Catchment Restoration Fund (CRF):

Limestone Ribble Project Area

Outcomes and achievements








REDRESSING REASONS FOR WFD FAILURE

Department for Environment Food & Rural Affairs

Ribble Rivers Trust

Environment Agency

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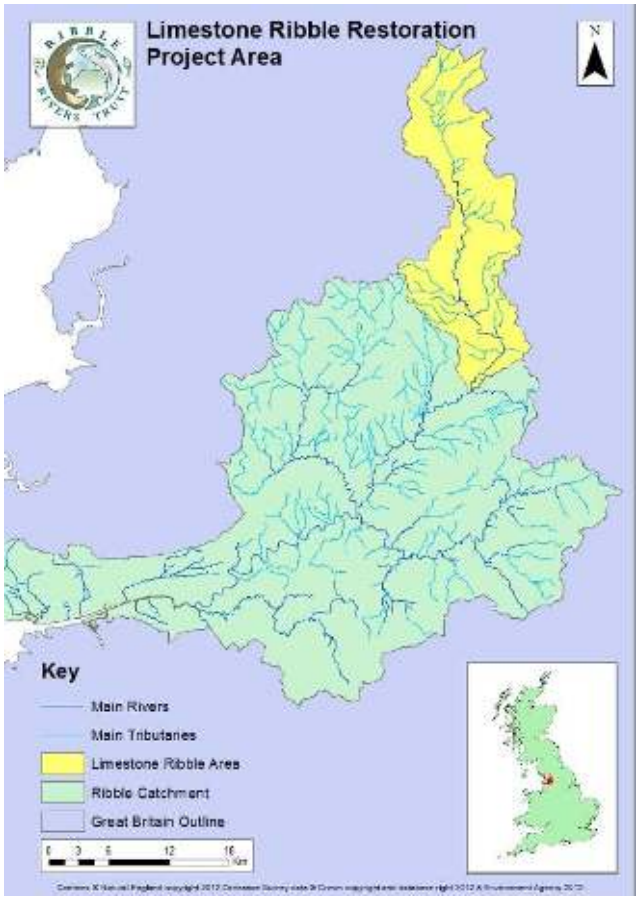
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Project Summary

The Limestone Ribble area of the catchment represents an iconic upland landscape within the Yorkshire Dales National Park of the west Pennine moors. Lying beneath them is a limestone aquifer through which the river is formed and flows. In these upper reaches the river has become over-widened, its water unusually warmed and many of its banks are barren of vegetative cover indicative of centuries old, unsympathetic land management. Through the Limestone Ribble Restoration project such issues were tackled through creating riparian habitat, encouraging better land practice, and improving natural hydrology and river connectivity.

Following an application to the Catchment Restoration Fund (CRF), funds were awarded to the Ribble Rivers Trust to boost the status of failing water bodies under the Water Framework Directive (WFD) 2000. The CRF was devised and allocated to all NGOs towards attaining Good Ecological Status (GES) within those water bodies identified within the project area. This driver provided the emphasis for the RRT's programme of works, delivered in partnership, to tackle the principle Reasons for Failure and sought to make the necessary practical changes that would naturalise the river system.



Map of the 'Limestone Ribble' area from within the Ribble Catchment.

The successful delivery of 'Limestone Ribble' has initiated and promoted relationships with local landowners to instigate natural restoration works to provide an impetus towards addressing the full magnitude and complexity of restoring the Ribble's headwaters. By taking a hydrological focus the project has brought wider reaching changes to the landscape of the Dales and started the restorative

process on the journey to attaining WFD goals. At all stages, the contribution of volunteers has been exacted to improve local understanding of and support for the riverine environment to add capacity for future delivery.

This document presents the projects' outcomes and achievements and attempts to evaluate the positive impact upon local communities, partners and stakeholders in addition to that of the upper catchment's hydrology and ecology.

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 Limestone Ribble.

CRF project partners include: -

- Craven Conservation Group
- Durham University
- DEFRA
- Environment Agency
- Forestry Commission
- Halton West Estate
- Hanson Cement
- Manchester University
- Riverfly Partnership
- Settle Anglers Association
- Settle Football Club
- Woodland Trust
- Yorkshire Dales Millennium Trust
- Yorkshire Dales National Park



1.0 Project Background

The Limestone Ribble project provided continuum to the works delivered by RRT under the previous WFD "River Improvement Fund" (RIF) and local Environment Agency project funding that had begun to address the poor habitat quality in the catchment's headwaters. The failure of the upper catchment's water courses to meet the necessary standards under the Water Framework Directive (WFD) provided the statutory driver for change. By coupling these factors, an opportunity was created to extend the RRT's practical delivery beyond the formative tributaries of Cam and Gayle becks. 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, £316,400 were spent in delivering the Limestone Ribble project.

1.2 Brief History of the Limestone Ribble Area

The naming of the project provides testament to the area's distinctive geology, which is dominated by the Carboniferous limestone. These massive, cave-forming limestone beds were originally deposited between ~325-350 million years



The Limestone Ribble

Of the lower Tems beck and Swaw beck habitat improvement scheme,

"I would like to commend you on a super looking habitat scheme, the fencing takes interesting lines, the streams, especially the one that has had the covering slates removed looks a great restoration feature and if the willows take root we should have a much better spawning stream, the whole scheme is a credit to the trust's ingenuity and I thank you on behalf of Settle Anglers. A great job".

Bob Garnett, Hon Sec. of Settle Anglers

ago, when the area was covered by a tropical sea and what is now the UK then bordered Greenland and Spain near the equator! As this sea receded, the limestone was overlain with sandstone and mudstone, indicative of estuarine depositional processes (Geotrails/Williams, 2013). However, it was not until the end of the last ice age (15-20,000 years ago) that the retreating ice sheets exposed the landforms of the catchment as we now recognise them. Today, the geological evidence of each of these periods is recognisable, but none more so than the limestone outcrops and pavements of the Ribble's upper catchment. The Ribble's headwaters, Cam and Gayle becks, drain the rough grassland and peat moorland that sit aloft the limestone aquifer. The upland peat moorland are a defining feature that represent one of the world's scarcest habitats (of which the UK comprises 15% of the worldwide total (Stern, 2006)). They provide habitat for rare ground nesting birds, such as the black grouse that are predated by peregrine falcons. The slow formation of peat is a feature of the growing conditions and of the associated plant life, most notably sphagnum moss and is also home to the carnivorous plant, Common Sundew.



The carnivorous plant **Common Sundew,** *Drosera rotundifolia in flower* upon Cam Fell (taken by A. Foley, 2014).

Since the arrival of the Romans in the region over two thousand years ago, the area was quarried for its limestone and extensively drained to increase agricultural land availability and productivity. The limestone provided the building materials for early construction of roads and settlements to connect the area with the surrounding region. The creation and evolution of lime kilns also provided the materials for liming agricultural soils to increase their productivity. The practice of liming occurred throughout of the valley further intensifying the pressure placed upon the land. With the arrival of the industrial revolution came larger kilns and quarry sites to meet an increasing construction demand. These factors sought to increase, not only production of limestone-based materials, but demands upon local water courses to feed the wet-firing process within the kilns. Whilst this practice no longer continues a legacy of remnant structures from this period of rapid growth was left behind. Weirs that once serviced mills at Langcliffe and Settle remain in river and provide modern functions for power generation and flow measurements. In each of the above ways, it is the harnessing of limestone that has shaped today's landscape.



Bordering the head of the catchment is a rugged moorland interspersed by craggy outcrops and overlooked by the three peaks of Ingleborough, Pen-y-gent and Whernside. The peaks draw many tourists attracted to walking the footpaths of the Yorkshire Dales National Park. At its lower lying south, Limestone Ribble comprises of lower gradient, slower flowing streams draining into the Long Preston Deeps area, a modified wetland home to an array of overwintering wading birds. The deeps form the largest aquatic SSSI within the catchment. The sheep farming of the uplands is superseded by cattle on the flood plains

below Settle, a small town of that developed rapidly during the nineteenth century with the cotton industry. Cotton brought the railway through from Leeds on route to Carlisle furthering the habitation and population size of Settle and the surrounding villages.



An example of Limestone Pavement overlooked by Whernside

Farming the upper catchment first began as early as 4000BC, evident from the remnants of prior land management practices and a lack of woodland. Earlier pollen records from Ingleborough indicate that a mixed broadleaf woodland existed here prior to intensive farming practice (Swales, 1987). The first clearances of woodland created open pasture for hunting with farming following soon after. Further enrichment of the land followed as farming intensified that also resulted insignificant losses in tree coverage during the middle ages. An increasing desire for pasture led to the drainage of the moorland through the creation of drainage ditches (known as 'grips'): A practice undertaken widely in upland Britain during the second half of the twentieth century. Partly this drainage was to improve the quality of grazing, but partly to remove the hazard presented by bog habitats to stock.



An over widened Gayle Beck leading to dry conditions and reduced habitat each summer.

There is little evidence that peat land draining fulfilled the claims made for it, but in fact resulted in a number of detrimental consequences (Holden, 2009). These included: -

- Erosion of grips leading to increases in sediment transport, affecting water quality of streams through colouration and quantity of fine sediments.
- Damage to the characteristic plant and animal species associated with a diversity of wet soil conditions. Changes in peat structure.
- Increased aerobic decomposition of peat as a result of the lowered water table.
- Increased leaching of soil nutrients, leading to loss of soil fertility.
- Significant alterations to catchment hydrology.

- Loss of young birds, including grouse and waders, which may fall into and cannot get out of steep-sided grips.
- A reduced number of invertebrates, which are used as a food source for a variety of birds and fish.
- A reduction in the viability of salmonid spawning grounds.
- Loss of the ability of peat lands to sequester large volumes of carbon from the atmosphere.



A typical drainage grip and evidence of the widening erosive problems they create. Dozens of miles of these have reached the proportions illustrated in the above photos.

1.3 Limestone Ribble: What did it set out to achieve?

The objectives for Limestone Ribble are shared by all CRF awarded areas within the Ribble catchment. These were to redress the reasons for failure under the WFD by improving the natural hydrology, riverine habitat and fish passage. By encouraging a sustainable return to Natural River processes upland drainage grips, disconnected fragmented habitats and diffuse pollution sources would be targeted. Additionally public engagement formed an important initial objective of the project. However changes in the initial 'Limestone Ribble' plan stemming from a delayed receipt of funding and changes to a complimentary project meant that the practical delivery of these solutions became the priority focus of the project. Subsequently, the preliminary monitoring of the works were affected in amongst the practical delivery outcomes. Once funding streams were fully re-established, monitoring practices were revised and then implemented.

As a secondary driver to the project, the exclusion of livestock was directed at reducing the number of pathogens entering water courses to positively impact upon local Bathing Water standards (both inland and estuarine).

Practical works have been recorded using metrics as requested by the CRF national steering group for each completed practical task and outputs, and monitoring of specific outcomes was focused on example case studies to ascertain the expected outputs of all activities linked to the SMART objectives set at the beginning of the project. Some activities undertaken we considered "best practice" and are heavily researched and monitored activities elsewhere. In these instances monitoring was significantly reduced. This was achieved through measuring ecological responses by volunteers, academic researchers and RRT employees. The outcomes of these measurements are summarised in sections 2.0 and 4.0 with further details provided in the Appendices.

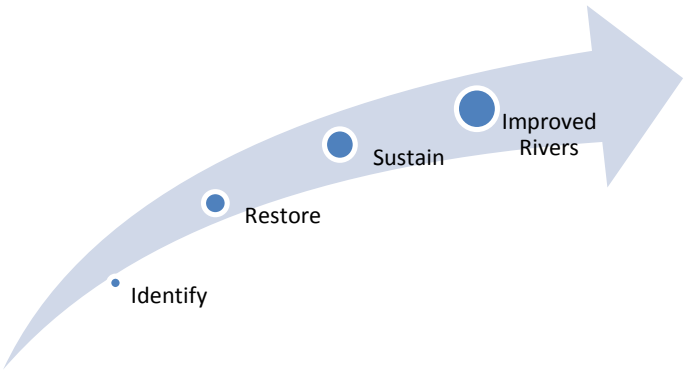
The Limestone Ribble project sought to achieve its aims through the delivery of physical works delivered in partnership with local communities and delivery organisations designed to raise public awareness of rivers. The project covers a vast area of the Ribble catchment, approximating 240 km^2 and as such not every issue could be addressed. This project tackled principle priority issues to gain maximum outputs with restricted resources, and attempted to develop the implementation of wider landscape scale changes beyond and plant more affirmations in the mind sets of local landowners to continue these activities into the future such that there was a lasting legacy of improvement in the area.

A programme of activities was derived: -

- Installation of pumped elver (juvenile eel) passes
- Riparian woodland and habitat creation
- Deculverting
- Grip blocking
- Gully tree planting
- Large Woody Debris addition
- Catchment appraisal tours
- Monitoring and research
- Walkovers 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:

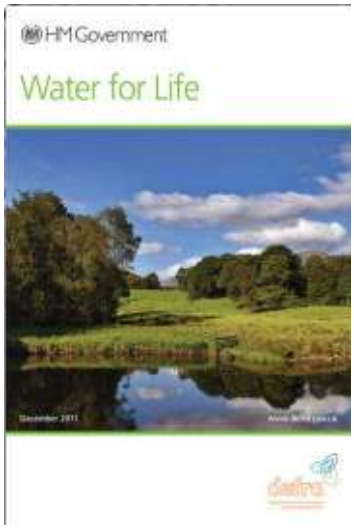
- enhance the status and prevent further deterioration of aquatic ecosystems and associated wetlands which depend on the aquatic ecosystems
- promote the sustainable use of water
- reduce pollution of water, especially by 'priority' and 'priority hazardous' substances
- ensure progressive reduction of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

Regional Policy

The latest Yorkshire Dales National Park Management Plan (2013-2018) sets out within its strategic vision to be 'home to the finest variety of wildlife in England (under objective C4)' whilst being 'resilient and responsive to the impacts of climate change, storing more carbon than it produces (objective D1)'. To contribute towards delivering these objectives within the aquatic environment and acknowledge the Park's desire to work with the voluntary sector, the RRT has led upon volunteer-delivered habitat creation works whilst facilitating research upon buffering the impact of climate change upon local water courses.

1.5 Who was involved?

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

- John Milne, Limestone Ribble Project Officer
- Jack Spees, Director
- Richard Atton, Volunteer Coordinator
- Catherine Birtwistle, Office and Publicity Manager
- Adam Walmsley, Project Officer
- Gareth Jones, Scientific Officer
- Aidan Foley, Project Officer

- Paul Peters, Assistant Fisheries Scientist

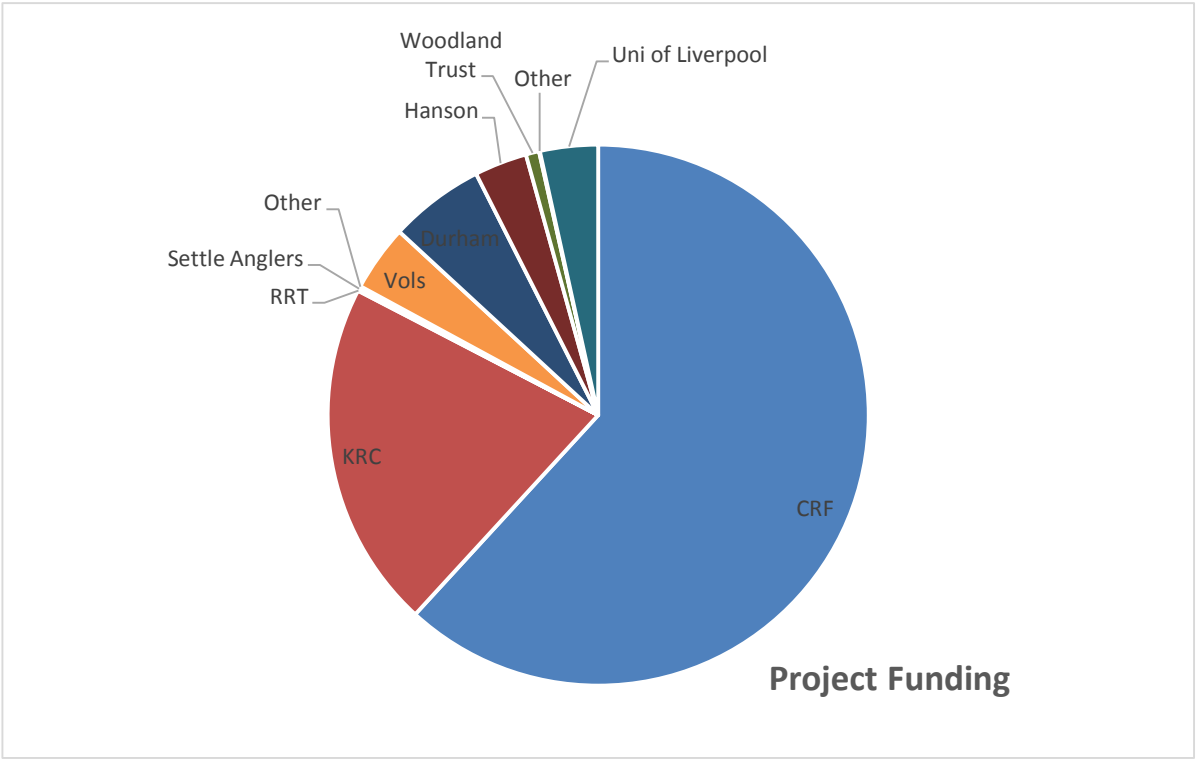
Representatives from academia, local authorities, governmental organisations, third sector organisations and local stakeholder groups all provided an input into informing or the undertaking of practical works as part of the project, to include: -

- Adrian Shepherd, Yorkshire Dales National Park
- Kat Kilner, Yorkshire Dales National Park
- Chris Maudsley, Owner at Stainforth Caravan Park
- Roger Worthington, Manager at Settle Football Club
- Graham Walsh, Natural England
- Rae Lonsdale, Conservation Volunteer
- Dr Martyn Lucas, Professor at Durham University
- Mike Forty, PhD Researcher at Durham University
- Dr Holly Shiels, Professor at Manchester University
- Karlina Ozolina, PhD Researcher at Manchester University
- Dr Karen Potter, Professor at Liverpool University
- Thea Wingfield, PhD Research at Liverpool University
- Bob Garnett, Secretary of Settle Anglers
- Pete Leeson, Woodland Trust
- Neil Handy, Fisheries Officer at the Environment Agency

1.6 Funding the project

The Limestone Ribble project was developed and delivered over a period of three years and in that time, £783,300 has been invested, with £337,400 awarded from the CRF (£92,800 was spent in the first year). A further £106,363 of match funding was secured from the Environment Agency's Keeping Rivers Cool initiative in addition to smaller amounts from Settle Anglers, Ingham and Yorke land agency and RRT core funds. 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 £16,100 contribution in kind from Hanson Cement, £4,059 from the Woodland Trust in addition to significant amounts from Durham and Liverpool Universities, ACE Engineering, Yorkshire Dales National Park Authority and not least our local volunteers. All reported values are as of February 2015.



2.0 Overall Achievements and impact

Limestone Ribble comprised five main activities aimed at improving river habitat connectivity and water quality, restoring natural hydrology and engaging the public to raise awareness of local issues and monitoring the impacts of these activities.

1. ACTIVITIES

Riparian habitat improvement: 21 sites were selected within the subcatchment for improvement. 9049m of riparian fencing was installed and 31,459 trees were planted, improving a total of 182.8 hectares of BAP priority habitat (to include the blocking of grips). In addition, 749m of watercourse over four separate reaches was furnished with large woody debris comprising x tree root plates. New wetlands were created at Stainforth.



Reconnecting habitat: 2 eel passes were installed to unlock over 84km of which was specifically focused on eel and elver migration. 170m of culverted reach was also removed in restoring a highly modified brook to a more natural state.



Restoring natural hydrology: 20,870m of grips and a further 12,000m were blocked on Cam moor and to the eastern side of Ingleborough fell. These works also incorporated 4,725 m of fence installation and repairs, and 4,900 trees planted in gullies across both sites. The prevention of water flows along upland grips is beneficial because it reduces the amount of land lost due to erosion, helps to restore peat blanket bog habitat, and contributes to the restoration of natural hydrology.

Increasing public awareness: 4 evening presentations and 2 Catchment Appraisal Tours were delivered to local community groups with a total of over 100 people in attendance. The involvement of 285 volunteers with the delivery of works has further informed them of river restoration measures. Project reports were delivered to RRT members at 3 AGMs and via RRT's annual newsletters. 1 local agricultural show was attended. Publicity was generated through 2 features in a local newspaper and RRT's social media pages (Facebook, Twitter and YouTube). Interpretation boards were installed at two locations.



Monitoring: Forty-one different sites were electrofished across the upper catchment over the course of the project (Appendix E) and 4

sites were kick-sampled annually to monitor invertebrate populations by volunteers. A positive response in the abundance of Brown trout has been captured subsequent to works.

The survey-mapping of a vast network of grips across the upper catchment was completed in summer 2014 in addition to the creation two hydrological models that were run to categorise and project where the greatest erosion/sediment loss risks exist (see section 4.1 and appendices F i-iii). A more focussed invertebrate study was undertaken in the Long Preston Deeps area (Appendix G) and observed greater abundance and taxa within reaches of habitat works.

Three PhD studies have been undertaken with the RRT or are ongoing within the project area. 1 PhD study assessed the ecological impact of the woody debris additions (Appendix C), another has assessed the physiology of trout to thermal stressors (Appendix E) and the most recent study has begun to develop a natural flood risk toolkit for catchment managers (Appendix H). Through the second study, a water cooling effect has been linked to tree planting and habitat works.

2. VOLUNTEERS

Over 285 individual volunteers have contributed 2250 hours of their time to aid the RRT in delivery of the Limestone Ribble project. Over 60 volunteer days, a range of broadleaved tree species have been planted, ecological surveys of fish and invertebrates completed, fencing and water troughs for livestock were installed and a dry stone wall demolished. General awareness of the river has been increased through publicity of the project and activities. It has also stimulated volunteer involvement from other areas of the catchment, which we believe, adds to health drivers.

3. TRAINING AND EDUCATION

3 PhD research studies and several work experience weeks were linked to the project. 120 individuals of ages 8-80 have been trained in a range of practical, countryside-management skills whilst actively volunteering their own time or conducting research with the RRT. The scope of this training has spanned tree planting, fence lining, a drystone wall demolition and repair, as well as ecological, hydrological and geomorphological surveying techniques

4. STAFF

1 full-time post was created to manage the project and co-ordinate activities. 3 PhD students have temporarily joined the Trust during periods of study and data collection, as well volunteering additional time towards the wider work of the Trust. A further 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 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 work undertaken at Staincliffe Caravan site provides added ecosystem service benefits for visitors to the site and Stainforth Foss.

The Limestone Ribble 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 construction works, soft engineering, monitoring studies and community engagement activities across the upper catchment. 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 public understanding of our local water resources
4. Investment in education, skills and training

As a secondary outcome the project was to influence farmers and landowners in to taking greater ownership of the issues affecting water curses, ensuring that they understand their direct and indirect dependence on these natural resources and the services they provide.

Maps charting the full extent of the RRT's work during the funding period are provided in Appendices A.

3.0 Evaluation Methodologies

The Limestone Ribble project had four main aims, to address excessive upland drainage, barriers to fish migration, reduce diffuse pollution and improve habitat quality. To monitor success the RRT devised four elements to the evaluation process: -

1. Identify the aquatic ecological response to the practical works throughout the course of the project (completed March, 2015).

2. Capture stakeholder feedback following consultation, design and delivery of the Limestone Ribble project (completed March, 2015).

3. Identify the re-vegetation of previously eroding banks and grips by the end of the project.

4. Collection of data and analysis by the project staff by March, 2015 using previous best practice templates (adopted from the Urban Rivers Enhancement Scheme).

The following techniques were adopted in assessing the delivery of these objectives to include: -

- Electro fishing
- AMI sampling
- 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
- Walkover surveys of river habitat features and drainage grips
- Website and social media activity analysis i.e. Facebook, Twitter and YouTube
- Water temperature monitoring
- Active and passive monitoring of fish movements using radio tracking.

