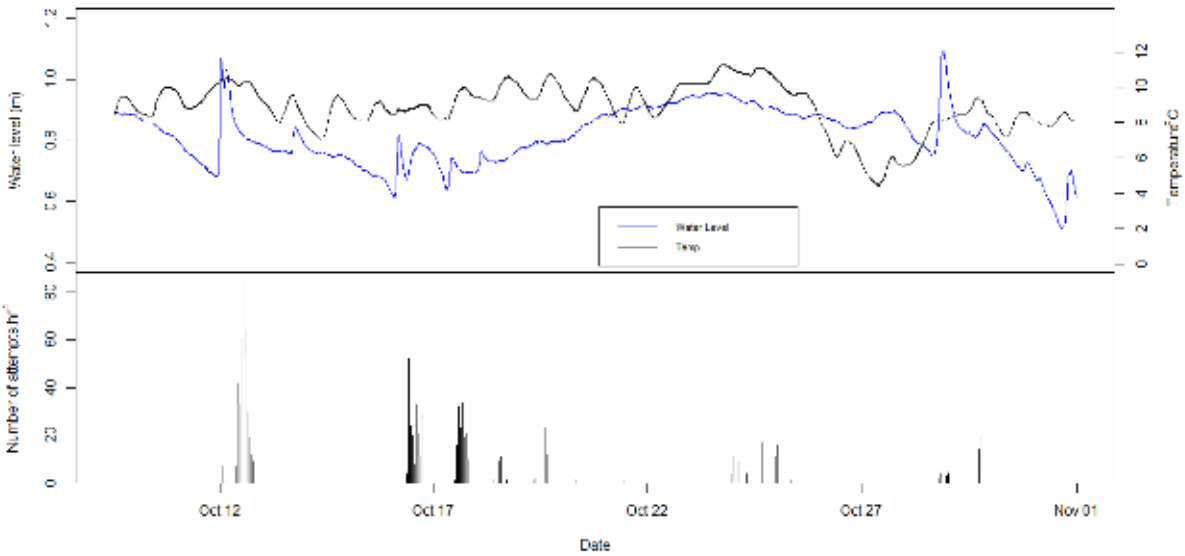


Figure C3. Stage, water temperature and total number of attempts per hour during the 2012 pilot study

2013 – 2014 study

Stage and water temperature data during 2013 are displayed in Figures C4 and C5 and the proportion of time stage was exceeded (S_t, where S = stage and t = the percentage of time that stage was exceeded) was calculated for each stream. Stage and temperature ranged from 0.73 - 1.23 m (S_{95} = 0.75 m, S_{10} =1.17 m) and 4.42 – 14.04 °C on Swanside Beck and from 0.82 – 1.28 m (S_{95} = 0.91, S_{10} = 1.15 m) and 4.42 – 14.04 °C on Chipping Brook.

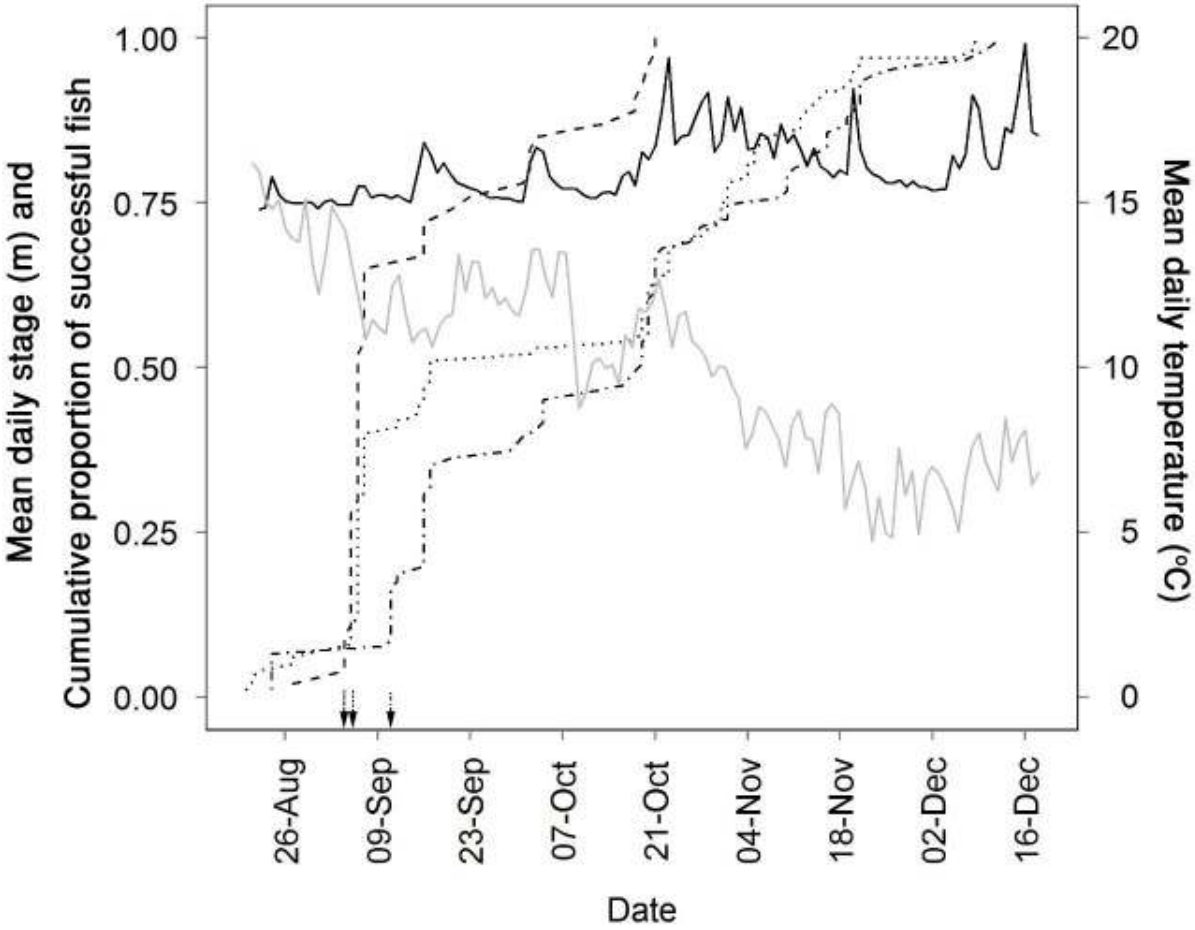


Figure C4. The cumulative proportion of successful fish for Culvert 1 (dashed), Low-cost baffle (dotted) and Pool-Weir 1 (dot-dash) plotted with mean daily stage (solid-black) and mean water daily temperature (solid-grey) for Swanside Beck in 2013. Arrows indicate dates of displacement respectively.

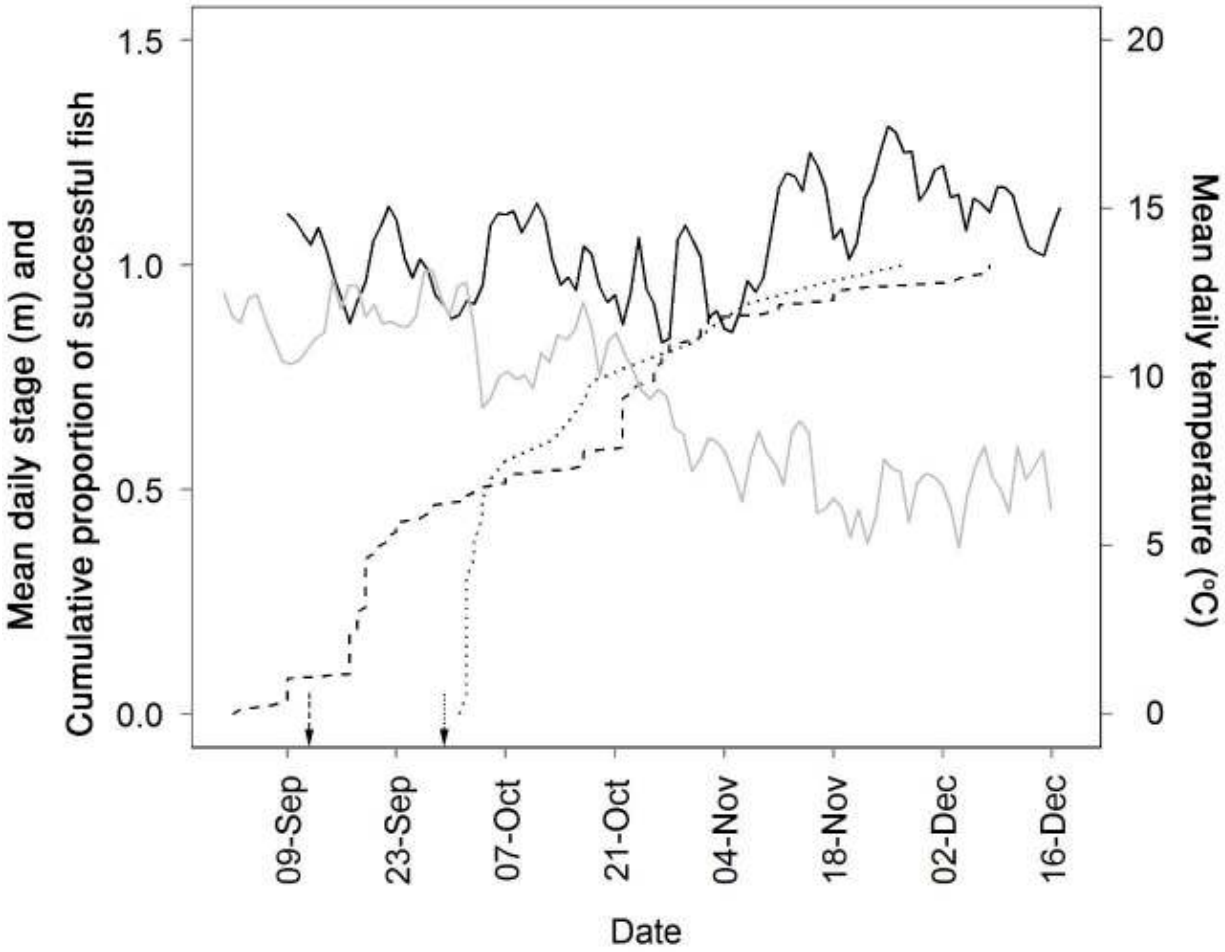


Figure C5. The cumulative proportion of successful fish for Culvert 2 (dotted) and Pool-Weir 2 (dashed) plotted with mean daily stage (solid-black) and mean daily water temperature (solid-grey) for Chipping Brook in 2013. Arrows indicate dates of displacements respectively.

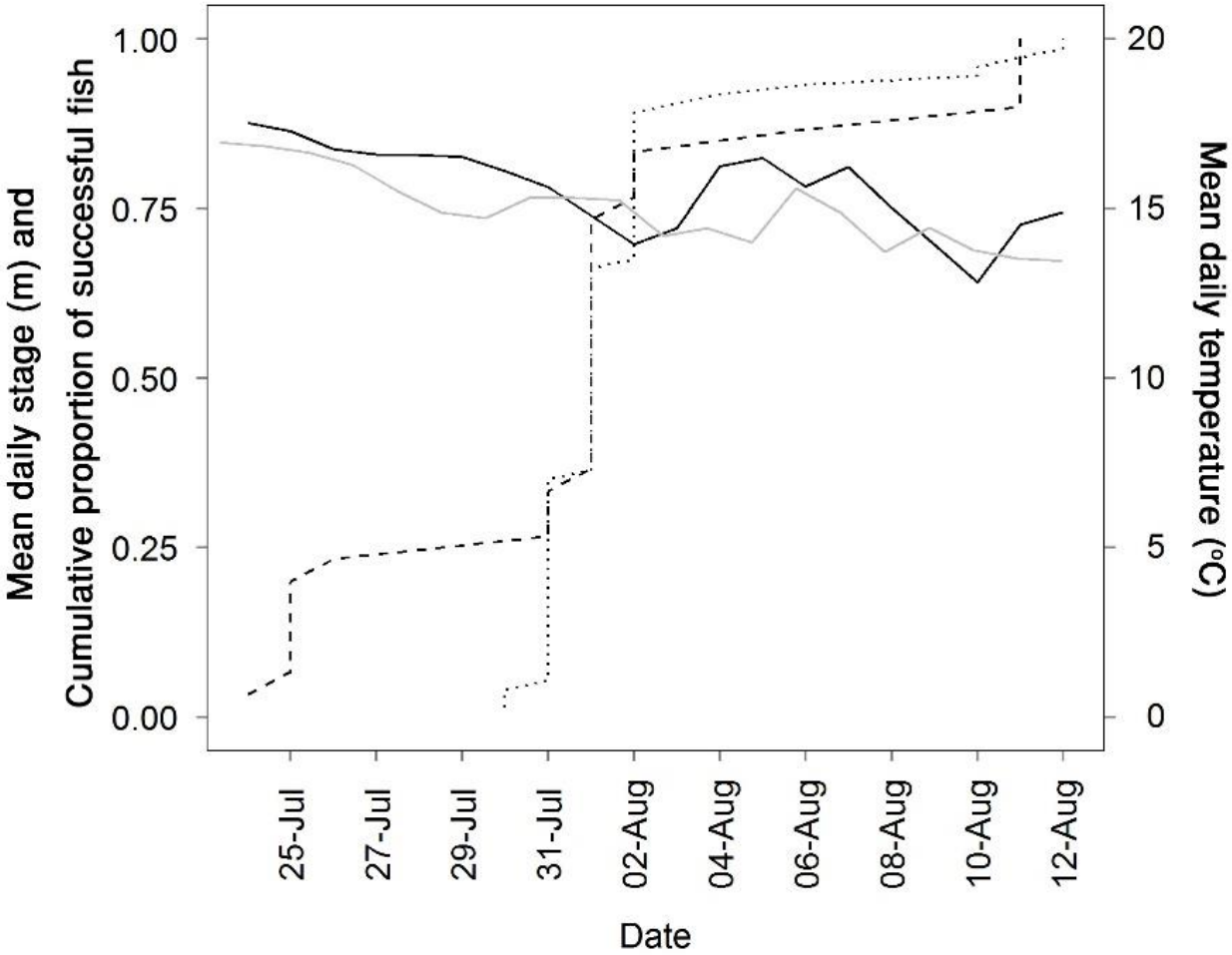


Figure C6. The cumulative proportion of successful fish for Culvert 1 (dashed) and Low-cost baffle (dotted) structures plotted with mean daily stage (solid-black) and mean daily water temperature (solid-grey) for displacement experiments on Swanside Beck in 2014.

