FISHERIES MONITORING OF THE RIBBLE CATCHMENT 2022

Ribble Rivers Trust

ABSTRACT

2022 marks the 15th year of Ribble Rivers Trust's fisheries monitoring programme. Results and observations from this work help inform the Trust on the productivity of sub-catchment fisheries and where to direct conservation efforts.

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Report title: Fisheries Monitoring of The Ribble Catchment 2022

Report reference: RRT_ Electric_Fishing _2022_Report

Report version: 1.3

Date: 24/01/2023

Prepared for: Ribble Rivers Trust

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Acknowledgments

Ribble Rivers Trust is grateful to all landowners for their permission to access their land and looks forward to continued cooperation for future work. In addition, the Trust wishes to thank the staff and volunteers for their continued hard work and contributions to this year's fisheries programme: David Bevis, Ellie Brown, Robert Cooper, Christi Lloyd, Naomi Lumsden, Guy Mason, Bethany Ryan, Mark Taylor, Leanne Tough, Adam Walmsley (Ribble Rivers Trust); Josh Morris and Archie White (Electric Fishing Volunteers); Matt Duffy (Don Catchment Rivers Trust); Andy Barry and Abigail Devaney (Calder and Colne Rivers Trust); Ruth Mackay (West Cumbria Rivers Trust).

Executive Summary

Ribble Rivers Trust (hereafter 'the Trust') concluded its 15th year of electric fishing surveys on the Calder, Hodder and Ribble catchments. From 12th June until 7th October 2022, a total of 294 sites were surveyed in the annual programme with additional sites on the River Douglas picked up as part of the Opening Up the River Douglas fish pass monitoring. During the survey season the Trust engaged with staff from the neighbouring Calder & Colne Rivers Trust and West Cumbria Rivers Trust to help build their experience in delivering their own survey programmes. The survey teams also had two weeks of volunteer days with high school and university students and engaged with 34 people on the riverbank.

The methodologies applied to the Trust's fisheries programme are adapted from Crozier and Kennedy's 'Application of Semi-quantitative Electrofishing to Juvenile Salmonid Stock Surveys' (1994) and Zippin's 'Removal Method of Population Estimation' (1958). National Fisheries Classification Scheme (NFCS) grades are then used as a metric for the standardisation of results which are comparable to national datasets. Outputs are used to support and identify future works on the catchment as well as monitoring the long-term impacts of river restoration schemes.

With winter river levels of 2021/22 being more favourable for spawning there has been a reduced potential for redd washout with less impactful flows during early life-cycle stages. Fish communities have evolved to withstand the dynamic nature of a river habitat and are relatively resilient to high hydrological events. Severe floods and extreme low flows at critical life-cycle stages can influence community composition which have short- and long-term effects. Along with natural variation between years, a reduction in salmonid productivity for 2022 may point towards in-river temperatures being above that of optimal survival during incubation and early life-cycle stages. The Ribble catchment's 2022 brown trout and Atlantic salmon cohort has also had to endure the warmest summer on record coupled with the driest year since 1976 (as of time of publication).

Brown Trout

Brown trout were found to be present in 77.5% of sites. However, the recruitment of brown trout fry on all three catchments has been reduced with the young-of-year only present in 64.3% of sites (Figure 1). As well as contending with high temperatures during early egg and alevin development, reduction in this year's productivity could also be attributed to a struggling 2019 cohort, as some brown trout reach reproductive maturity at 3+ years (Figure 1). The Calder catchment has seen the largest drop in productivity with the

Hodder least affected. The observed number of trout parr in 2021 was very low reflecting 2019 and 2020's poor fry results. However, with fry densities lifting in 2021, parr densities have improved which has also been observed in rod catches across clubs (Figure 2).

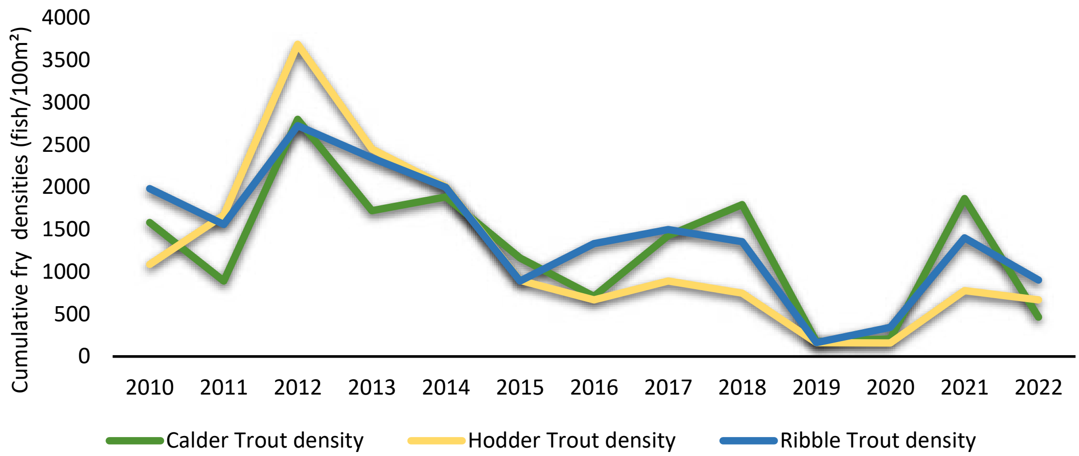


Figure 1: Brown trout fry densities on the Calder, Hodder and Ribble catchments for 135 sites fish 2010-2022.

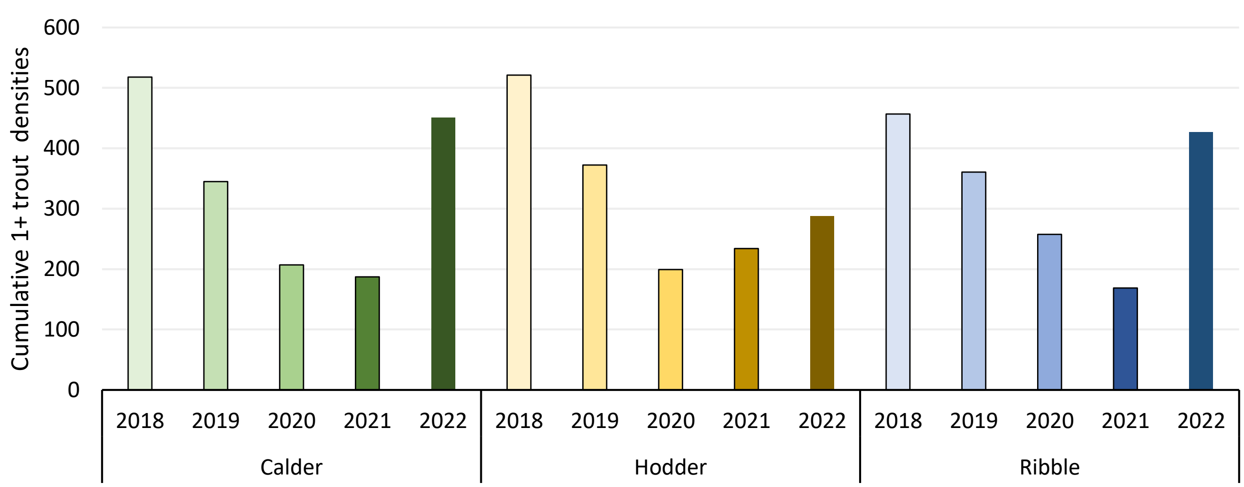


Figure 2: Cumulative brown trout parr densities of sites fished 2018-2022 on the Calder, Hodder and Ribble catchments.

Atlantic Salmon

The recruitment of Atlantic salmon fry on all catchments has seen little improvement for 2022 (Figure 3). Results from this year show limited areas across the catchments where Atlantic salmon are spawning, and many sites are absent of fry or are returning poor densities. Only five sites returned NFCS 'Good' to 'Excellent' grades; two on the main stem Hodder between Slaidburn and the Knowlmere Estate, one on the main stem Ribble below Gisburn, one at the bottom of Croasdale Brook and one at the bottom of Langden Brook.

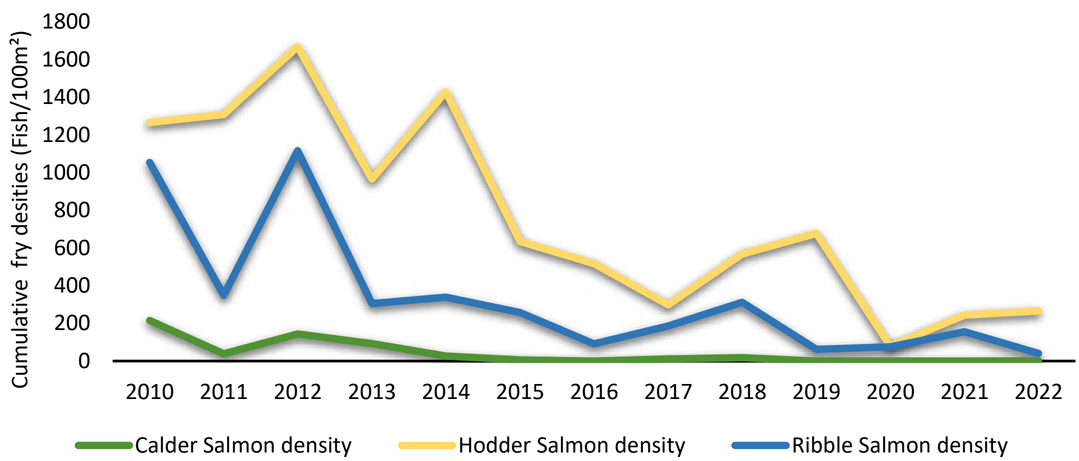


Figure 3: Cumulative Atlantic salmon fry densities for the 135 sites fish on the Calder, Hodder and Ribble catchments between 2010 – 2022.