Owing to the size of the project area, high resolution surveys upon a representative number of sites have provided a practicable means of evaluation. Feedback from the listed activities (as well as other supplementary studies) is returned in the following section.



Grip blocking surveys underway in 2012

Limestone Ribble aimed to improve riverine habitat quality, naturalise local hydrology, 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, grip blocking, 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

Limestone Ribble aimed to improve riverine habitat quality, naturalise hydrology, 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, grip blocking, 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: Three sections on Gayle and a single on Cam Beck were installed ranging in length of up to 80m of river banking. Both becks are ecologically damaged by extreme low flows during the summer and lack of 'thermal refuge' from elevated water temperatures. The channels are shallow, over widened and combined with a number of other factors result in a lack of pool habitat. To counter some of these impacts the trunks of the roots were piled into the soft banks exposing the roots and partially immersing them in the river immediately providing cover and refuge for aquatic species. Time lapse footage of these works on Gayle beck can be viewed on the RRT YouTube channel <https://www.youtube.com/user/RibbleRiversTrust>.



An example root-ball (left) as installed upon Gayle beck

Their presence also provides a complex array of micro habitats and flow patterns whilst acting as natural debris snags that collect additional nutrients for exploitation by aquatic macroinvertebrates. The combination of the roots with the river's erosive potential are anticipated to increase downward scour of the river bed although this has yet to establish itself within the preliminary geomorphology surveys undertaken.

Undercut pools fringed by trees repeatedly produce great habitat for juvenile fish, particularly Brown trout. Since the installations took place, the number of Brown Trout along Gayle beck was observed to increase (see Appendix C). Longer term monitoring over the past eight years has observed a strong preference for this and type of habitat that continues to form (see Appendix D).



Gayle beck works shortly after completion, November 2011 (left). Exemplar habitat for trout (right).

A lack of tree coverage in the head waters and the surrounding land impacts on water temperature and energy budgets that can have a deleterious impact upon river ecology (Garner et al., 2014). The water temperature impacts resulting from the addition of trees is currently being investigated by the University of Manchester in association with the RRT. Research led by Karlina Ozolina has captured real temperature profiles along Rathmell beck (within the Limestone Ribble) to provide a river-based scenario for the application of lab-based observations. The profile is to be linked to controlled experiments that monitor fish energetics and swimming abilities in response to temperature controls. Initial results from these demonstrate that trout swimming abilities and energetic recovery times are hampered with prolonged exposure to high water temperatures. The results of this study demonstrate that the increased coverage of upper catchment land and tributaries with tree cover provides useful mitigation towards high summer temperature. Further details about the research is presented in Appendix E.



A brown trout appears from its refuge on Gayle Beck, demonstrating the value of cover in an otherwise barren river scape, authored by Mike Forty

Furthermore, the potential impacts of a warming climate will first be exerted upon aquatic species. Recent studies on Mayfly show that cooler water supports the natural cycle of hatching from their larval stage to become winged adults. This is important because the likelihood of mating success is to be maximised during a very short breeding season (Everall *et al*., 2015). Changes to natural cycles of

maturation as a result of water temperature threatens to impact upon this element of timing. The same process is applicable to many other invertebrates and has implications for the prey availability for the wider ecosystem amongst their consumers, such as fish.

Recognising the pressures that will increase upon our water courses in the future, the RRT has actively sought academic partnerships and created twenty-two planting schemes to provide multiple benefits. Seventeen of the twenty-two incorporate new fences to directly exclude bankside damage due to trampling and prevent defaecation inchannel. Before and after photographs for each planting scheme are found in Appendix B.

Diffuse pollution reduced

The creation of riparian habitat schemes can represent a cost to farmers where drinking water access is cut-off by new riparian fencing. To mitigate, the installation of alternative sources has been offered and taken up on four farms. Depending upon the availability of water the RRT has implemented gravity fed, mains fed or solar panelled pumping options to landowners within the CRF areas of the catchment. These have subsequently maintained by a team of volunteer engineers led by the RRT.



New drinking water provision with a water pipe being installed down to the trough (right).

The exclusion of livestock has reduced the number of animals defecating immediately next or in to twenty locations along the Limestone Ribble's watercourses. The addition of trees and maturation of riparian vegetation within newly fenced off sections now buffers surface run-off. This may exact an immobilising effect upon heavy metals from the land to the water course where the land is acidic. The reduction in faecal and heavy metal loads reduces contaminant loads and toxicity in higher aquatic organisms, as well as contributes towards attaining regulatory standards within local bathing waters.

Bankside habitat improved

To examine the multiple impacts of the riparian habitat works, the ecological response of aquatic invertebrates and fish has been continually monitored. Kick samples and electrofishing surveys were performed as part of the RRT's annual, core survey programme and in contribution towards two ecology themed PhD studies (see Appendices C and E) that were delivered using trained volunteer help.

Invertebrate species diversity increased within habitat works delivered along the Ribble main stem, in the Long Preston Deeps area (See Appendix G). Compared to sections above and below, the number of taxa and the abundance of invertebrates in the schemes was comparably highest. Species that were more representational of healthier rivers were also more abundant where previous works had been

completed. This is also consistent with the observations of other CRF investigated areas delivered by the RRT (i.e. Diffusing the Issue and Colne Water).

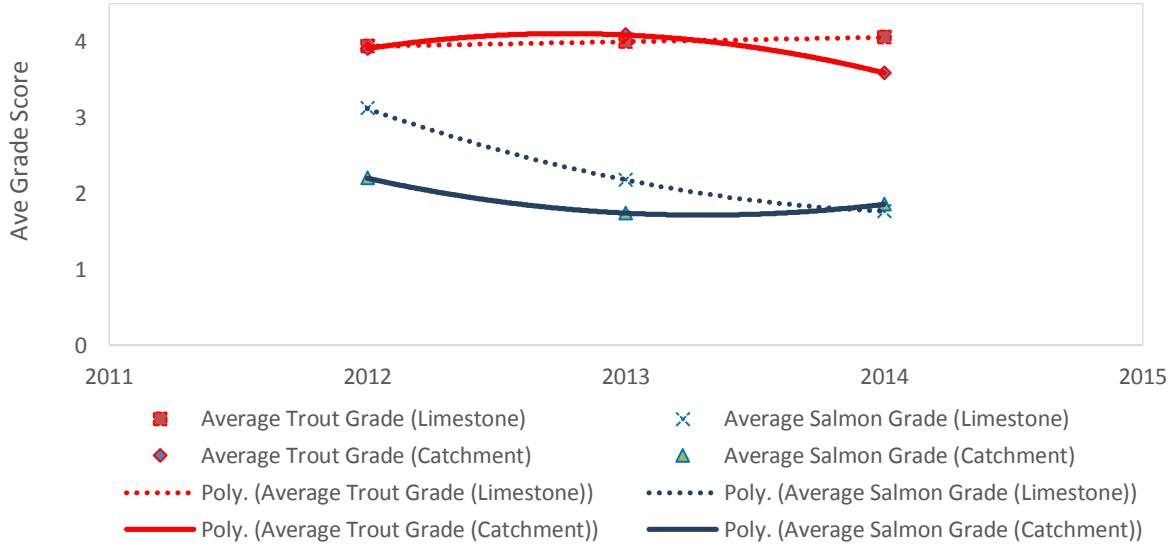
The response of fish between survey locations has been highly localised masked by the impacts of environmental variables and migratory behaviours. Summaries are provided below alongside the results for survey sites in the Limestone Ribble area. A more comprehensive overview is provided in Appendix D.



A salmon parr captured on Hellifield beck, adjacent to habitat improvement works installed in Feb, 2015.

The average number of juvenile brown trout present within sites of habitat works during the three years of CRF funding was greater than it was prior to the work. During the same period of time, the average number across all sites surveyed elsewhere in the catchment fell. These results provide a positive association towards graduated improvements in habitat condition as a result of CRF works.

A reduction in the average number of salmon fry was observed in both Limestone Ribble and the catchment as a whole between 2012 and 2014 (see below). Average abundances in the Limestone Ribble was higher in 2012 and 2013 than that for the rest of the catchment, until 2014 when abundances marginally reduced. This decline reflects the regional trend for adults. Through safeguarding the in river habitat for spawning fish and juveniles, a greater opportunity for spawning and rearing success is afforded.



Average NFC grade scores for trout and salmon fry surveyed by electrofishing sites in Limestone Ribble compared to the whole catchment.

In 2012 the RRT, in partnership with the Environment Agency and the Ribble Fisheries Consultative Association, also began trapping and tagging 'spring-run' salmon. The run represents a small proportion of the overall number that migrate the Ribble to spawn and with little known about them.

The presence of salmon fry within the RRT electrofishing programme demonstrates the utility of the Limestone Ribble as an important part of the catchment for salmon. The study was delivered utilising help from angling volunteers to trap the fish at a designated location and to help tag them.





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).

The study revealed that the tagged fish mainly spawned in the main stem reaching as far upriver as Stainforth. Further to the findings, the RRT and its partners have used CRF funds to fence line sections of water courses along, Ged beck, Stainforth beck as well as the main Ribble at Langcliffe. These locations represent locations adjacent to or affecting those used by the spawning salmon. Hence, the works here are of a direct benefit to the run of spring salmon.

Throughout the annual electrofishing programme the RRT, with the help of volunteers, has identified the presence of juvenile salmon in Rathmell, Wigglesworth, Tems and Hellfield becks, acting upon this knowledge to install habitat schemes that will improve the quality of the bankside habitat. The utility of the small becks helps to safeguard the A summary of the results that pertain to the CRF areas of the catchment can be found in Appendix D.

4.1.2 Reduced land loss and restored natural hydrology

Ground surveys of over 50km of grips and by supplementary use of aerial photography (see Appendix Fi,ii,iii), the RRT has blocked 16936m of those mainly categorised as of 'intermediate' priority. Highest priorities were classified by physical size and their angle of slope. Those categorised as of the highest priority did not often represent the most cost-effective solutions for practical reasons. The requirement for the additional materials needed to block them and the ease of access to remote locations. By contrast many smaller grips are re-vegetating naturally. The targeting of grips classified as 'intermediate priority' that were actively eroding was prioritised in order to maximise coverage and turnaround with the available funds. Works were sympathetically completed leading to visible reductions in bare peat and of overland flow as observed by our surveyors (See Appendix Fiii). Reduced exposure of peat and clay has now reduced the amount of land lost to wash out and wind erosion and will improve the clarity of water flowing into Cam and Gayle becks.



Diggers blocking grips on Cam Houses (left) and an example of blocked grips two years after maturation (right), January 2014. Please note minimal track damage due to wide tracks.

The general principle behind the works was to divert water from the drainage network (of grips) on to the surrounding land. Holden's (2009) review of over 150 restoration projects reports the additional benefits in reducing turbidity and colour, fine sediment and potential carbon losses presented the foundation for this scheme of works. With these guiding principles the work was undertaken and within two years sphagnum growth achieved with vegetation presiding over areas where bare peat was previously observed (Appendix Fiii).

Standing areas of water have been created where it previously drained, transporting eroded, peaty sediments away. The establishment of blocked grips is expected to positively contribute towards improving the diversity and number of upland invertebrate species and game fowl. Head Gamekeeper at Cam House Moor estate, Dave Roxby, has welcomed the work recognising these benefits locally and that 2014 was an excellent year for the successful rearing of Red Grouse and Partridge.

Hydrological models produced at Leeds University have projected the surface flow conditions 'with' and 'without' grips in contribution to main stem flows. This did not return the expected result following grip blocking and the outcomes presented only a partial picture in the absence of groundwater contributions (Appendix Fii). This evaluation demonstrates the complexity of modelling aquifer hydrology, hence, the full contribution of the CRF funded works remains unquantified. A more extensive monitoring effort and further development of the model is sought. For the purposes of this report, the blocking of grips has had a clear empirical benefit towards a return to a more natural hydrology.

4.1.3 Improved habitat connectivity for migrating fish

The introduction of pumped elver passes now opens up over 84Km of water course for maturing eels at the head of the catchment. The passes now ease the passage of young eels over Settle and Langcliffe weirs that have present an obstruction. By drawing water into the centre of the pass from the river at night, water is dispersed through the pass to facilitate eels' swimming through a series of bristle-filled sections. The sections are bracketed to the river banks running alongside and up over the weir. Each weir has an existing fish pass suitable for salmonids however this is restricted to other, poorer swimming fish such as eels. A lack of eels was identified within the catchment north of Settle via the RRT electrofishing programme. Within the twenty sites routinely surveyed above Settle weir no eels have been detected to date after a single migratory year.



Settle weir before and after eel pass installations, February 2014.



Locks weir (at Langcliffe) before and after eel pass installations, February 2014.

To improve farm access between sections of agricultural land, the lower reaches of Swaw beck (a tributary of Tems Beck) were historically abridged by a culvert and became overgrown with vegetation. All semblance of the brook had been disguised. Culverts are recognised as a barrier to migrating salmon and trout (Wild Trout Trust, 2013) due to the changes in flow that they create. The removal of the culvert now fully exposes the channel to air and reconnects it to its flood plain.



Swaw Beck deculverting, Giggleswick completed in 2012. Before (left) and after (right).

4.1.4 Increased Awareness of Local Rivers and Their Heritage

Catchment appraisal tours (CATs) were undertaken in 2012 at Long Preston and Stainforth (36 attendees) by local residents as part of the WFD pilot for the Ribble catchment delivered under Ribble Life. These included members of the Yorkshire Dales Millennium Trust, Yorkshire Dales National Park, Craven Conservation Group, the Environment Agency and local individuals. Their aim was to identify means of improving water quality within the locale, impress a greater understanding of the issues and take action from the outcomes. As a direct result of the Stainforth walkover the requirement for a riparian habitat improvement scheme was identified and later realised by the RRT under the CRF. Newly planted sections of riparian woodland along the Ribble at Stainforth are now more accessible to walkers via a new walk board, new fence lines and the installation of an interpretation panel. This also helped to develop some of the learnings from the original CAT.



A catchment appraisal tour in action at Stainforth, May 2012.

The capture of stakeholder perceptions of the Limestone Ribble project has informed the initial phases of a new PhD project led by Thea Wingfield of the University of Liverpool (Appendix H) that will examine natural flood risk. The research is aimed at providing a toolbox for practitioners to select which natural measures could be adopted to reduce flood risk across the catchment scale. Stakeholder assessments of the impact of works and their delivery by the RRT under the Limestone Ribble project have been conducted via questionnaires. From the responses local stakeholders have learnt of the multiple benefits of the works and feel positively towards them being beneficial, whilst reserving their judgement over the longer term outcomes until the schemes of work have fully established. Through working closely with landowners and tenants/gamekeepers and taking into

account their needs bespoke practical working plans were drafted and implemented. These have enabled grip-blocking and riparian planting work to go ahead with consent. By adopting this approach the works achieve not only a positive natural benefit, but a more conscientious investment from those working the land. From the feedback obtained a pragmatic and positive outlook has been ascertained.



A new interpretation panel was installed by the Ribble at Stainforth, September 2014.

Four evening presentations were delivered to the Austwick Field and Local History Society and the Craven Conservation Group (on the 19/2/14 and 18/2/15, and 27/1/14 and 23/2/15 respectively). The two groups represent local stakeholders with a vested interest in their water courses. Both groups exceed thirty members and requested an input as to the work of the RRT. The presentations related to the geological formation of the upper catchment and climate change effects. Additionally, a summary of the 'Wildlife of the Ribble' and the presence of invasive species was reported. The latter placed an emphasis on Himalayan balsam with a view to an organised removal activity in the Wigglesworth area during summer, 2015. The success of these events have led to calls for further events in future.

The findings of the first year of the salmon tracking study drew an audience of over 80 attendees on the 21/2/13 at the Swan and Royal, Clitheroe. A further event in May 2015 is proposed whilst active tracking activities have led to regular engagement on the river with land owners, anglers and walkers.

The Horton-in-Ribblesdale agricultural show was attended by the RRT in summer 2014 which attracted over 100 visitors to the event with the opportunity to showcase rivers and the work that was undertaken locally.

Activities completed under the Limestone Ribble project have also been covered in two articles published by the Craven Herald newspaper and also by the Settle & District Community News. This is in addition to ongoing online coverage via the Ribble Rivers Trust social media channels (Facebook, Twitter and YouTube).

4.1.5 Investment in Skills and Training Provision

The attendance by students of Settle middle school contributed towards their environmental 'John Muir' award[1]. The award recognises the importance of caring for and conserving wild places amongst the students who new practical skills in tree planting and species identification.

The RRT facilitated the training and development of three PhD students, providing the local knowledge, practical expertise and office support to aid in their studies. Each study provides an answer to the various responses of the RRT's works. The students, from Durham, Liverpool and Manchester have developed the Trusts and its partner's knowledge of our upper catchment, contributing to the scientific literature and wider understanding in the disciplines of Ecology, Geology, Hydrology, River Restoration, Social Sciences and Statistics.

Mentoring was offered to one countryside practitioner in erecting fence lines along water courses. This individual is now sufficiently trained to operate as a contractor and has already contributed to RRT works in other parts of the region. Two students also completed their Duke of Edinburgh awards having assisted contractors with tree planting and fence lining. An electrofishing demonstration was performed for Fish Management BTEC Level 3 Diploma students from Myerscough College in September, 2013. Work conducted during the CRF has also been showcased to new students from the same course in addition to NVQ Level 3 FdSc Ecology and Conservation Management at the RRT Office and the College in Dec, 2014 and Jan, 2015.

4.2 Who benefitted from the Limestone Ribble project?

The audiences that the Limestone Ribble project set out to reach included the residents and local communities of upper Ribble, local farmers and landowners as well as visitors to the North Yorkshire Dales. These audiences are important because they all have the ability to have an impact on the future landscape.

4.2.1 Local Residents and Visitors

The Limestone Ribble project engaged with local residents in a variety of ways, including public shows, river walks, catchment appraisal tours (CAT) and presentations by RRT staff and its partners. The aim

[*"Short term you can already see the impact it has had up on the moors, up on the uplands"*]

[*"The quantity of riparian habitat improvement work has been impressive"*] was to showcase to the local community, the reasons for failure of the local catchment under WFD and examine what they could to improve matters. The CAT at Stainforth was posted upon our RRT YouTube channel at https://www.youtube.com/watch?v=ZdL2zcS-f0A attracting twenty five participants to explore their local river.

Local stakeholders have reported that they feel the works under the Limestone Ribble have primarily been successful in the delivering on the project's intended outcomes, but especially with providing better habitat for people and wildlife (See Appendix H). There was further recognition amongst over the professional way the projects have been planned, managed and delivered.

The Limestone Ribble area of the Yorkshire Dales National Park attracts well over one hundred thousand walkers and visitors each year. They will benefit from the added provision of ecosystem services presented through the creation of new river and moorland habitat. More blanket bog, riparian and inchannel habitat and better water availability and quantity will support wider biodiversity, adding recreational value. By sustaining iconic wild species such as the Atlantic Salmon, White Clawed Crayfish, Black Grouse and Common Sundew wild assets are available to be enjoyed by visiting walkers, anglers, conservationists, shooters and most importantly, future generations.

4.2.2 Schools, Colleges and Universities

A group of students from Settle middle-school attended and supported a tree planting day at Stainforth which enabled them to complete their environmental 'John Muir' award.

Two students who volunteered to assist with riparian tree planting exercises also attained their bronze Duke of Edinburgh awards (see Appendix I).

The delivery of monitoring objectives has contributed towards the learning and scientific understanding for three PhD students through collaboration with Durham, Liverpool and Manchester Universities. The two environmentally themed PhD research studies (with a third commencing (See appendices C, E and H)) are now underway that have studied water courses within the project area with support from the RRT. A three-year fish telemetry study was also been delivered in partnership with the EA and local angling clubs. The study identified locally important areas for conservation as priorities for practical works.

4.2.3 Volunteers

A total of 120 individuals of ages 8-80 have been trained throughout of project related activities. The installation of fence lines and tree planting has taught new skill in 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. The ecological surveys conducted as part of the project have also provided wider experience for our volunteer and student entomologists (see appendices C and G).



Young volunteers tree planting at Long Preston

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.

4.2.4 Community and Interest Groups

The Craven Conservation Group and Austwick Field and Local History Society actively sought the Ribble Rivers Trust to teach public groups about the wildlife of their local water courses through a series of evening presentations. These were delivered by RRT staff and were widely received resulting in requests to return and repeat the evenings.

The RRT has engaged with Settle Football club to install a new fence line along the Ribble main stem adjacent to their pitches. Working alongside the club, the RRT has promoted its cause to improve local water courses and heightened awareness amongst their members.

The Ribble Fisheries Consultative Association and Environment Agency have supported a fish telemetry study to run concurrently alongside the Limestone Ribble. This had the wider objective of improving understanding about the threatened stock of spring salmon. The outcomes have provided target areas for habitat improvements then delivered through the Limestone Ribble project. Two presentations and attendance at committee meetings have widen public interest and knowledge to the benefit of a declining stock. Support from the angling clubs has ranged from physical assistance with tracking tasks to providing guidance on communication and project delivery to result in habitat improvement.

4.2.5 Local Business and Organisations

As a predominantly rural catchment the RRT has worked closest with farmers within the Limestone Ribble area. Previous exposure to agricultural businesses was low in this area, and through partnership working with groups such Settle Anglers and Stainforth Caravan Park, these brokers have been vital in encouraging other local landowners to participate.

The project has sought to utilise local contractors and organisation wherever possible (and within procurement guidelines), which has supported the local economy. Local skillsets utilised have included: Civil engineering; fencing; ecological monitoring; tree planting.

Twenty farms and four non-agricultural businesses have changed their working practices to incorporate more sustainable methods and make infrastructure improvements that aid protection of the water environment.

4.2.6 Partner Organisations and the Wider Sector

The Limestone Ribble project partnered with several organisations with particular mention to Settle Anglers, Stainforth Caravan Park, the Environment Agency, the Forestry Commission, Yorkshire Dales National Park, Yorkshire Farming and Wildlife Partnership and the Yorkshire Dales Millennium Trust. These organisations have all benefitted from being part of the Limestone Ribble project in that they were all able to deliver on their objectives. The quality of the practical works and the benefits to the local ecology have been recognised by partners and attracted praise (for the grip blocking, see Appendix J).

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 water courses reducing faecal matter and allowing vegetation to naturally recover, however the maturation of trees planted will see increases in shade, habitat and buffering diffuse 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, white-clawed crayfish, otters, and Black Grouse 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

Prior to the Limestone Ribble project, the RRT had delivered comparatively few river improvements compared to elsewhere on the catchment. The positive reactions to the Limestone Ribble project and its demonstrable successes, have fostered personal relationships not to mention a greater understanding of what the Ribble Rivers Trust wishes to achieve in the upper catchment. In doing so, the RRT has greater public support towards further reaching improvements in 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 through the actions of this project, and the sharing of evidence and outcomes, such as the extensive surveys and mapping of grips has provided the data and evidence to that will result in delivery by other groups, such as the Yorkshire Dales National Park and Yorkshire Peat Partnership, 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 Limestone Ribble represents the first significant impact upon the landscape of the upper Ribble area. This has brought the RRT in to contact with more Yorkshire based delivery bodies, landowners and agencies on a local scale. The 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 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 the 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 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 effective high 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. Furthermore working with funders to enable longer term resourcing of monitoring is seen as vital given the period over which full realisation of improvements is expected.

The delivery of practical works has been a feature of successful negotiations through an appreciation of practical constraints placed upon working partners. Taking examples from the early delivery stages of the grip blocking work, the interference of such was potentially in conflict with agricultural and sporting use of the land. Through open dialogue and a desire to get the job competed, conflicts where avoided to achieving a mutual benefit. Such experiences with the delivery of project outcomes enable the RRT to become more effective in future and having established rapport with individuals with whom there is more to be done.

There is also greater emphasis required on early engagement and inclusivity of partners and stakeholders. Although the constraints of this project prevented the aspired level of engagement being achieved, improved communications, publicity and innovative methods of gathering input could be included in the future to increase engagement and inclusivity.