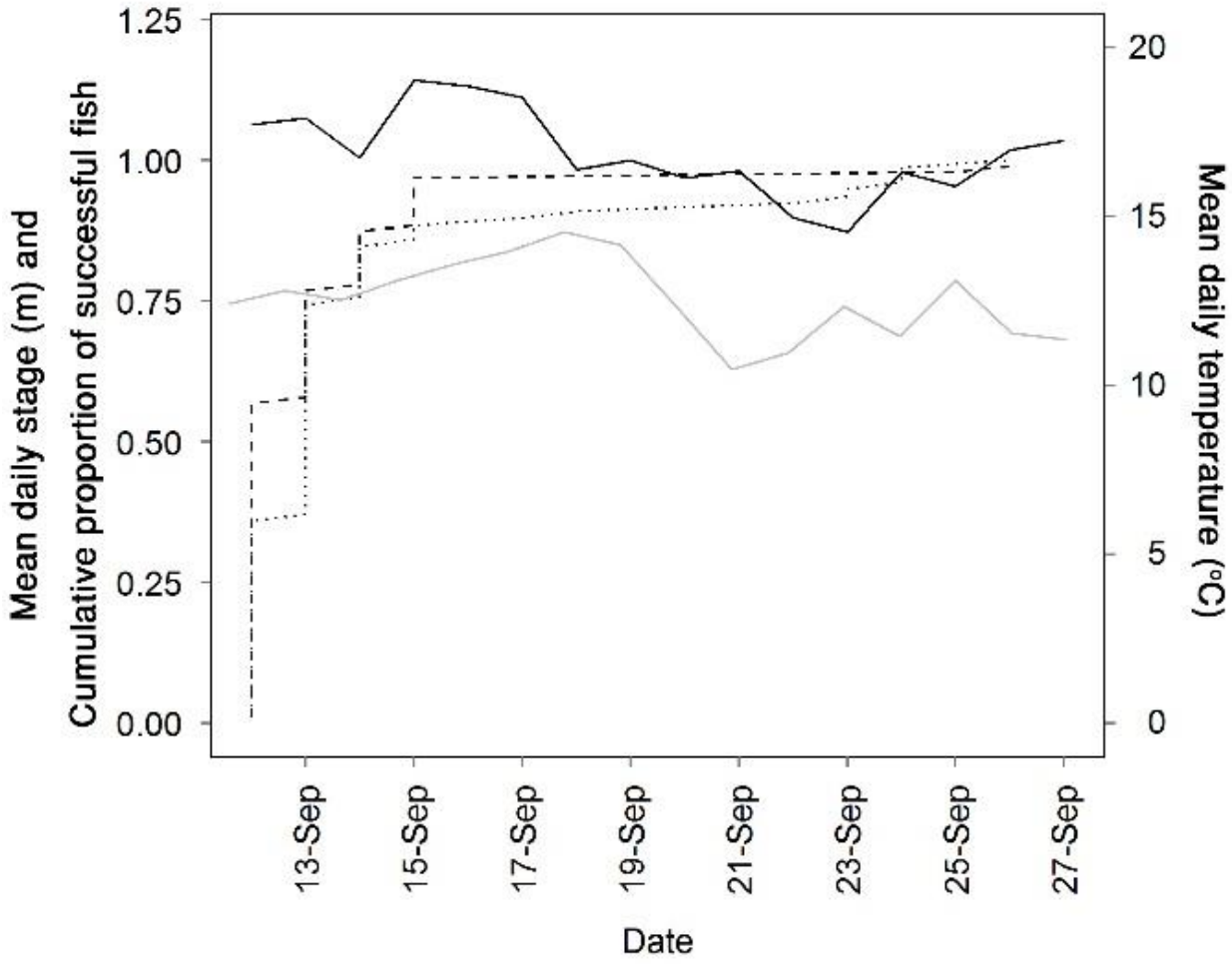


Figure C7. The cumulative proportion of successful fish for Pool-Weir 2 (dashed) and Rock Ramp (dotted) structures plotted with mean daily stage (solid-black) and mean daily water temperature (solid-grey) for displacement experiments on Chipping Brook in 2014.

A total 1228 and 336 trout were PIT tagged in 2013 and 2014 respectively across the two study streams with fork-lengths ranging from 74 – 450 mm (Table C2). Of the five structures investigated in 2013 passage efficiency of trout was observed to be highest at Culvert 1 (100%; Table C3) and lowest at Culvert 2 (37%), highlighting the impact of the differing characteristics of these two structures. Within the three fish passage structures highest passage efficiency was observed at Pool-Weir 1 (76%) followed by the Low-cost Baffle (68%) structure. Passage efficiency was observed to be higher for non-displaced trout than displaced only at Culvert 2.

Table C3. Passage success of *Salmo trutta* in autumnal migration season in 2013

	C1	C2	LCB	PW1	PW2
Number displaced	68	49	128	73	-
Number attempted					
Displaced	35	20	117	48	-
Non-displaced	7	39	78	61	80
Total	42	59	195	109	80
Passage efficiency (%)					
Displaced	100	30	74	79	-
Non-displaced	100	42	63	74	84
Total	100	37	68	76	84
Attraction efficiency (%)	51	41	91	66	-

In 2014 the low-cost baffle structure (82%, Table C4) demonstrated the best passage efficiency of the three fish passes studied, second only to the control Culvert 1 (96%). Of the two cumulative structures in close proximity the most downstream of them, Pool-Weir 2 (79%), recorded a higher passage efficiency than the embedded rock ramp (71%). The Low-cost baffle structure was also more efficient in 2014 than 2013 (Table C4) in displacement experiments by 15%.

In terms of attraction efficiency the Low-cost Baffle structure performed best (91 %; Table C3) with both Culverts 1 (51%) and 2 (41%) performing substantially worse. The lower attraction efficiency observed at Pool-Weir 1 may be an artefact of the data loss in the period directly after displacement. Within the 15 day monitoring displacement experiments attraction efficiency was higher in the 2014 experiments for Culvert 1 and the Low-cost baffle structure which were monitored both years (Table C4). Attraction efficiency was very similar for Pool-Weir 2 (87%) as to the Low-cost baffle (88%) in 2014, with the upstream rock ramp, similarly to passage efficiency, having a lower attraction efficiency than Pool-Weir 2 immediately downstream of it.

Table C4. Passage success of *Salmo trutta* within 15 days following displacement below structures in 2013 and 2014.

	2013			2014			
	C1	LCB	C2	C1	LCB	PW2	RR
Number displaced	68	128	49	53	101	178	154
Attempted	25	94	12	26	89	154	109
Attraction efficiency (%)	37	73	24	49	88	87	71
Succeeded	25	63	4	25	73	121	77
Passage efficiency (%)	100	67	33	96	82	79	71

Delay before successful passage

Delay before successful passage in the long term experiment was shortest at the control Culvert 1 (median = 0.70 h; Figure C8) and longest at Pool-Weir 2 (median = 127.22 h). Though Culvert 1 still provided the least delay in displacement experiments ($median_{2014}$ = 0.51; Figure C9), longest delays were experienced at the Low-cost baffle in 2013 (median = 4.01 h) but were notably shorter in 2014 (median = 0.97 h). Delay was also shorter in the displacement experiment at Pool-Weir 2 in 2014 (median = 2.37 h) following adjustments in its construction after long delays were observed in long term experiments in 2013 (median = 108.29 h). Of the fish passage structures the embedded rock ramp provided the shortest delay both in terms of delay in hours and number of attempts (median = 0.66 h and 1 respectively). As with delay, number of attempts before successful passage was lowest at Culvert 1 (median = 1; Figure C8) and greatest at Pool-Weir 2 (median = 7).

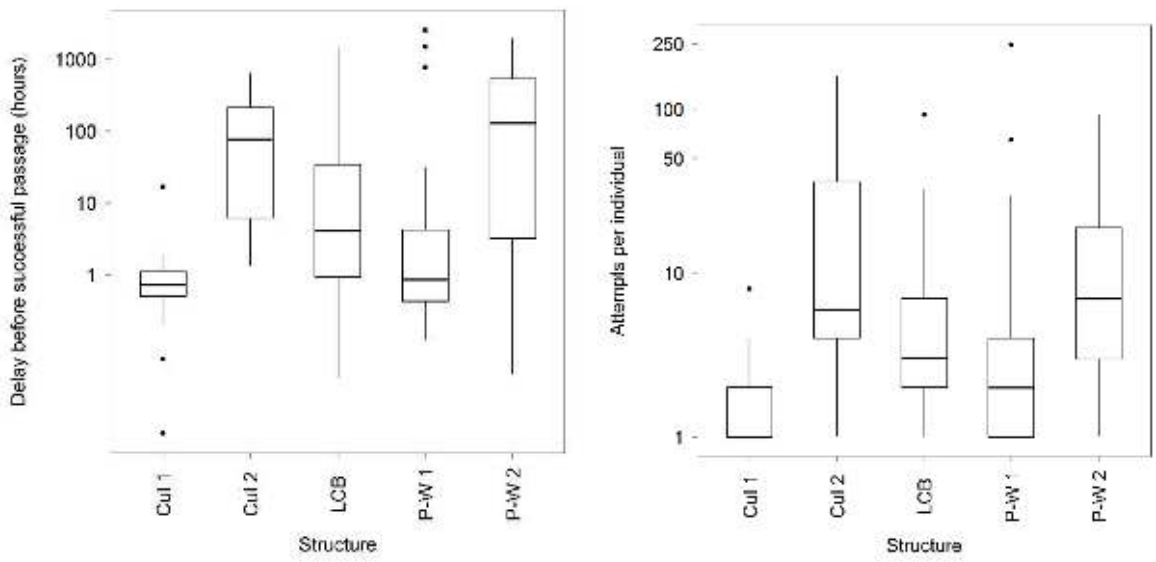


Figure C8. Boxplots of the delay (h) and number of attempts before successful passage for long term experiments in 2013. Boxplots display the median, 1st and 3rd quartiles and the 95% confidence interval of the median with outliers.

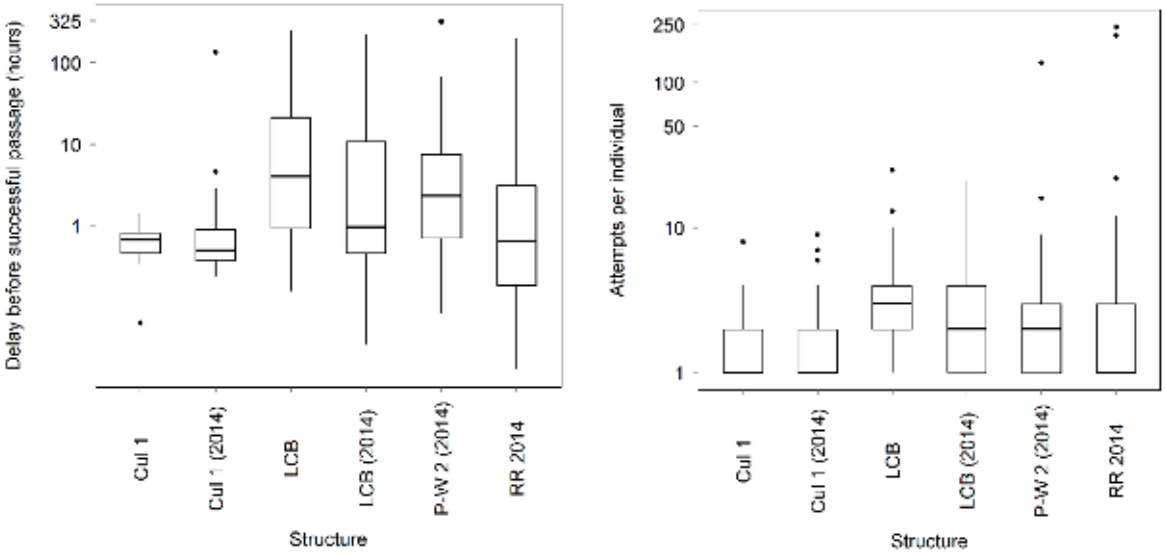
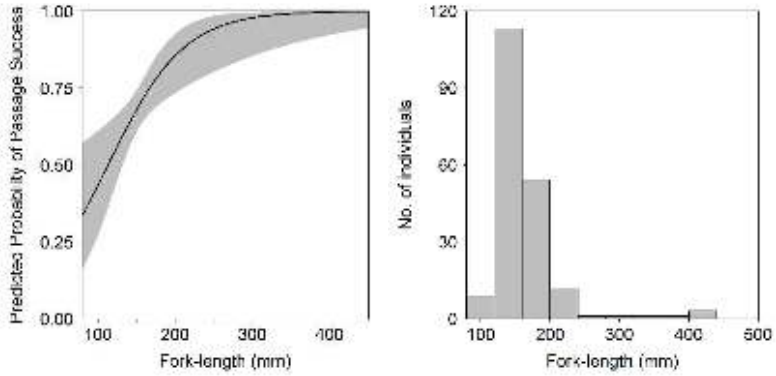


Figure C9. Boxplots of the delay (h) and number of attempts before successful passage for short term displacement experiments. Boxplots display the median, 1st and 3rd quartiles and the 95% confidence interval of the median with outliers.

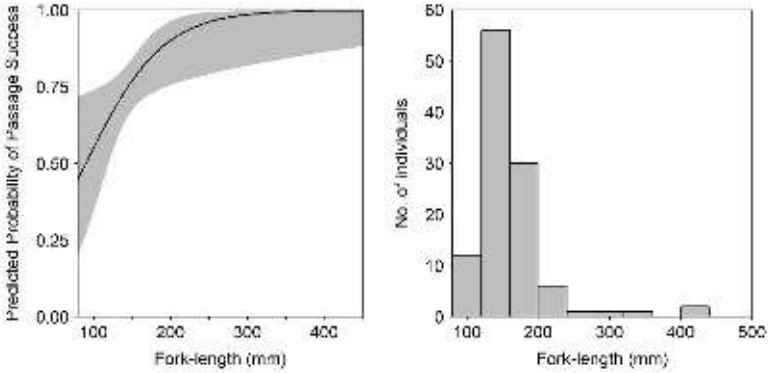
Fork-length and passage success

Significant logistic regression models ($P < 0.05$) were created for three structures (Low-cost baffle, Pool-Weir 1 and Pool-Weir 2) based on data collected in 2013 (Figure C10, Table C5). The models suggest that the Pool-Weir 1 design functioned best for smaller lengths of fish with a 50% predicted probability of passage (P_{50}) associated with a length of 91 mm (Figure C10). Of the other two structures Pool-Weir 2 (P_{50} = 132 mm) performed worse than the Low-cost Baffle (P_{50} = 113 mm) for smaller fish. All structures had a P_{90} under 250 mm with Pool-Weir 1 (P_{90} = 199) showing evidence of better performance than the Low-cost Baffle (P_{90} = 222) and Pool-Weir 2 (P_{90} = 222). Significant models could not be constructed for the two culverted sites.

LCB 2013



PW1 2013



PW2 2013

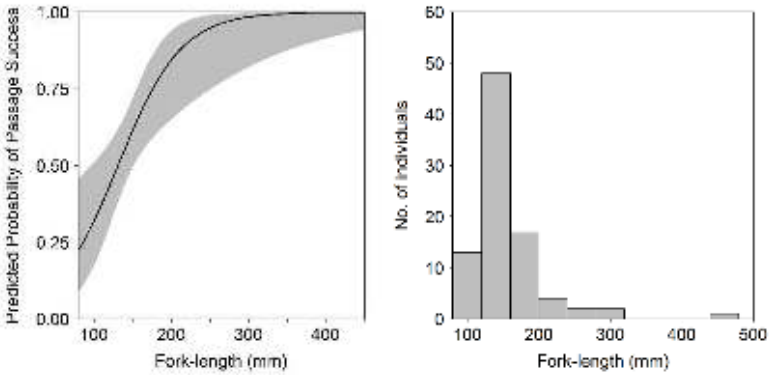


Figure C10. Logistic regression models for predicted probability of passage of an individual based on its length and ultimate passage success data collected during study with 95% confidence intervals (grey area). All models significant against the Null model at $P < 0.05$.

Table C5. Summary of logistic regression models of length and successful passage based on long term observations in 2013.