There has been a lift in salmon fry densities on the Hodder catchment with a reappearance of fry in Langden Brook sites after being recorded as absent in 2021. Sites on the main stem Hodder below Slaidburn regularly see the highest densities of the year. However, this is not reflected everywhere on the catchment, with a significant drop in productivity from 2015.

A single salmon fry has been recorded on the Calder catchment for the first time in three years. Sabden Brook is considered to be prime habitat for salmon spawning, owing to habitat suitability, substrate composition and good water quality. This tributary produces some of the highest densities of brown trout fry in the Calder catchment, although this is not reflected in the salmon population. The Calder catchment is struggling for adult returns and spawning productivity of Atlantic salmon. It is more of a concern that no salmon parr have been recorded present in the Calder electric fishing surveys since 2020. Natural mortality rates for the first year of development are around 90%, so the absence of parr is of particular concern.

The Ribble catchment has seen densities decrease with only a single 'Good' grade site on the main stem Ribble below Gisburn recorded. Swanside Beck and Ings Beck were historically good spawning tributaries for Atlantic salmon but since 2015 the average salmon density has dropped significantly. In the Upper Ribble most sites returned 'Poor' to 'Very Poor' results, with only a single site at the bottom of Rathmell Beck returning 'Fair' densities.

The decline of Atlantic salmon has been geographically widespread and is well documented in academic papers. The major determining factor of Atlantic salmon fry numbers is driven by the number and size of returning adults. Spending more time at sea, allows for a greater size and higher fecundity but this runs a larger risk of mortality prior to reproduction. Over time the proportion of one-sea-winter to multi-sea-winter adult Atlantic salmon has seen variation. Since the 2000s, there has been a shift in the North-East Atlantic population towards an increased proportion of later maturing individuals. Adult salmon are now tending to return to rivers at older ages and in poorer condition due to reductions in marine feeding opportunities limiting the growth and maturation potential of the fish (Gillson *et al*, 2022).

Egg deposition rates for the Ribble catchment are calculated by the Environment Agency (EA) through the modelling of rod catch data. This data takes into account the exploitation of adult salmon, the survival rates after catch and release and the weight and length data of captured salmon. With offsetting this data against the Trust's own fisheries data, we can see that egg deposition trends follow that of fry densities in the catchment. Where egg deposition and fry densities differ (*e.g.* 2015 and 2020), there are other factors impacting egg to fry survival.

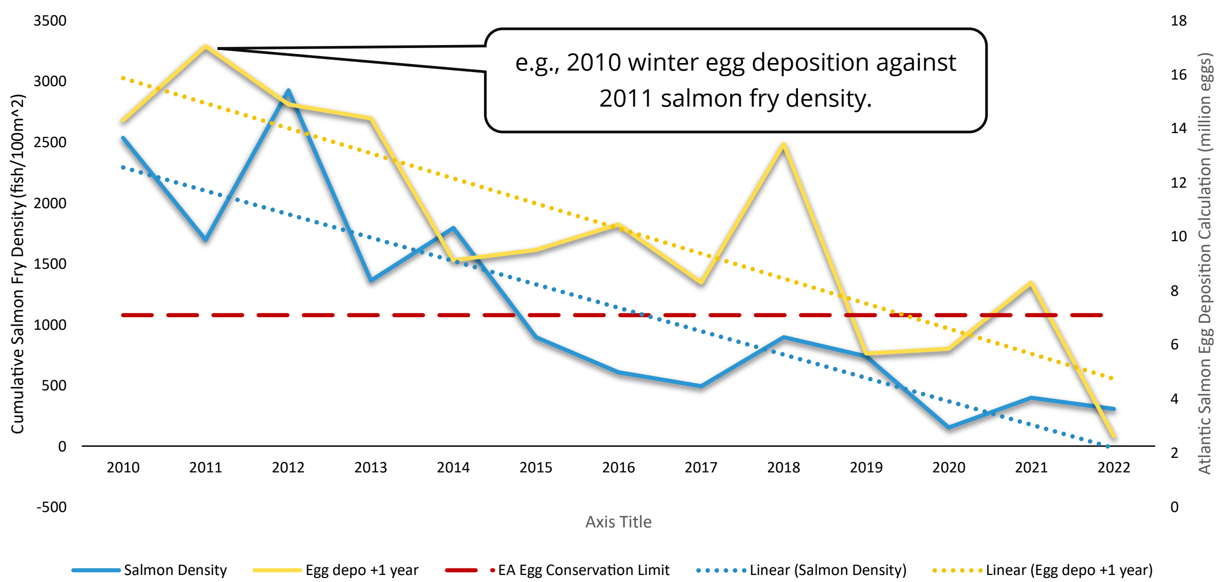
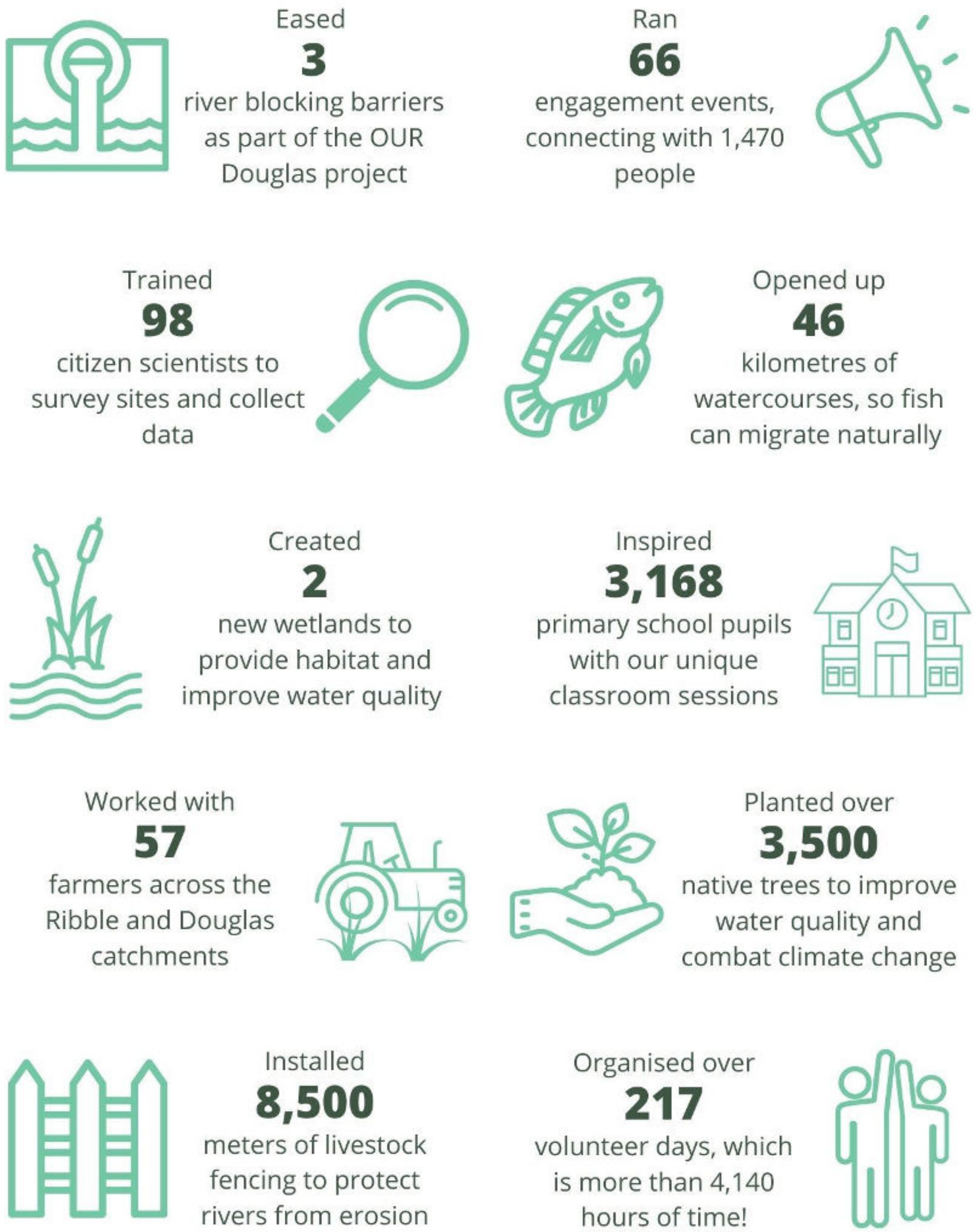


Figure 4: EA Atlantic salmon egg deposition (offset to match that years fry population) and Cumulative Atlantic salmon fry densities for sites holding sequential years data between 2010 – 2022 on the Calder, Hodder and Ribble catchments

To ensure the future of Atlantic salmon within the Ribble catchment, freshwater management and habitat restoration is paramount. The Trust's fisheries work contributes towards salmon populations during their freshwater, early life-cycle stages, aiming to ensure that the number of fish that survive to smolt in good condition are sufficient to provide a strong returning spawning population, driving up egg deposition.

In 2022 alone Ribble Rivers Trust achieved:



1.0 Introduction

The Trust has been directing habitat restoration, improving river connectivity and facilitating improved land management for over twenty years in the Ribble catchment. With more than 6,000 kilometres of watercourses, the Trust's vision is that the catchment and its rivers have excellent water quality and habitat that is well connected, with appropriate flows in which there are the resources to support abundant and diverse wildlife, including fish which are a critical indicator of catchment health.