The legacy that the project leaves will be largely positive and fully realised through periodic revisits and upkeep. It is important that this element is not forgotten and that future funds be made available to provide the best chance of the Limestone Ribble succeeding in its original objectives beyond the three year delivery phase.

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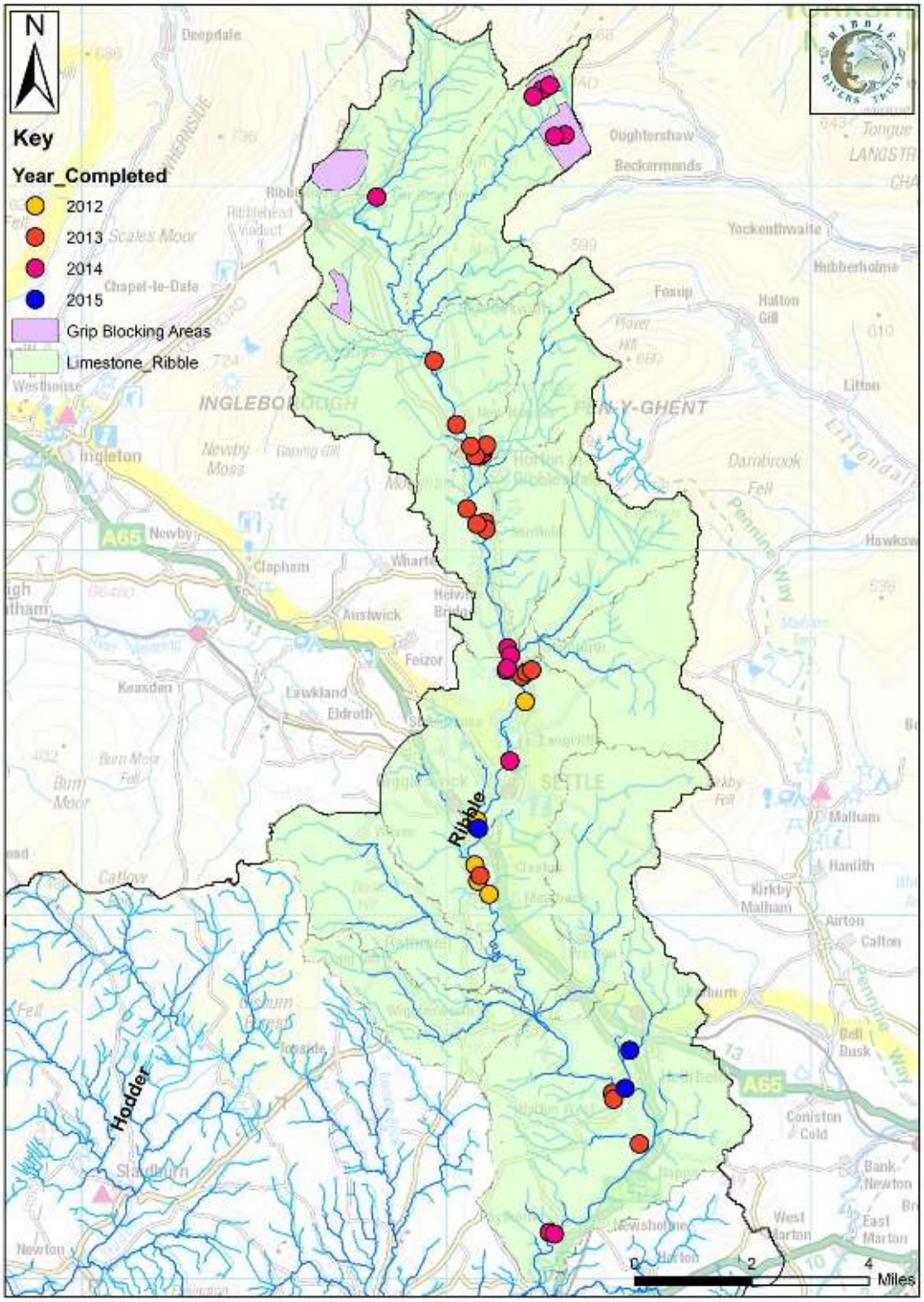
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Appendix

Appendix A. Summary map of the extent of RRT habitat (with completion dates) and grip blocking works delivered under the CRF



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Appendix B. Fixed point photography

All of the following photographs demonstrate before and after shots of riparian habitat scheme completed under the Limestone Ribble project (authored by John Milne, RRT).



Gayle Beck before



Gayle Beck after



Langcliffe Mill (River Ribble) before



Langcliffe Mill (River Ribble) after



Wigglesworth Beck before



Wigglesworth Beck after



Tems Beck before



Tems Beck after



Gildersleets (River Ribble) before



Gildersleets (River Ribble) after



Bradley's Long Preston (River Ribble) before



Bradley's Long Preston (River Ribble) after



Maudsley's Long Preston Deeps (River Ribble) before



Maudsley's Long Preston Deeps (River Ribble) after



Ged Beck before



Ged Beck after



Brook House Farm before



Brook House Farm after



River Ribble – Newhouses B before



River Ribble – Newhouses B after



Ribble - Fawcetts After



Ribble – Newhouses B before



Ribble – Newhouses B after



Ribble – Horton Playing Fields Before



Ribble – Horton Playing Fields After



Ribble – Stainforth Caravan Park before



Ribble – Stainforth Caravan Park After



Ribble - Settle AFC before



Ribble - Settle AFC after



Pan Beck before



Pan Beck after



Ribble - Runley Mil, Settle before



Ribble - Runley Mill, Settle after



Ribble - Home Farm A, Halton West before



Ribble - Home Farm A, Halton West after



Ribble – Home Farm B, Halton West before



Ribble – Home Farm B, Halton West after



Candlerush Beck before



Candlerush Beck after

Appendix C. Ecological Response to the Placement of Large Woody Debris on Gayle Beck, by Mike Forty.

Introduction

The placement of large woody debris (LWD) in streams has become an ever increasingly popular method of improving habitat for both in-stream biota as well as non-aquatic wildlife which utilise the river and its banks. LWD has been determined to have a significant influence on both physical and ecological processes, providing velocity refuges, overhead cover from predators such as birds and otters, substrate for invertebrates, increasing primary productivity through input of particulate organic matter, and playing an important role in the determining of stream channel structure (Allouche, 2002; Gregory *et al*., 2003; Whiteway *et al.,* 2010).

Langford *et al*. (2012) note that there are a lack of quantitative studies of the effects of introduced or natural wood accumulations on fish communities in spite of the fact that LWD is so widely used in restoration efforts e.g. Kail *et al*. (2007) found a large proportion of highly rated European projects for creating fish habitat could not provide definitive conclusions on its impacts on fish communities. Of the studies which have been conducted, many have been directed towards salmonids with communities comprising of age 1+ fish (e.g. Roni & Quinn, 2001; Kail *et al*., 2007; Stewart *et al*., 2009; Whiteway *et al*., 2010). With fish species displaying spatial and temporal variation in preference for different physical and hydrological habitat parameters not only between species but also at different ontogenic stages (e.g. Maitland and Campbell, 1992; Armstrong *et al*., 2003), there is a need for studies of the placement of LWD on mixed species fish communities as well as those with multiple age classes e.g. Langford *et al*., 2012 who found that LWD accumulation in stream is not always beneficial to all species or ontogenic stages.



Figure C1. Example of the large woody debris placement on Gayle Beck.

The Ribble Rivers Trust (RRT) identified through annual monitoring surveys that Gayle Beck was failing to meet European Water Framework Directive requirements for fish and as such undertook a physical habitat walkover survey in 2011 to identify potential reasons for this failure. The report indicated that potential reasons for failure may include an over widened channel causing insufficient channel depth for sustaining the expected juvenile brown trout and Atlantic salmon populations. It was also noted that the shallow depth may be enhancing stream temperature extremes which can cause stress and eventually mortality for these species. A 1 km priority reach on Gayle Beck was identified as also having major issues with bank erosion due to the presence of a very flashy hydrological regime and exposed banks. This section has been subject to improvement in March 2013 through the placement of bank protection in the form of tree stems with their root wads intact facing upstream in to the current. These stems have been inserted in to the eroding banks by force using heavy machinery with the premise that the upstream facing root wads will dissipate the main erosive force of the water column reducing erosion.

LWD placement takes the form of two categories in terms of its goals: (1) to improve habitat by increasing LWD quantities in the stream; and (2) to alter flows such that it improves aquatic habitat (Fischenich & Morrow, 1999). The LWD placement in this study is a mixture between these two goals with a primary goal to reduce bank erosion to stop the river migrating in its flood plain and enhance in-stream habitat by reducing fine sediment input from bank erosion and reduce channel width and increase channel depth. Its secondary goal is to directly influence in-stream biota by providing cover for fish from non-aquatic and aquatic predators and as flow refugia and substrate for invertebrates. Where tree stems were of sufficient length and available, they were secured in to the bank at substrate level to provide the more classically defined large woody debris, improving in-stream habitat in the form of this organic substrate. Reducing the active channel width will aim to benefit the ecosystem by creating a deeper channel to help sustain juvenile salmonid populations and reduce temperature extremes experienced by riverine biota. Also, where the root wads are in contact with the water column the productivity of the ecosystem may be improved by providing an organic habitat/substrate for macroinvertebrates, macrophytes and other flora to colonise further improving the suitability of this reach for juvenile salmonids. To further enhance this reach, the RRT have completed stock fencing along both banks of the channel as well as planted native tree saplings to add further bank protection through root growth, a riparian buffer zone for land sourced pollutants, provide shade to the channel to further reduce channel warming and to increase organic matter input to the stream from the riparian zone increasing the streams productivity. However, these additional benefits to this reach cannot be measured in the short duration available to this study. This study aims to measure the ecological response an upland limestone catchment stream to the placement of large woody debris.

Methodology

Study site

This study was conducted on Gayle Beck, a formative tributary of the River Ribble which rises in the south-west Yorkshire Dales before joining with Cam Beck north of Horton-in-Ribblesdale to form the Ribble (Figure C2). The study area is located at ca. 300 m.a.s.l. just below a gorge with an impassable waterfall to fish marking the end of anadromy. Riparian land-use is dominated by semi-improved pasture throughout the entire section over an underlying geology of limestone bedrock. This

contributes towards a normal pH value of ca. 7-8 in the stream which also has relatively low conductivity of ca. 100 – 200 µS. Fish communities in the area consist of Atlantic salmon (*Salmo salar*), brown trout (*Salmo trutta*), European bullhead (*Cottus gobio*), stone loach (*Barbatula barbatula*), European minnow (*Phoxinus phoxinus*), and white-clawed crayfish (*Austropotamobius pallipes*).

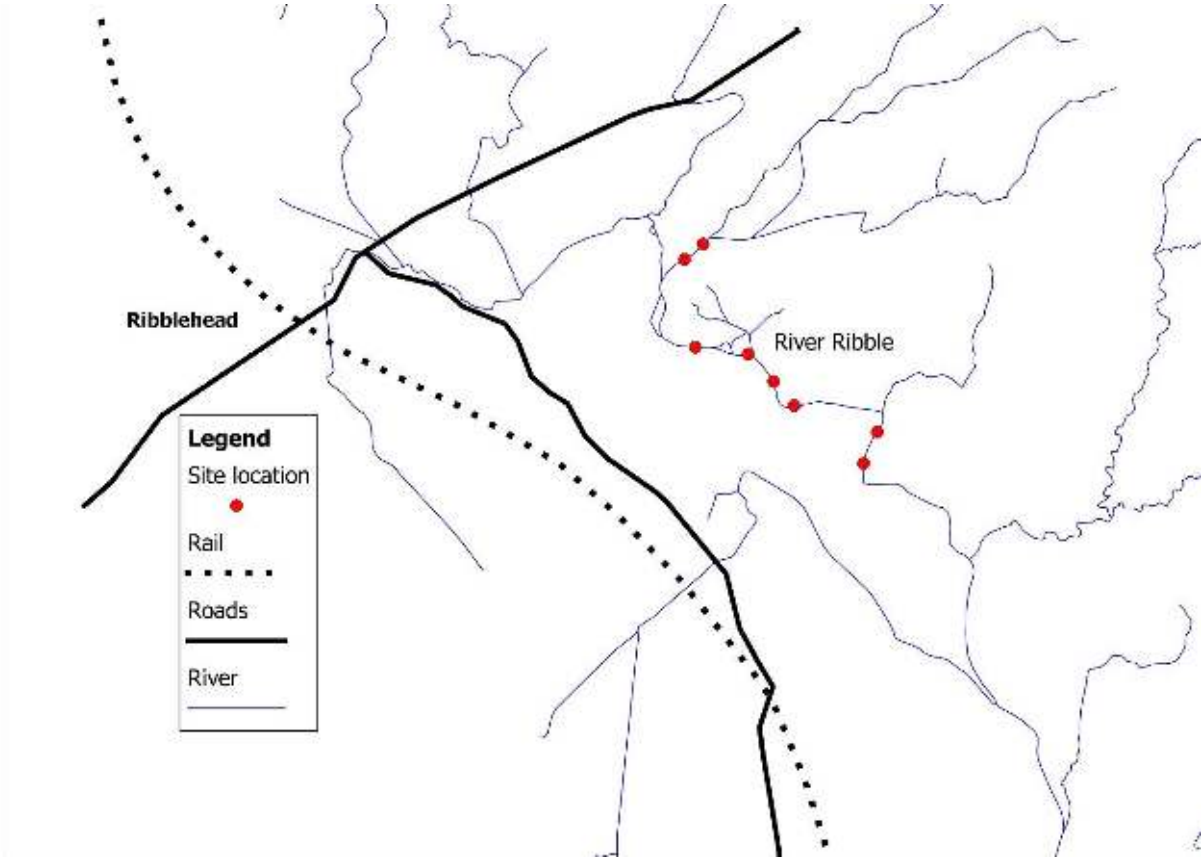


Figure C2. Map of study area.

Study design and data collection

This study utilises annual sampling in September/October as part of a before-after-control-impact design with baseline data collected in 2012 pre-restoration and post-restoration in 2013 and 2014 with another year of post-restoration sampling to be completed in 2015. The length of the restored section allowed for the placement of three treatment sites with four control sites, two upstream and two downstream of the treatment area. Sites were distributed such that there was at least twice the length of the site between them to ensure they were independent reaches.

Of the biota, macroinvertebrate and fish populations were surveyed with fish being surveyed using three-pass depletion quantitative electric fishing (Electracatch WFC4, Wolverhampton, UK and 1 KVA Honda generator). Captured fish were identified to species and their fork or total length measured where appropriate. Fork/total length was measured for every individual *Salmo trutta* and *Salmo salar*, but was only measured for the first 100 individuals per reach for other species in order to create length-frequency distributions. Eight quantitative macroinvertebrate samples were taken per reach using a Surber sampler. For each sample all the substrate was completely cleared of any invertebrates and the underlying fine sediment disturbed up to a depth of 10 cm and invertebrates washed in to the net. Samples were preserved in a 70% ethanol solution for later identification. In order to identify any physical changes in habitat, wetted channel width, flow forms and habitat were mapped at each

sample site and velocity-depth profiles taken (electromagnetic flow meter, Valeport, model 801) and sediment grain size distribution measured. Sediment grain size distribution was estimated by a visual assessment of the river bed where particles were discerned by their b-axis length and categorised according to the Wentworth scale (Wentworth, 1922).

Results

Physical habitat data collected pre-restoration is presented in Table C1. Mean velocity through the area varied from site to site (range, 0.14 – 0.28 ms^{-1}) with highest velocities found at site 1, coinciding with the presence a faster flowing riffle-run feature at the upstream extent of the site. The substrate was well mixed and cobble dominated with minimal sand or silt/clay present providing suitable spawning substrate for large salmonid adults.

Table C1. Physical habitat measurements for sites pre-restoration in 2012.

Site Number	1	2	3	4	5	6	7
Site type	US control	US control	Treatment	Treatment	Treatment	DS control	DS control
Mean width (m)	8.1	7	7.9	5.4	5.9	7.5	4.8
Mean velocity (ms^{-1})	0.28	0.17	0.25	0.16	0.14	0.23	0.27
Morphology (%)							
Riffle	45	45	35	50	45	50	40
Run	15	30	0	0	0	20	40
Glide/Pool	40	25	65	50	55	30	10
Substrate (%)							
Bedrock	0	0	0	0	0	0	0
Boulders	15	3	0	20	5	40	15
Cobbles	45	40	65	46	4	30	55
Pebbles	20	35	10	25	35	18	15
Gravel	15	17	10	8	15	11	10
Sand	5	5	10	1	0	1	3
Silt/Clay	0	0	5	0	5	0	2

Fish communities

The total density of fish captured from the up to 2.3 km^2 of stream surveyed each year was highest in 2014 (181.8 fish $100m^{-2}$), and lowest in 2013 (131.7 fish 100 m^{-2}) reducing from the baseline survey in 2012 (168.9 fish 100 m^{-2}). Pre-restoration fish communities were dominated by bullhead (75%) and minnow (15%), with low numbers of stone loach (6%), Atlantic salmon (3%) and brown trout (1%). White-clawed crayfish were present in three of the seven sites but in very low abundances (< 1%) The relative abundance of the population varied between years (Figure 3) with the greatest changes observed between bullhead and minnow.

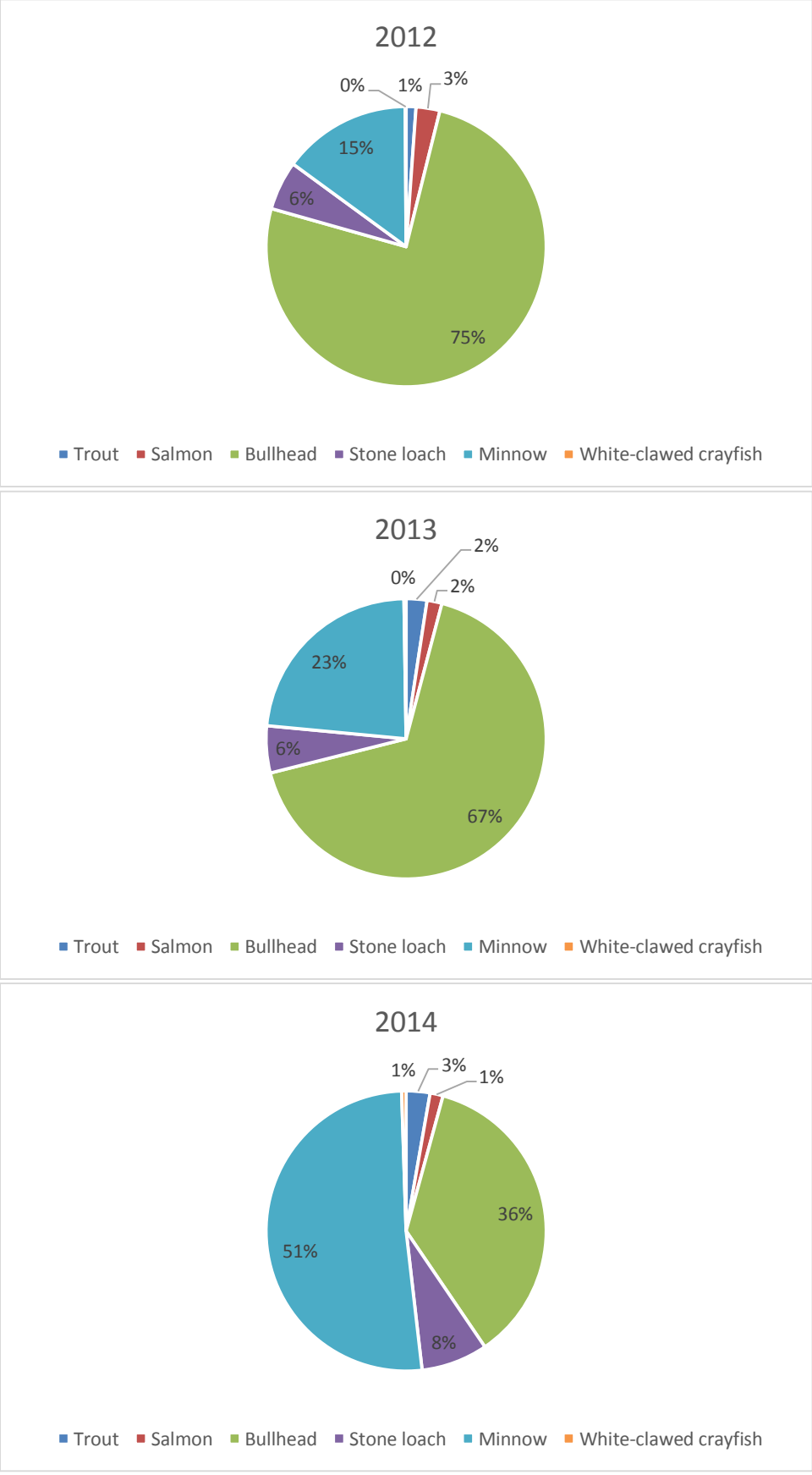


Figure C3. Relative abundances of fish species across all sites for 2012, 2013 and 2014.

Brown trout and Atlantic salmon

Mean brown trout densities were observed to increase from 2012 in both treatment and control sites (2.6 and 1.4 fish 100 m^{-2}) in 2013 (4.9 and 1.9 fish 100m^{-2}) and 2014 (Figure C4) more than doubling the density in both groups during that time period. Highest densities were observed in the treatment areas which showed the greatest increase between 2012 and 2013, whereas control reaches showed a much larger increase between 2013 and 2014 compared to that observed in treatment sites. These changes in densities led to an increase in their relative abundance from 1% in 2012 to 3% in 2014 across all sites. The increase in densities of brown trout are predominantly due to increased numbers of age 0+ fish in 2014, this is particularly true within control sites where the presence of greater numbers of parr and adult trout also contributed (Figure C6).

Patterns in Atlantic salmon mean densities were nearly opposite with reductions across treatment and control sites between 2012 and 2013 with a slight recovery seen in 2014 (2.5 and 2.9 fish 100 m^{-2}, Figure C4). The pattern was very similar between both treatment and control sites indicating this may be due to natural variation. This reduction led to the decrease in relative abundance of Atlantic salmon from 2012 (3%) to 2014 (1%). However the increase observed in brown trout coinciding with this period means that the salmonid relative abundance remained at 4% across all three years regardless of the relative change between salmon and trout. Between 2012 and 2013, there were large reductions in the age 1+ cohort for salmon (Figure C7) with no parr present within treatment sites in 2013. Parr survival appeared to be slightly higher in 2014 but lower 0+ numbers in both treatment and control lead to lower overall densities.

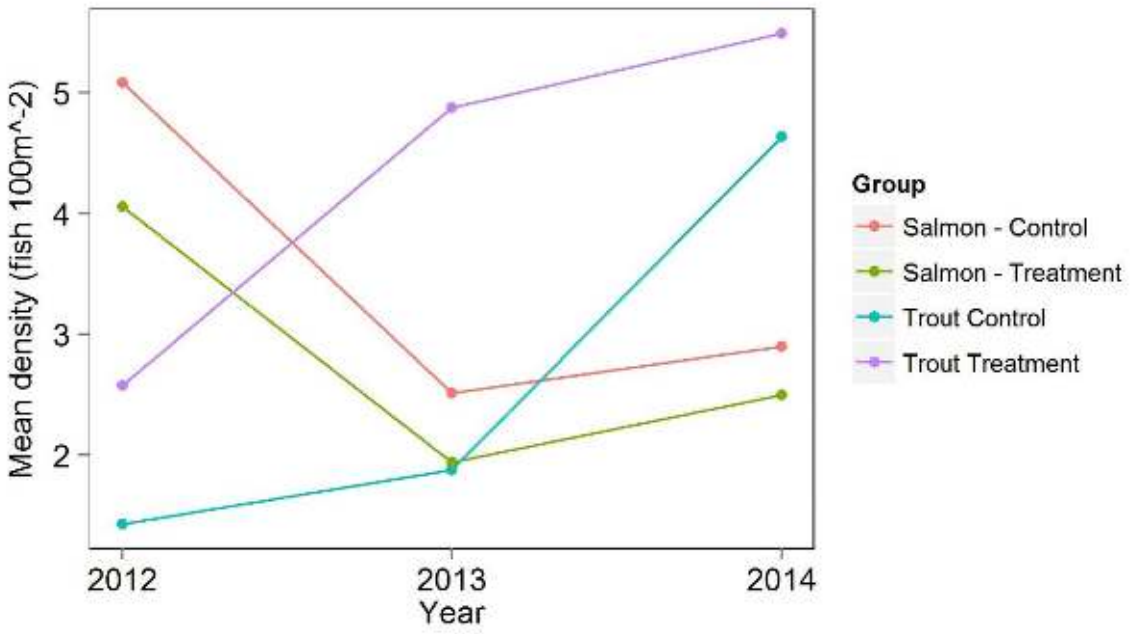


Figure C4. Mean density of brown trout and Atlantic salmon per 100 m^2 within control and treatment sites.