					Wald test					
Site	Coefficient	Std. Error	z statistic	P <	χ2	df	P <	Likelihood ratio test	df	P <
LCB	0.02	0.007	2.998	0.003	9	1	0.003	13.672	1	0.0002
P-W 1	0.02	0.009	2.331	0.02	5.4	1	0.02	7.8	1	0.005
P-W 2	0.024	0.008	2.977	0.003	8.9	1	0.003	13.669	1	0.0002

Additional electric fishing results

Previous to the construction of the low-cost baffle structure on Swanside Beck, electric fishing surveys upstream of that structure had shown no evidence of Atlantic salmon (*Salmo salar*) spawning upstream of the structure (i.e. presence of juvenile Atlantic salmon) during the history of Ribble Rivers Trust monitoring (Ribble Rivers Trust , unpublished). However in 2014, 1 year post construction, age 0+ Atlantic salmon were found present in quantitative surveys conducted immediately upstream of the low-cost baffle structure and immediately downstream of the P-W 1 structure demonstrating that adults had successfully ascended the structure during the spawning season and successfully spawned, immediately extending their range above the structure when the opportunity presented itself.

Discussion

This study has evaluated the efficacy of three fish passage designs for upstream passage of both juvenile and adult *Salmo trutta* at low-head barriers and the variation in delay that can be incurred even between similarly designed passes. Included in this is the first evidence of the efficacy of a low-cost baffle (Servais, 2006) passage structure for the upstream passage of *Salmo trutta* for which it is compared with other fish pass designs. Predictive models suggested that passage success at fish passage structures was related to fork-length of individuals with probability of passage much reduced for shorter lengths of fish.

Passage efficiencies observed at fish passage structures in this study were all below the 90-100% threshold that has been recommended as a minimum for the sustaining and recovery of populations of diadromous species (Lucas and Baras, 2001). In addition to this passage efficiencies were found to be variable between and within design types with differences also observed across years. Bunt et al. (2012) reported that passage efficiency varied broadly across a range of fishway types when conducting a meta-analysis of 19 studies of 26 species at instream barriers to migration. Where fish had to pass two structures in close proximity at Pool-Weir 2 and then the rock ramp both passage efficiency and attraction efficiency were both lower at the upstream structure (Table C4) despite delays before successful passage being shorter in terms of time and number of attempts at the rock

ramp (Figure C9). Due to the close proximity of these structures it is hard to discern whether this result is influenced more by the individual design of the structures or whether the energy expended in passing the first structure reduces a fish's desire to attempt the second or impacts the likelihood it will pass both structures. Cumulative barriers to migration can potentially have substantial effects on upstream passage even when individual structures pose what seem to be a negligible impact (McKay et al., 2013).

The low-cost baffle structure was found to have a comparable passage efficiency for *Salmo trutta* as the pool-weir design and better than the embedded rock ramp despite the increased slop of the low-cost baffle. Culvert 2 was identified as a key barrier to migration with only 22 of 59 (37%) fish that attempted successfully passing upstream, and those that did incurring long delays both in time and number of attempts before passage. Salmonids are considered to have a strong swimming capacity, however high mean entrance (3.31 ms^{-1}) and in structure velocities (2.32 ms^{-1}) which have to be overcome by fish is one of the likely causes of poor passage performance, particularly to shorter fish as swimming capacity has been shown to be a factor of body length (Beamish, 1978;Videler, 1993). The length of the structure is a likely a compounding factor in poor passage performance with the high velocities being greater than the expected prolonged swimming performance (Beamish, 1978). That fish were successful in ascending the structure suggests that they may be able to exploit flow refugia when passing through the culvert.

In this study 50% probability of successful passage at passage structures was associated with lengths representative of trout in the 1+ age cohort for this catchment (92 – 132 mm; Forty, unpublished). Creating fish passage structures in small streams so that they are passable by juvenile fish as well as adults is beneficial for recovery of populations following disturbance events such as high stream flows or pollution incidents.

Migratory delay incurred before successful passage at structures was found to be highly variable between structures with long delays not always being associated with low passage efficiencies (e.g. Pool-Weir 2 in 2013; Table C3). Delays in terms of time were slightly shorter within displacement experiments than long term likely because of the shorter duration of monitoring post-displacement biasing towards fish which may have a greater desire to pass upstream than ones which wait longer before attempting. However the median number of attempts fish made to pass was not particularly different between years. As with improved passage efficiency, the low-cost baffle structure also showed improved performance in terms of delay before passage with the reasons for this likely being similar to those discussed previously. The improvement works on Pool-Weir 2 between 2013 and 2014 appear to have been successful in addressing the issues with long delays, suggesting that these were caused by conditions caused by the unsuitable head drop at the entrance notch to the structure (Table C1, Table C4).

Field studies are a vital component of evaluating fish pass effectiveness and informing management decisions as demonstrated by positive results observed in 2014 following the actions that could be taken after the identification of long delays incurred at Pool-Weir 2 during 2013 in this study. The relatively small number of fish passage structures which have been evaluated in relation to the large number constructed globally is very small (Schmultz et al., 1998). This is particularly true of low-head instream structures present within smaller streams (Ovidio & Philippart, 2002; Alexandre & Almeida, 2010) as demonstrated in this study, there is a wide variation in efficacy between and within fish pass

designs, especially in terms of efficiency for different life stages and in the delays which can be incurred even between similarly designed structures. Further results from this work will be available in the future as a chapter in a Ph.D. thesis by Michael Forty from Durham University.

Acknowledgements

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Appendix D. Invertebrate monitoring of the riparian habitat schemes delivered under the Diffusing the Issue project, 2014.

Introduction

RIVPACS (Wright *et al*., 1997) lists 637 standardised, aquatic macroinvertebrate taxa in existence in UK rivers and ponds. Their variation in physical form is suited to different functions in behaviours to suit their food, habitat and water quality preferences. Presence of individual species may therefore provide a suitable measure for assessment of these variables. The ecological response of macroinvertebrates was sought in response to works installed by the Ribble Rivers Trust.

The RRT has maintained a range of invertebrate monitoring work for eight years largely in support of the Riverfly partnership. This has provided a simple overview of the local environmental conditions and helped to inform sudden deterioration in states (e.g. incidences of pollution). One of the RRT network of volunteers has undertaken their own programme of study (through the FBA) to develop their competence and provide the expertise for CRF investigation purposes. The reassessment of habitat works through sampling the invertebrates was led by Steve Johnson during the summer, 2014.

Additional investigations are also ongoing as part of a PhD being undertaken by Mike Forty, of Durham University. The key findings from these activities are due to be reported in late 2015 early 2016 noting the ecological response to river restoration techniques adopted by the RRT.

Methodology

Habitat schemes were created upon three tributaries of the Ribble; Skirden Beck, Stock Beck, and Swanside. It also incorporated two from the Hodder system; Easington Beck and the River Loud. These habitat schemes were created between 2013 and 2015, with the majority of works undertaken in 2013-2014. To assess the short-term impact of the improvements, monitoring of the invertebrate assemblages was undertaken. Paired or triplicate kick samples were taken above, within, and below habitat improvement works within the water bodies outlined above with except to Skirden Beck. Sampling techniques were adopted in accordance with RiverFly Monitoring protocols http://www.riverflies.org/rp-riverfly-monitoring-initiative

Figure A1 i. *Map of habitat scheme (indicated in yellow) at the Stock Beck*

Figure A1 ii. *Photographs of paired kick sample site locations situated, above (upper photographs), within (middle) and below habitat schemes (lower) upon Stock Beck 15/08/2014.*

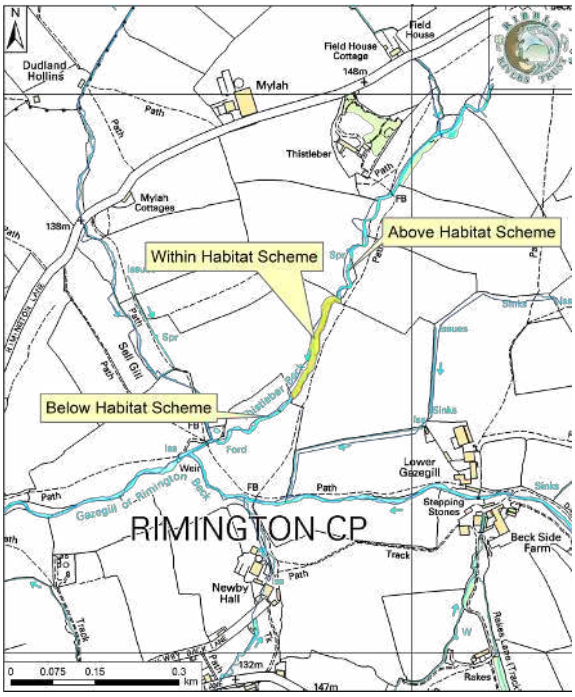


Figure A2 i. *Map of habitat scheme (indicated in yellow) at the Eel Beck on Swanside*

Figure A2 ii. *Photographs of paired kick sample site locations situated, above (upper photographs), within (middle) and below habitat schemes (lower) upon Eel Beck 03/09/2014.*

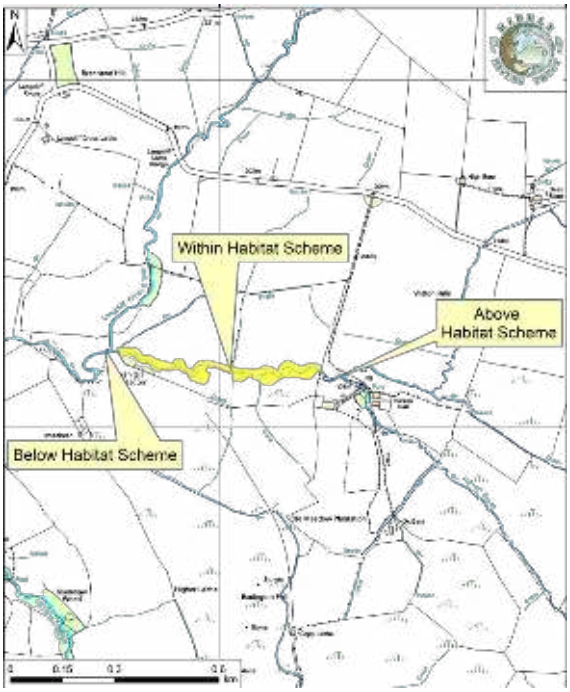


Figure A3 i. *Map of habitat scheme (indicated in yellow) at the Easington Beck*

Figure A3 ii. *Photographs of paired kick sample site locations situated, above (upper photographs), within (middle) and below habitat schemes (lower) upon Easington Beck 10/09/2014.*

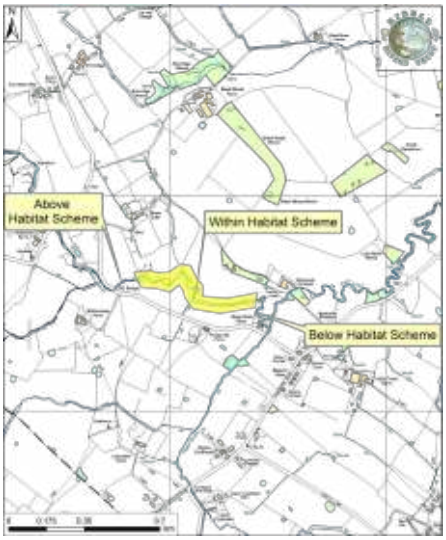


Figure A4 i. *Map of habitat scheme (indicated in yellow) along the River Loud*

Figure A4 ii. *Photographs of paired kick sample site locations situated, above (upper photographs), within (middle) and below habitat schemes (lower) upon the River Loud 05,19/08/2014.*

Results

Where assessing the kick sampling results using any of the selected scoring systems, the best performing conditions were observed within the section of river enclosed by the habitat scheme.

Relative abundance and species diversity of aquatic invertebrates found in relation to proximty of a habitat improvement works. The raw data obtained was analysed and displayed using a range of different array of scoring systems to include: The number of taxa; WHPT; WHPT average score per taxa; BMWP score (old).

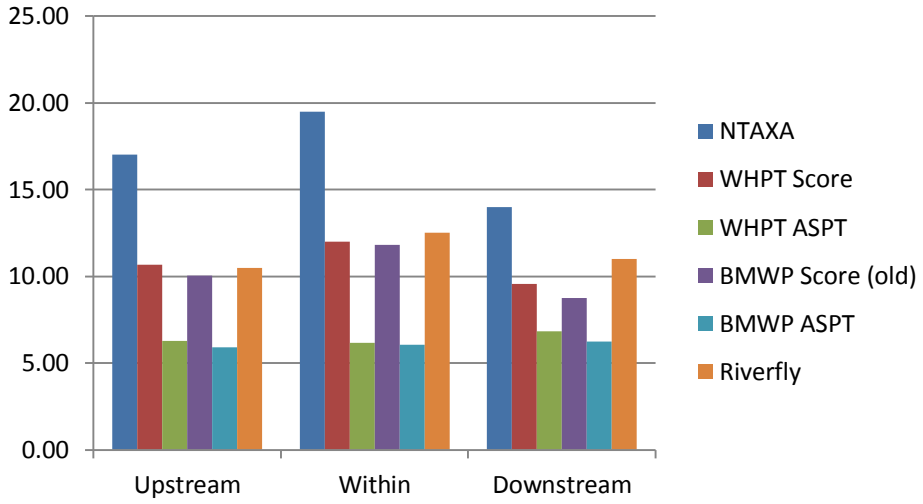


Figure A5. *Results of the riverfly monitoring for Stock beck, displaying an array of invertebrate scoring systems.*

The data in Figure 5. collected along Stock beck shows that the average species per taxa (WHPT ASPT, BMWP ASPT) remained largely the same throughout the three sample types. However, the Riverfly scoring system (which assigns a score to each family based on its' tolerance to pollution) shows higher scores for 'within' and 'downstream' of the habitat scheme compared to the 'upstream' sites.

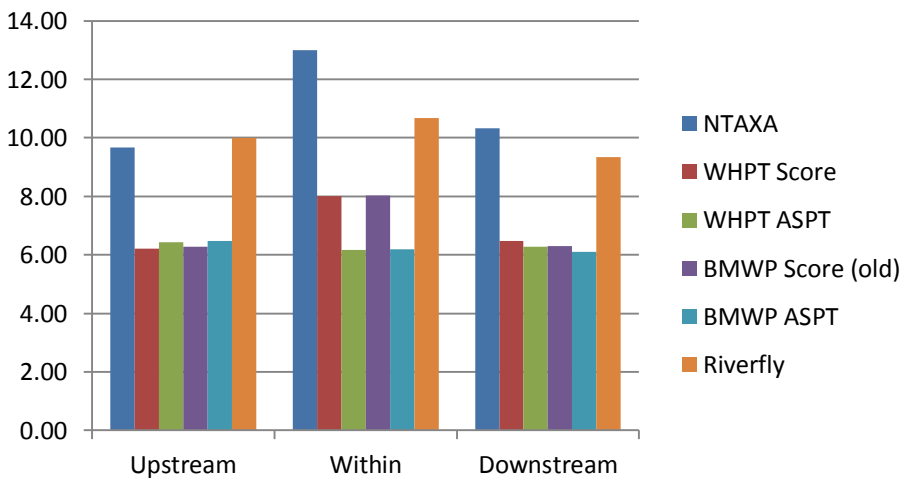


Figure A6. *Results of the riverfly monitoring for Eel beck, Swanside, displaying an array of invertebrate scoring systems.*

The data in Figure A6. (Eel beck) shows that the average species per taxa (WHPT ASPT, BMWP ASPT) remained largely the same throughout the three sample types. However, the Riverfly scoring system (which assigns a score to each family based on its' tolerance to pollution) shows a slightly higher score for 'within' when compared to sites 'upsteam' and 'downstream' of the habitat scheme.