To support achieving this vision our fisheries monitoring aims are to:

1. Assess the overall status of the juvenile population of salmonids (salmon and trout)
2. Monitor the inter-annual variations of the salmonid young-of-year population
3. Determine underperforming areas and direct improvement works
4. Capture the effectiveness of previous habitat improvement works
5. Generate data and evidence in support of, and to report on, grant bids and applications
6. Generate knowledge of rare species to inform responsible development
7. Locate ecological threats posed by invasive species
8. Derive future research questions

The Trust concluded its 15th year of electric fishing surveys on the Calder, Hodder, and Ribble catchments (Figure 1.1). A total of 294 sites were surveyed with priority given to those with a long-term data series or that were considered to be of higher conservational importance.

1.1 Sub-Catchment Map

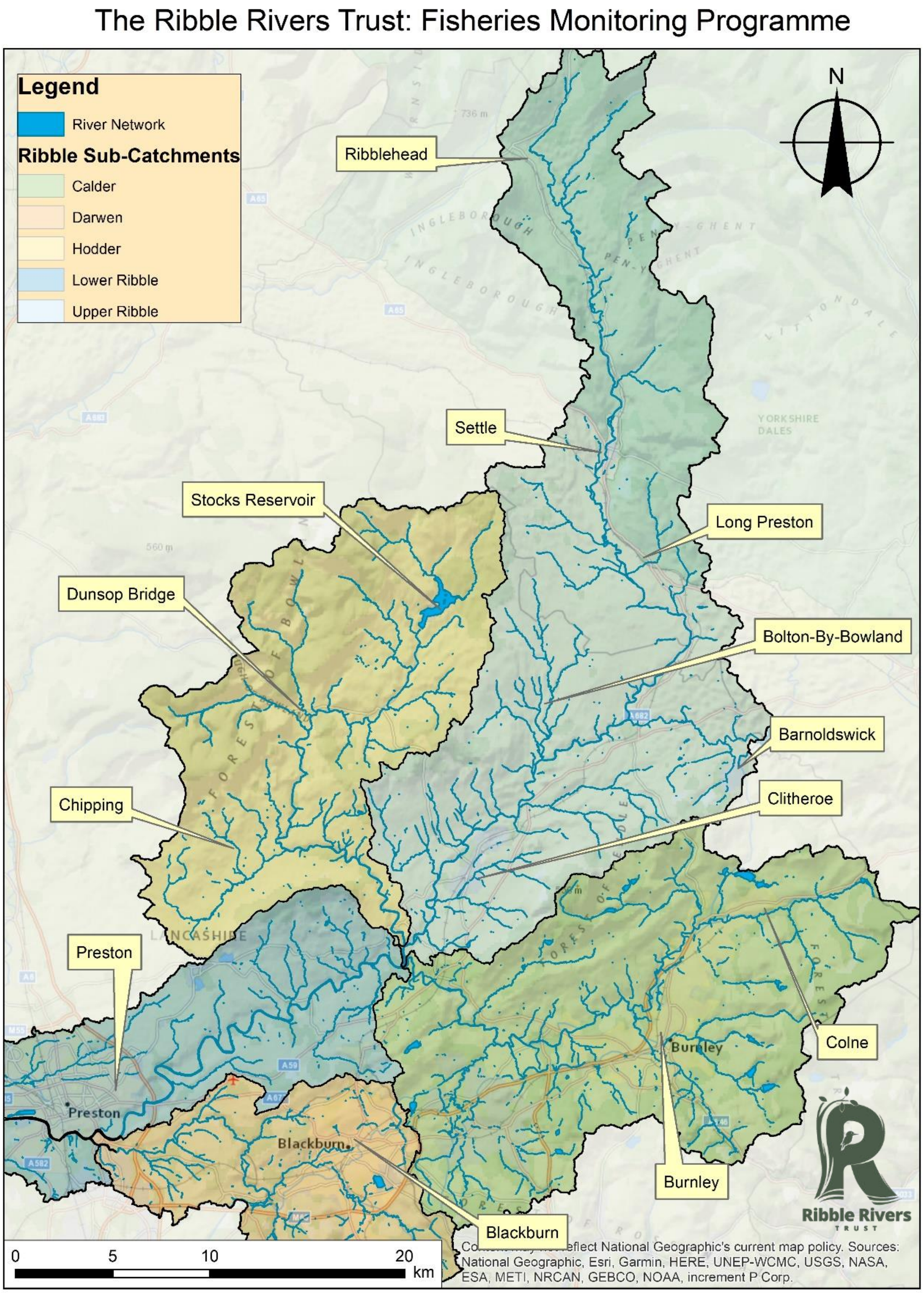


Figure 1.1: River Ribble catchment map displaying sub-catchment boundaries and reference locations.

2.0 Methodologies

2.1 Electric fishing Surveys

The Trust applies an adapted Crozier and Kennedy (1994) methodology which has been operated since 2008. Riffle / pool habitat is targeted to capture both the young-of-year (<0 or fry) and the >0 parr populations of Atlantic salmon and brown trout using an electric fishing backpack system. Two types of survey are undertaken; semi-quantitative, where the river is actively fished for five minutes covering a measured unisolated area; and quantitative, where an isolated area of river is sampled over several depletive passes. The fork length of salmonids is recorded (mm) at each location and the abundance of other species is noted.

For 2022, sites identified for surveying were those holding the most significant dataset, with ten or more years of continuous data or in key locations for monitoring restoration works. The survey team worked from 13th June until 7th October, with a total of 294 sites completed.

From the above activities, the young-of-year are determined by establishing a maximum fork length discerned from the frequency-length distribution of the species. This method is applied to each major catchment individually to reflect the temporal and spatial differences in fry as the electric fishing season progresses (Appendix B.1-B.7). Quantitative surveys provide fry densities per 100m^2 from the depletion of a known measured area; these densities are generated from Zippin's (1956; 1958) K-Pass Removal method using the FSA package in R version 3.1.0 (R core Team, 2019), whereas semi-quantitative results are calculated from the number of fry captured in an active five-minute fish. The equation applied to the semi-quantitative results is formed from the quantitative fry population relationship between a five-minute fry capture in the first pass and the total electric fishing result (fry per 100m^2) (Appendix C.1 and C.2). Data used must reflect the variation in fishing results based on the constant effort of the electric fishing team for each site surveyed. This relationship uses quantitative data collected as well as the addition of a zero, zero point to represent a total absence of salmonids. The resulting equation is taken from the fitted linear regression for 0 + salmonids where:

$$ln(y + 1) = a + b\ ln(x + 1)$$

The densities of trout and salmon fry per 100m² are allocated a grade score (Table 2.1), which standardises the Trust's field observations with those of the NFCS.

Table 2.1: National Fisheries Classification System for trout and salmon fry density per 100m²

Grade	Description	Trout fry per 100m²	Salmon fry per 100m²
A	Excellent	>38	>86
B	Good	17 -38	45-86
C	Fair	8-16	23-44
D	Poor	3-7	9-22
E	Very Poor	1-2	1-8
F	No Fish Present	0	0

Graded results are transferred to a map layer using ArcGIS 10.8.1 to display catchment-scale results. Within the results section the inter-annual comparison of data is based on sites which hold thirteen years of consecutive data, and the grade change evaluation is the comparison of all sites fished in both 2020 and 2021. Grade results have been organised within the analysis of this report according to geographical coverage determined by sub-catchment.

3.0 Monitoring Results

3.1 Brown Trout (*Salmo trutta*)

During the 2022 survey season a total of 3,037 brown trout fry, parr and adult fish were captured over 294 electric fishing sites. The density estimations from all sites containing the young-of-year were 1-111 fry/100m² with a mean site density of 12.5 fry/100m². This is a reduction on 2021's results where sites had a wider range of 1-346 fry/100m² and the mean site density of fry at 23.9 fry/100m². Brown trout were found present in 77.5% of sites, but recruitment of brown trout fry on all catchments has been reduced with the young-of-year only present in 64.3% of sites (Figure 3.1.1).

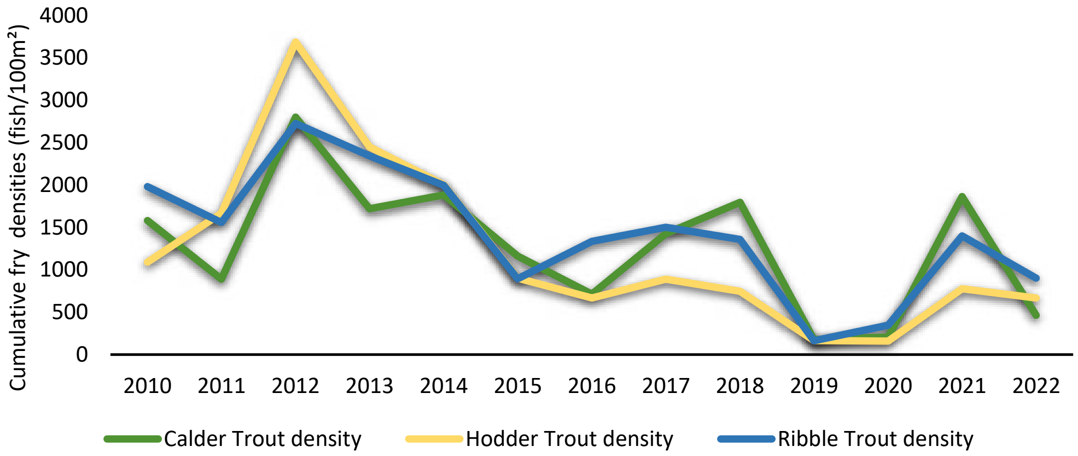


Figure 3.1.1: Cumulative brown trout fry densities on the Calder, Hodder and Ribble catchment for 135 sites 2010-2022

The observed number of trout parr in 2021 was very low reflecting 2019 and 2020's poor fry results (Figure 3.1.2). However, with fry densities lifting in 2021, parr densities have improved, with an average across all sites reported as 6.03 parr/100m² in 2022.