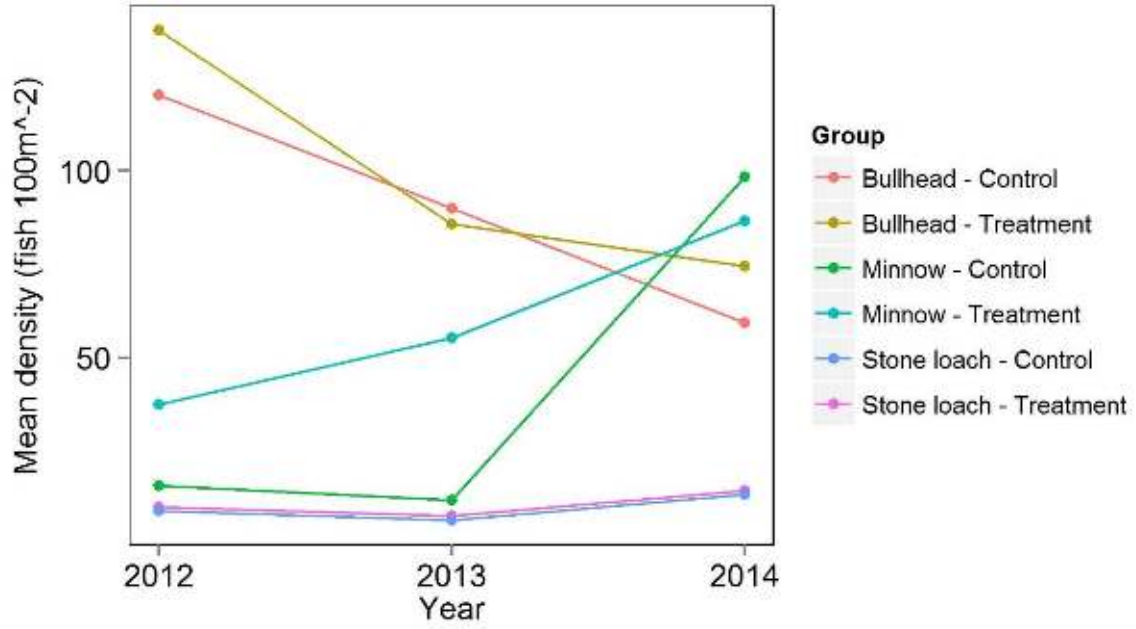


Figure C5. Mean density of European Bullhead, European Minnow and Stone loach for control and treatment sites.

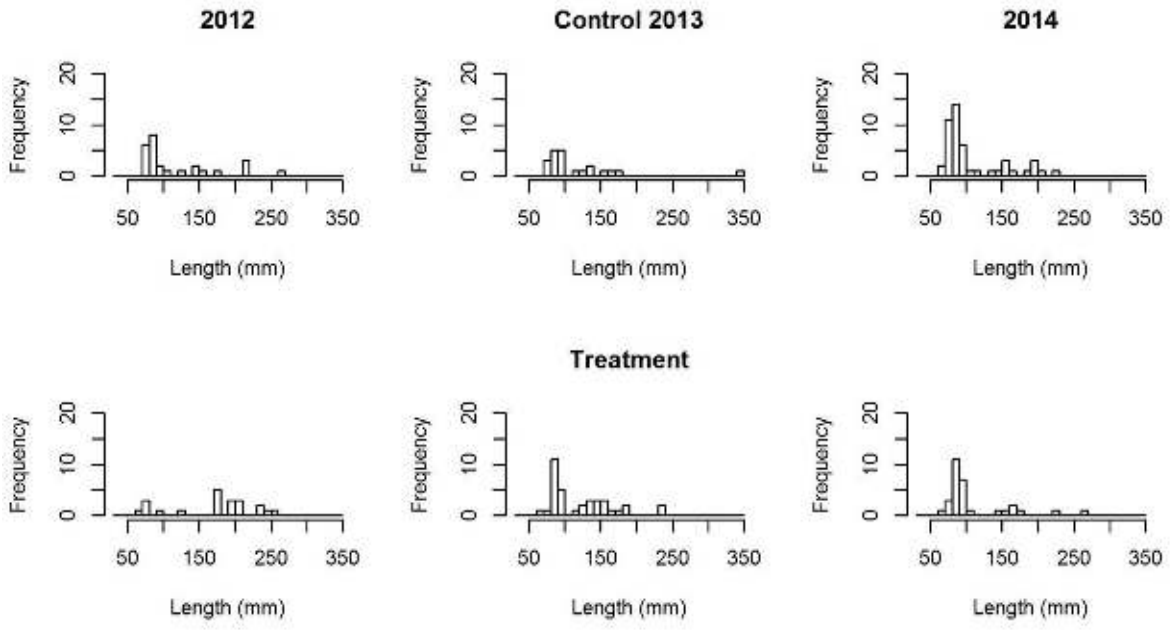


Figure C6. Fork-length histograms for brown trout in treatment and control sites in 2012, 2013 and 2014.

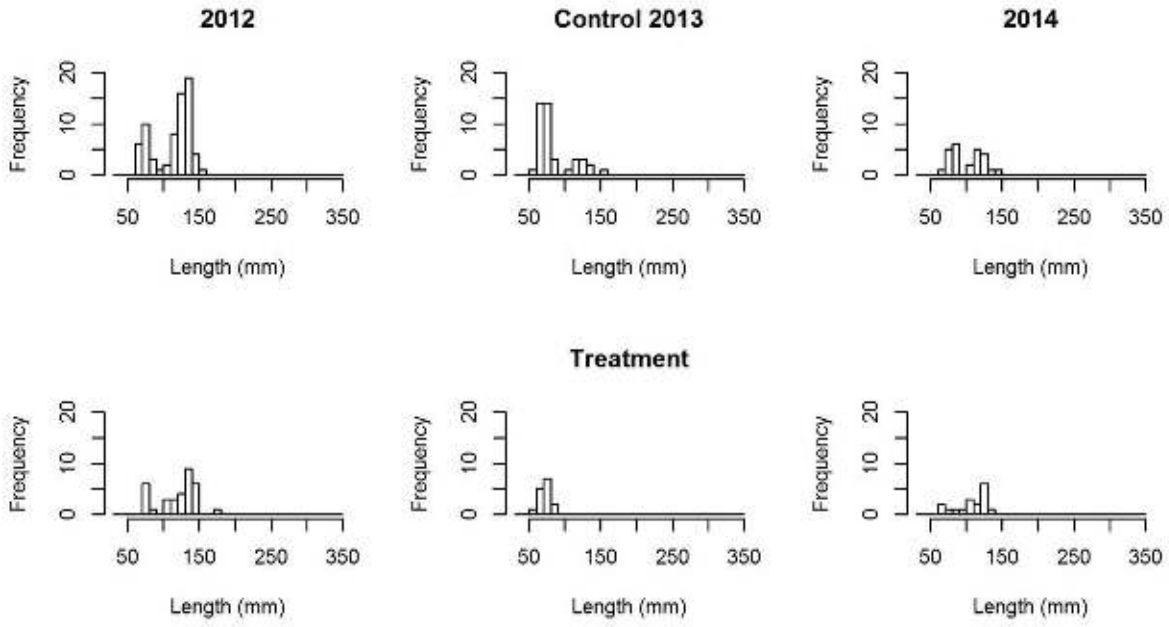


Figure C7. Fork-length histograms for Atlantic salmon in treatment and control sites in 2012, 2013 and 2014.

Bullhead, stone loach and minnow

Bullhead mean densities reduced in a similar pattern across treatment and control sites from 2012 (137.4 and 120.1 fish 100m^{-2}) to 2014 (74.4 and 59.4 fish 100 m^{-2}, Figure C5). This progressive reduction led to the greatest shift in relative abundance from 75% in 2012 to 36% in 2014. Opposite to this the minnow population had a large increase between 2012 and 2014, in particular within control reaches where mean density jumped from 12 to 98.3 fish 100 m^{-2} between 2013 and 2014 (Figure C5). Stone loach mean densities remained fairly consistent throughout the three years with near identical patterns observed between treatment and control sites of a slight reduction from 2012 to 2013, then an increase in 2014 (14.5 and 13.5 fish 100 m^{-2}) to densities greater than those in 2012 (Figure C5).

Discussion

This study has observed the response in fish communities in a stream within an upland limestone catchment following the placement of large woody debris in to the banks. There has been much interannual variability in densities, relative abundance and age structure within the community across both control and treatment sites. Increases in mean density within the brown trout population are positive in terms of its survival. The increase in density between 2012 and 2013 following restoration within treatment reaches may indicate an increase in the suitability of the habitat for age 1+ brown trout where there was a greater increase in their number within treatment reaches than control reaches. However, there was also an increase in the density of brown trout in control sites, particularly between 2013 and 2014, which means it is not yet possible to discern whether this change in community structure can be explained by the restoration works alone.

In contrast to brown trout, there have been coinciding reductions in the Atlantic salmon density within control and treatment reaches. This area is at the very end of anadromy for Atlantic salmon so the number of spawning adults which reach this area may be limited, particularly when taking in to

account the number of in-stream barriers, both man-made and natural, which they have to pass on their way from sea to source. This reduction in density across sites in line with increases in brown trout where the relative abundance for salmonids stayed at 4% but brown trout became more dominant may indicate competition between the two species, but may also be a factor of poor spawning runs, lethally high temperature extremities in summer months, a flashy hydrological regime washing out redds. In addition to salmonids, changes were observed within other species, particularly minnow and bullhead which showed large increases and reductions in their densities respectively. These changes were observed across both control and treatment sites so are likely due to natural variation due to more favourable conditions for one species or the other.

This study is in need of more long term monitoring in order to discern the ecological response to the improvement works. More in depth results for this study will be available in the future once macroinvertebrate data have all been collected and identified, geomorphology data collected and processed along with the completion of data collection for 2015. These data will give a clearer understanding of the ecological response of this stream to the large woody debris placement as well as possibly indicating reasons for it failing to meet Water Framework Directive standards for fish. Fish populations generally have a long recovery time following a disturbance/change to their habitat or environment compared to macroinvertebrates (Milner, 1994), therefore we may expect to see a more rapid response to the works within the macroinvertebrate data set. These results will be available in the form of a Ph.D. thesis by Michael Forty from Durham University in 2016.

Acknowledgements

Thanks go to those who have aided in this work, notably Gareth Jones, Paul Peters, Adam Wheeler, Jeroen Tummers and Sergio Silva for their contributions to fieldwork and Dr. Martyn Lucas and Jack Spees for their guidance and supervision. Thanks also to DEFRA's Catchment Restoration Fund for providing funding for this work and land owners for their cooperation.

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Appendix D. Results of electrofishing surveys

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. Fifty nine sites have surveyed across 'Limestone Ribble' during the course of the past seven years with forty one re-visited in 2014 (see map). Academic volunteers, often as part of their degree programmes, benefit from learning an industry standard fish sampling technique with some ascertaining data for their own personal research projects. The activity acts as an important engagement tool with local landowners and stakeholders and helps to identify where opportunities may arise. In more public areas, people are often attracted to the visual spectacle created by the technique. This presents an opportunity to inform people about their aquatic environment, its inhabitants and how productive it can be.

Method

All electrofishing surveys were conducted following the methodology of Kennedy and Crozier method (1993) and have been employed by the Trust since 2008. All sites are fished upstream in a zigzag pattern over congruous riffle/pool habitats using an E-fish 500W electrofishing backpack system. Typically, two types of survey were undertaken: Semi-quantitative, where the river is fished for five minutes covering an undefined but recorded area; and quantitative, where a netted area of river is sampled and re-sampled over another two runs. Quantitative surveys allow for the identification of capture efficiencies of each electro fisher, thus allowing more accurate results from semi-quantitative surveys to be presented.



An electrofishing survey underway upon Gayle beck, 3/10/14.

The densities of trout and salmon from the above activities were calibrated and allocated a grade (see Table D1) to standardise our observations with those of the National Fisheries Classification System (NFCS). The system is based upon the number of fry capture per species. Grades A – F are assigned by extrapolating the density of fry per $100m^2$ based upon the number captured in five minutes and using the capture efficiency of the electrofishing team. Capture efficiencies are obtained from measurements of the numbers of fish captured during the quantitative surveys. For the purpose of this report the grades provide a proximal estimate to the performance of the water course and the water course's health.

Table D1. National Fisheries Classification Scheme Gradings

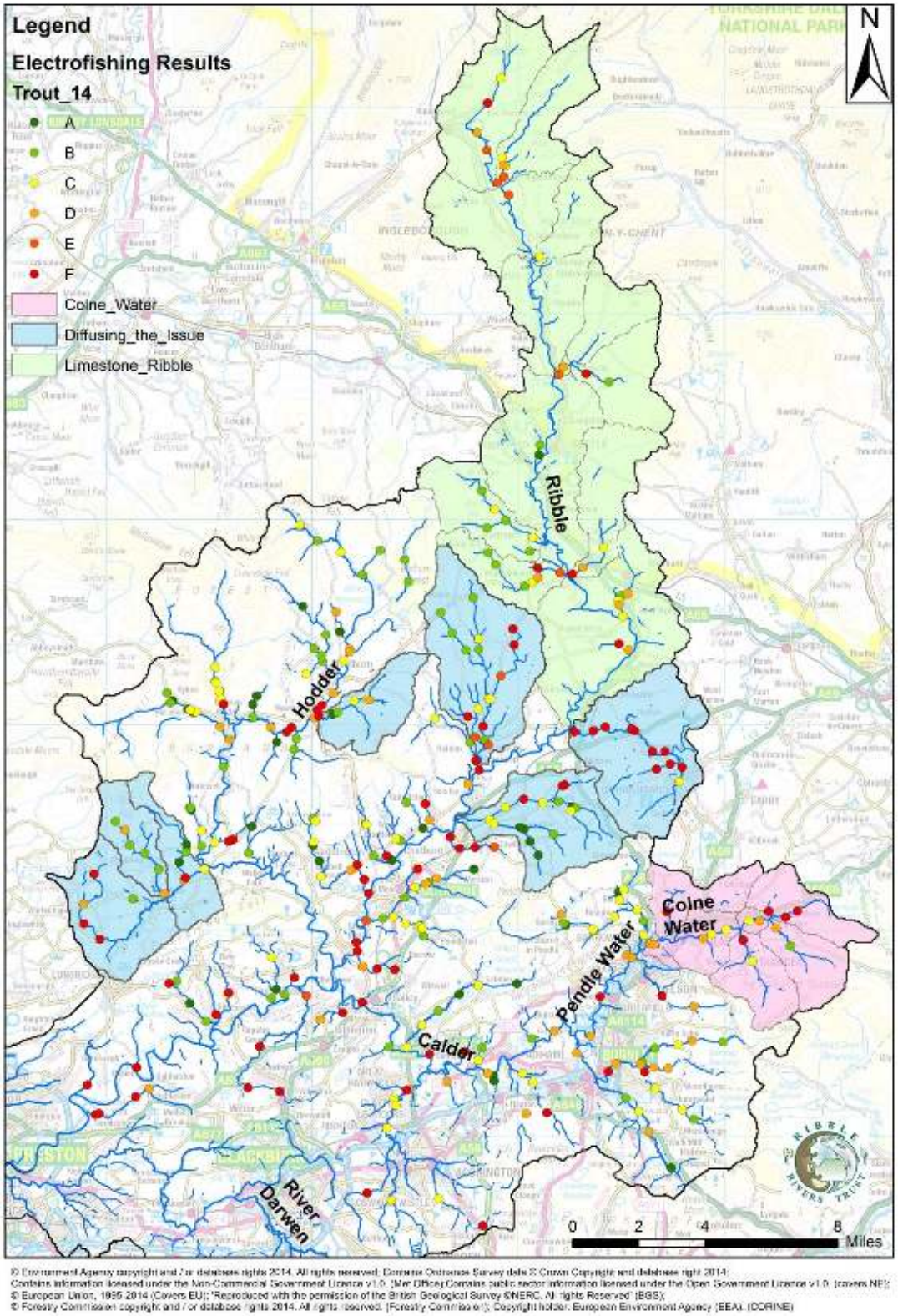
Grade	Fish Density
A	Excellent
B	Good
C	Fair
D	Poor
E	Very poor
F	No fish present

The accumulation of data from repeated sites between years is presented below for both the Limestone Ribble sites and the average for the catchment. Electrofishing records for fifty-nine sites within the Limestone Ribble area have been retained and are compared with the catchment averages within the data analysis.

Results

The Ribble catchment as a whole has a healthy Brown trout population that is widely dispersed and with the greatest abundances found in the higher gradient headwaters. Typically, there are fewer trout in the lower tributaries of the Ribble compared to those of the Calder, Hodder and mid-to-upper Ribble. Within the Limestone Ribble area the healthiest populations exist within the Ribble tributaries of Rathmell, Wigglesworth and Tems becks (see Figure D1). The formative tributaries of Cam and Gayle becks present moderate to poor grade sites. The main stem of the Ribble is not fished below Horton-in-Ribblesdale due to equipment capabilities.

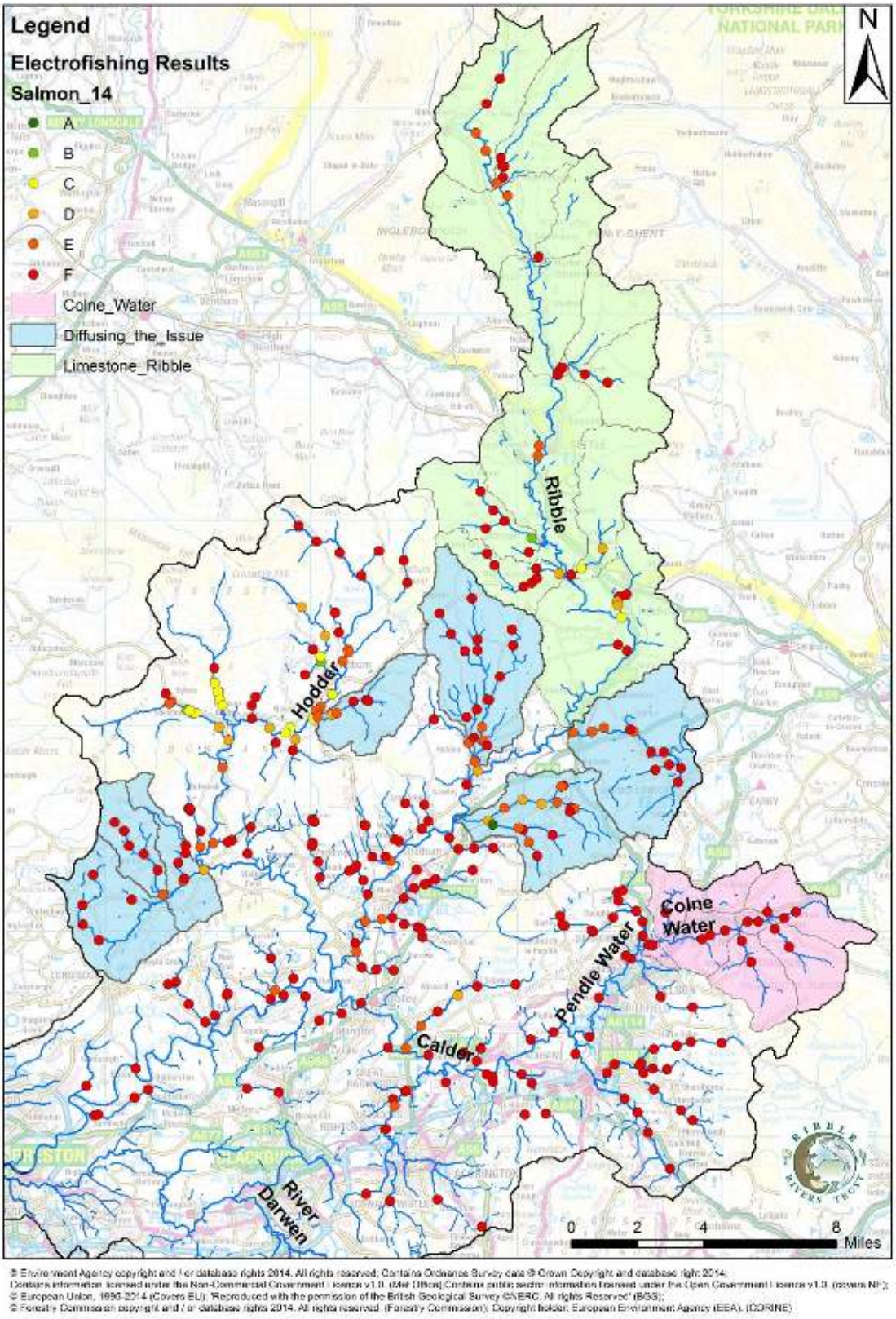
By contrast to Brown Trout, the Salmon population is more sporadic and less abundant, with the healthiest populations found within the lower reaches of Hellifield and Long Preston becks (see Figure D2). In the head of the catchment, the surveyed sites are generally low grade owing to the low number of adult fish ascending a large natural barrier at Stainforth.



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Figure D1. *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.*



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Figure D2. *Map of the Atlantic 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.*

Results continued…

Since the CRF was awarded, there has been an overall reduction in the total and average NFCS grades for salmon within CRF survey sites (Figures D3,D4). The average grades for salmon within CRF areas has mirrored those for non-CRF sites and the catchment average during the same time period (Figure D4). For sites in the Limestone Ribble, salmon grades were higher during 2012 and 2013 than the average for the catchment. In 2014, grades for both sets of sites were equal.