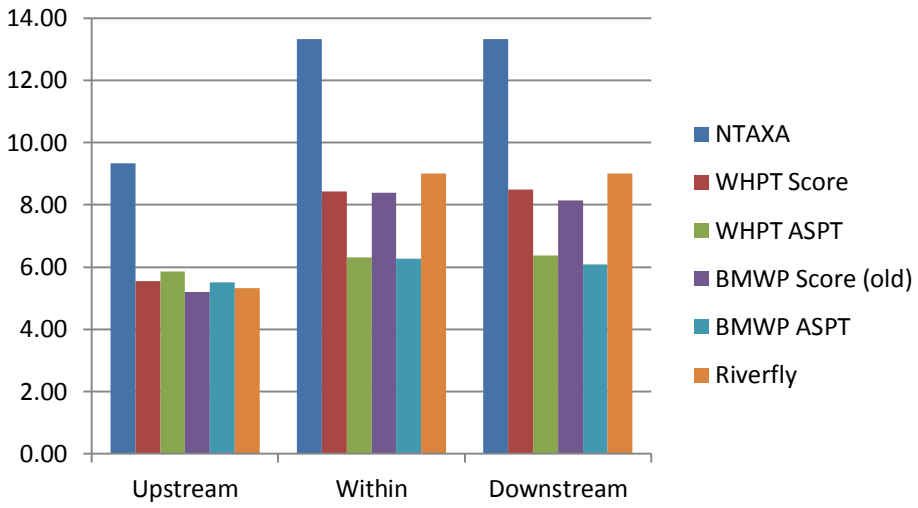


Figure A7. *Results of the riverfly monitoring for Easington beck, displaying an array of invertebrate scoring systems.*

The data above shows that the average species per taxa (WHPT ASPT, BMWP ASPT) and Riverfly data (which assings a score to each family based on its' tolerance to pollution)show a noticibly higher score 'within' and 'downstream' of the habitat scheme when compared to sites 'upstream'.

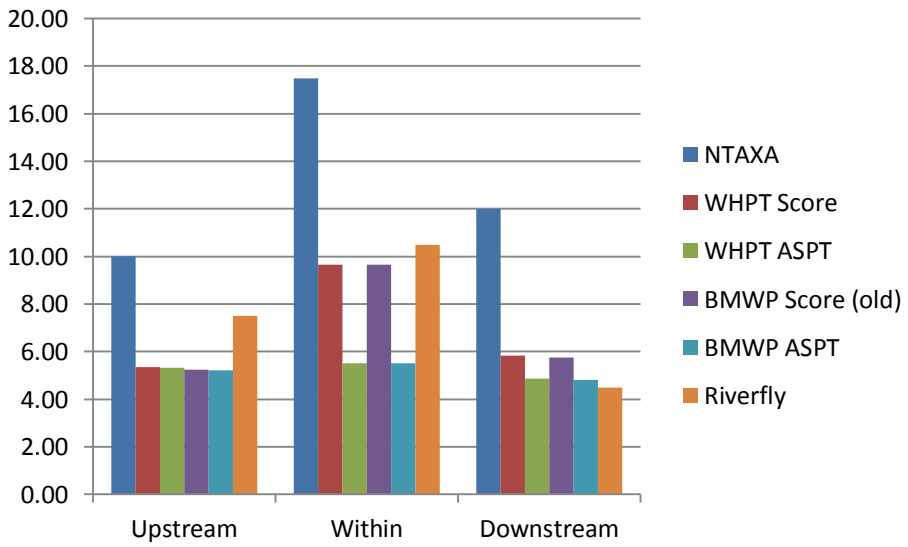


Figure A8. *Results of the riverfly monitoring for the River Loud, displaying an array of invertebrate scoring systems.*

The data in Figure A8. shows that the average species per taxa (WHPT ASPT, BMWP ASPT) remained largely the same throughout the three sample types. However, the Riverfly scoring system (which

assigns a score to each family based on its' tolerance to pollution) shows higher scores for 'within' when compared to sites 'upsteam' and 'downstream' of the habitat scheme.

Generally, when looking at the data across the Diffusing the Issue project area the number of taxa was highest within the river section enclosed by tree planting to either side. The lowest number of taxa was discovered in the unfenced section above the habitat scheme, except along the River Loud scheme.

Discussion

The preliminary findings from these surveys provide an indication that a more abundant and to a lesser degree, a richer macroinvertebrate assemblage exists within the river section that has been fenced off and tree planted to both banks. This is compared to those sections were there is fencing to one bank (below the scheme) or none at all (above). The increased presence of species over small spatial scales reduces the chance that water quality variability is the principle controlling factor and that other environmental variables are impacting on the result. Greater vegetative growth and species diversity within protected, riparian zones has been observed (Appendix F) and provides a plausible reasoning for the observed differences. However, further monitoring of the macroinvertebrate response to habitat variables would be required to answer whether a sustained, postive change is confirmed.

References

Wright, J., Sutcliffe, D. and Furse, M. (1997). Assessing The Biological Quality Of Fresh Waters: RIVPACS And Other Techniques. [Online] Ambleside, Cumbria, UK: Freshwater Biological Association. Available at: http://aquaticcommons.org/5341/1/SPEC8a_2000_wrig_anin.pdf [Accessed 18 Mar. 2015].

Appendix E. RRT Electrofishing survey results

Introduction

Since 2008, the RRT has undertaken a programme of electrofishing led by its Fisheries Scientist utilising volunteers mainly from academia and local angling clubs. The technique involves passing an electrical current into the water which invokes a swimming response in nearby fish. They are drawn towards a point where the fish can be netted off. Typically, 300 sites are surveyed to gain an understanding of the catchment fish population and its health. There are a total of 67 sites across the Diffusing the Issue project areas surveyed during the course of the past seven years, all of which were surveyed in 2014. Surveys as follows; Seventeen in River Loud, six in Easington, seventeen in Skirden, Eleven in Stock, and 16 within Swanside (see Figure B1). Academic volunteers, often as part of their degree programmes, learn from the experience as a novel survey technique and ascertain data for their own research projects. The activity also acts as an important engagement tool with local landowners and stakeholders. Whilst often attracting people through the visual spectacle it creates it also represents an opportunity to inform the public about the aquatic environment and its inhabitants.

Results

Since the CRF launch there has been an overall reduction in the total and average NFCS grades for salmon within accessible CRF areas (Figures B2). The results over the last three years suggest an upward trend leading into 2015. The average grade for salmon fry densities within CRF areas has mirrored the averages for non-CRF sites or the catchment average during this period (Figure B4). Therefore, it remains possible that the impact of riparian habitat schemes has yet to be established until they are more mature.

For Trout, grade averages reduced over the period for CRF, non-CRF and the entire Ribble catchment (Figure B3). The rate of decline was least in the CRF areas compared to non-CRF and catchment wide sites, although the average grade score was consistently lower. For sites where the RRT retain four years' worth of data, there was an overall grade improvement in 2014 compared to 2011.

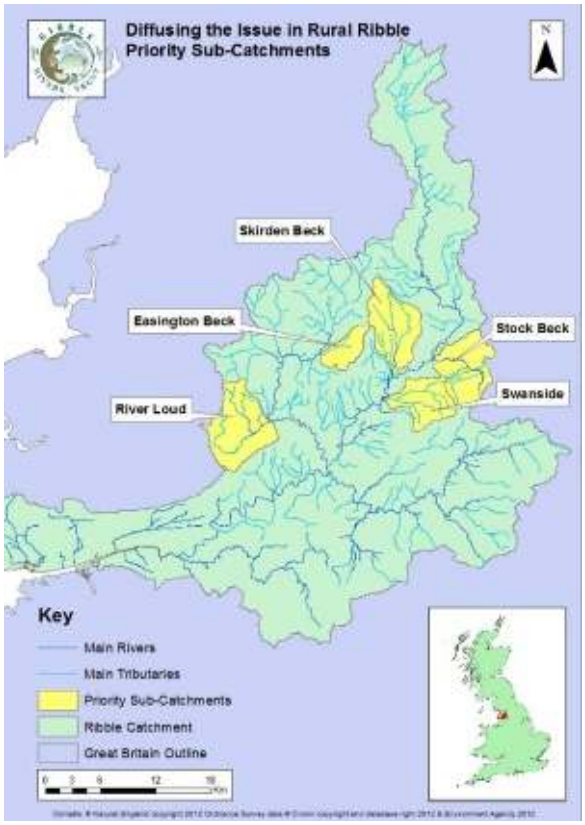


Figure B1. *Map of the 'Diffusing the Issue' areas within the Ribble Catchment*

Electrofishing survey underway upon Waddington beck, 29/8/14.

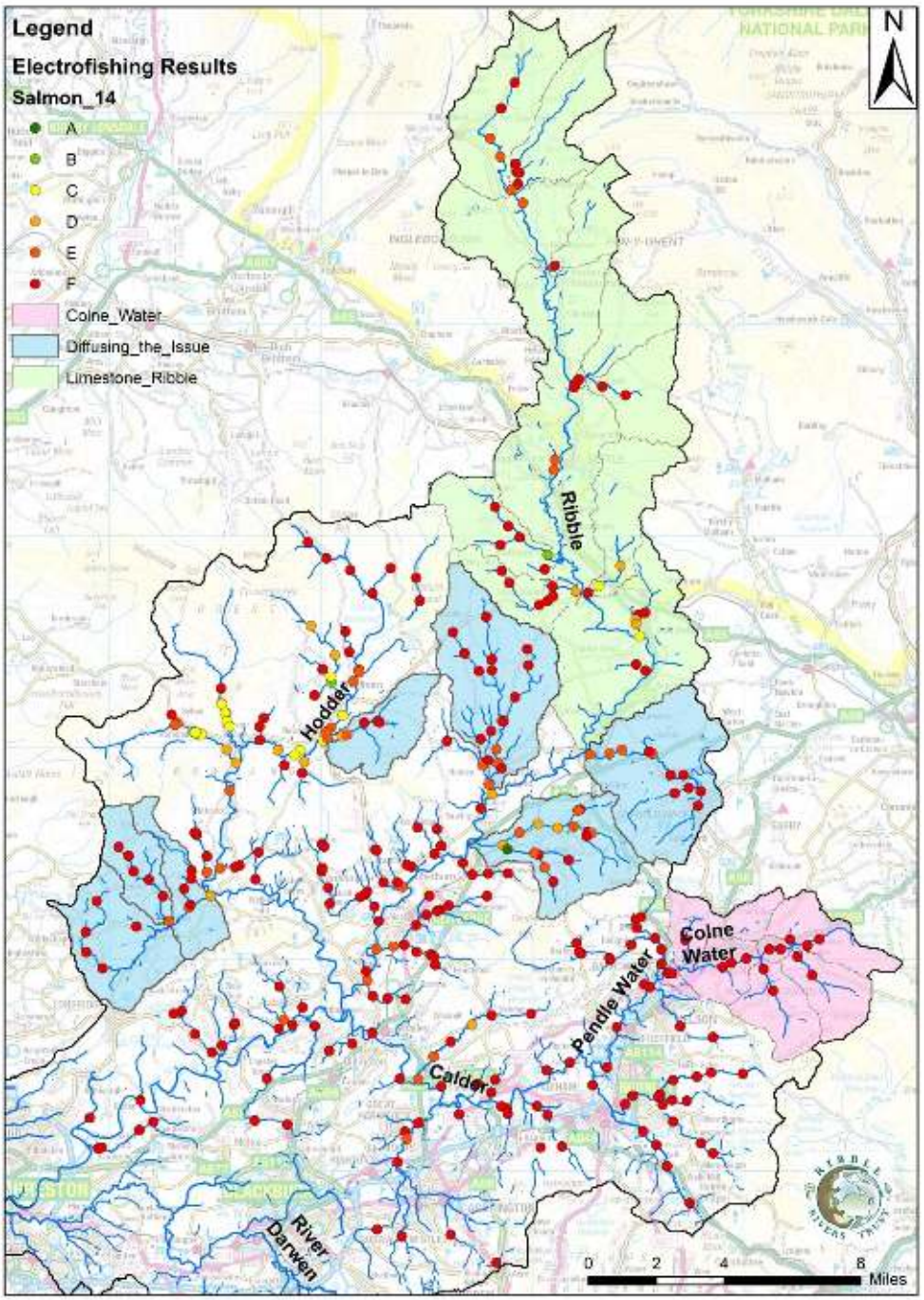


Figure B2. *Map of the Brown trout NFCS grades for survey sites electrofished by the RRT, 2014**. Green colouration indicates higher grades and higher densities of fry, red indicate an absence of fry. The display of grades is taken from an integrated data set obtained from RRT and EA electrofishing surveys.*

***display of grades is taken from an integrated data set including EA electrofishing for 2014.*

Figure B3. *Map of the Salmon NFCS grades for survey sites electrofished by the RRT, 2014**. Green colouration indicates higher grades and higher densities of fry, red indicate an absence of fry. The display of grades is taken from an integrated data set obtained from RRT and EA electrofishing surveys.*

***display of grades is taken from an integrated data set including EA electrofishing for 2014.*

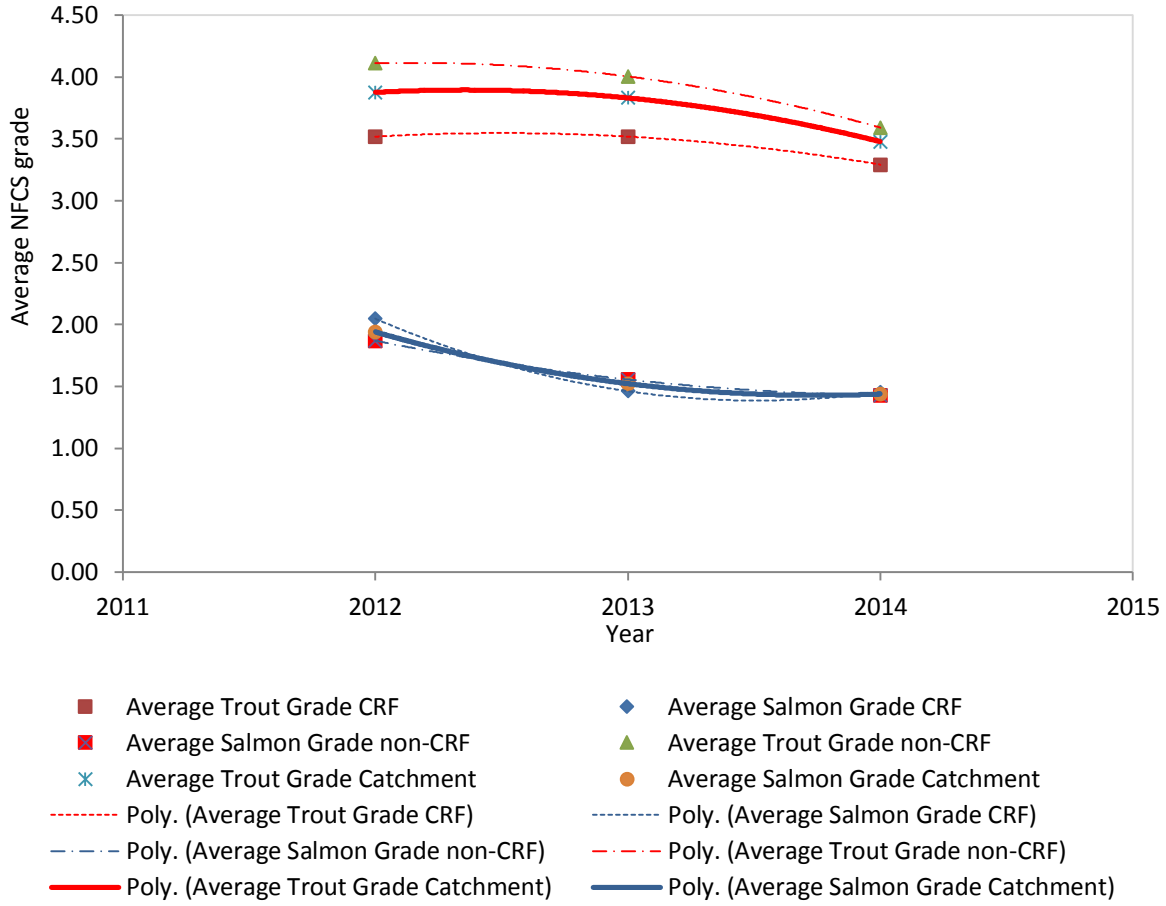


Figure B4. *Average grades for juvenile trout and salmon across sites within: Designated CRF areas; non-CRF areas; and across all of the catchment in 2012 to 2014.*