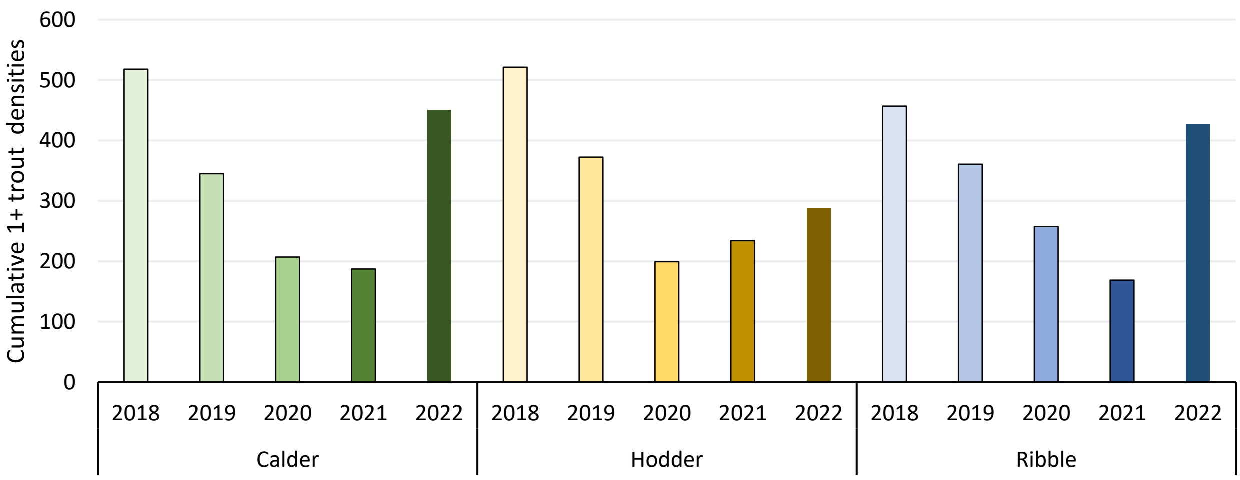


Figure 3.1.2: Cumulative brown trout parr densities of sites fished 2018-2022 on the Calder, Hodder, and Ribble catchments

Despite river levels during egg development and emergence being more favorable than previous years, with a reduction in the frequency and severity of maximum river level events, the trout recruitment on all catchments is down. With some of the top NFCS grade sites in stronghold areas suffering, the question is whether certain areas are seeing natural variation between years or are other factors at play?

When looking at the absence of trout fry on rivers it will always be of concern, especially in areas where they have previously been documented in reasonable numbers; these will be flagged within the report. However, it should be noted that not all sites are suitable nursery habitat for trout. For example, there are many main stem sites on the Ribble, Hodder and Calder that are recorded as F grades and spawning will be highly pocketed (Figure 3.1.4).

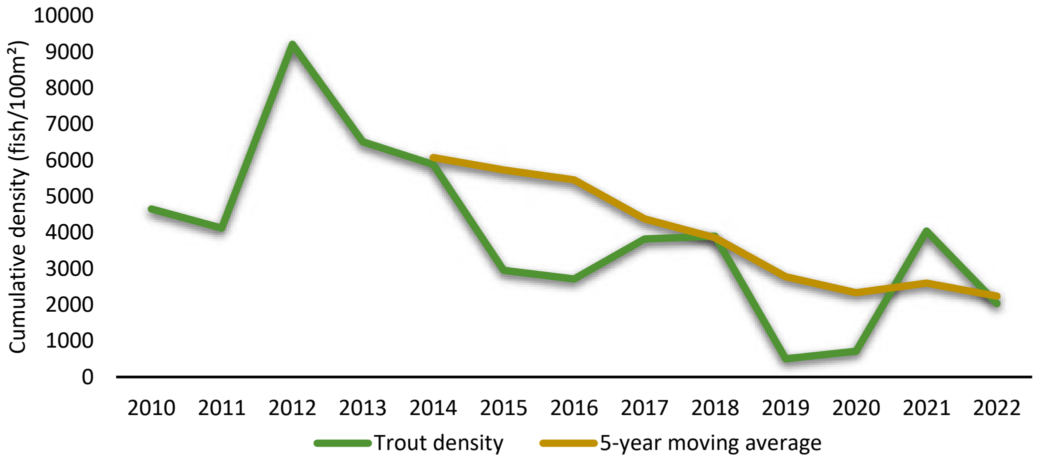


Figure 3.1.3: Cumulative brown trout fry densities on the Ribble catchment for 135 sites fish 2010-2022 including five year moving average.

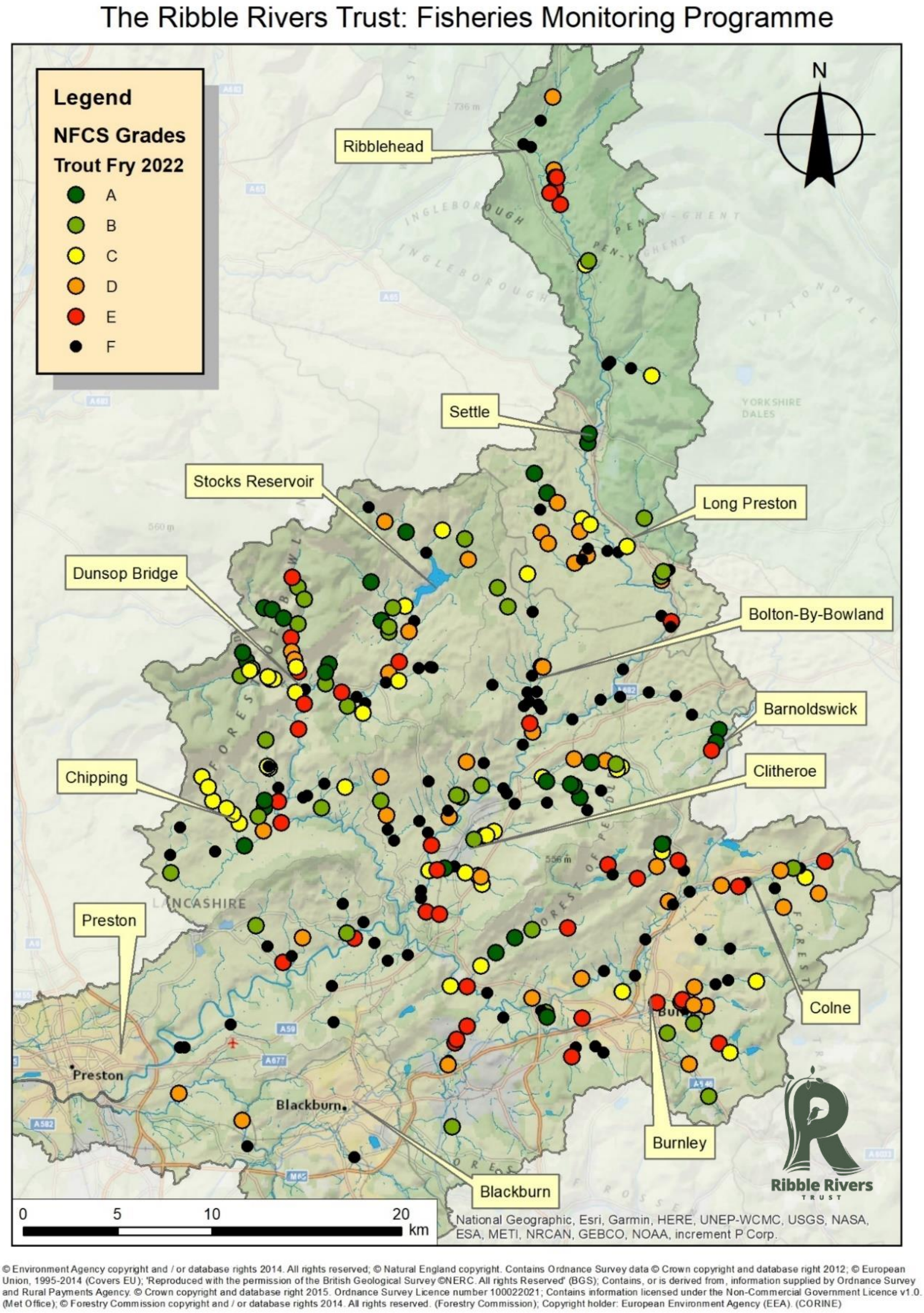


Figure 3.1.4: Catchment map [1:250,000] showing brown trout fry NFCS grades from 294 surveys undertaken by the Trustin 2022. Green to red points indicate higher to low grades; black indicates an absence of trout fry.

3.1.1 Calder Brown Trout

In comparison to 2021, 69% of sites surveyed have reduced in trout fry NFCS grade score on the Calder catchment (Figure 3.2.5). Out of the three major catchments, the Calder has seen the biggest change in fry recorded. The density estimations from Calder sites containing the young-of-year were 1-91 fry/100m² with a mean density of 8.43 fry/100m². This is a significant drop from 2021, when site densities averaged at 29.8 fry/100m². (Figure 3.2.6).