Over the period of 2012 to 2014 there was a minor decline in the abundance of trout fry as observed in all areas of the catchment. Survey sites within CRF areas mapped tightly to the average trend, although in the Limestone Ribble abundances were higher during 2014

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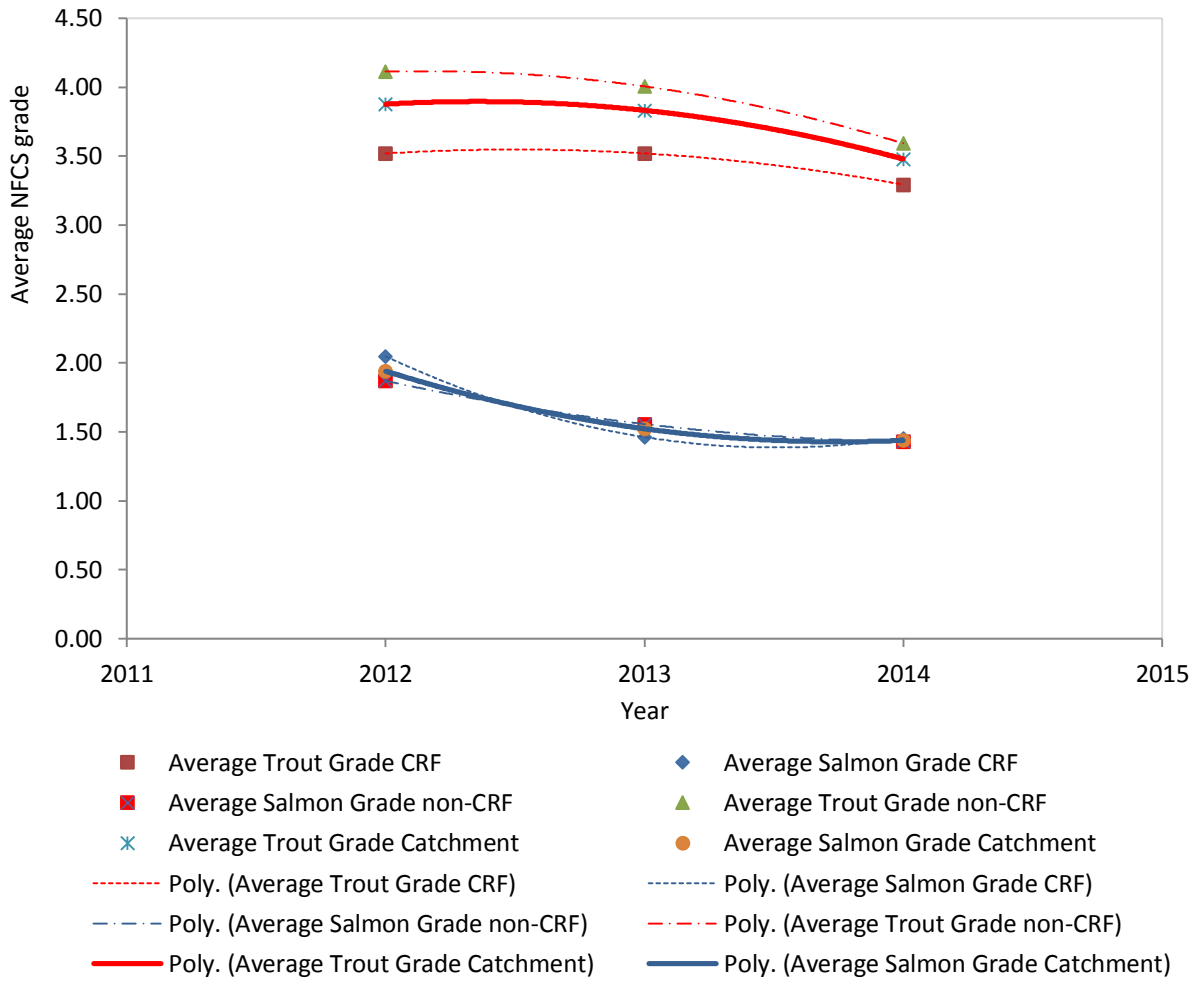


Figure D3. *Average grades for juvenile trout and salmon across sites within: Designated CRF areas; non-CRF areas; and across all of the catchment in 2012 to 2014.*

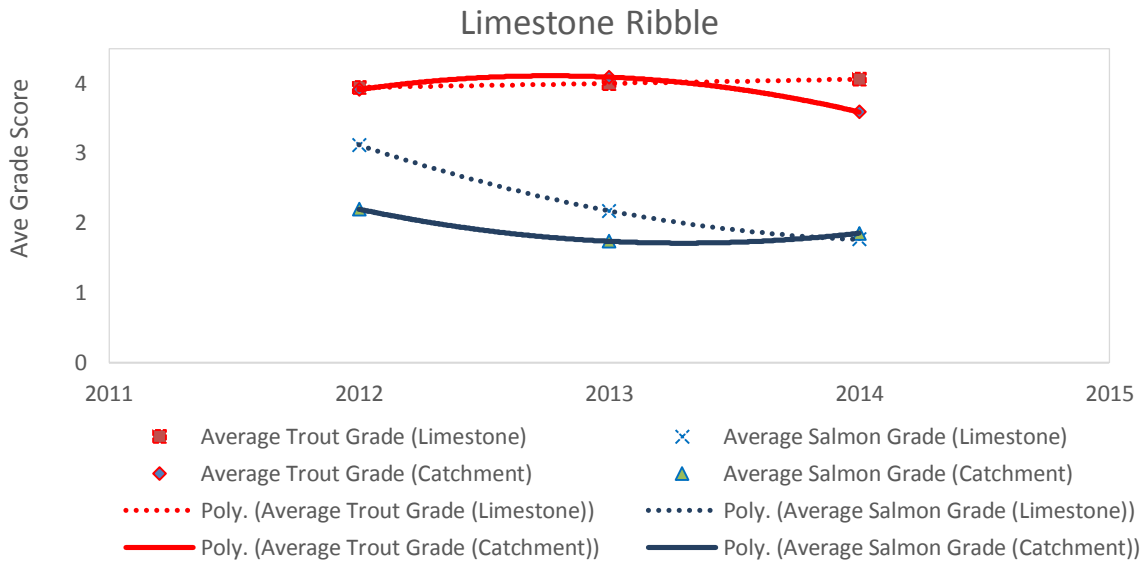


Figure D4. *Average grades for juvenile trout and salmon across the Limestone Ribble project area in 2012 to 2014.*

Discussion

Salmon grade averages were consistently higher within 'Limestone Ribble' than the catchment average until 2014 (Figure D4). The decline in salmon numbers is considered to be the outcome of increased mortality during the marine phase of the lifecycle (Atlantic Salmon Trust, anecdote). Therefore, the selection of salmon as a suitable proxy for measuring habitat improvement presents a distorted view given such complexities. Only the presence of migratory species above barriers can provide the measure of success that is otherwise sought.

Average grade scores for resident Brown Trout may provide a more adequate measure of localised success. A decline in their abundance over the three-year period was observed for the catchment as a whole, whilst an increasing trend was observed within the 'Limestone Ribble' area (See Figure D4). These observations present a positive outlook for the localised impacts of the works. The theoretical benefits of providing cover, scour pools and invertebrate prey items would promote trout survivability. The inter-annual variation identified between survey results demonstrates the plasticity of their behaviour to variable environment conditions and flows. Hence, a longer term monitoring program is required to show whether there is any signs of a sustained upward trend owing to habitat improvement. However, the results do provide cause for cautious optimism.

Appendix E. Research upon cooling effects from riparian tree shading by Karlina Ozolina (University of Manchester)

The aim of the project was to collaborate with the Ribble Rivers Trust (RRT) in monitoring and assessing the effect of tree cover on river water temperature and fish abundance and to validate a modelled data set on tree cover. We used "River Shade Maps" provided by the Environment Agency (EA) to select target areas for fish abundance studies and water temperature monitoring.

The River Shade Maps are produced by the EA by using topographical data, solar radiation based on geographic location and Surface object shading (or trees providing shade). To determine the location of trees, the EA obtained LiDAR data which can geographically identify different vegetation types specifically trees, by combining this data in a GIS model the relative shade for a given river or stream can be calculated. Due to the complexity of this data set a lot of the geomorphology work is yet to be completed, however two streams with shaded and exposed areas have been identified for temperature monitoring and fish abundance comparisons – Bashall brook and Rathmell beck. Remote data loggers were placed at each location and the changes in temperature were monitored from late July onwards.

Changes in water temperature across a 10 day period in Rathmell beck are shown below (Figure E1). Upper Rathmell (red data points) is an exposed site with no tree cover, whereas Lower Rathmell (blue data points) is a shaded site. Even though the average temperature in the two sites was similar (15.62 ± 1.61 °C and 15.22 ± 1.19 °C respectively) the daily temperature fluctuations are more extreme in the exposed site, with daily maximum temperature 1-2.5 degrees higher on most days when compared to the data from the shaded site.

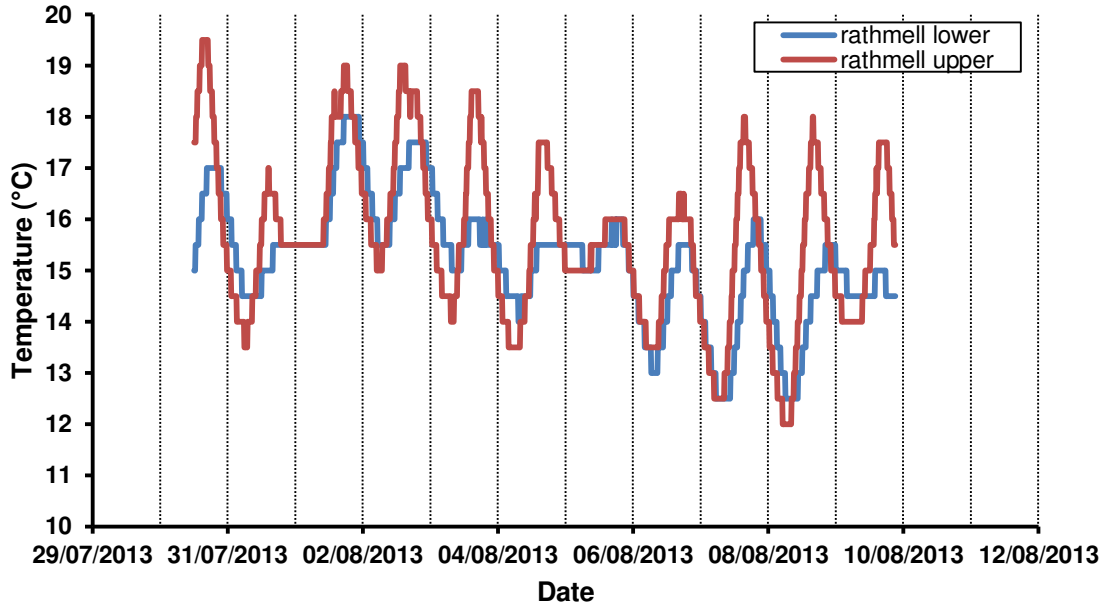


Figure E1. *Change in water temperature in exposed (red line) and shaded (blue line) areas of the Rathmell beck monitored from 30th July till 10th August. Temperature was remotely logged every 10 minutes using iButton temperature loggers.*

Additionally Ribble Rivers Trust has identified that the mean relative shade is related to woody debris presence and absence, and that woody debris presence and absence is related to trout fry density

(see Figure E2). This suggests that the relative shade data may be related to trout fry density (see Figure E3). Further analysis of this data is being undertaken.

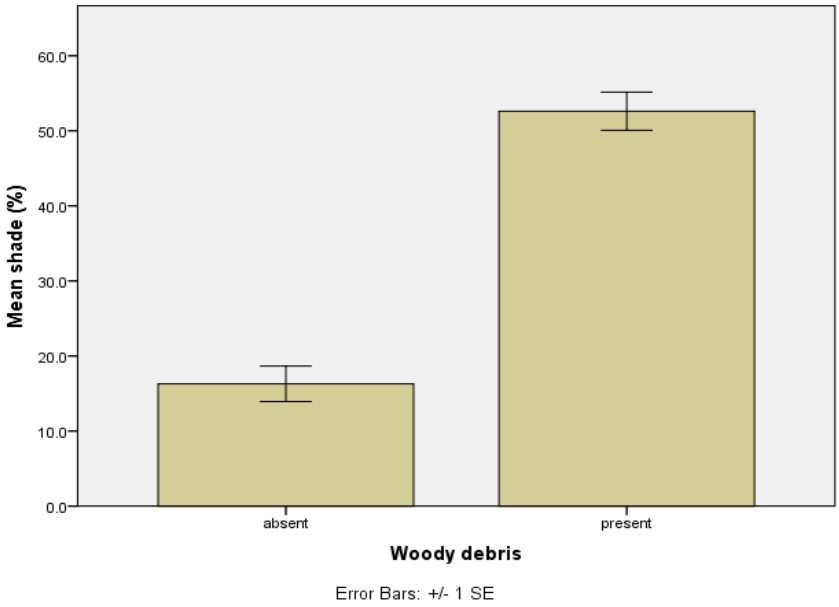


Figure E2. *A comparison of mean shade percentage between survey sites with woody debris present and absent.**

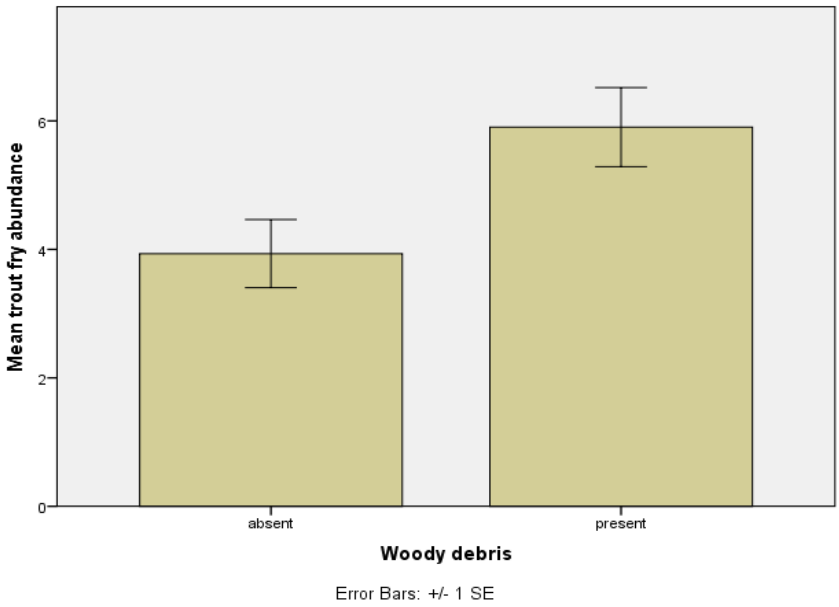


Figure E3. *A comparison of woody debris presence and absence and mean trout fry abundance.**

**Error bars are displayed as indicative of the 5% confidence interval about the mean values.*

Appendix F i. Field and aerial photographical survey of the drainage grips in the upper Ribble catchment.

Introduction and method

To ascertain the extent and location of drainage grips and their impacts upon the landscape, a small survey team initiated a mapping project of the upper catchment. Two grip report surveys were completed upon Pen-y-ghent, Fountains Fell and Langcliffe Scar in July, 2014 and of Cam Fell and Syke Moor and during the following month, of Gayle, Blea, Ingleborough moors by EGG Consultants.

Surveyors coursed sinusoidal pathways across the grips to ensure their periodic inspection along their length. At each crossing point, the grip was photographed and categorised according to its physical size and condition (in terms of the exposure of bare peat and potential for erosive loss). From the preliminary surveys the area of drainage grips was discovered to be more extensive than first envisaged. To save on time and resources, the completion of the mapping exercise was completed using an aerial photography data layer in ArcMap cross referenced with the field observations for calibration purposes.





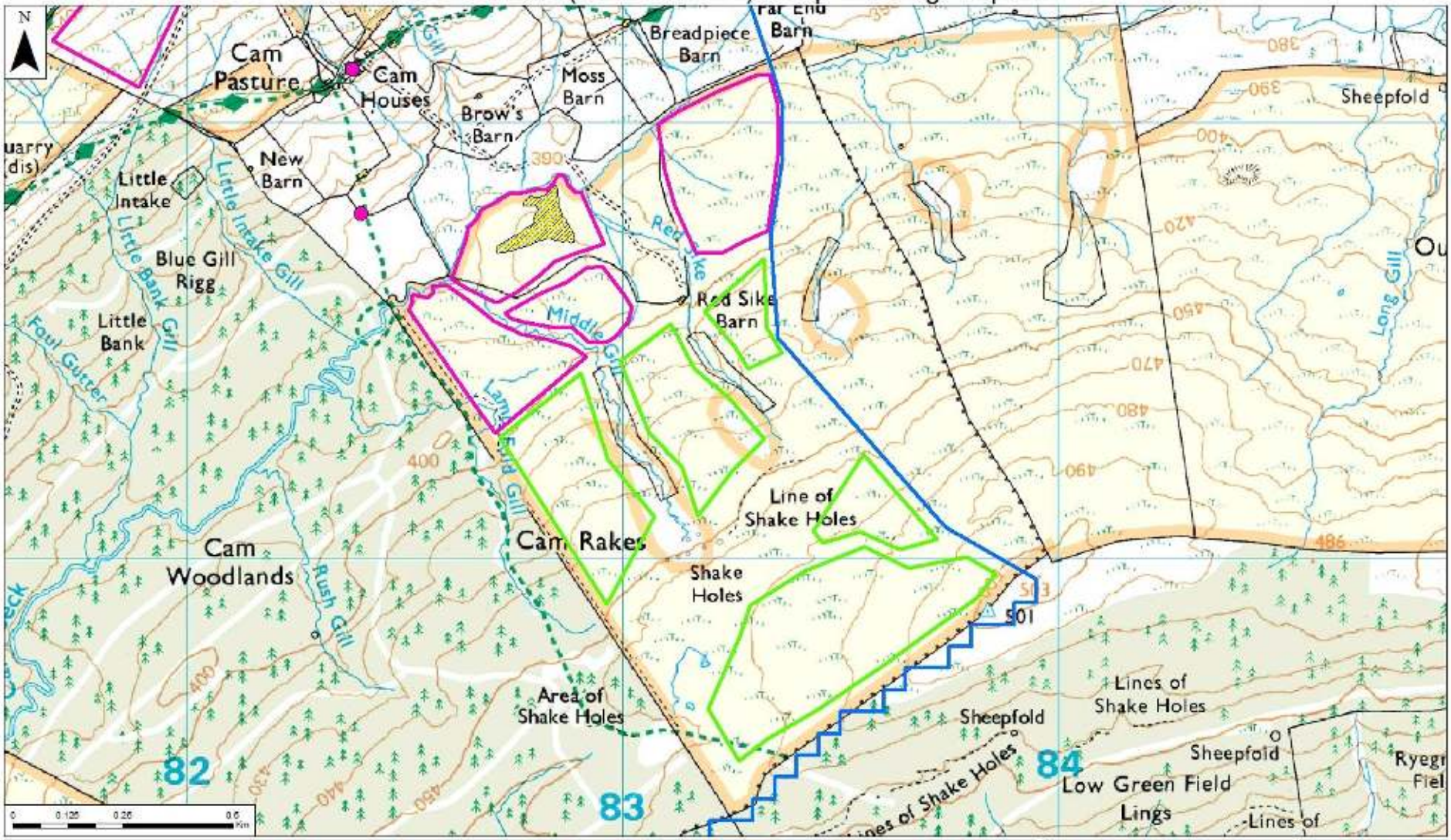
Grip walkover surveys, undertaken in Summer 2014.

The mapping of all observations was completed in ArcMap to generate the outputs in the results section below. All opportunities to engage with local landowners and partners were taken whilst out in the field. These proved useful for the purposes of facilitating negotiations over potential, practical works to redress the impacts of the grips.

Results

The results of the grip surveys are contained within a series of maps overleaf. The majority of the largest grips, categorised with scores of ‘5’ or ‘6’ were discovered upon Gayle Moor and Birkwith to provide initial targets. These were reflective of their west facing aspect whereby fewer, high priority grips were discovered on Ingleborough upon Park fell (with its eastern facing aspect).

Cam Houses (southern area) - Grip Blocking Proposal



Legend

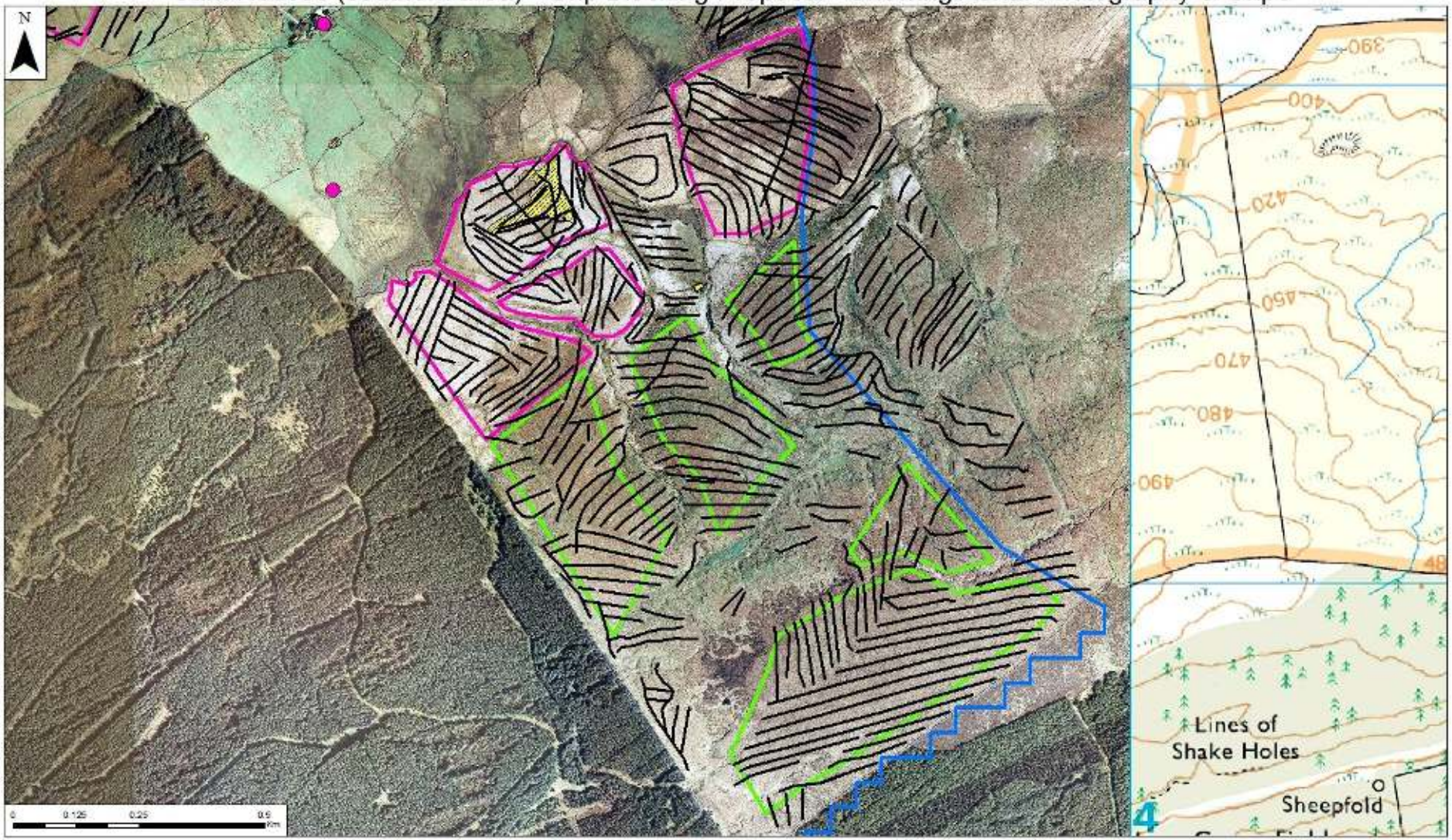
- Ribble Catchment Boundary
- Majority of grips to be blocked
- Only worst eroding grips to be blocked
- Archaeological Features - Cairns, Limekilns, Other
- Archaeological Features - Mediaeval Peat Workings

Author: Aidan Foley
Checked By: Adam Walmesly
Project: Limestone Ribble (CRF)
Client: RRT
Date Produced: 23/10/2013

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Cam Houses (southern area) - Grip Blocking Proposal - Showing Aerial Photography & Grips