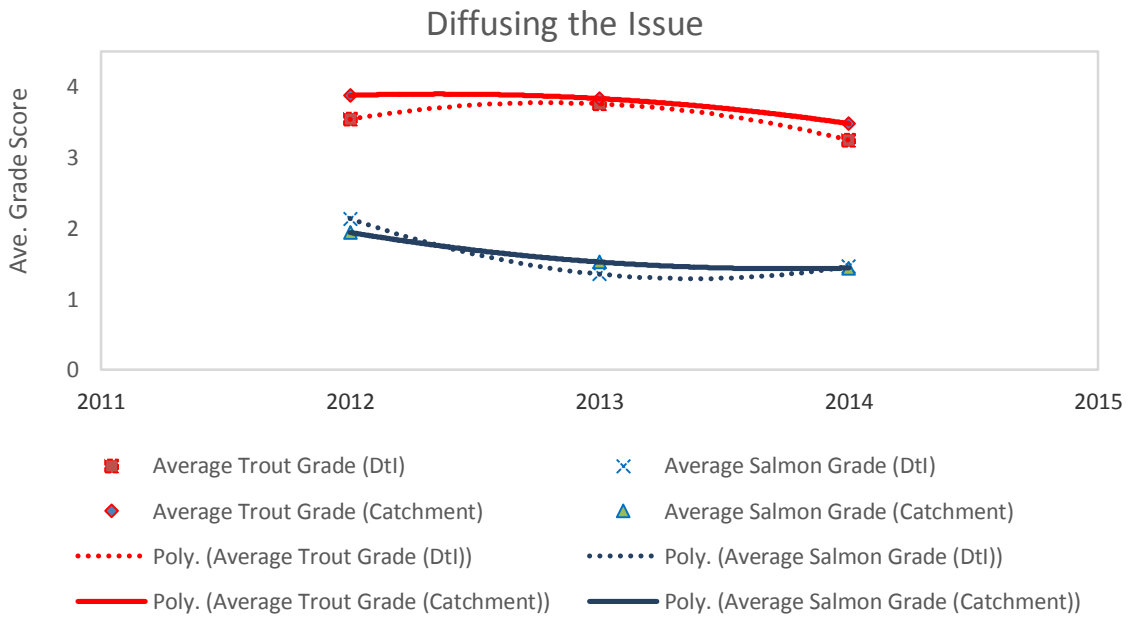


Figure B5. *Average grade scores for Brown Trout and Salmon within Diffusing the Issue and across the whole catchment for the period 2012 to 2014.*

Further interrogation of the individual CRF areas is considered thus: Salmon grade averages have been higher in 'Diffusing the Issue' than the catchment wide average until this year (Figure B4, B5). On current trends this may fall below the catchment average in future years. The trend for the 'Diffusing the Issue' mirrors the catchment average and suggests that the future salmon grade average will improve. The area north of Pendle Hill through Ings Beck and Swanside represents one of the most productive salmon spawning becks in the catchment.

Within the 'Diffusing the Issue' area, average grade scores for Trout declined over the period (see Figure B4, B5). This decline in grade scores mirrors the general decline across the catchment.

Appendix F. The effect of excluding livestock on ground flora and soil compaction along Easington Brook. Highlights taken from a draft BSc dissertation by volunteer and student, Stephen Harrison (York University).

Abstract

Water quality on UK farms has decreased due to an increase in diffuse pollution, mainly from fertilisers and faecal matter from livestock. To improve watercourses environmental schemes have been implemented on farms in the UK. Riparian Habitat schemes exclude livestock from watercourses and create buffer strips which can be high in biodiversity. This study compared five areas along Easington Brook, Lancashire. Three of the areas were under Riparian Habitat schemes and two were not. In each area, a stratified sample was used to measure percentage cover of ground flora species, including nutrient enrichment indicator species and soil compaction.

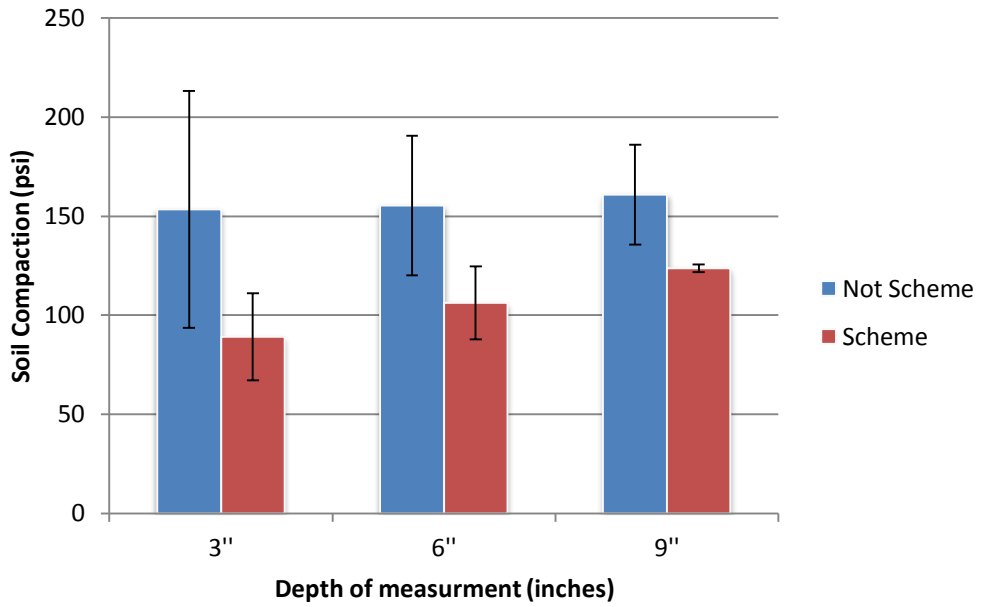
The areas in schemes had significantly higher mean species richness compared to the non-scheme areas. The scheme areas has higher species diversity, however there was only statistical differences between certain areas. Overall the scheme areas have higher percentage cover of the nutrient enrichment indicator species: cleaver, dock and nettle. Soil compaction was highest in the non-scheme sites, compaction also increased with depth and distance away from the Brook in all five areas. From the study it is clear that excluding livestock from watercourses increases the richness and diversity of ground flora species, and decreases soil compaction. However more research needs to be done on the effect of Riparian Habitat schemes on nutrient enrichment species. It can be concluded that Riparian Habitat schemes can be used to restore rivers and riparian habitats, and are greatly beneficial.

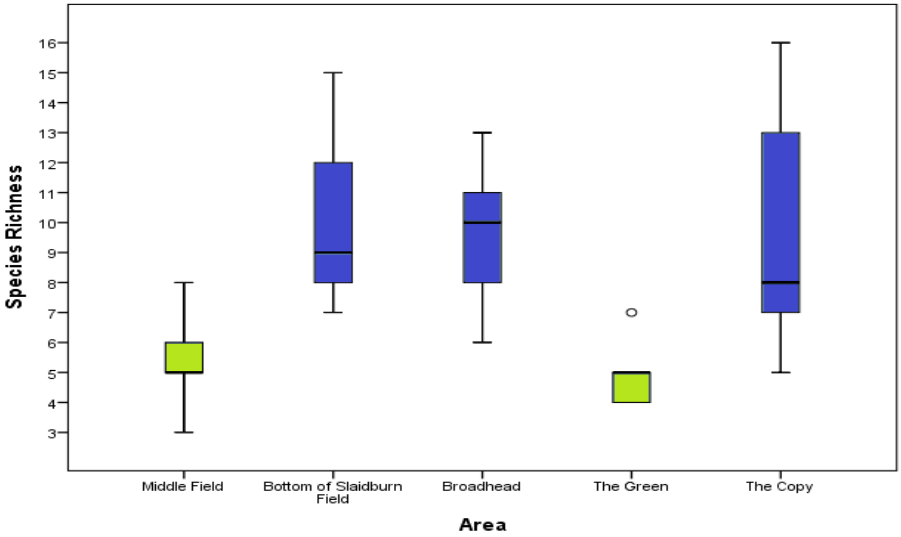
Key findings

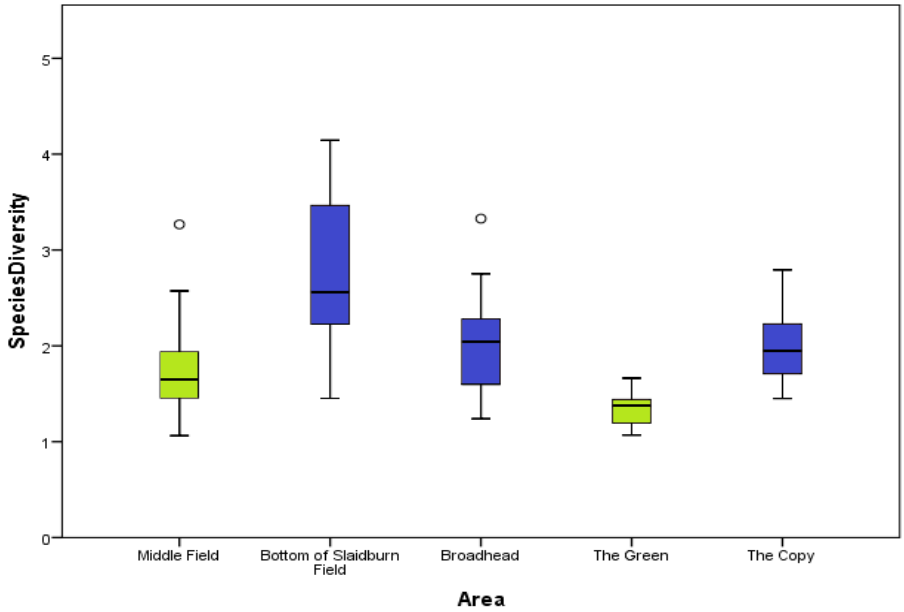
The following figures summarise the findings from the dissertation presenting a positive indication of the impacts upon soil compaction, plant species richness and diversity resulting from the installation of riparian habitat schemes. Each of the sampling sites correspond to sections of riparian habitat along Easington Brook (within the Diffusing the Issue area) some fenced off others not. A summary of these location is provided in the table below.

Area	Name of Area	Location	Restoration Scheme	Year of scheme implementation	Land Use (Before scheme or currently)
1	Middle Field	Harrop Hall Farm	None	N/A	Grazing - Sheep and beef Cattle
2	Bottom of Slaidburn Field	Harrop Hall Farm	Riparian Habitat Scheme	2009	Grazing - Sheep and beef Cattle
3	Broadhead	Broadhead Farm	Riparian Habitat Scheme	2003	Grazing - Sheep and dairy Cattle

4	The Green	Manor House	None	N/A	Grazing - Sheep
5	The Copy	Manor House	Riparian Habitat Scheme	2011	Grazing - Sheep and dairy Cattle


250
200
150
100
50
0
Soil Compaction (psi)
3''
6''
9''
Depth of measurment (inches)
Not Scheme
Scheme


Species Richness
16
15
14
13
12
11
10
9
8
7
6
5
4
3
Middle Field
Bottom of Slaidburn Field
Broadhead
The Green
The Copy
Area


SpeciesDiversity
5
4
3
2
1
0
Middle Field
Bottom of Slaidburn Field
Broadhead
The Green
The Copy
Area

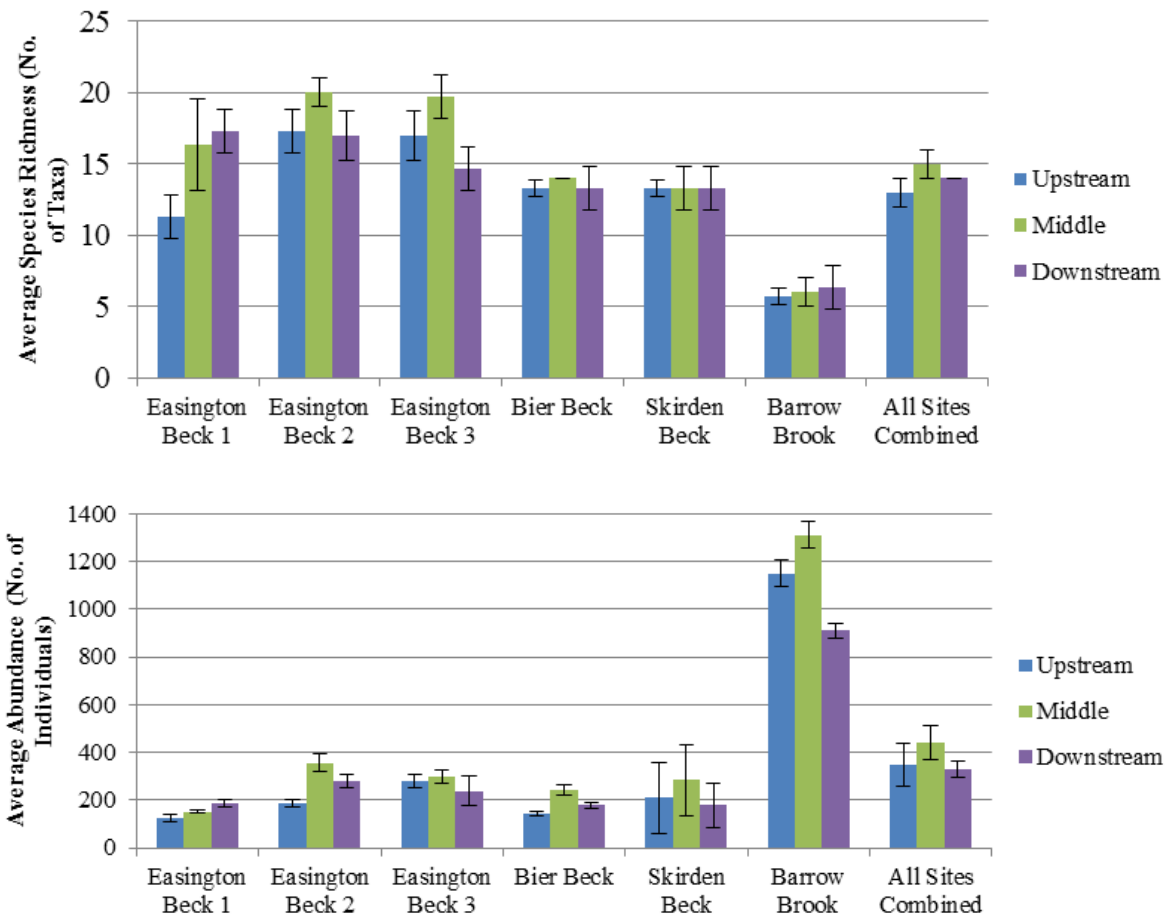
Appendix G. Analysing the Success of Physical Habitat Restoration Schemes within the Ribble Catchment by Sarah Underhill (Lancaster University).