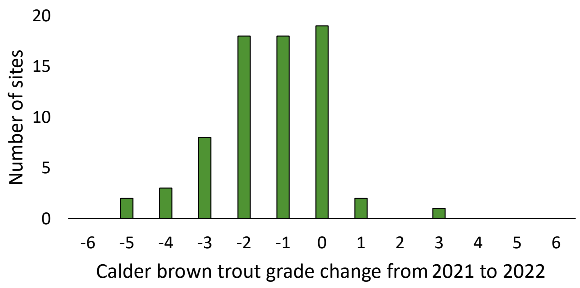


Figure 3.1.5: NFCS grade change comparison of brown trout on the Calder catchment 2021-2022 (0 = no change).

The headwaters of Pendle Water to the confluence of Colne Water has been highlighted as a problem waterbody for 2022, with four of its nine sites dropping between three and five NFCS grades. This waterbody has been producing some of the highest fry densities within the Calder catchment over previous years (Figure 3.2.8).

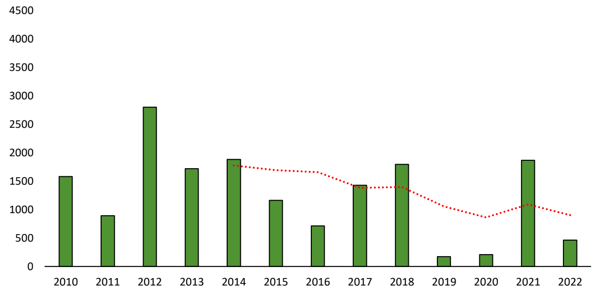


Figure 3.1.6: Cumulative brown trout fry densities on the Calder catchment for 49 sites fish 2010-2022 including 5 year moving average.

Walverden Water and Catlow Brook have again produced no fry this year, and away from its headwaters, the River Calder is recording poor densities. Due to a canal breach 10th-11th October 2021, Hyndburn Brook was impacted when the bed and the towpath of the Leeds and Liverpool Canal failed. As a struggling tributary, polluted sediments being flushed as far as the main stem Ribble have not improve the situation (Figure 3.2.8).

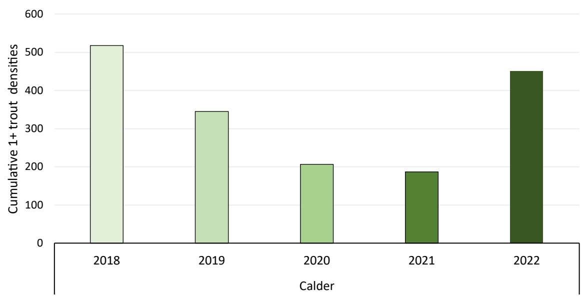


Figure 3.1.7: Cumulative brown trout parr densities of sites fished 2018-2021 on the Calder.

The observed density of parr on the Calder catchment is much improved with a site average doubling to 6.03 parr/100m², with sites containing trout parr at densities of 0.3-66 parr/100m² (Figure 3.2.7). With last year's cohort of fry being higher than 2019/20, the number of individuals surviving to their second year has boosted the number >0+ fish.

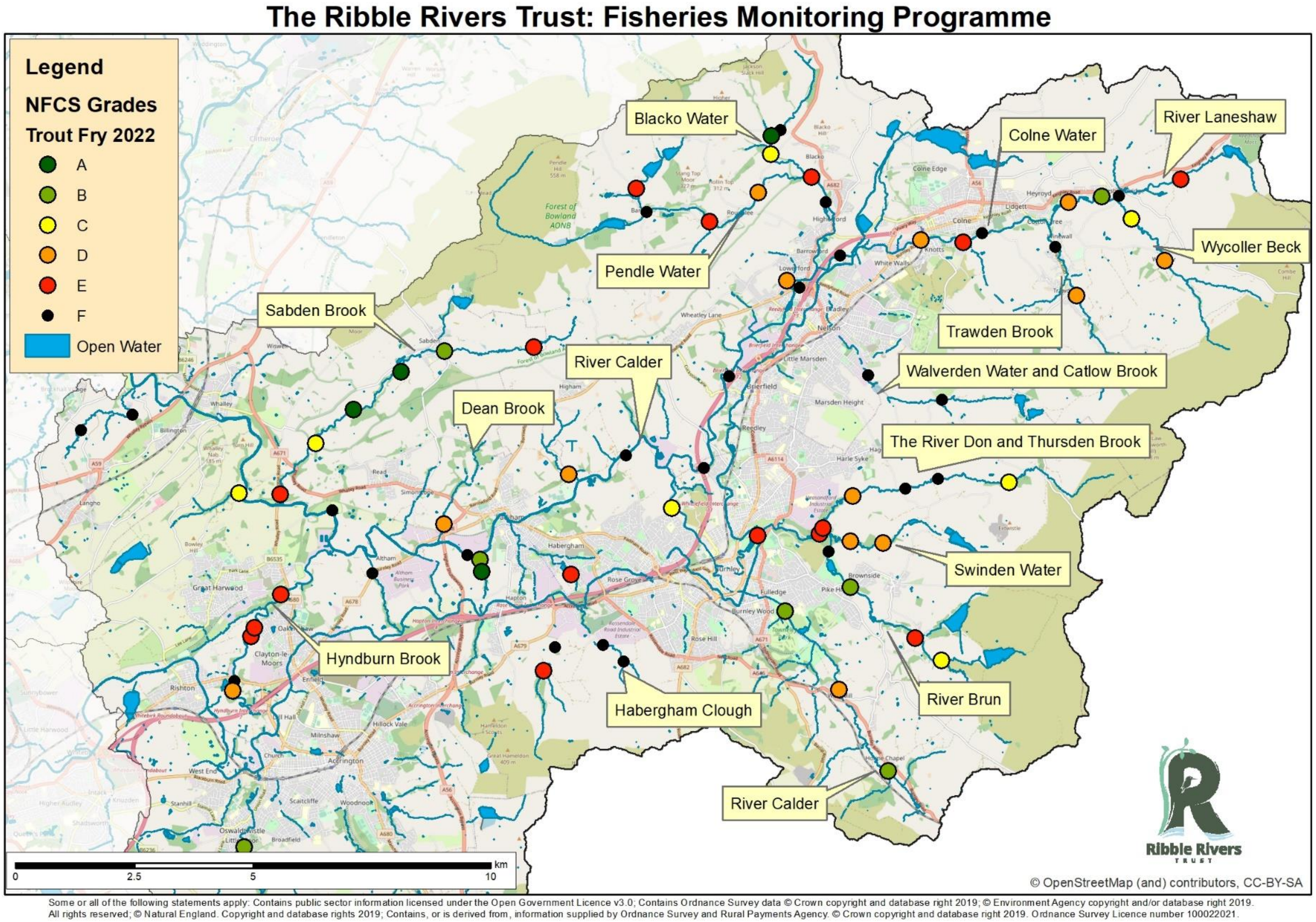


Figure 3.1.8: Brown trout fry NFCS grades from Calder catchment surveys undertaken by the Trust in 2022.

3.1.2 Hodder Brown Trout

There has been little change in the density of brown trout fry on the catchment in comparison to 2021 (Figure 3.1.9). However, the longer-term dataset (thirteen years) does not hold successive results for sites on Whitendale, Brennand and Dunsop waterbodies. Data is also limited for Chipping and Langden Brooks with only a few sites holding a continues thirteen years' worth of data. As these waterbodies are important spawning tributaries, all sites on the catchment have been compared to results from 2021.

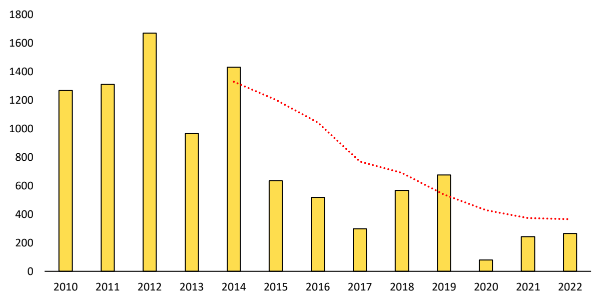


Figure 3.1.9: Cumulative brown trout fry densities on the Hodder catchment for 44 sites fish 2010-2022 including 5 year moving average.

51.4% of sites surveyed have reduced in trout fry NFCS grade scores on the Hodder catchment, 19.4% have seen improvements and 29.2% have seen no change (Figure 3.1.10). The density estimations from sites containing the young-of-year were 2.8-135 fry/100m² with a mean density of 18.5 fry/100m². This is a significant improvement from 2019/20 lows (Figure 3.1.9), but there has been a reduction in productivity from last year's site average of 26.7 fry/100m² (Figure 3.1.10).

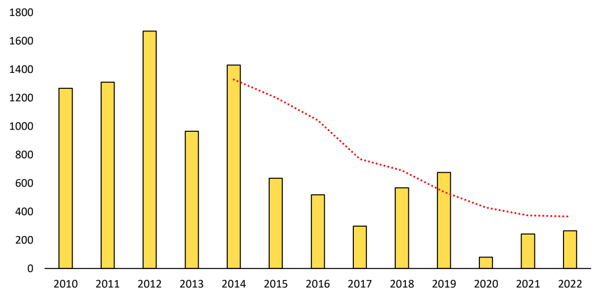


Figure 3.1.10: NFCS grade change comparison of brown trout on the Calder catchment 2020-2021 (0 = no change).