Legend

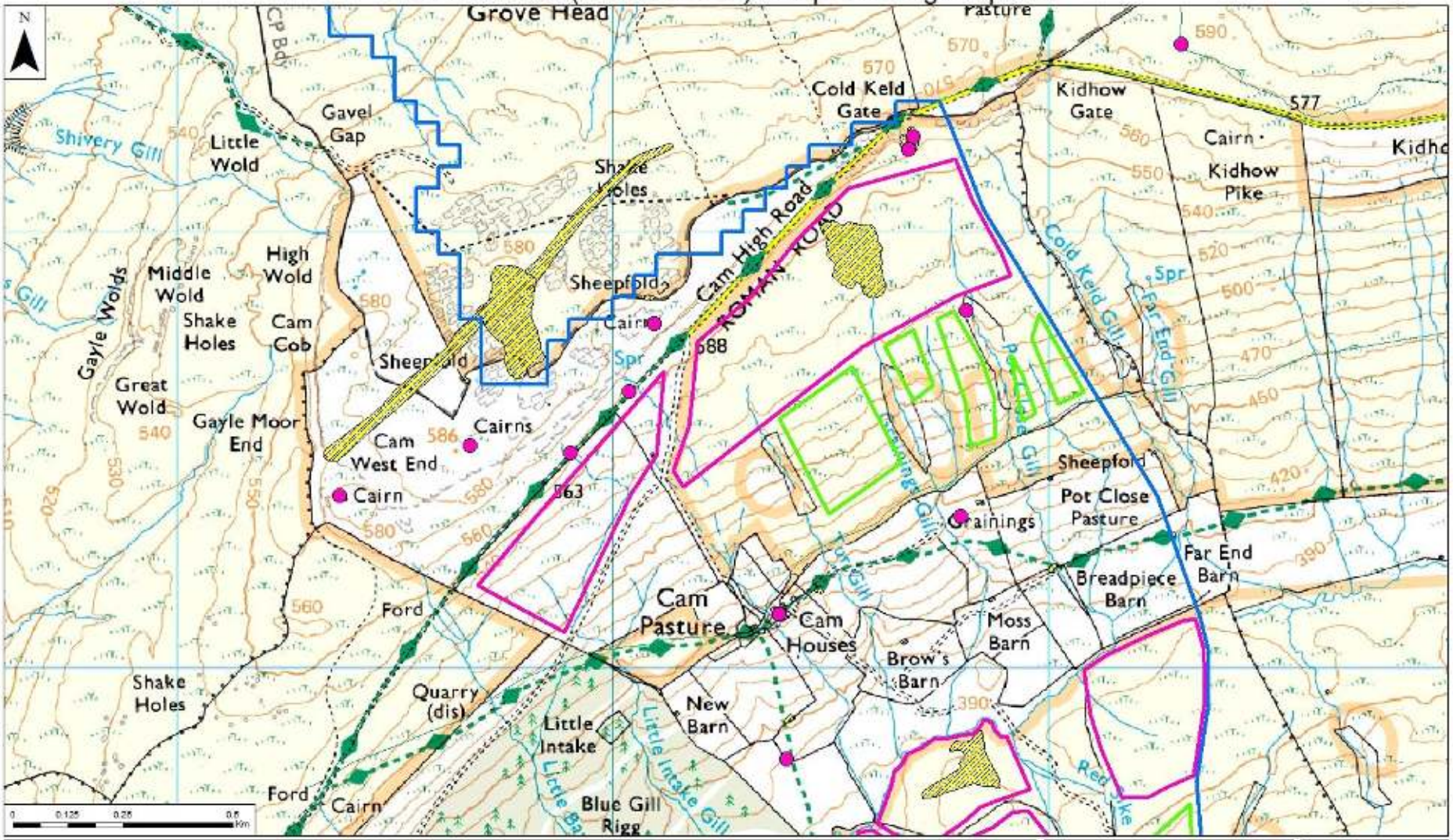
- Only worst eroding grips to be blocked
- Majority of grips to be blocked
- Grips (CRF Area 1)
- Ribble Catchment Boundary
- Archaeological Features - Cairns, Limekilns, Other
- Archaeological Features - Mediaeval Peat Workings

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Checked By: Adam Walmesly
Project: Limestone Ribble (CRF)
Client: RRT
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Cam Houses (northern area) - Grip Blocking Proposal



Legend

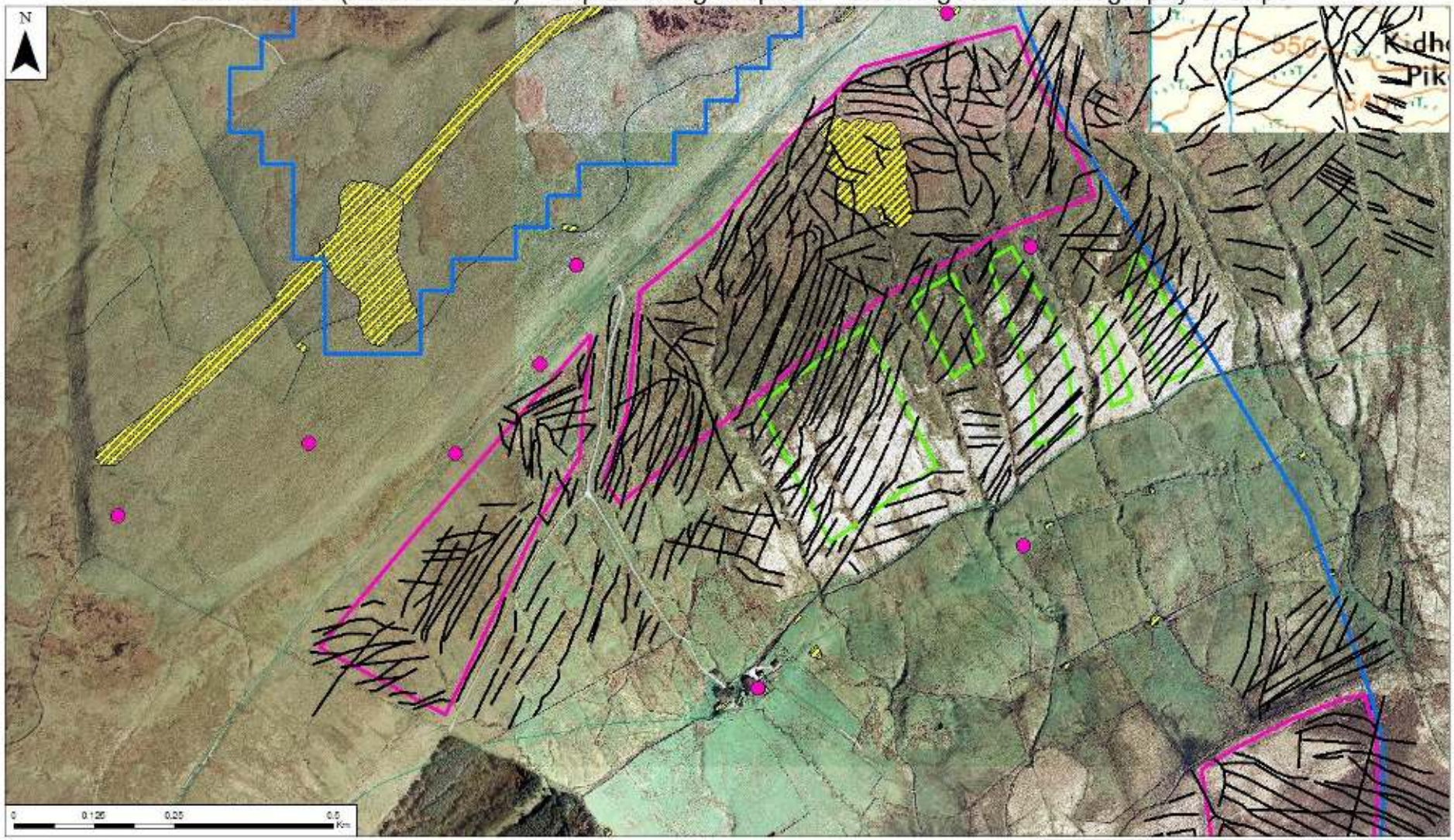
- Ribble Catchment Boundary
- Majority of grips to be blocked
- Only worst eroding grips to be blocked
- Archaeological Features - Cairns, Limekilns, Other
- Archaeological Features - Mediaeval Peat Workings

Author: Aidan Foley
Checked By: Adam Walmesly
Project: Limestone Ribble (CRT)
Client: RRT
Date Produced: 23/10/2013

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Cam Houses (northern area) - Grip Blocking Proposal - Showing Aerial Photography & Grips



Legend

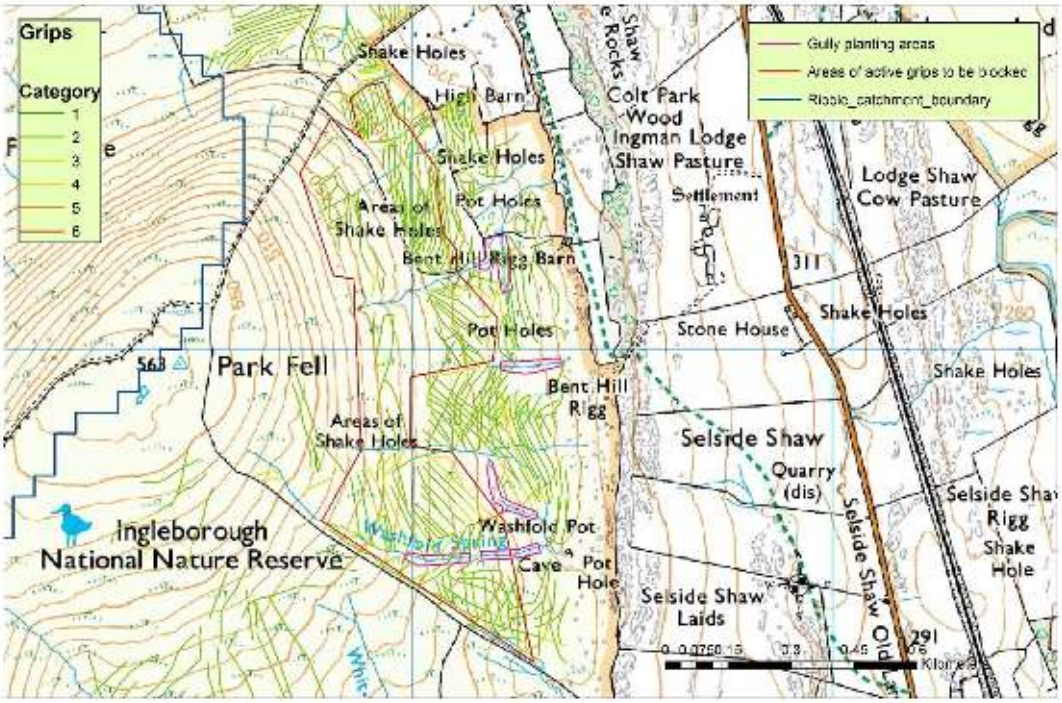
- Only worst eroding grips to be blocked
- Majority of grips to be blocked
- Grips (CRF Area 1)
- Ribble Catchment Boundary
- Archaeological Features - Cairns, Limekilns, Other
- Archaeological Features - Mediaeval Peat Workings

Author: Aidan Foley
Checked By: Adam Walmsley
Project: Limestone Ribble (CRF)
Client: RRT
Date Produced: 23/10/2013

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Park Fell grip blocking and gully planting scheme of works. (Ribble Rivers Trust.)



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Outcomes

The disproportionate costs of restoring the higher category (more severely eroding) grips diminished the opportunity for undertaking works given financial constraints. The prioritisation of where to undertake grip blocking projects was therefore made on the basis of targeting intermediate category grips (categories 2-4), and where good landowner buy-in could be obtained. In one instance this could not be obtained meaning some of the highest priority grips could not be restored. Results of grip blocking activities are shown in photographs presented in Appendix F6 iii.

Appendix F ii. Predicted hydrological impacts of grip blocking using SCIMAP and FlowMAP prepared by Dr David Milledge (Durham University): Modelling discharge for gripped and intact scenarios in the Ribble Catchment

Introduction

The adoption of a hydrological model was required to forecast the impacts of blocking drainage grips in the upper catchment. It was envisaged that this would provide partial justification for undertaking works on the basis of them contributing a natural flood risk benefit. An overview of how the model was run and its outputs are presented by EGG Consultants below: -

Method

I have run the same model described in Lane and Milledge (2012) for the five catchments. In each case I have run the model with and without grips. I have used the same GLUE approach, taking 1000 random samples of the parameters listed in Lane and Milledge (2012) from uniform distributions across the range of values quoted in that paper (Table 1). I have used 15 minute resolution rainfall data from the Outershaw gauge from 13/12/05 to 20/01/06 to simulate a reasonable rainfall time series for the study area which includes a very large storm. I have used NEXTMAP 5m resolution DTM data for the topographic data and mapped grips provided by NRT. I ran the model at one metre resolution with the exception of Gayle and Ingleborough catchments, which I ran at two metres resolution due to computing constraints. In each case I re-sampled the topographic data to the desired resolution using bilinear interpolation. The results represent model predictions for the difference between a gripped and intact (i.e. pre-grip) version of the same catchment.

The model assumes hydrological steady state conditions inside each time step and as a result is expected to overestimate the water table drawdown on the down slope side of grips (Coles, 2012). On this basis I think that it is reasonable to say that the predicted increases to peak flow for intact as opposed to gripped catchments are likely to be overestimates of the true increases but that peak discharges for these catchments are unlikely to be lower in the intact than the gripped case. To give some indication of this I consider a 'worst case scenario' for the increase in peak discharge due to grips for the first two catchments (Cam and Gayle).

Finally, my confidence in the results for the Ingleborough catchment (which is effectively the entire Ribble headwater catchment down to Horton but only adding grips for the Ingleborough area) is considerably reduced relative to that for other catchments. This is because the size of the catchment is very large, considerably larger than the size of the catchment on which the model was developed and tested.

Table 1. Model parameter ranges used in GLUE simulations based on recommended ranges from Lane and Milledge (2012).

Parameter	Rec. min.	Rec. max.
IRZS, initial depth of water stored in the root zone (m)	0.010	0.020
m, Topmodel parameter, controls rate of decline of transmissivity with storage deficit	0.040	0.050
T_o, transmissivity ($m^2 s^{-1}$)	0.37	0.43
UZTD, unsaturated zone time delay (h)	40.0	56.0
InitQS, initial subsurface flow ($m h^{-1}$)	0.00065	0.00085
ER, effective rainfall (proportion of rainfall entering the unsaturated zone)	0.65	0.69
ChV, channel velocity ($m s^{-1}$)	0.46	0.66
HV, hillslope velocity ($m s^{-1}$)	0.10	0.20
GV, grip velocity ($m s^{-1}$)	0.35	0.55

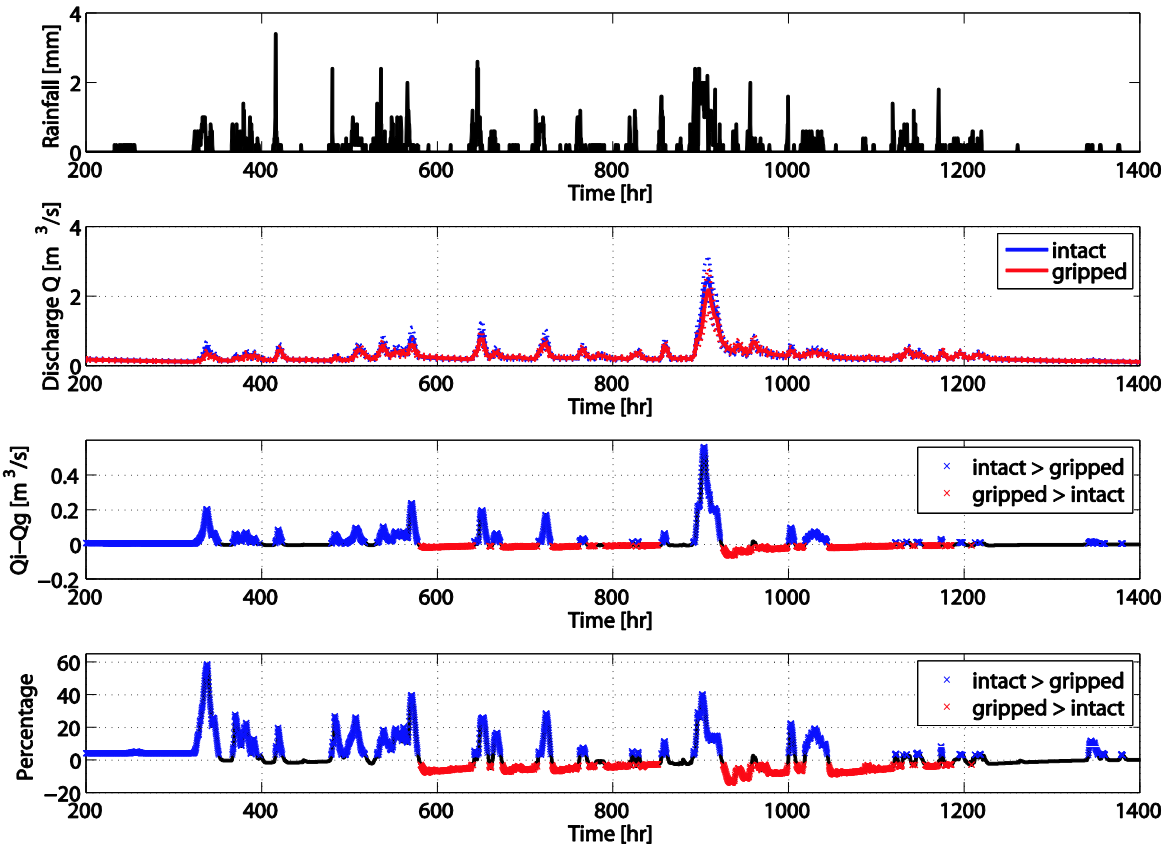
Results

In all cases peak flows are higher for intact than gripped catchments while base flows and recession limbs are lower. The differences are correlated with discharge so that the largest increase in peak flow occurs during the largest discharge events. However, in percentage terms the larger discharge events have a smaller percentage difference in peak flow. A straightforward difference in the discharges for each timestep can result in overestimating the difference between scenarios since the grips can also affect lag times. I have included a comparison of the peak discharge for the 10 largest events, which is probably more informative. It indicates the same broad conclusions but suggests that the true increase in peak discharge is slightly lower than indicated by the straightforward differencing shown in the graphs.

Subcatchments

Cam

Catchment Area: 3.4 km^2, 1% of cells contain grips, the intact case has a discharge up to 0.56 m^3/s higher than the gripped case, the maximum increase is 59% of the modelled discharge. **Top graph** shows applied rainfall in mm per timestep. **Second graph** shows predicted discharge for intact (blue) and gripped (red) cases, with mean (solid line) of 1000 model runs sampling the range of parameter values +/- 1 standard deviation (dashed lines). **Third graph** shows difference in discharge between intact and gripped cases for each timestep (i.e. Q_i-Q_g). Red crosses indicate that intact discharge at this timestep is significantly lower than gripped discharge at the 99% confidence interval based on an unpaired t-test. Blue crosses indicate intact discharge is significantly higher. Timesteps without crosses show no significant difference. **Fourth graph** shows the difference in discharge as a percentage of the gripped discharge with the same significance test results overlaid. The same format is followed for each of the catchments shown below.

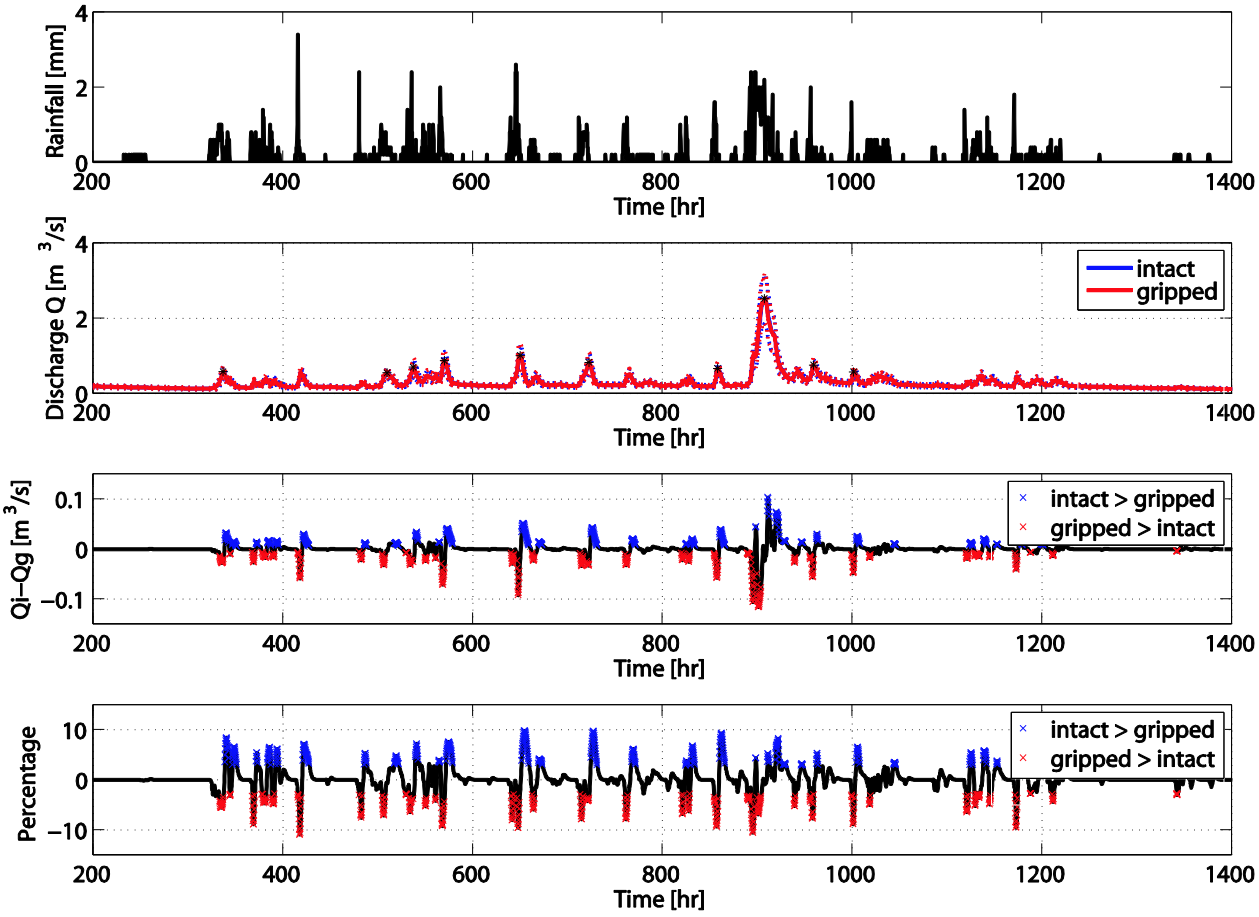


A comparison of the 10 largest discharge events in the record: lag time is the difference in timing of the peaks (positive when intact peaks first). Qdiff (intact-gripped) shows the absolute (m^3/s) and relative (%) difference in peak discharge for each event, percentage differences are normalised by the intact discharge. Maximum difference between peak discharges is only 28% and only 13% for the largest storm.

timestep [hrs]	lag time [hrs]	Qdiff [m3/s]	Qdiff [%]	intact Q [m3/s]	gripped Q [m3/s]
907.75	0.5	0.32	12.89	2.50	2.18
650.5	0.5	0.19	20.18	0.95	0.76
570.5	0.75	0.23	28.12	0.83	0.60
722.75	0	0.15	19.63	0.79	0.63
959.5	0.5	0.02	2.42	0.70	0.68
537.75	0.25	0.09	13.21	0.67	0.58
858.25	0.5	0.06	9.84	0.61	0.55
337.25	0.5	0.20	36.58	0.55	0.35
510	0.5	0.07	13.34	0.54	0.46
1001.75	0.25	0.09	17.23	0.52	0.43