Abstract

Based on sound ecological theory, the practice of restoring physical habitat heterogeneity either within or adjacent to the river system to address freshwater degradation is at the forefront of applied hydrologic science. Specifically, large investments into methods such as gravel placement, livestock exclusion, weir removal and riparian vegetation planting are being applied worldwide, with over 2000 physical habitat restoration schemes now implemented across England and Wales alone. However, despite the great importance and growing activity surrounding these schemes, their success in improving both the ecological integrity and functioning of freshwater ecosystems is currently uncertain or unknown. In an attempt to address this issue, the present study analysed the success of a variety of physical habitat restoration schemes implemented throughout the Ribble Catchment in relation to macroinvertebrate community assemblages within the river system.

Specifically, this research found that macroinvertebrate community abundance levels were significantly higher ($P<0.005$) within the middle, compared to upstream or downstream, of riparian habitat restoration schemes implemented throughout the Ribble Catchment. Furthermore, macroinvertebrate diversity levels were also found to be significantly higher after the introduction of gravel into the river system in comparison to a number of control sites, e.g. BMWP Score ($P=0.012$) and LIFE Score ($P<0.005$). These results therefore support the paradigm that the heterogeneity of physical habitat is one of the most dominant factors organising stream communities within the freshwater ecosystem. However, to advance this research further, future work is required to address both the inconsistencies within the results and sampling artefacts that were found within this research. In conclusion, despite these concerns, this research study provides a case study for the success of physical habitat restoration schemes in improving aquatic community assemblages within the freshwater ecosystem that can be applied to wider research.

Easington brook, Skirden and Bier Becks fall within the 'Diffusing the Issue' project area. The following charts illustrate the comparative abundance and species richness of areas above, within and below the habitat scheme to provide an illustration of the spatial variation that exists in proximity to practical works. The charts present the major outcomes of the study pertinent to the Diffusing the Issue areas.



Bar charts representing Average Species Richness (upper chart) and Average Abundance (lower chart) found at the upstream, middle and downstream sampling locations at each individual site and all sites combined (error bars = standard deviation).

Appendix H. Walkover surveys of 'Diffusing the Issue' project area.

INTRODUCTION

Between 2009 and 2011 the APEM consultancy group undertook a series of systematic walkover surveys at the request of the Environment Agency across the Ribble catchment. Their aim was to identify sediment pathways running off farmland and into water courses in areas failing to meet Water Framework Directive (WFD) standards. The failures were identified, in part, as due to elevated levels of ammonia and phosphate resulting from such practices.

The identification of these pathways provided the locations for targeted improvement works by the Ribble Rivers Trust (RRT) utilising Catchment Restoration Funds. Many of the works took the form of riparian fencing and tree planting schemes to create buffer strips alongside the water course. The purpose of this survey exercise was to revisit those features as identified by APEM in 2010 and re-assess their physical condition following the RRT works.

METHODOLOGY

Within the geographic boundaries set by the 'Diffusing the Issue' project, previous walkover surveys were completed along sections of the River Loud and Stock Beck. The River Loud is a low gradient system flowing south then North East through good-quality rural pasture from its source below Parlick fell (432m above sea level). The river carries a heavy silt burden and is atypical of other tributaries of the Hodder in terms of its course and planform. It retains a run of salmon across its lower tributaries across Chipping, Leagram and Greystonely brooks yet they do not ascend beyond Gibbon Bridge.

Stock Beck drains the town of Barnoldswick below its source on Weets hill (397m above sea level). The beck charts North East then due west through mixed-pasture land where it reaches the main stem of the Ribble above Gisburn. The lower end of the beck provides rearing habitat for salmon, grayling and white clawed crayfish.

Walkover surveys were performed on the 17th December 2014 along Leagram Brook and between the 19th and 23rd January 2015 along the River Loud, Brown Brook, Chipping Brook, and Stock Beck within the area enclosed by 'Diffusing the Issue' (see **Annexes A-F**). Wet conditions were targeted but owing to low temperatures and snow fall this was not fully achieved. Two surveyors walked the lengths of the habitat works re-assessing the features originally identified in 2010, a snapshot of which can be seen in **Annexes G-N**. A grading score (see **Table 1.**) was used to apportion a severity score rating of 1 to 4 to each feature as identified by APEM during their 2010 walkover. A score of 1 indicates a high level of impact and 4 the lowest.

A minor adjustment to the scoring system was introduced for the 2015 reassessment. This identified river sections with an improving condition further to Catchment Restoration Funded works. The Grade 4 'improving' replaced the previous APEM Grade 0. The alteration was necessary for capturing areas of good practice that were previously absent and were defined by the mature growth of riparian vegetation within sections of water course where livestock were excluded. AS only surface water fed systems were sampled, the designation of grade scores was in many cases directly attributable to the length of the source pathway.

Additionally, the feature locations were georeferenced and photographed and a description to the adjacent land use for cross comparison.

Table 1: Definitions and examples of fine sediment sources of Grades 1 to 3, with a new 'improved' Grade '4' (amended from APEM 2010 report).

Grade	Definition	Example
1	Observed (or potential for) widespread deposition of instream sediment causing localised and widespread impacts more than 100m from the point or diffuse source.	• Fields with major erosion gullies • Fields with evidence of large-scale overland flow • Major instream works (such as dredging) • Heavily poached and trampled fields • Farm tracks with evidence of overland flow • Drains and ditches discharging large quantities of fine sediment
2	Observed (or potential for) local deposition of instream sediment causing noticeable impacts within 100m of the point or diffuse source.	• Fields with evidence of localised runoff • Localised poaching • Drains and ditches discharging small quantities of fine sediment
3	Minimal observed (or potential for) deposition of instream sediment with very localised (less than 50m) deposition in the immediate vicinity of the input.	• Minor land drains, • Ditches • Road drains and other pipes • Minor stocking drinking areas and other points of livestock access
4	Improved condition whereby the original issue has been/or is being addressed.	• Fenced of river banks with improved drinking solutions i.e. Solar or gravity fed drinking troughs • Areas of 'good practice' e.g. Gated ford with adequate hardpack.

RESULTS

The results below outline that overall, the four surveyed reaches improved score (**Figure 1**). On closer inspection, two sites (4%) were downgraded, however 60% of sites showed an increase in score with 36% showing no change. These results are further explained within the **Annexes G-N** which contain information sheets for a range of sites.

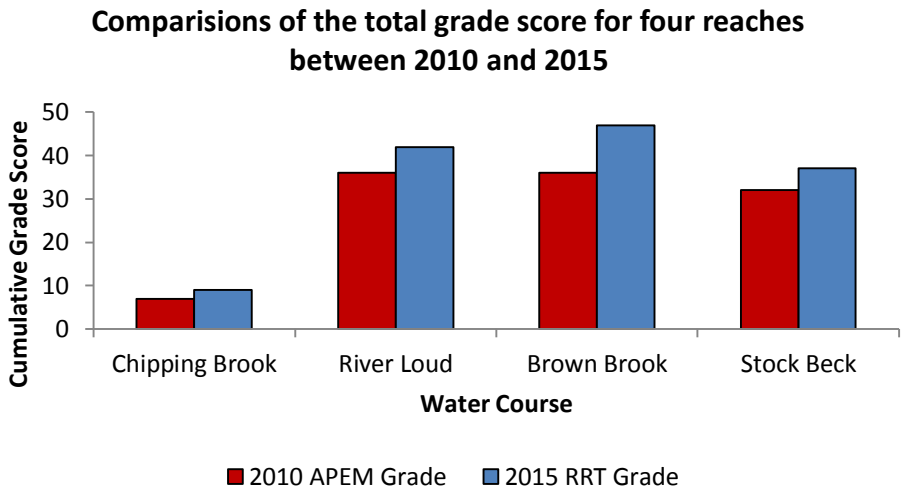


Figure 1. Bar chart comparing the total grade score for sites surveyed in 2010 by APEM against that of data collected by the Ribble Rivers Trust (RRT) in 2015 within the Diffusing the Issue project area.

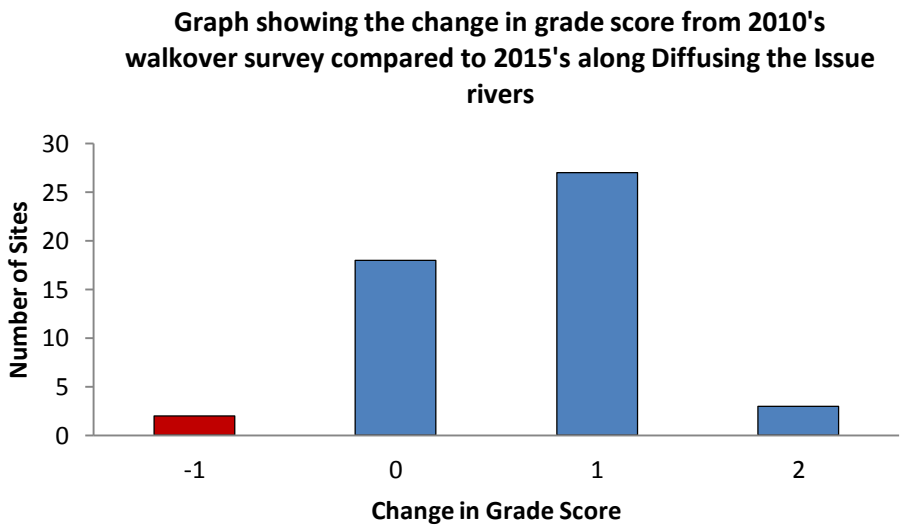
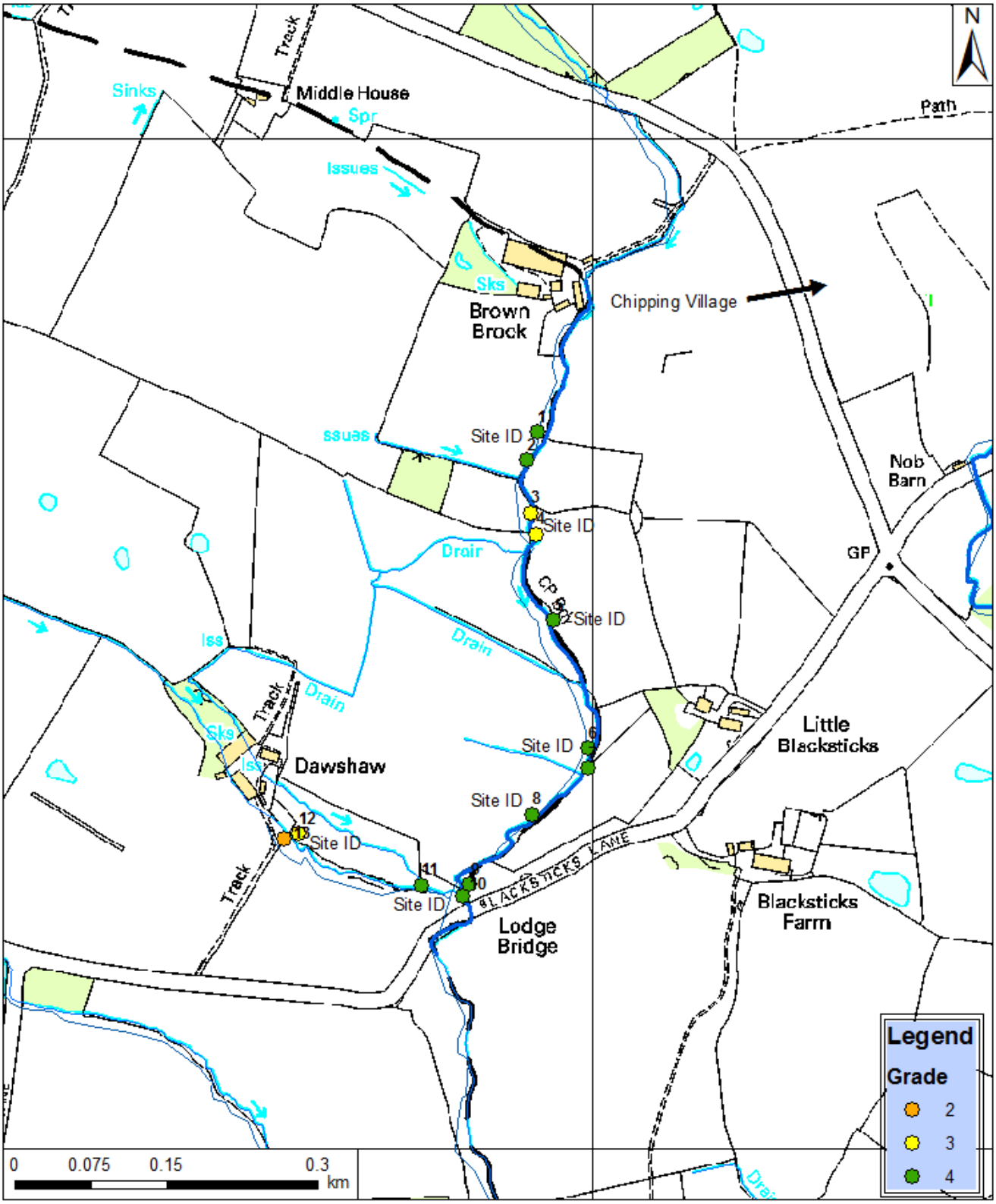


Figure 2. A bar chart outlining the change in grade scores of the re-assessed sites within the 'Diffusing the Issue' project area. The blue bars indicate a positive change whilst the red shows a negative.

The arrows used in **Annexes G-N** show the flow path and possible input path of fine silts. The arrows are as follows; Blue – active flow path, Orange – interrupted or temporary flow path, Red – inactive flow path.

Annex A: Map showing the survey sites along Brown Brook.

Diffusing the Issue Project Area

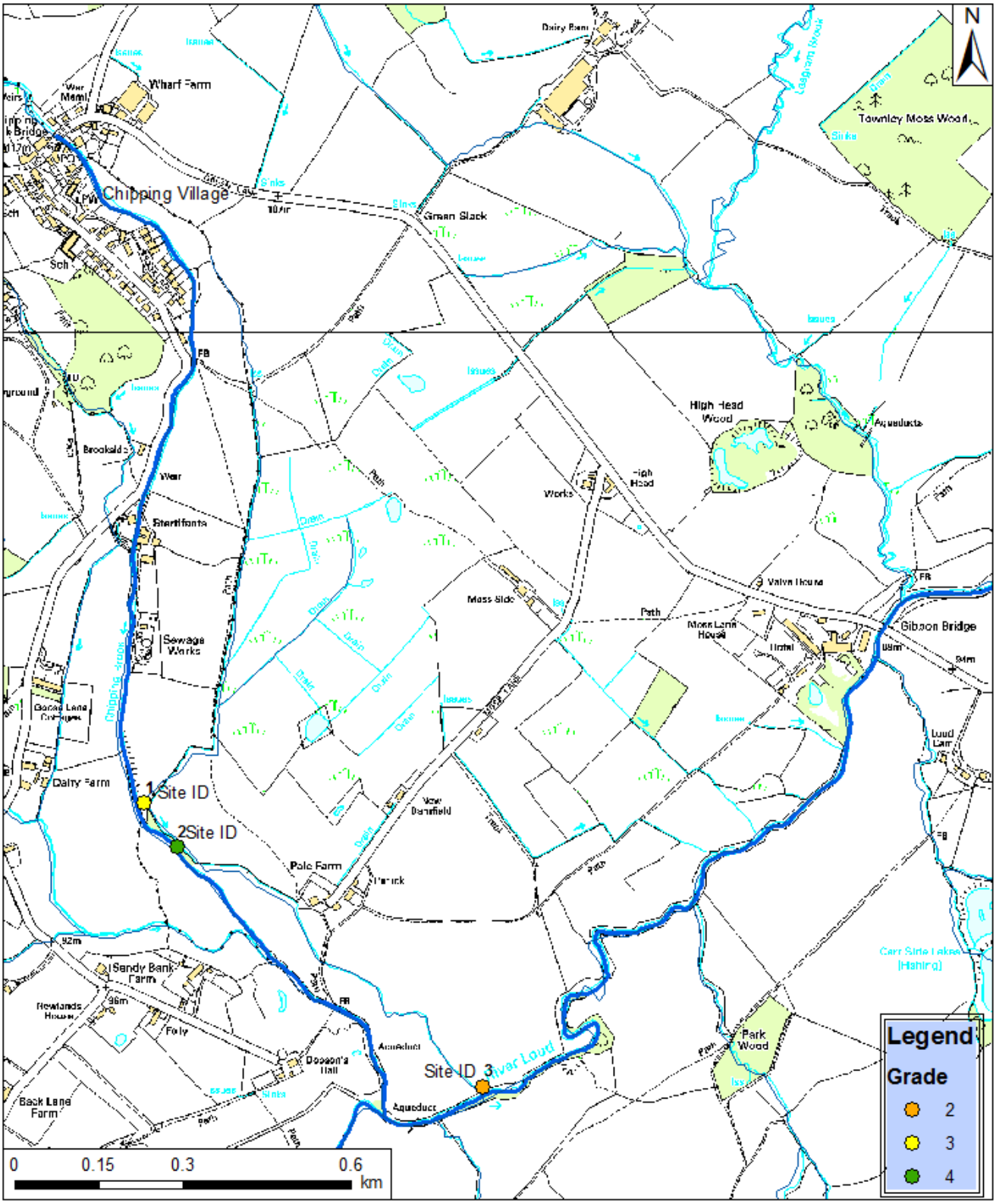


Author: Paul Peters
Project: Catchment Restoration Fund

Scale: 1:5,000
Date: 05/02/2015

Annex B: Map showing the surveyed brook that runs alongside Chipping Brook before joining the River Loud at Site ID 3.