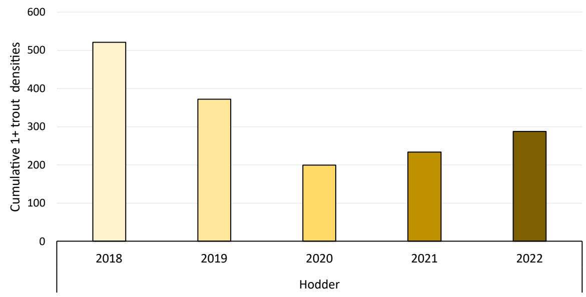


Figure 3.1.11: Cumulative brown trout parr densities of sites fished 2018-2022 on the Hodder.

Greystoneley Brook has seen some improvements in the headwaters after last year's concerns of uncharacteristically low abundance and diversity of other minor coarse fish species and salmonids. This has not been reflected on the lower reaches, with several sites not delivering young-of-year or 'Very Poor' NFCS grades. Chipping Brook has produced 'Fair' NFCS grades in all sites surveyed this year and Leagram Brook has retuned its best results since 2017. Lees Beck was found dry over summer and many other sites reported high temperatures, low water and algal blooms.

The observed density of parr on the Hodder catchment is up in comparison to 2021 (Figure 3.1.11) with a site average of 9.7 parr/100m², with sites containing trout parr at densities of 1.4-66.9 parr/100m².

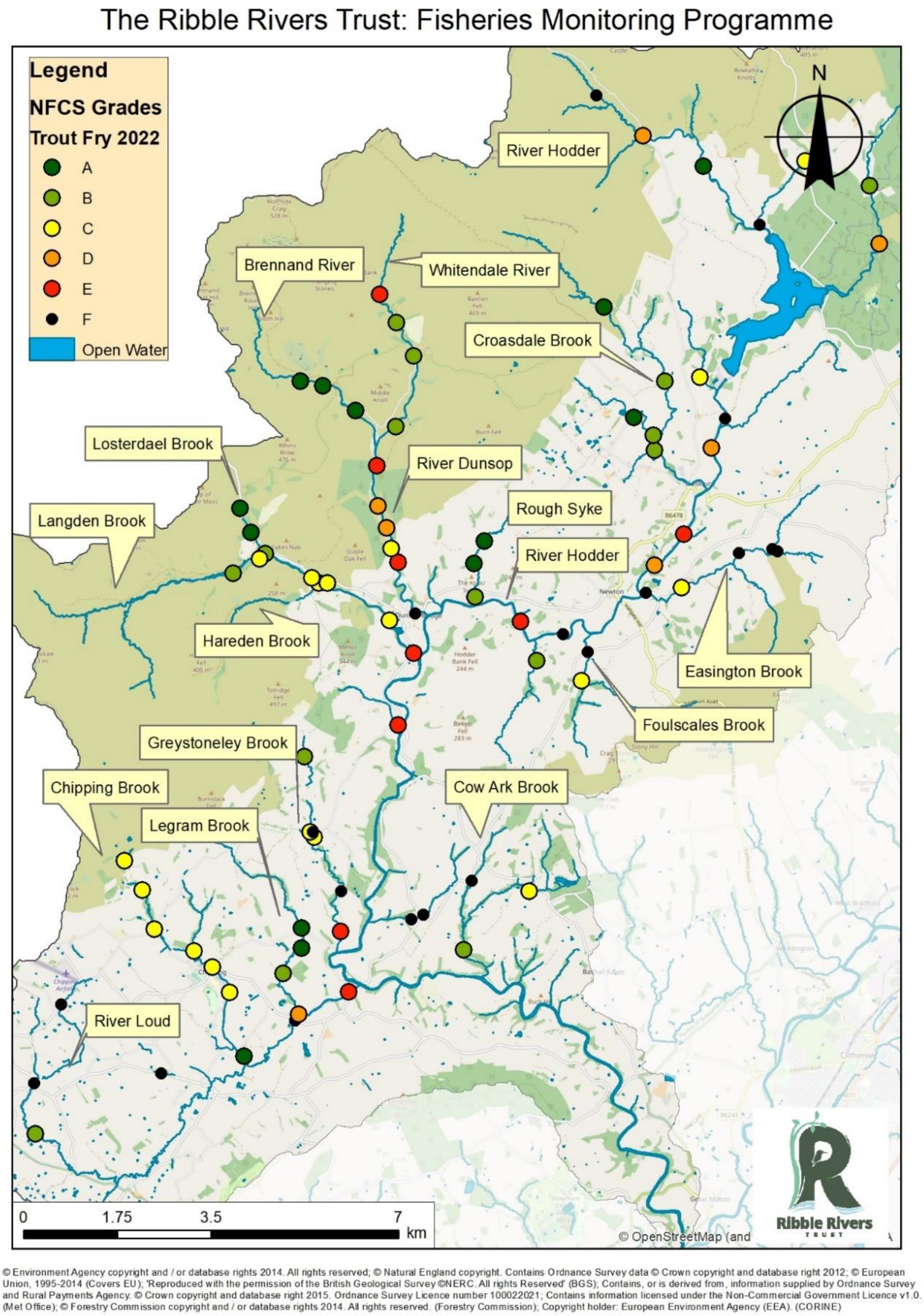


Figure 3.1.12: Brown trout fry NFCS grades from Hodder catchment surveys undertaken by the Trust in 2022.

3.1.3 Ribble Brown Trout

The density estimations from sites containing the young-of-year were 1-111fry/100m² with a mean density of 11.3 fry/100m². This is a reduction from 2021 (Figure 3.1.14).

The observed density of parr on the Ribble catchment showed significant improvement from last year's site average of 2.4 parr/100m², increasing to 4.5 parr/100m² with sites containing trout parr at densities of 2.6-35.5 parr/100m² in 2022.

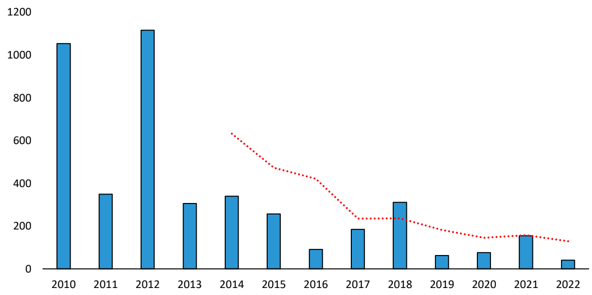


Figure 3.1.13: Cumulative brown trout fry densities on the Mid and Upper Ribble catchment for 44 sites fish 2010-2022 including five year moving average.

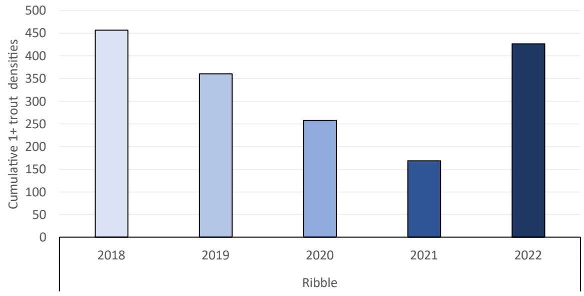


Figure 3.1.14: Cumulative brown trout parr densities of sites fished 2018-2022 on the Ribble.

Lower Ribble

Sites fished on the Lower Ribble are those tributaries that flow into the main stem Ribble between the Calder confluence and the tidal limit. The lower Ribble tributaries are found to be sub-optimal spawning habitat for salmonids and are mainly dominated by other minor-coarse fish species. For 2022, the sites that have produced trout fry have been on the Duddel Brook waterbody and sites on Dean Brook (Figure 3.1.15).

Mid-Ribble

Holden Beck and Skirden Beck waterbodies struggled again with trout fry being absent from most sites. Sites on the headwaters of Bond Beck were in extreme low flows over the summer months with highly pocketed pools for refuge. These surveys were carried out later in the summer when water levels improved, and fish were given sufficient chance to re-distribute. Stock Beck again has been flagged, as no sites returned trout fry below the site at Greenberfield Lane. The largest drop in NFCS grade was seen on Pendleton Brook and Swanside Beck. Swanside Beck has still produced some 'Excellent' and 'Good' grade sites, but overall has been less productive than neighboring Ings Beck which remains consistently high most years.

Upper Ribble

On the Upper Ribble catchment (Figure 3.1.18) Tems Beck has performed well and Rathmell Beck has returned excellent densities in the headwaters. However, the lower reaches of Rathmell Beck saw a significant drop in densities in comparison to last year's highs and Wigglesworth Beck has struggled to produce anything but poor results. Cam and Gayle Becks, at the top of the Ribble catchment, have also struggled to produce high densities of brown trout fry and rarely get above a 'Poor' NFCS grades. This area is known to have degraded habitat quality and river management and restoration projects are ongoing.