Cam - worst case scenario for grip impact

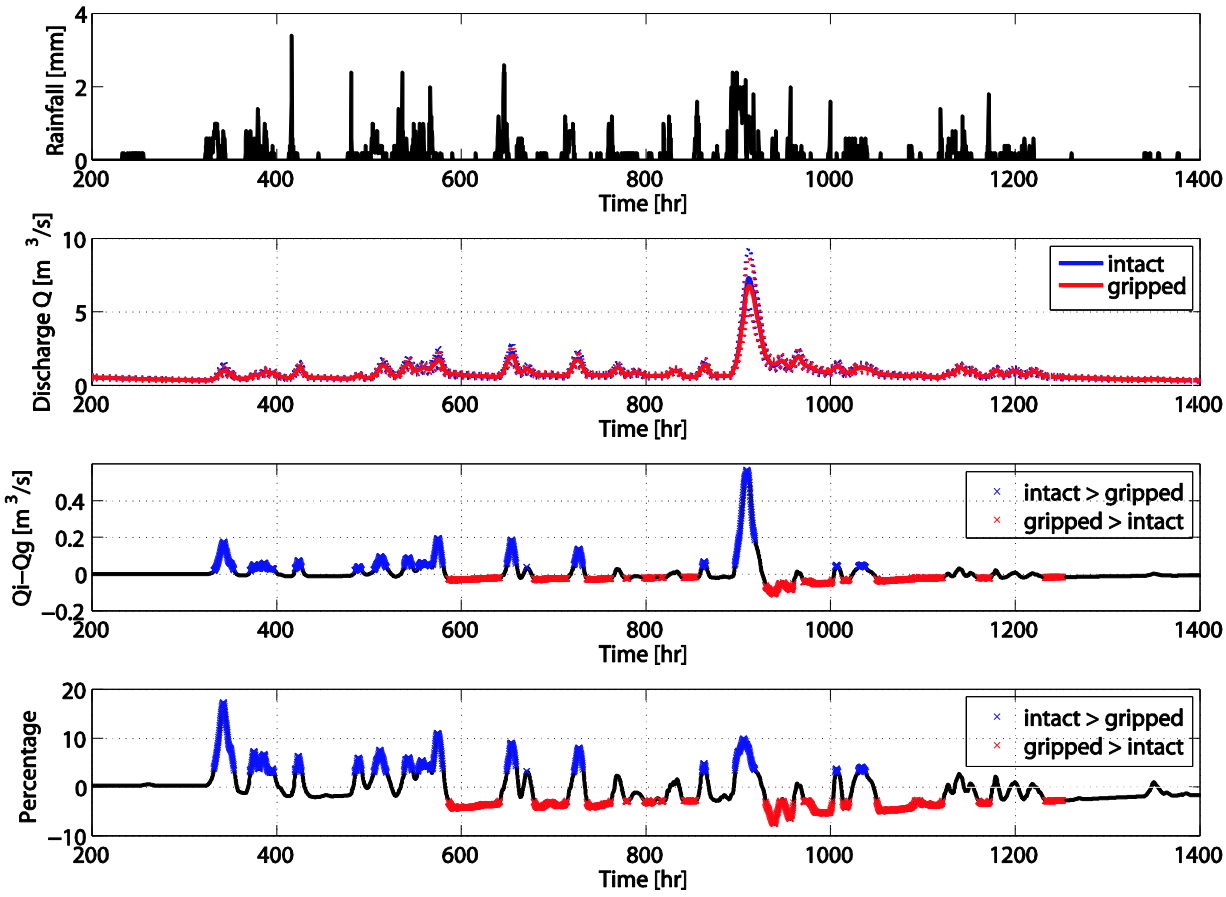
The most likely source of error in the model is its representation of the influence of grips in drawing down water tables. This may lead to an overestimation of the amount of rainfall that is stored in the catchment rather than converted into storm runoff and as a result to underestimates of peak discharge in the gripped case. To assess the influence of this component of the model I have also run a worst case scenario for grip discharge (i.e. a scenario that will maximise grip discharge). In this case I have assumed that the grips do not result in any change in the storage capacity of the peat but only affect the routing of the water. Under this scenario, considering the 10 largest storms, the maximum relative increase in peak discharge in the gripped case is only 8% and the increase for the largest storm only 0.5%. We know that this scenario is overly conservative, grips do result in water table draw down and a resultant increase in available storage but these runs provide an upper limit to the discharge increase that could be expected due to grips. Note: black asterisks indicate peaks compared in the table below.



timestep [hrs]	lag time [hrs]	Qdiff [m3/s]	Qdiff [%]	intact Q [m3/s]	gripped Q [m3/s]
907.75	0.5	-0.01	-0.50	2.50	2.51
650.5	-1.5	-0.04	-4.46	0.95	1.00
570.5	0	-0.03	-3.31	0.83	0.86
722.75	0.25	-0.03	-3.51	0.79	0.82
959.5	-0.5	-0.05	-6.61	0.70	0.74
537.75	0.5	-0.02	-3.32	0.67	0.69
858.25	0.25	-0.05	-7.39	0.61	0.65
337.25	0.25	-0.02	-4.09	0.55	0.57
510	0.5	0.00	-0.25	0.54	0.54
1001.75	0.25	-0.04	-7.79	0.52	0.56

Gayle

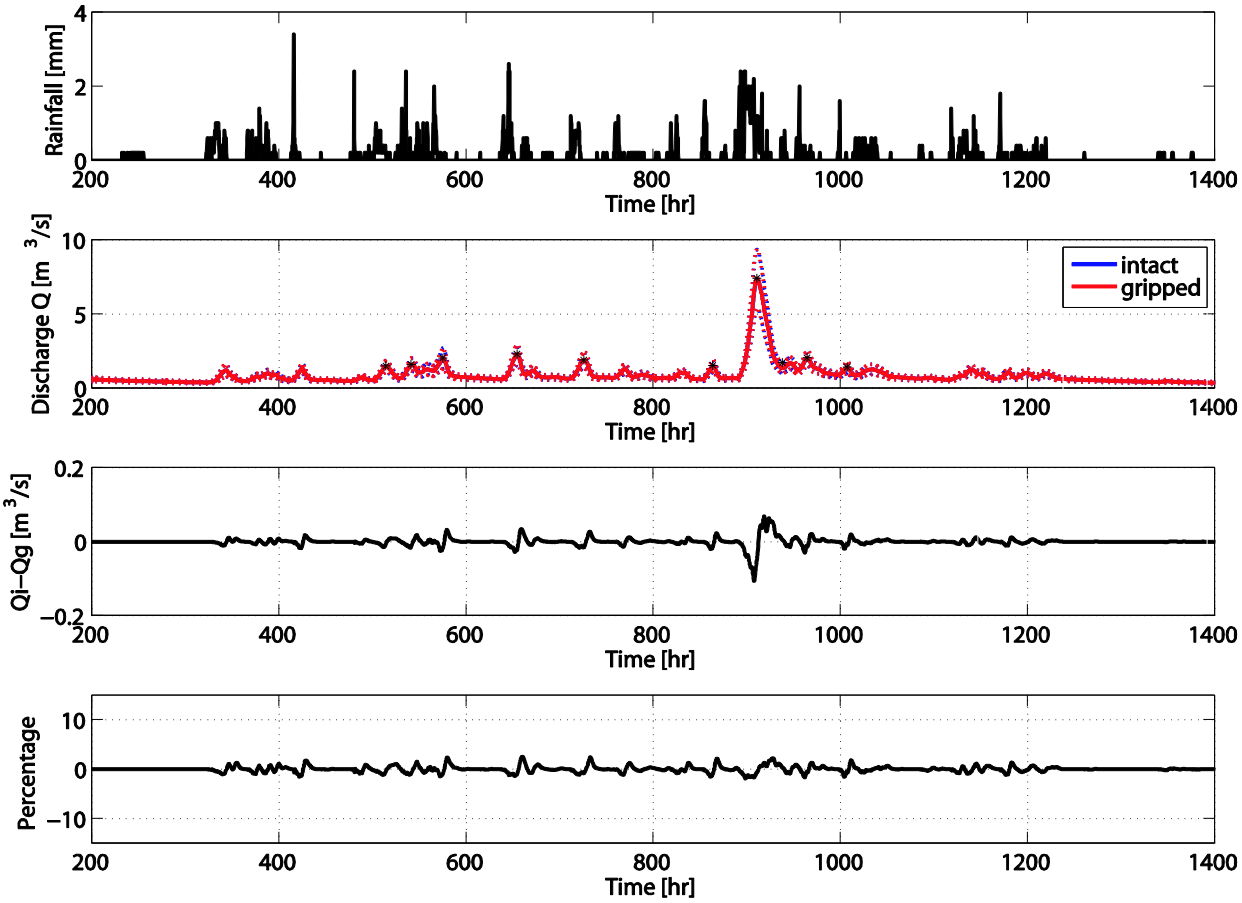
Catchment Area: 10.7 km^2, 0.5% of cells contain grips, the intact case has a discharge up to 0.57 m3/s higher than the gripped case, the maximum increase is 17% of the modelled discharge. However, the maximum difference between peak discharges is only 10% and the difference for the largest storm only 7%.



timestep [hrs]	lag time [hrs]	Qdiff [m3/s]	Qdiff [%]	intact Q [m3/s]	gripped Q [m3/s]
910.75	1	0.54	7.33	7.35	6.81
654.5	0.5	0.19	8.25	2.25	2.07
964.5	0.5	0.00	0.07	2.01	2.01
575.25	0.5	0.19	9.74	2.00	1.80
726	0	0.13	6.94	1.86	1.73
541.5	0.25	0.08	5.34	1.57	1.49
863.75	0.75	0.06	4.11	1.50	1.44
514.5	0.5	0.08	5.72	1.47	1.39
1007.5	0.5	0.04	2.96	1.38	1.34

Gayle - worst case scenario for grip impact

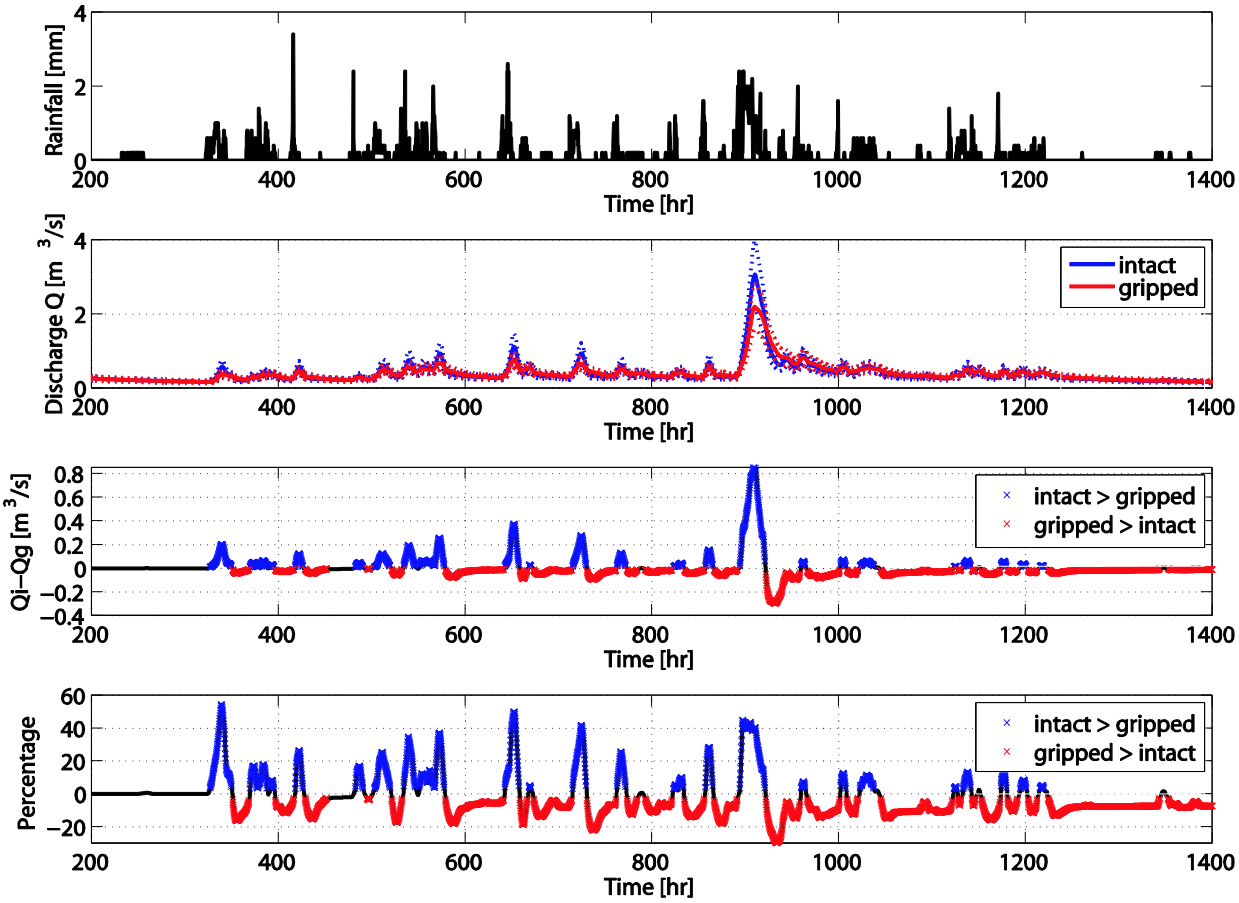
Catchment Area: 10.7 km^2, 0.5% of cells contain grips, the maximum difference between peak discharges is only 0.8% and the difference for the largest storm only 0.6%. Note that unlike previous cases, there are no significant differences between gripped and intact discharges in the third and fourth panes of the figure below.



timestep [hrs]	lag time [hrs]	Qdiff [m3/s]	Qdiff [%]	intact Q [m3/s]	gripped Q [m3/s]
910.75	0.25	-0.04	-0.58	7.35	7.39
654.5	0.25	-0.02	-0.84	2.25	2.27
964.5	0.5	-0.02	-0.78	2.01	2.03
575.25	0.25	-0.01	-0.65	2.00	2.01
726	0.25	-0.01	-0.74	1.86	1.88
541.5	0.25	-0.01	-0.75	1.57	1.58
863.75	0.5	-0.01	-0.55	1.50	1.51
514.5	0.25	0.00	-0.14	1.47	1.47
1007.5	0.5	-0.01	-0.61	1.38	1.39

Horton

Catchment Area: 4.7 km^2, 1% of cells contain grips, the intact case has a discharge up to 0.87 m3/s higher than the gripped case, the maximum increase is 54% of the modelled discharge. However, the maximum difference between peak discharges is only 33% and the difference for the largest storm only 28%.

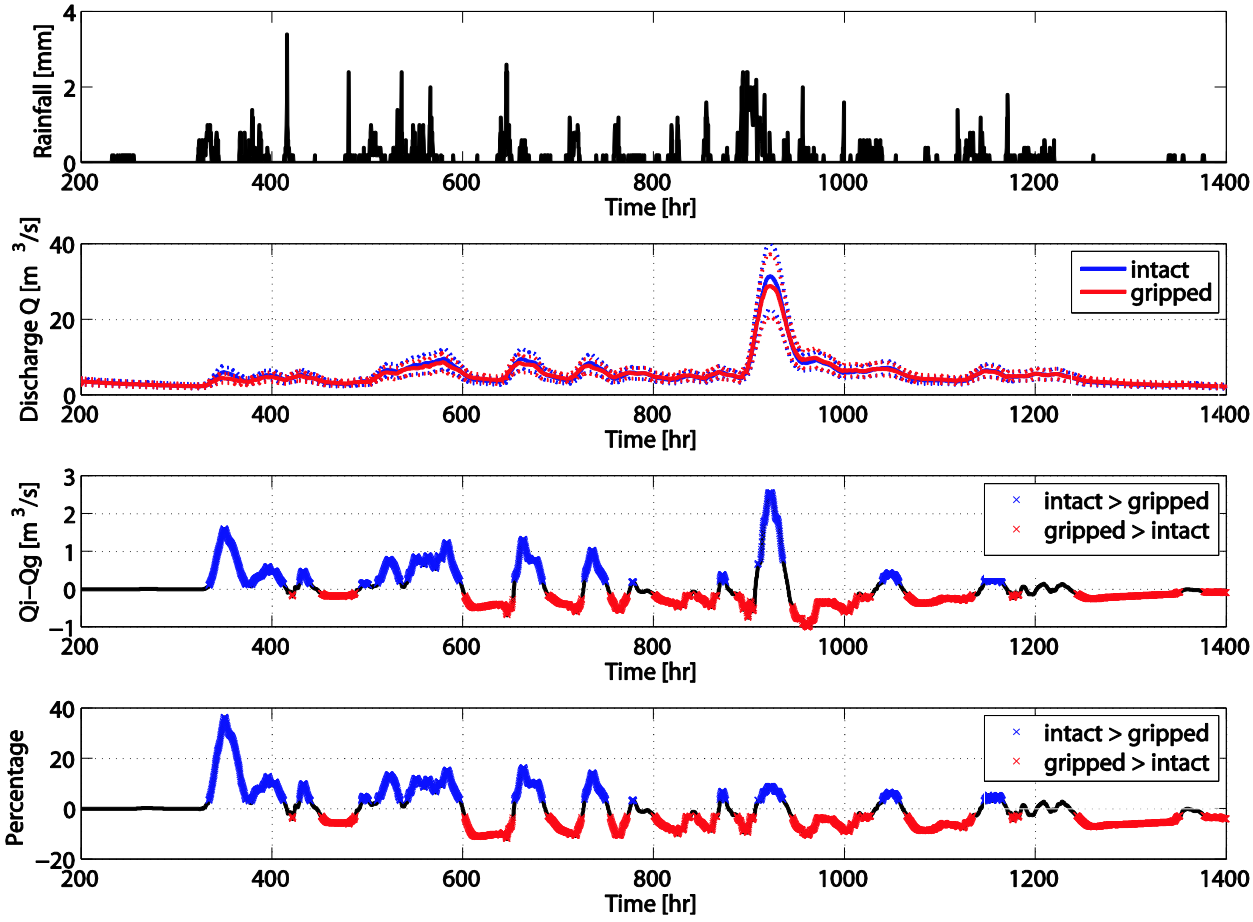


timestep [hrs]	lag time [hrs]	Qdiff [m3/s]	Qdiff [%]	intact Q [m3/s]	gripped Q [m3/s]
909.75	0.5	0.86	28.19	3.05	2.19
652	0	0.37	32.91	1.12	0.75
572.5	0.75	0.25	26.89	0.94	0.68
724.25	-0.75	0.27	28.83	0.93	0.66
962	0	0.06	6.49	0.87	0.81
539.75	1	0.18	24.52	0.75	0.57
861	0.5	0.15	21.80	0.70	0.55
1004.75	0	0.07	10.75	0.63	0.56
767	1	0.13	20.24	0.62	0.50

Ingleborough

Catchment Area: 65 km^2, 0.2% of cells contain grips, the intact case has a discharge up to 2.55 m3/s higher than the gripped case, the maximum increase is 36% of the modelled discharge. However, the maximum difference between peak discharges is only 11%; the difference for the largest storm is also 11%.

Note that, my confidence in results for this catchment is considerably reduced relative to that for other catchments because the size of the catchment is very large, considerably larger than the size of the catchment on which the model was developed and tested. The travel times for the larger rivers that are present in a catchment of this size are not well treated in the current model and I think this is leading to an over smoothing of the hydrograph. However this is based only on my expectations for the form of the hydrograph at this site since I have not tested the predictions against field observations.



timestep [hrs]	lag time [hrs]	Qdiff [m3/s]	Qdiff [%]	intact Q [m3/s]	gripped Q [m3/s]
521.5	-1.25	0.73	10.90	6.69	5.96
556	4.5	0.33	4.13	8.01	7.68
580	-1	0.92	9.58	9.59	8.67
662	-2.75	1.10	11.49	9.54	8.45
733	-1	0.78	9.19	8.50	7.72
921.5	0.5	2.51	7.99	31.38	28.88
970.25	-1.75	-0.65	-7.01	9.23	9.87
1012.75	-1	-0.32	-5.11	6.29	6.61
1044.75	-1.25	0.36	4.97	7.22	6.86

References

Coles (2012), Impact of the density and orientation of artificial drainage networks on flood risk in upland blanket peat catchments, MSc Dissertation, Durham University.

Lane and Milledge (2012), Impacts of upland open drains upon runoff generation: a numerical assessment of catchment-scale impacts, Hydrological Processes, DOI: 10.1002/hyp.9285.

Appendix F iii. Surveyed photographs of drainage grips

BEFORE examples of moorland grip erosion on Birkwith Moor (upper paired images), Birkwith Allotment (Middle) and Green Haw Moor (lower), January 2014. Note the exposure of peat and bare earth.







DURING works: View from Cam High Road looking South Diggers working along adjacent grips. Please note minimal track damage due to wide tracks (below)



Diggers as viewed from Cam High Road (below right)



IMMEDIATELY after works on Cam houses grip blocking works, January 2014.





POST works. Grip dams and ponding after heavy rainfall night before 7/1/14 upon Cam fell (upper image). Grip dam, with clear evidence of ponding with adjacent overspill channel (to left of dam, running downhill)(lower image).





POST-works. Blea moor, 9th January 2014: Two years two months after grip blocking. Grips are fully vegetated and are difficult to view. The upper image is viewed downhill along a blocked grip showing recovery of dams and vegetation. The lower image represents an uphill view along the blocked grip.





POST works: Close up views of the blocked grips following two years re-vegetation. A close-up view of grip dam (top left). Remains of ponding behind grip dam (top right). View along recovering grip, showing significant sphagnum growth within dammed pool (lower).







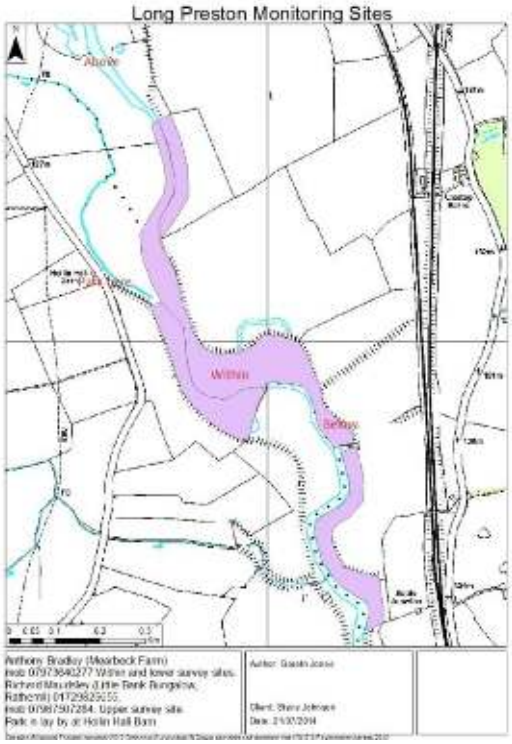
Appendix G. Macroinvertebrate monitoring of the Long Preston Deeps.

Introduction

Benthic macroinvertebrates provide useful subjects for the detection of riverine changes over the short-term given their limited range of dispersal and species specific preferences to water quality and habitat. Ongoing invertebrate monitoring studies are being performed by Durham University and the findings from these activities are due to be reported in late 2015 early 2016. Monitoring work by volunteers under the RRT Riverfly partnership network also provides a picture of the catchment's riverine health. The continuity of this data set for the duration of the CRF is limited and subject to high variability in data quality and expertise in species identification. The assistance of volunteer entomologist Steve Johnson has been invaluable. Steve has taken this practice and developed it through training at the FBA and has provided his expertise at his own cost to undertake the surveys for this assessment.

Methodology

The habitat scheme upon the main stem of the Ribble was created in 2013. To assess what impact in the short-term this has taken, monitoring of the invertebrate assemblages was undertaken. Paired kick samples were taken above, within and below habitat improvement works in the Long Preston deeps area of Limestone Ribble (see map). Sampling techniques were adopted in accordance with RiverFly Monitoring protocols http://www.riverflies.org/rp-riverfly-monitoring-initiative All samples were collected, sorted and identified by the same sampler to provide consistency of effort.



Map of habitat scheme (indicated in purple) at the Long Preston Deeps area

The raw data obtained was analysed using a different array of scoring systems to include: The number of taxa; WHPT; WHPT average score per taxa; BMWP score (old); BMWP ASPT; and the Riverfly scoring system.

'Above'





'Within'





'Below'





Photographs of the locations of each pair of kick samples, Long Preston 24/7/14.

Results

The number of taxa was highest within the river section enclosed by tree planting to either side followed by the river section below the works (see Figure G1). The lowest number of taxa was discovered in the unfenced section above the habitat scheme. The same observations were made when using the old BMWP (old) and WHPT scoring systems. The BMWP ASPT and WHPT ASPT scores were still highest within the habitat scheme but the section 'below' the habitat scheme was lower than that above i.e. better scoring taxa were onaverage found above the habitat scheme than futher below.

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.