Diffusing the Issue Project Area

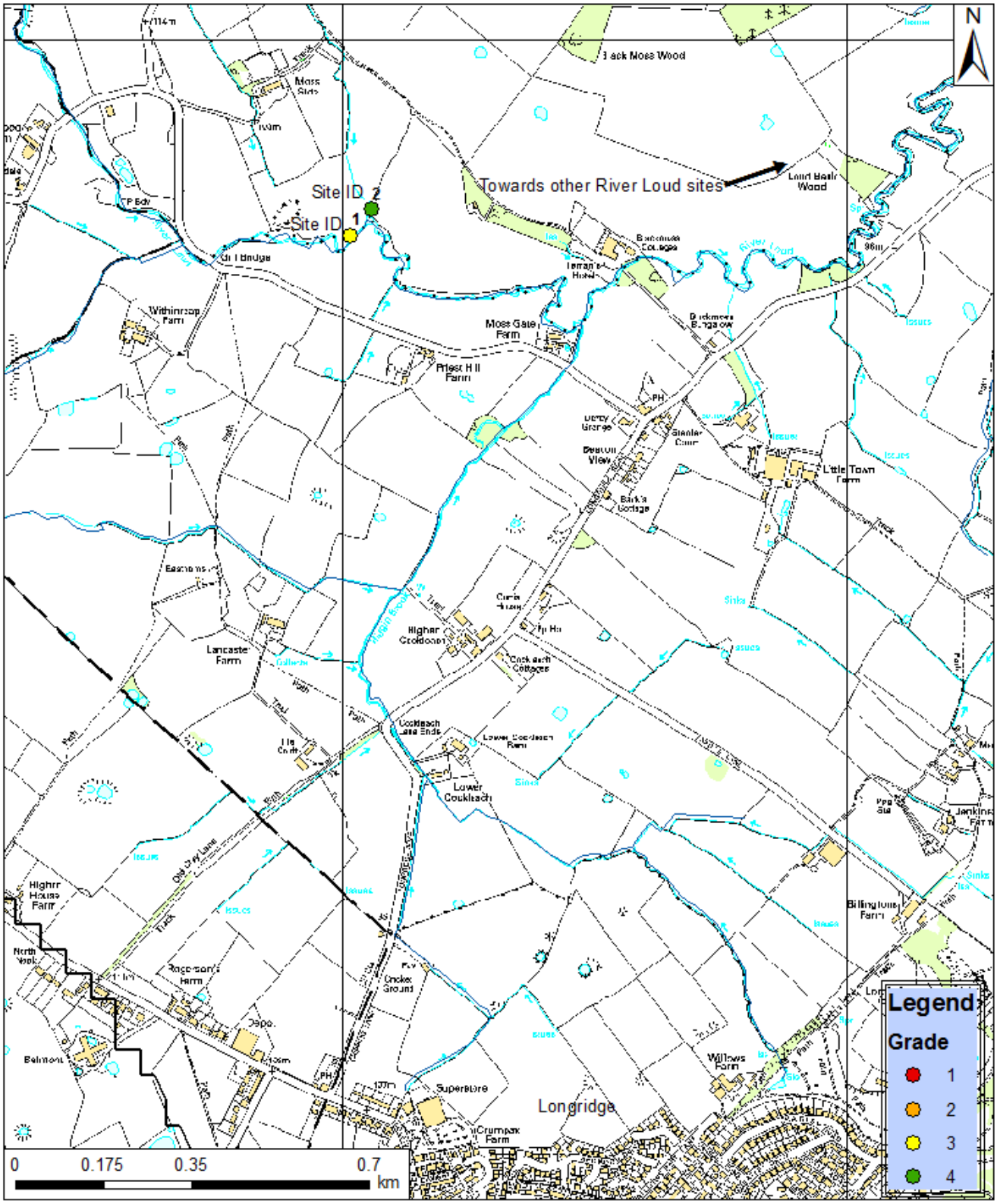


Author: Paul Peters
Project: Catchment Restoration Fund

Scale: 1:9,000
Date: 05/02/2015

Annex C: Map showing the first two survey sites along the River Loud which continues to the East – see **Annex D**.

Diffusing the Issue Project Area

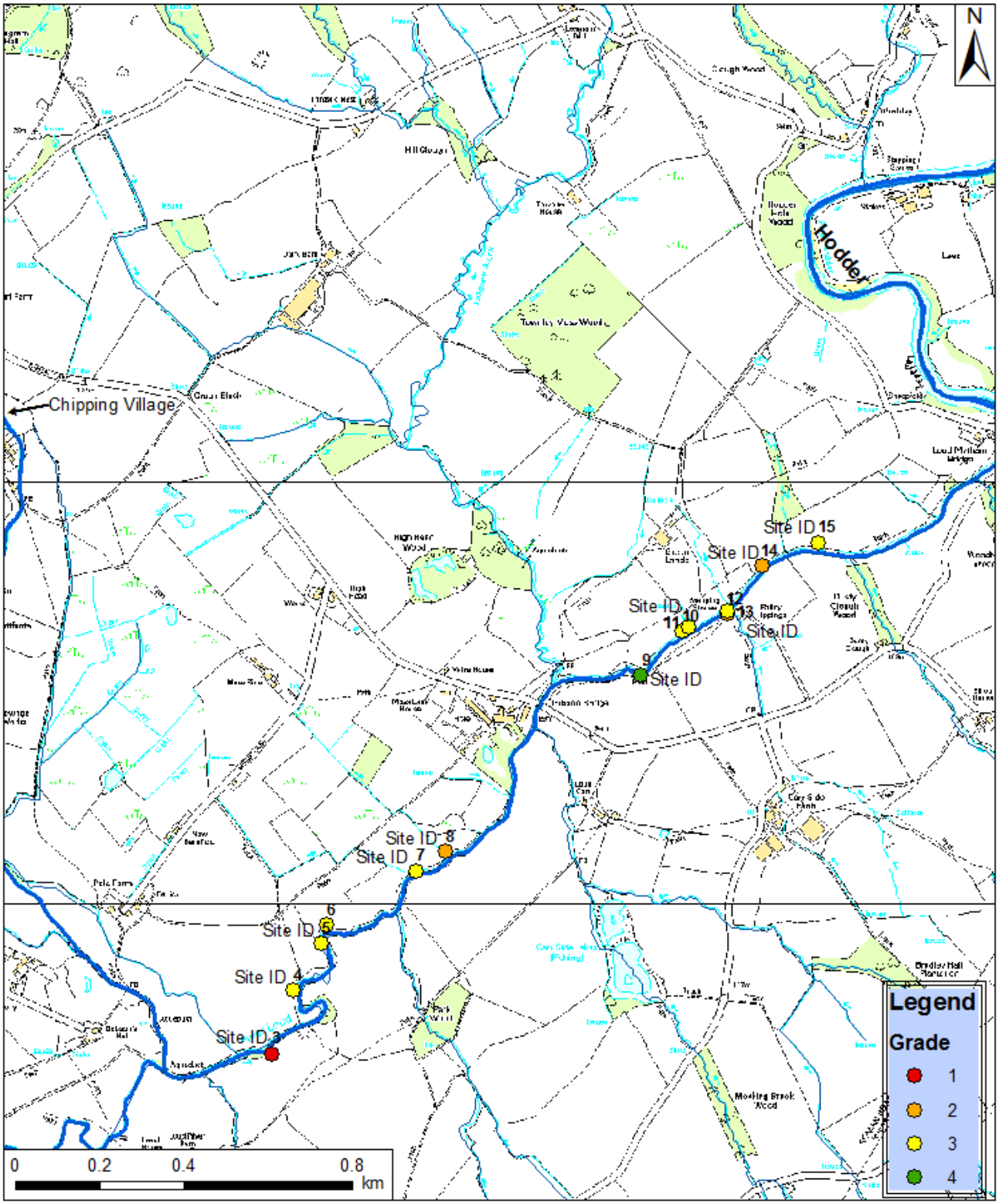


Author: Paul Peters
Project: Catchment Restoration Fund

Scale: 1:10,000
Date: 05/02/2015

Annex D: Map showing the remaining survey sites (ID 3-15) along the River Loud. Site ID 3 is the only grade 1 site located within the Diffusing the Issue Project Area – see **Annex G**.

Diffusing the Issue Project Area

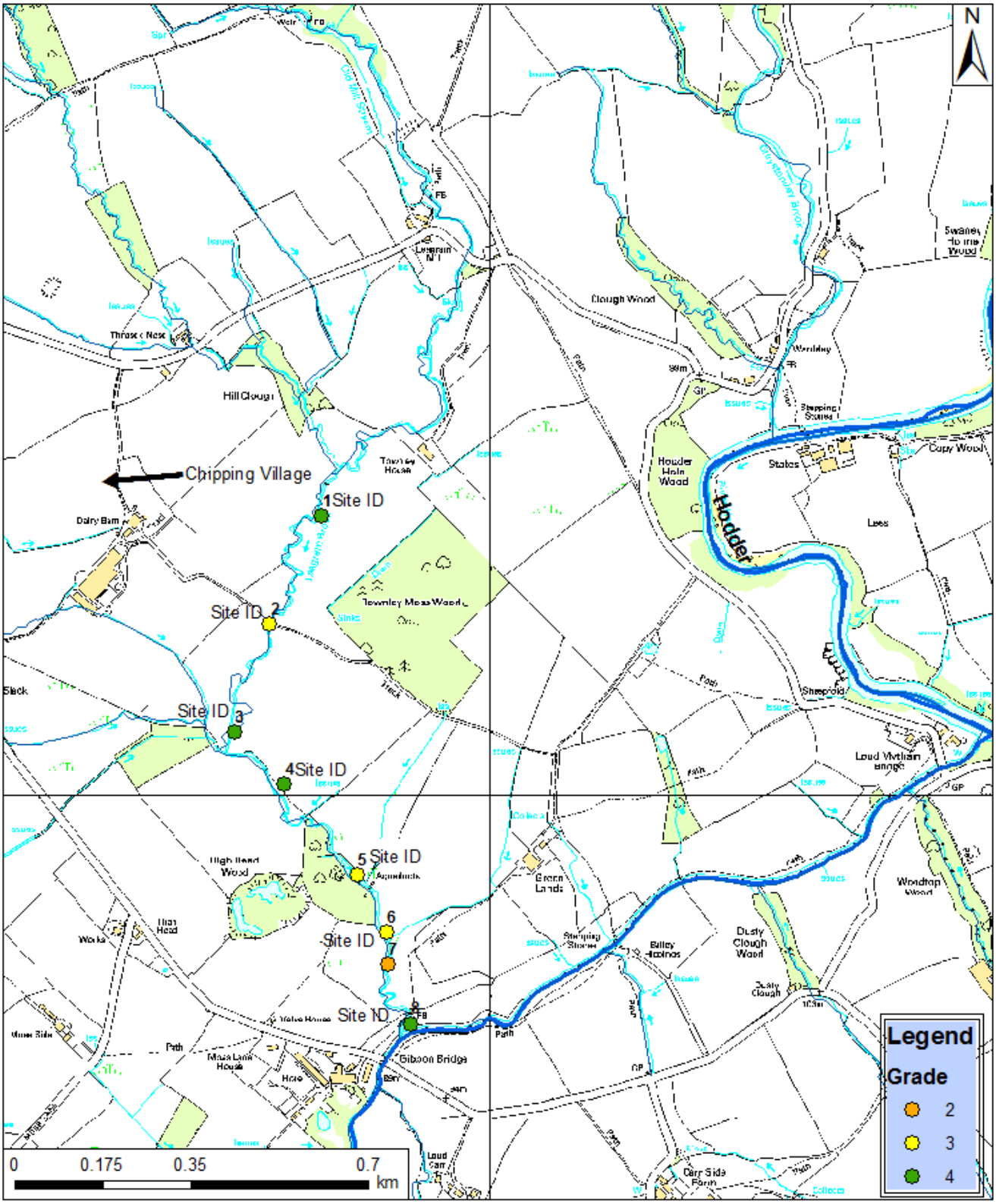


Author: Paul Peters
Project: Catchment Restoration Fund

Scale: 1:12,000
Date: 05/02/2015

Annex E: Map showing the survey sites along Leagram Brook which meets the River Loud just past Site ID 8.