The Ribble Rivers Trust: Fisheries Monitoring Programme

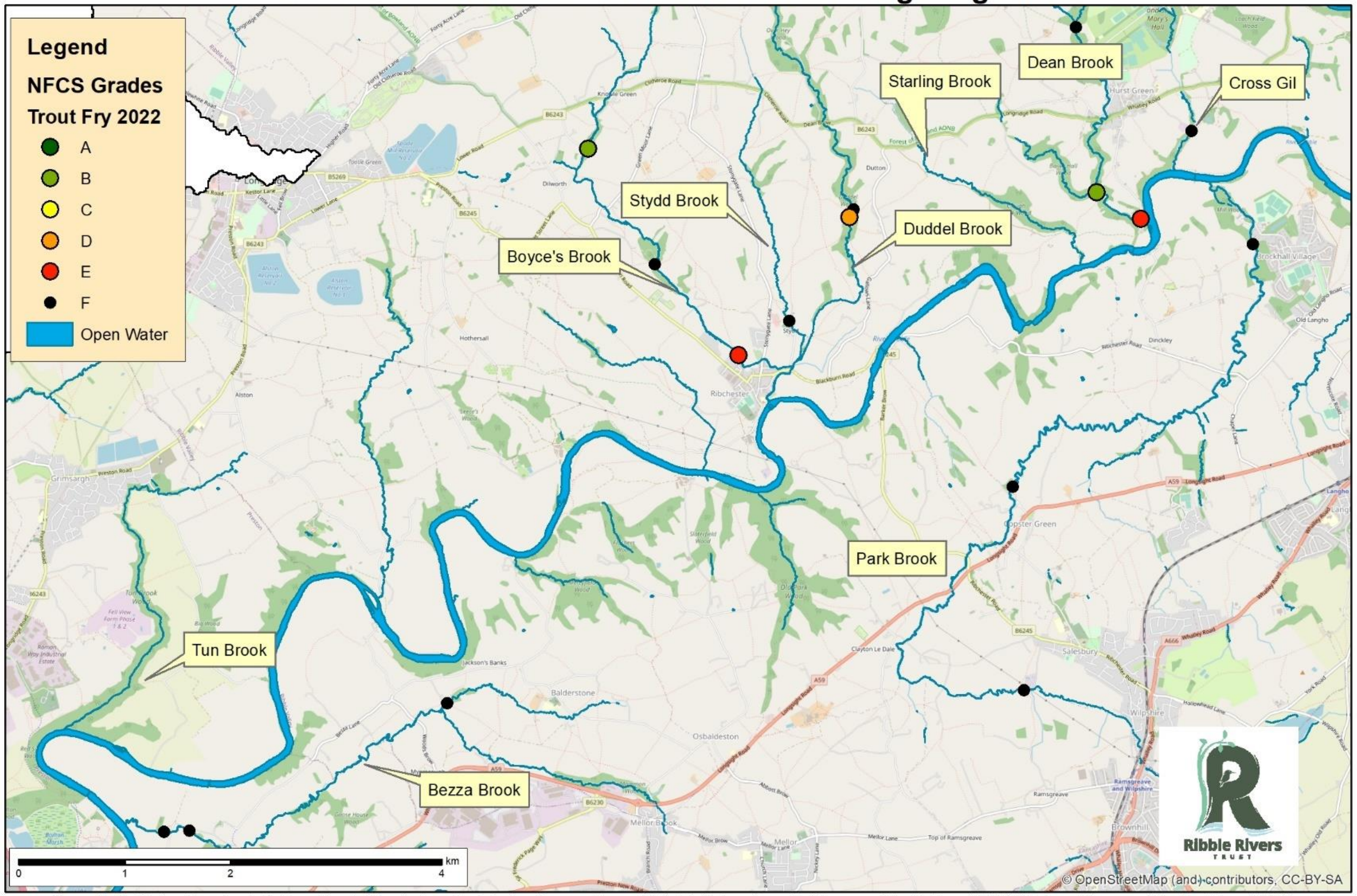


Figure 3.1.15: Brown trout fry NFCS grades from Lower Ribble catchment surveys undertaken by RRT in 2022.

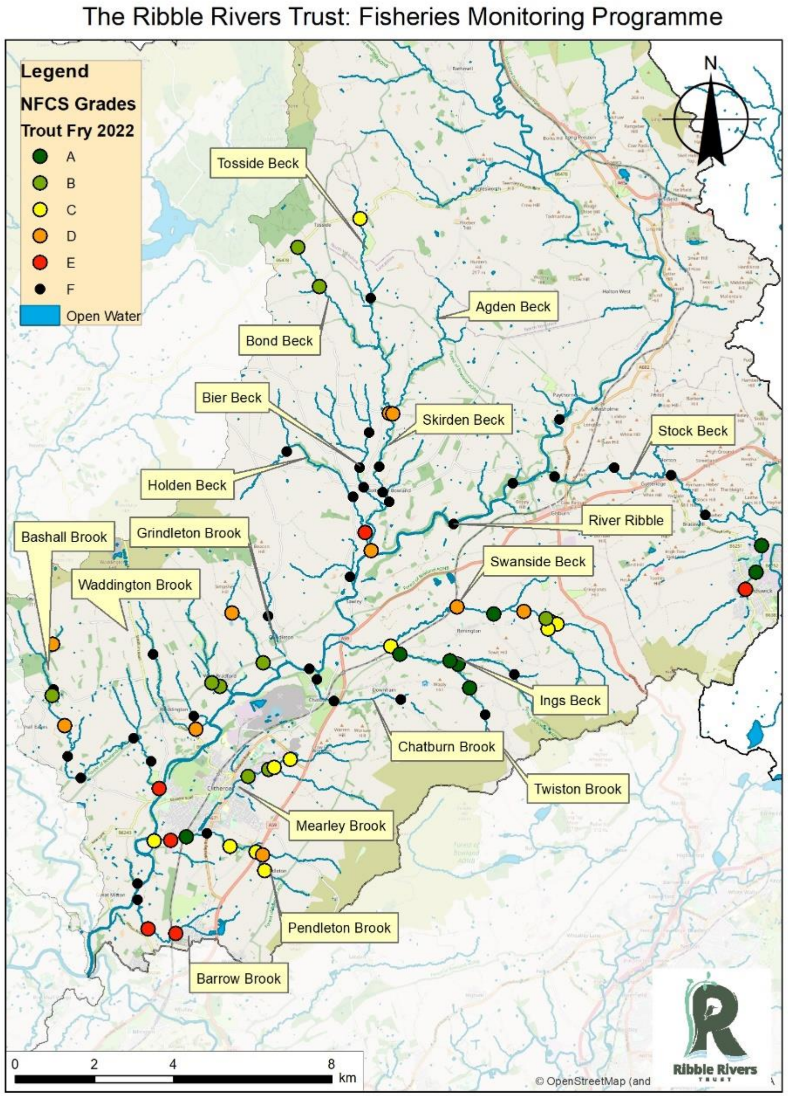


Figure 3.1.16: Brown trout fry NFCS grades from Mid-Ribble catchment surveys undertaken by the Trust in 2022.

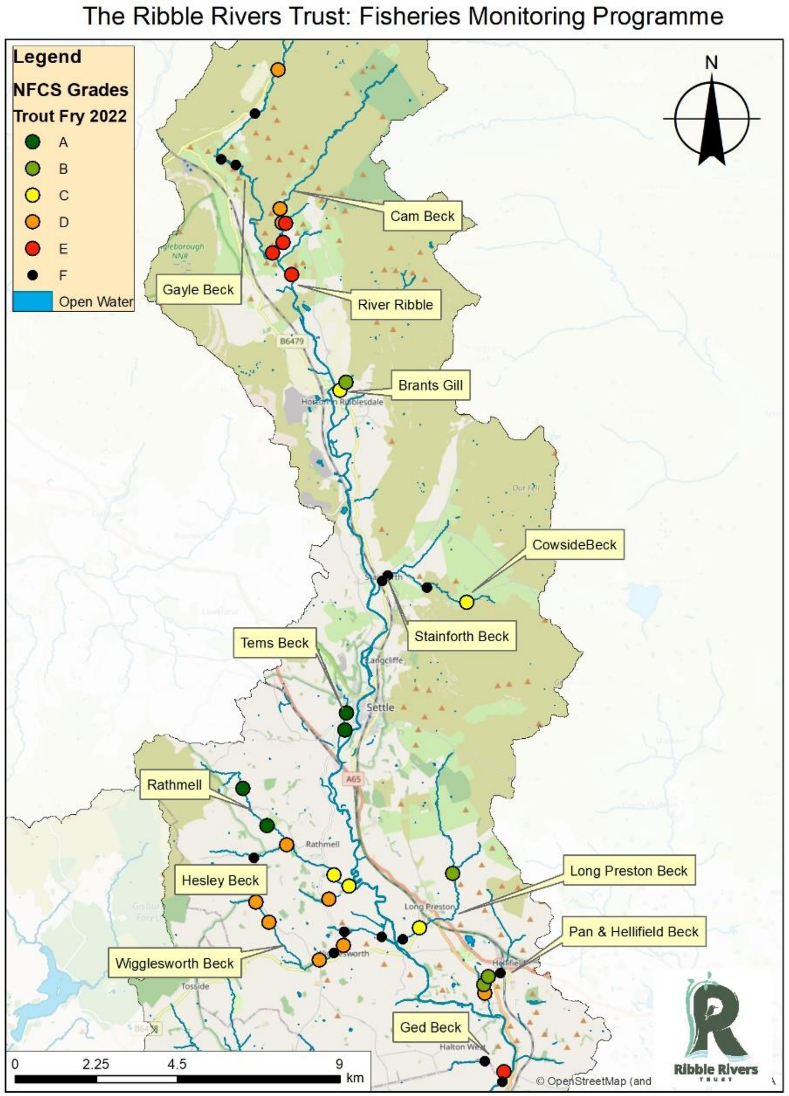


Figure 3.1.17: Brown trout fry NFCS grades from Upper Ribble catchment surveys undertaken by the Trust in 2022.

3.2 Atlantic Salmon (*Salmo salar*)

During the 2022 survey season a total of 561 Atlantic salmon fry and parr were captured over 294 electric fishing sites. The recruitment of Atlantic salmon fry on all catchments has seen pocketed improvements but overall densities have reduced (Figure 3.2.1). Salmon have only been recorded in 18.7% of sites surveyed with only 17.3% of sites holding young-of-year. The density of fry estimations were 0.67-110.2 fry/100m², a reduction on 2021's results where sites had a greater range of 1.5-271 fry/100m².