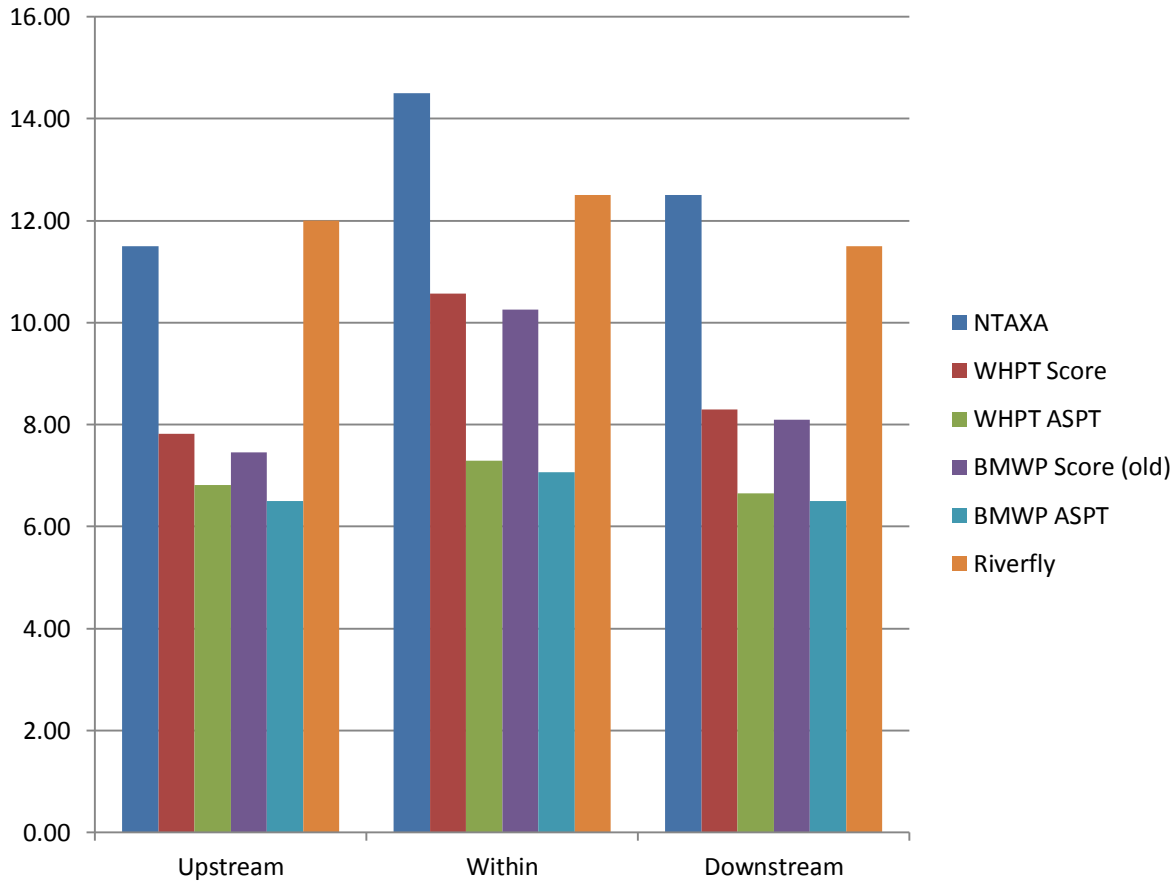


Figure G1 .Relative abundance and species diversity of aquatic invertebrates found in relation to proximty of a habitat improvement works. Data is displayed according to various ecological monitoring scoring systems.

Discussion

The preliminary findings from these surveys provide indication that 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 and taxa act as proxies for the water quality using the scoring systems reported here. However, small scale variations on localised scale as observed here indiciate additional envioronmental variables take effect and principally, the most notable of these being habitat quaility. Further monitoring wil be required to answer whehter the defining factors are associated to habitat quality and whether a sustained, postive ecological response has occurred.

Appendix H. Limestone Ribble and the Catchment Restoration Fund produced by

Thea Wingfield, School of Environmental Sciences, University of Liverpool

Executive Summary

The purpose of this document is to report the findings of an independent participant feedback exercise, undertaken by the University of Liverpool, in February 2015. Questionnaires were designed to gauge the level of participant satisfaction with the restoration fund activities, whilst semi-structured interviews were designed to explore participant motivation, knowledge and alignment of overlapping objectives.

When asked how well the project had performed against its 4 objectives, 40 percent of interview responses were either 'successful' or 'very successful', whilst 34 percent of responses were 'somewhat successful'. These results must be interpreted with caution, the participants held back from giving more positive answers given stating that it was too early to be able to objectively conclude how well the objectives had been achieved as the habitat had not had time to establish. Thus ongoing monitoring is required to understand the full impacts of the catchment restoration.

The semi-structured interviews highlighted that the project participants had a good understanding of the catchment-based approach and knowledge of the need to improve water quality and biodiversity. However there was less understanding of restoring hydrological function, carbon cycling, climate change adaptation and flood management. Indicating that there could be opportunities to involve other organisations with the knowledge, objectives and/or available funding to further broaden project objectives in the future.

Introduction

From August 2012 to February 2015, the Limestone Ribble project undertook riverine habitat improvement activities in the upper Ribble Catchment. The project was developed to align with the objectives of the Catchment Restoration Fund to address the reasons for failure under the WFD. Moorland drainage and a lack of the climax vegetation of native woodland are the causes for failure. Together these factors have created unnaturally wide and shallow channels with elevated water temperatures.

The Environment Agency administered the fund and specified that projects should: reduce pollution by improving rural and urban land-use techniques; improve the quality of riverine habitat by restoring natural features; or adapt or manage man-made structures to reduce their impact on aquatic wildlife. Whilst the Catchment Restoration Fund did not require projects to address multiple objectives, the complex and interrelated causes for water body failures in the Limestone Ribble project area led the Ribble Rivers Trust and partners to design a project that used a mix of activities to improve the area's hydrological, ecological and hydro-geomorphological conditions.

The activities were steered by four principle objectives: -

1. Improved connectivity and flows for migrating fish;
2. Improved riverine habitat for both people and wildlife;
3. Increased resilience to diffuse pollution and climatic change;
4. An advancement in public understanding of our local water resources.

In an effort to improve waterbodies that are currently failing to achieve Good Ecological Status under the WFD, upland drainage grips were blocked and riparian buffer zones that exclude stock were created. Woodlands were planted to reduce diffuse pollution and create shade for the water course across the upper Ribble catchment. This will encourage a sustainable return to a natural hydrological and geomorphological regime.

The purpose of this report is to present the findings of an independent evaluation of the Limestone Ribble Project - a project that depended on partnership funding and collaborative working through a combination of direct finance, benefit in kind and volunteer activity. This evaluation reviews the participants' perception of success of the project outputs, the different project stages, and the levels of satisfaction amongst project partners (Figure H1 and Table H2).

The objectives of the Limestone Ribble project were designed to align with those of the Catchment Restoration Fund. The shared principal objective is to address the reasons for failure as defined by the WFD. The questionnaire was designed to explore the idea of overlapping objectives of managing the water environment and its associated habitat at the catchment scale and where these can be aligned more closely to enable access to funds, expertise and local community participation (questionnaire, common themes).

Data and Methods

In February 2015, twenty-two project partners were contacted for feedback on the Limestone Ribble Project (Table H1). Of the 22, eleven gave feedback, five of whom also took part in an extended semi-structured interview (Five declined and six did not respond.)

Participants were asked to give feedback on the success of the project measured against the project objectives; how well the different stages and elements of the project were managed, from project planning, designing interventions, communication and working with partners. Participants were asked a further three questions, what aspect of the project was particularly successful, what hurdles were there to overcome and were they and finally what work would they like to be addressed in the future.

Table H1. Partners who gave feedback

	Representing	Project feedback	Interviewed
1	Settle Anglers	✓	✓
2	local volunteer	✓	✓
3	Ribble Rivers Trust (moorland restoration)	✓	×
4	Consultant Hydrologist	✓	×
5	Yorkshire Dales National Park (woodland officer)	✓	×
6	Landowner	✓	×
7	Contractor, (habitat restoration)	✓	✓
8	Ribble Rivers Trust project officer	✓	×
9	Ribble fisheries consultative association	✓	✓
10	Yorkshire Dales National Park, Land manager	✓	×
11	Natural England (conservation advisor)	✓	✓

The contents of the participants' answers to the semi-structured questionnaire were analysed and common themes were identified.

Results

Limestone Ribble Project Objectives

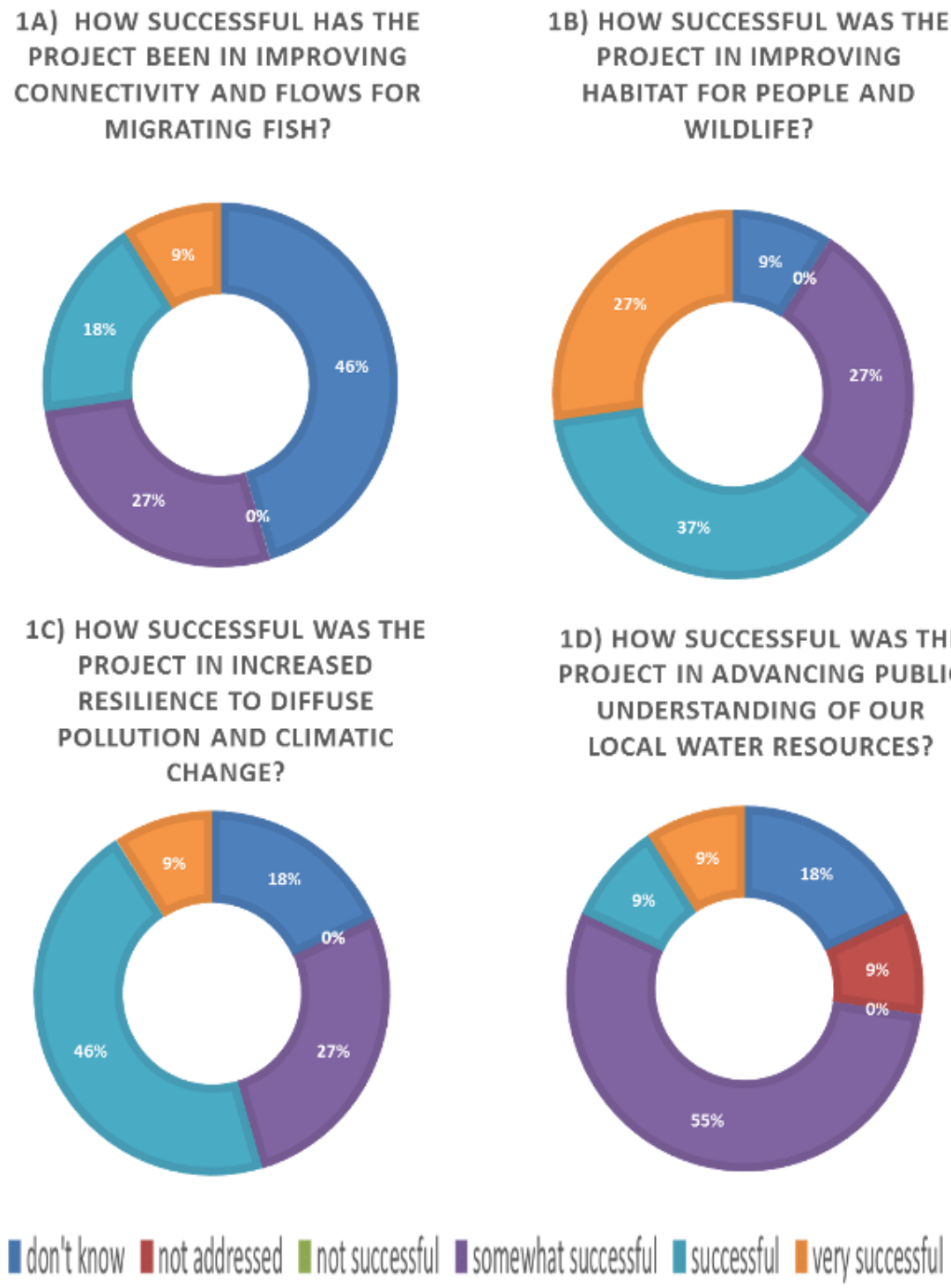


Figure H1. Measure of project participants' assessment of achievement of the four project objectives.

Project planning and management

Table H2. Participant satisfaction with stages of planning and implementing the Limestone Ribble Project

How well were the following aspects managed?	(% of respondents)					
	Don't know	not managed	poorly managed	managed satisfactorily	managed well	excellently managed
2a) project planning	27	0	0	0	55	18
2b) involvement of local community organisations and volunteers	18	9	0	0	36	36
2c) balancing diverse project objectives	9	0	0	27	46	18
2d) communication of project objectives	0	9	0	27	36	27
2e) communication of project activities and events	9	9	0	27	27	18
2f) publicity of the project	27	0	9	18	27	18
2g) achieving multiple objectives	27	0	0	9	36	27
2h) identification of suitable restoration sites	0	0	0	18	46	36
2i) design of restoration measures	9	0	0	0	55	36
2j) monitoring techniques	46	9	0	18	9	9

Questionnaire

Common themes

- **Motivation** – The interviewees often referred back to a particular theme or objective that they were themselves motivated by. They also classified partners other than themselves according to their perceived motivations, e.g. bird people, fish people, flood engineers.
- **Changing hydrological regime** – The majority of the interviewees described the upper Ribble catchment as being "flashier" than it was in previous decades and therefore resilience within the system needs to be increased.
- **Catchment-based approach** – There was unanimous agreement that the catchment-based approach is a desired way of managing the water environment however It was not clear from the responses how that should be achieved.
- **Natural Flood Management** – Interviewees stated that natural flood management should be included as part of the catchment-based approach. Over the last 18 months there has been more integration between those working towards water quality improvements and those who work in flood risk management.
- **Hurdles** – The most consistent hurdle described by the interviewees is working with land owners and trying to find a mechanism to obtain their permission and/or cooperation in changing land use methods.
- **Time** – The time investment required when looking to influence land owners to change practices or support a habitat scheme on their land was frequently described when discussing the difficulties that catchment restoration projects face. Also the time required for habitat restoration interventions to establish is significant. It could be decades before real benefits can be measured.
- **Rural and urban** – The interviewees often drew a distinction between rural and urban populations. Urban populations were seen as the source of problems but unaware or unwilling to recognise the value of an ecologically functioning landscape.
- **Prioritisation** – The interviewees did not feel that habitat restoration and water and land management were a government priority and as such it was very often difficult to secure funding.
- **Future work** – All of the interviewees indicated that they would like to continue the partnership.

Participant feedback

Almost half of the participants stated that they did not know whether the project has improved flows and connectivity for migrating fish. A common reason for this is that they felt their involvement had been in habitat restoration work, river bank and moorland restoration, rather than in-rivers work and that they were therefore not qualified to comment.

Those who did state that the project had either been successful or somewhat successful in improving connectivity and flows for migrating fish felt that they had to be conservative in their responses due to a lack of evidence. The elver passes were installed in February 2014, and so more time and monitoring is required in order measure the success of objective 1; improving connectivity and flows for migrating fish.

> *"I have no way of knowing…It's too early to say unless you're down watching the river everyday"*

The majority of the Limestone project activities were either wholly or partially driven by objective 2; improving riverine habitat for both people and wildlife. Activities included culvert removal, wetland creation, fence erection, tree planting, and river restoration with large woody debris and blocking of upland grips.

> *"Short term you can already see the impact it has had up on the moors, up on the uplands"*

> *"The quantity of riparian habitat improvement work has been impressive"*

These activities required the input of a wide range of project partners and hundreds of volunteer

> *"It's certainly on its way. It's inevitable it will do, at the moment the trees are only 1.5 metres high"*

hours. Feedback from the project partners was very positive but again many felt that it was too early to draw any conclusions as to how successful the interventions had been without allowing time for the habitat restoration and environmental enhancements schemes to establish and develop. This requires ongoing input and monitoring that at least one project partner was concerned has not been established.

The scheme at Stainforth Caravan Site was singled out by more than one partner as a stand out achievement of the project. Three new large woodlands that blend into existing woodlands alongside the River Ribble were planted with over 5,600 new trees along with the creation of two new wetlands. The woodlands help stop erosion, reduce pollution, provide dappled shade and create better habitat for all wildlife, whilst at the same time providing an environment that the local community and tourists can use and enjoy.

> *"I think what they're doing is really good. I love what I do; I'm passionate about what I do. Obviously subject to funding they've (The Ribble Rivers Trust) got loads of things which they'd like to do which I would like to be a part of. They do serve a good purpose"*

The project partners had a good understanding of those activities that were undertaken under objective 3; increasing resilience to diffuse pollution and climatic change. Such activities included fencing to exclude stock from accessing the water course and planting trees that will provide shade to the water course lowering in river temperatures. In common with the previous two objectives, participants felt that it was too early and there was also insufficient evidence to draw conclusions as to how successfully the objectives had been achieved. A number expressed concern that there was insufficient monitoring in place which will make it difficult to show how successful the interventions have been.

> *"What we want is scientific evidence…then you are in a much better position to make a case"*

The final objective is about communicating with the local community. Both the questions about objectives (Figure H1, (1d)) and the responses to the management of project planning and management (Table H2, (2b, 2d, 2e and 2f)) indicate that there is room for improvement. A further factor to consider is that the Ribble Rivers Trust is working across an administrative boundary of the counties of North Yorkshire and Lancashire. A number of interviewees felt that effort was not evenly distributed throughout the catchment.

Those interviewees who are motivated through a fisheries interest reported that communication was managed well. Further research is needed to conclude whether this is a coincidence particular to the interviewees that participated in the feedback exercise or whether it is a trend that can be detected more widely.

The Future

The participant feedback exercise has shown that there is a support and motivation amongst a wide variety of participants to undertake catchment restoration work. The objectives of the Limestone Ribble project is driven by addressing the causes of water body failures under the water framework directive which is underpinned by the concept of managing the water environment at the catchment and river basin level. The project participants show a high level of commitment and motivation to improve water and habitat quality but the high score of an "I don't know response" to the question about how well the objective to Improve connectivity and flows for migrating fish had been addressed illustrates that the connection between quality of the habitat in the upper catchment and its role in a natural flow regime, with a variability that supports downstream functions including fish migration is not well understood even amongst those involved in catchment restoration. The high number of "I don't know" responses also supports the low scores amongst those questions designed to capture feedback on the quality of project communication.

The most significant hurdle has been gaining permission from landowners, which in the Limestone Ribble project area are predominantly farmers, to undertake habitat improvement works. The process is particularly long and time consuming without any guarantees of success. Even when the project was able to offer tens of thousands of pounds of improvement works at no cost to the land owner, more often than not this offer was refused. It is felt on the whole that landowners need to be sure that their business will be more profitable following any habitat restoration work before they will give permission. Further research is needed to overcome this significant hurdle.

A number of participants stated that they would like a coordinated effort in the catchment to choose locations or areas of work to focus resources. Work under the catchment-based-approach is wide ranging but as of yet, as shown by this feedback exercise, not fully integrated. Future projects can widen their scope from water quality and biodiversity to include overlapping and complimentary priorities such as flood risk management, climate change adaptation, restoring hydrological function and carbon cycling.

Appendix I. Duke of Edinurgh Assessor's Report Volunteering

DE | ASSESSOR'S REPORT VOLUNTEERING

Participant: Emma Thompson
eDofE ID No:
Level: **Bronze**

Activity: Fencing and Tree Planting

Date started: __/__/__ Completed: 31/01/15

Goals set by participant: to help preserve and protect river habitats

Assessor's comments:

Please write as much as possible, talking about training, teamwork (if applicable) and achievements. What you write will celebrate the achievement of the young person and will form part of their permanent record of their DofE programme.

Emma works very hard and diligently in sometimes quite challenging conditions

Signature: R.P. Atton

Assessor's first name: RICHARD Last name: ATTON

Assessor's position/qualification: VOLUNTEER COORDINATOR

Assessor's phone number: 01200 444452

Assessor's email: richard@ribbletrust.com

Participants should scan or photograph this page and upload to eDofE as evidence.

DE | ASSESSOR'S REPORT VOLUNTEERING

Participant: Katie Hardy
eDofE ID No:
Level: **Bronze**

Activity: Tree Planting and fencing

Date started: __/__/__ Completed: 31/01/15

Goals set by participant: to protect the environment and river habitats

Assessor's comments:

Please write as much as possible, talking about training, teamwork (if applicable) and achievements. What you write will celebrate the achievement of the young person and will form part of their permanent record of their DofE programme.

Katie works very hard and diligently in sometimes quite challenging conditions

Signature: R.P. Atton

Assessor's first name: RICHARD Last name: ATTON

Assessor's position/qualification: VOLUNTEER COORDINATOR

Assessor's phone number: 01200 444452

Assessor's email: richard@ribbletrust.com

Participants should scan or photograph this page and upload to eDofE as evidence.

Appendix J. Positive Feedback from the Yorkshire Farming and Wildlife Partnership.

YORKSHIRE FARMING AND WILDLIFE PARTNERSHIP

Bents House, Dallowgill. Ripon. North Yorkshire. HG4 3QZ 0771 3333 170
phil.lyth@farmingandwildlife.net www.farmingandwildlife.net

23rd June 2014

Mr Ian Wallace
Station House
Staveley
Knaresborough
North Yorkshire

Dear Ian,

Camm Farm

I spent half a day walking around Camm on Friday as suggested and had a good talk to Dave too. He mentioned seeing several blackcock as well as red grouse with young recently, as well as trout in the beck and lots of frogs, which is good news. While I was walking around there were lots of curlew and skylark, and I also saw snipe in the bottom land.

The plant-life in the wetter areas has improved some interesting species (see attached plan) – I noted Common spotted orchid, bogbean, sundew, cranberry (abundant), milkwort. Below farm – lots of sedges, lousewort, forget me not, cuckoo flower, kingcup, lesser spearwort, horsetail, commons sorrel.

Woodlands

The Ribble Trust has done a really good job improving woods 1,2,3,9 & 10. The trees they have planted in the 1.2m guards are growing well and apparently they used cell-grown trees which should grow even better than the bare-rooted plants which were used before. They have also used some shorter rabbit spiral guards on shrubs nearer the streams, but I think these are likely to get browsed.

I am concerned about the light hardwood tree stakes they have used (22mm square x 1.3m long). I am not convinced they will last very long with the high winds & snow at Camm, but Aidan Foley from the Ribble Trust seems happy they will.

The RT are not doing any follow-up weeding on the woods they have improved and **I strongly recommend that you spot spray around the new trees with Roundup this year to give them a good start.**

There is a massive vole population on the farm, and this may well impact on the tree survival. Weeding around the trees will help but other than that there is nothing much that can be done except encourage birds of prey to eat them!

Within all of the fenced woodland areas the bilberry is now coming through very well and this will be a great benefit to the black grouse.

The survival of the original planting generally is looking better this year than last time I visited, I think after two good growing seasons. However, most trees are being browsed off at tube height (0.75m) by sheep/ deer. **In all of the woods I strongly recommend "doubling-up" the tree shelters as shown on the attached photos – using the shelters without live trees to double the height of the ones with live (browsed) trees, in order to allow them to get away. I may be able to find some volunteers to do this for you – I will let you know. You would need to supply around 3000 longer tree stakes for this work (based on 10,000 trees planted originally & 30% survival).** As well as protecting from any sheep which get in, this would also help to protect from deer, including Sika Deer which Dave says he thinks he has seen recently on the farm.

With woods 4,5,6,7 & 8, tightening the top wire should be a priority as this will help to discourage sheep getting in. (Sheep were in wood 8 when I visited). Also the bottom section of fence in wood 7 is down and needs sorting out urgently. This is not a massive job, but will make a big different I think.

I also wonder if fixing grouse deflector plates to all woodland fences, as well as benefiting the growing grouse population, would help to discourage sheep too?

In all of the woods not improved by the Ribble Trust it would be good to do some additional planting in 1.2m guards too, particularly wood 6 where survival is particularly poor. **I will enquire if the Woodland Trust or Yorkshire Dales Millennium Trust might be willing to help with this and let you know.**

<u>Grips</u>

The grip blocking (by a company called Taylors from Lancashire) has been very well done, and as you said we have learned a lot since the original blocking we did on the farm. Dave explained that the grips above house were not blocked because of concern on house water supply.

There would probably be scope for more grip blocking on the Wharfe (E) side of the farm if funding was available. **I will enquire if this could be added into your HLS agreement or possibly supported by the Yorkshire Peat Partnership.**

Please let me know your thought when you have considered these notes.

Best wishes.

Yours sincerely,

Phil Lyth
Farming and Wildlife Adviser