Diffusing the Issue Project Area

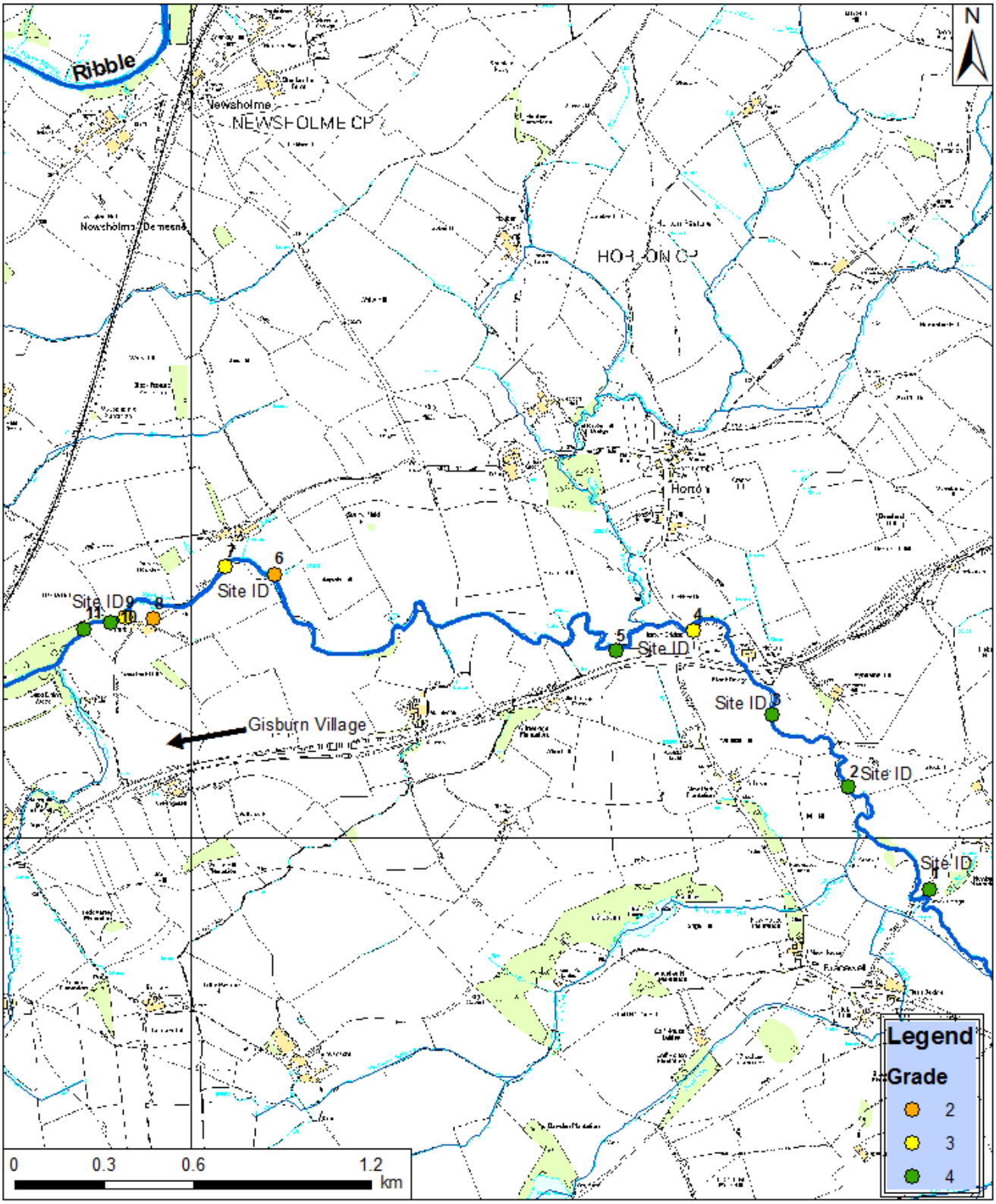


Author: Paul Peters
Project: Catchment Restoration Fund

Scale: 1:10,000
Date: 05/02/2015

Annex F: Map showing the survey sites along Stock Beck

Diffusing the Issue Project Area



Author: Paul Peters
Project: Catchment Restoration Fund

Scale: 1:17,000
Date: 05/02/2015

Table H2: Information sheet for Site 3 along the River Loud, upstream of Gibbon Bridge. Displaying additive effects of overland flow and spreading that can lead to a high inflow of sediments.

Site Number	3	**Water Course**	River Loud
Date	20/01/15	**NGR**	SD 6315541643
Type of Input	Fine Sediment, Organics	**Grade**	1
State of Change	Not Improving	**2010 Grade**	1 (Site 124)
Description	Overland Flow and bank erosion		
Land Use	**LHB:** Grazing		**RHB:** Grazing
Vegetation	**LHB:** Grasses/reeds		**RHB:** Grasses/reeds
Arrow Key: Orange: active flow path, Green: interrupted or temporary flow path, Blue: inactive flow path			
Comments: Fine sediment input from overland tributary. Organic input from muck spreading with direct, active flow from treated fields into the river.			

Table H3: Information sheet for Site 5 along the River Loud, upstream of Gibbon Bridge – an excellent example of improving riparian habitat through low stocking densities, exclusion from the river banks and tree planting.

Site Number	5	**Water Course**	River Loud
Date	20/01/15	**NGR**	SD 6327341905
Type of Input	Fine Sediment	**Grade**	3
State of Change	Improving	**2010 Grade**	1 (Site 122)
Description	Riparian run-off		
Land Use	**LHB:** Grazing		**RHB:** Grazing
Vegetation	**LHB:** Rough pasture		**RHB:** Rough pasture
Arrow Key: Orange: active flow path, Green: interrupted or temporary flow path, Blue: inactive flow path			
Comments: Fenced LHB bank excludes stock and associated poaching.			

Table H4: Information sheet for Site 8 along the River Loud, upstream of Gibbon Bridge – displaying a typical drainage ditch used to drain fallow marshy land.

Site Number	8	**Water Course**	River Loud
Date	20/01/15	**NGR**	SD 6356742123
Type of Input	Fine sediment, organics	**Grade**	2
State of Change	No Change	**2010 Grade**	1 (Site 119)
Description	Drainage ditch		
Land Use	**LHB:** Grazing		**RHB:** Grazing
Vegetation	**LHB:** Grasses		**RHB:** Grasses
Arrow Key: Orange: active flow path, Green: interrupted or temporary flow path, Blue: inactive flow path			
Comments: Drainage channel (400m approx.) fed by marshy riparian fields. Small land drain directly opposite on RHB			

Table H5: Information sheet for Site 6 along Leagram beck – an excellent example of improving riparian habitat through stock exclusion and tree planting.

Site Number	6	**Water Course**	Leagram Beck
Date	17/12/14	**NGR**	SD 6349343125
Type of Input	Fine sediment, Organics	**Grade**	4
State of Change	Improving	**2010 Grade**	2
Description			
Land Use	**LHB:** Grazing		**RHB:** Grazing
Vegetation	**LHB:** Wooded		**RHB:** Wooded
Arrow Key: Orange: active flow path, Green: interrupted or temporary flow path, Blue: inactive flow path			
Comments: Used as a crossing point/drinking bay. Poaching evident. This is no longer an issue; drinking trough has been installed downstream and both banks have been fenced. Trees have been planted to improve riparian habitat and bank stabilisation.			

Table H6: Information sheet for Site 8 along Leagram beck – an excellent example of improving riparian habitat through low stocking densities, exclusion from the river banks and tree planting.

Site Number	8	**Water Course**	Leagram Beck
Date	17/02/14	**NGR**	SD 6384342547
Type of Input	Fine Sediment	**Grade**	4
State of Change	Improving	**2010 Grade**	2
Description			
Land Use	**LHB:** Grazing		**RHB:** Grazing
Vegetation	**LHB:** Rough pasture, tree cover		**RHB:** Rough pasture
Arrow Key: Orange: active flow path, Green: interrupted or temporary flow path, Blue: inactive flow path			
Comments: 'Trampling' as outlined in the 2010 APEM report is no longer an issue. Beck is fenced to both banks with riparian buffer strip.			

Table H7: Information sheet for Site 6 along Stock beck downstream of Horton Bridge – an example of poached crossing points that cumulatively introduce high amounts of sediment into the beck.

Site Number	6	**Water Course**	Stock Beck
Date	22/01/15	**NGR**	SD 8428049891
Type of Input	Fine sediment	**Grade**	2
State of Change	Not Improving	**2010 Grade**	2
Description	Land drain, poached crossing points.		
Land Use	**LHB:** Grazing		**RHB:** Grazing
Vegetation	**LHB:** Grasses		**RHB:** Grasses
Arrow Key: Orange: active flow path, Green: interrupted or temporary flow path, Blue: inactive flow path			
Comments: Land drain with four poached crossing points introducing fine silts to beck. Bank side has been fenced and planted with trees reducing direct input of organics.			

Table H8: Information sheet for Site 10 along Stock beck downstream of Horton Bridge.

Site Number	10	**Water Course**	Stock Beck
Date	22/01/15	**NGR**	SD 8372849728
Type of Input	Fine sediment	**Grade**	4
State of Change	Improving	**2010 Grade**	3
Description	Riparian land drain		
Land Use	**LHB:** Grazing		**RHB:** Grazing
Vegetation	**LHB:** Grasses		**RHB:** Grasses
Arrow Key: Orange: active flow path, Green: interrupted or temporary flow path, Blue: inactive flow path			
Comments: Small riparian land drain with minimal flow. Good grassland cover.			

Table H9: Information sheet for Site 11 along Stock beck, downstream of Horton Bridge.

Site Number	11	**Water Course**	Stock Beck
Date	22/01/15	**NGR**	SD 8364049706
Type of Input	Fine sediment	**Grade**	4
State of Change	Improving	**2010 Grade**	3
Description	Natural riparian overland drain		
Land Use	**LHB:** Grazing		**RHB:** Grazing
Vegetation	**LHB:** Grasses		**RHB:** Grasses
Arrow Key: Orange: active flow path, Green: interrupted or temporary flow path, Blue: inactive flow path			
Comments: Fenced LHB excluding stock. Poached ground covered in grass, well drained riparian habitat.			

Appendix I. Feedback collated by Natural England further to the Nutrient Management on Grassland Farms Event, 12/11/14.

In response to the event all responses received were positive and indicated that the attending farmers had learnt something new and would consider changing their own farming practices (see Q8). The following document is representative of the positive feedback received in response.

Feedback Form: CSF Group Event

Name of trainer/adviser:	Joint Meeting – RRT/FAS/CFE/NE	Visit date:	Wed 12th November 2014
Training topic:	Nutrient Management on Grassland Farms Funding/Training Opportunities		

To help improve future training/advice and support, we would appreciate a few minutes of your time to fill in this feedback form.

Q1. Your gender: ☑ Male ☐ Female **Your age range:** ☐ under 25 ☐ 25-40 ☑ 40+

Q2. What are your primary farming activities?

☑ Cattle/sheep (lowland) ☐ Cattle/sheep (upland) ☐ Dairy ☐ Horses ☐ Pigs/poultry
☐ Cereals/oil seeds ☐ Horticulture/fruits/bulbs ☐ Arable with roots ☐ Mixed farming
☐ Other (please specify).....
☐ **Please also tick if your main farming activities are more than 66% livestock**

Q3. How many hectares do you farm?

☐ Less than 10 ha ☐ 10–20 ha ☑ 21–50 ha ☐ 51–100 ha ☐ 101–200 ha ☐ 201–300 ha
☐ More than 300 ha

Q4. Land Classification (tick the main type)

☐ Lowland ☐ LFA (Severely Disadvantaged Area SDA) ☑ LFA (Disadvantaged Area DA)
☐ Common Land

Q5. Where did you first hear about Catchment Sensitive Farming?

☐ Catchment Sensitive Farming Officer ☐ Newsletter
☐ Word of mouth ☐ Advert/press
☐ Invitation to event ☐ Event, which? _____
☐ Other, which? _____

Q6. Overall, how would you rate the training/advice you received?

☐ Excellent ☑ Good ☐ Below average ☐ Poor

Q7. Please rate the following aspects of the event by ticking in the appropriate box:

	Excellent	Good	Fair	Poor
a. Trainer/adviser(s) knowledge of subject area	☐	☑	☐	☐
b. Comparison between good and bad practices (if applicable)	☑	☐	☐	☐
c. Clarity of demonstrations (if applicable)	☑	☐	☐	☐
d. Presentation of best practice and/or new techniques and equipment	☑	☐	☐	☐
e. Quality of chairing/facilitation (e.g. opportunity to ask questions)	☑	☐	☐	☐
f. Signposting to further sources of information	☑	☐	☐	☐

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Q8. For the topic areas covered by today's event, please indicate (by ticking in the boxes below) whether:

	Yes	No	Maybe
a. The training/advice was relevant to your farm business?	☑	☐	☐
b. Your understanding of the topic area has improved?	☑	☐	☐
c. Do you expect to apply the skills you have acquired through the training/information in practice?	☑	☐	☐
d. There are actions you can take on your farm?	☑	☐	☐
e. Do you intend to take action on your farm?	☑	☐	☐

Q9. Are there any obstacles or problems to making changes on your farm (e.g. to farming practices) to reduce water pollution?

☐ Yes, please specify_____ ☑ No ☐ Don't know

Q10. Are you intending to use further help through the England Catchment Sensitive Farming Delivery Initiative?

☐ On-farm one-to-one visits ☑ Farmer workshops/meetings ☐ Newsletters
☐ Pre-booked/drop-in sessions ☐ On-farm walks/demonstrations
☐ CSF Capital Grant Scheme ☐ None

Q11. Will you be recommending catchment sensitive farming events to other farmers following this event?

☑ Yes ☐ No, please specify_____

Q12. Do you have any comments/suggestions to help us to improve future events?

If you would be interested in receiving further training in the future, please contact your Catchment Sensitive Farming Officer.

Thank you for your feedback

Catchment Sensitive Farming (CSF) is delivered in partnership by Natural England, the Environment Agency and Defra.

NATURAL ENGLAND

Environment Agency

defra

Appendix J. Summary of the NFU Ribble Workshop Notes: A consultation towards the Ribble RBMP, 13th February, 2015.

Q1 what are the key water related issues you would like to see addressed?

- Watercourse fencing – maintenance costs? Livestock access?
- Erosion – river bank washing away loss of land
- Support needed for infrastructure, slurry storage, settlement ponds
- No government support if it's for a regulatory requirement
- CSF targeting – Clitheroe area excluded for help, need site specific advice
- What are sewage treatment plants doing to improve their infrastructure?
- River maintenance – not done enough, e.g. gravel/sediment extraction
- Miss out the Hodder for water improvement grants
- Need to maintain the good work already being done
- High rainfall on farms = high volume of slurry
- Support needed to keep good areas good
- Need to look at the reasons why moderate areas are classed this way, no difference in the farming taking place e.g. Gisburn Forest

Q2 should the priority be maximising the number of water bodies to achieve good status or just improve the worst water bodies?

- Don't forget the good ones
- What would we have to do to improve from good to high?
- How could we achieve this and how much would it cost?
- Grants for slurry stores
- Concentrate on poorest areas
- Don't be complacent in areas with good water quality
- Rural properties with septic tanks

Q3 a) what are you already doing to help improve water quality, b) what can you deliver to help achieve improvement, c) What are the barriers?

a)

- Spreading slurry at optimum times – use it as a valuable fertiliser
- Lots of fencing already done along rivers
- Settlement ponds to reduce dirty water
- Installed drinking troughs in field
- Roofed dirty yards
- Maintained gutters
- Buffered watercourses
- Soil testing
- Agri-environment schemes
- Plant hedges along watercourses
- Ensure sprayer handling areas are properly drained
- Test & calibrate sprayers
- Collect runoff from dirty yard and muck heaps

- Use manures for nutrients
- Test soils and fertilise appropriately
- Separate clean & dirty water
- Improved tracks – resurfaced
- Fenced watercourses
- Livestock feeders/drinkers placed away from bank
- Inspect for soil compaction before drilling
- Plant hedges across slopes to intercept water
- Minimise open yard areas
- Built bridges across watercourses

b)

- Improve public knowledge
- Continue to follow GFP
- Relocate gateways (x3)
- Plant hedgerows across slope
- Update sprayer certification (x3)
- Improve/increase slurry storage (x2)
- Separate clean & dirty water
- Build bridges across watercourses (x2)
- In-field grass strips to avoid erosion
- Test for soil compaction before drilling (x2)
- Remove soil compaction
- Take full account of nutrients in manures
- Watercourse fencing
- Plant hedgerows alongside watercourses
- Test & calibrate sprayer equipment
- Fertilise according to soil information
- Tracks – resurface, install cross drains
- Create & follow nutrient management plan

c)

- Flooding incidents
- Erosion of banks on corners
- Himalayan balsam behind fences along rivers
- Funding required for concreting yards, separating clean & dirty water, roofing yards, drainage, water harvesting
- Money & time
- Knowledge that what you are delivering is having a positive impact