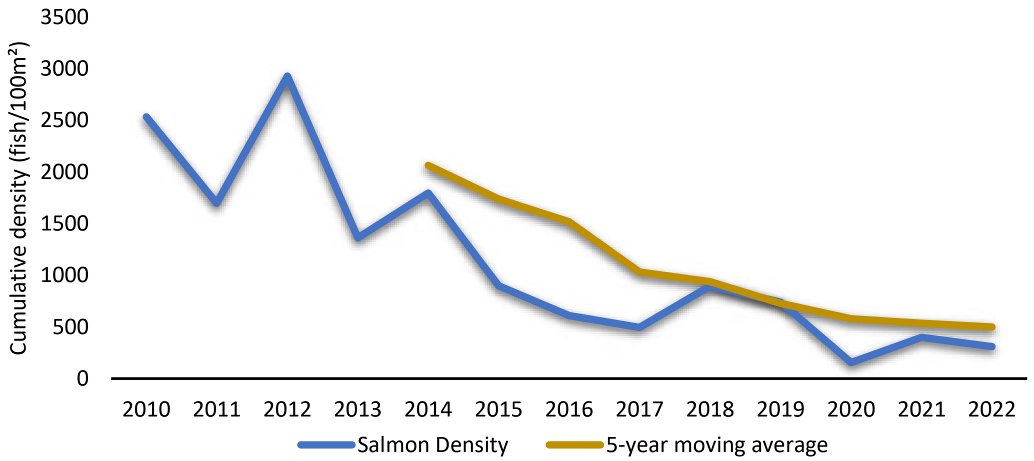


Figure 3.2.1: Cumulative Atlantic salmon fry densities for the 135 sites fish 2010-2022 including five year moving average.

With 2022's results showing little improvement in salmon recruitment (Figure 3.2.2), numbers continue to be of concern. Winter river levels were more favorable for spawning, although high winter temperatures potentially affecting early development. Results show limited areas in the catchment where Atlantic salmon are spawning (Figure 3.2.3). Many sites are in the lower NFCS grade boundaries and only five sites have been classified as 'Good' or 'Excellent'.

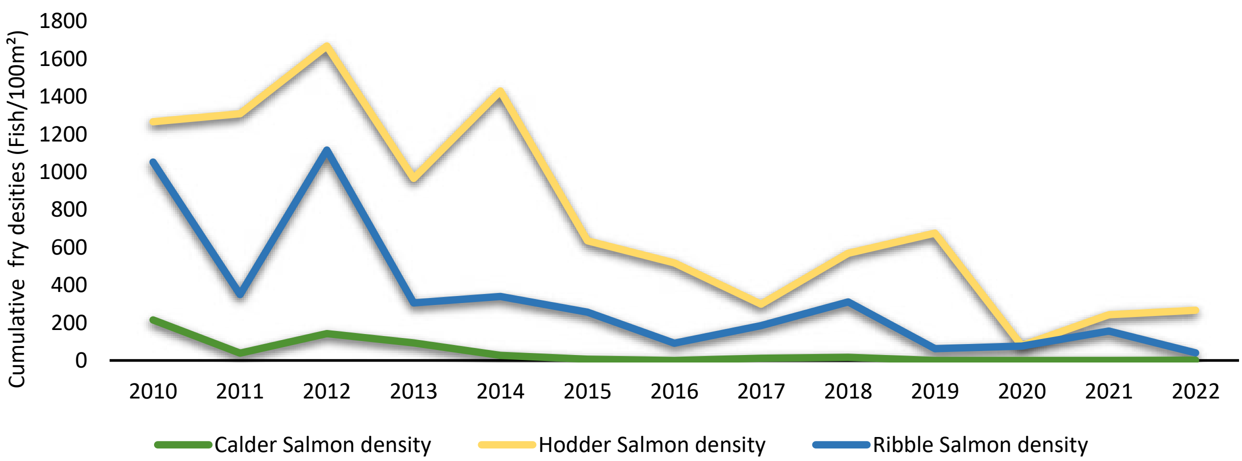


Figure 3.2.2: Cumulative Atlantic salmon fry densities for the 135 sites fish on the Calder, Hodder and Ribble catchments 2010-2022.

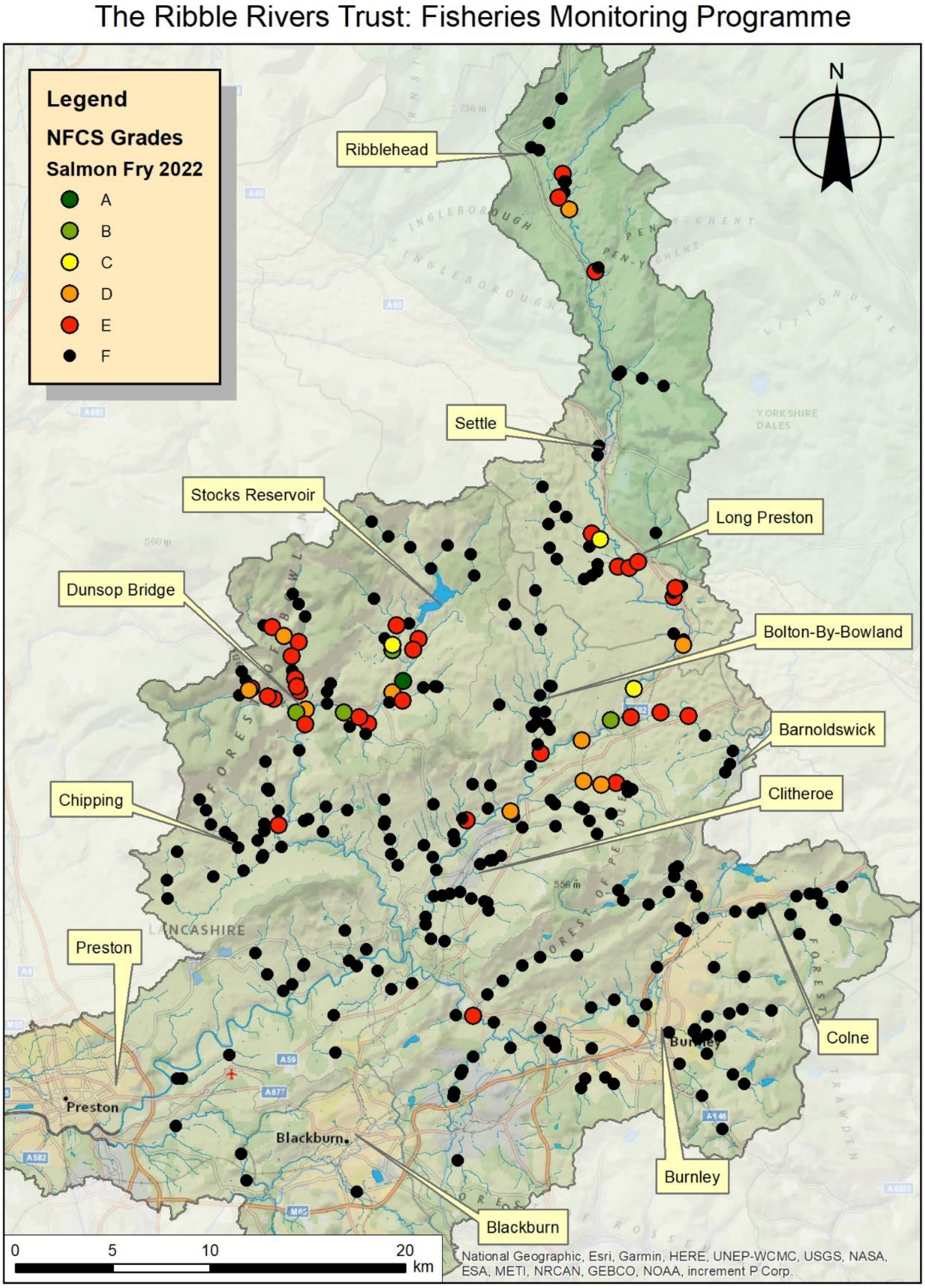


Figure 3.2.3: Catchment map showing Atlantic salmon fry NFCS grades from 294 surveys undertaken by the Trust in 2022. Green to red points indicate higher to low grades; black indicates an absence of trout fry.

3.2.1 Calder Atlantic Salmon

The Calder catchment has recorded a single salmon fry in 2022. This is a very small positive as the young-of-year have not been present in survey sites for the last three years. As a struggling catchment for Atlantic salmon numbers, it is more worrying that no salmon parr have been recorded in the Calder electric fishing programme since 2020. With mortality rates in the first twelve months of development being around 90% the lack of parr in any location shows that densities of fry are below that of a viable cohort, especially when brown trout fry densities indicate good habitat and water quality. It is looking likely that the Calder population of Atlantic salmon could be classed as unsustainable, where initial results after Padiham weir removal and subsequent fish passage projects by the Trust and EA saw what appeared to be a dispersal in the population. In 2015 there was an increase in the number of sites producing salmon fry, most of which were in areas that hadn't been accessible since before the industrial revolution. Salmon fry were recorded on the River Brun above Townley Park and at Carry Bridge on Colne Water. Thus far there have been no further records of salmon spawning in those areas. The Trust has a wide coverage of survey sites on the Calder catchment, however, potentially not all spawning sites are picked up due to the low abundance of returning salmon.

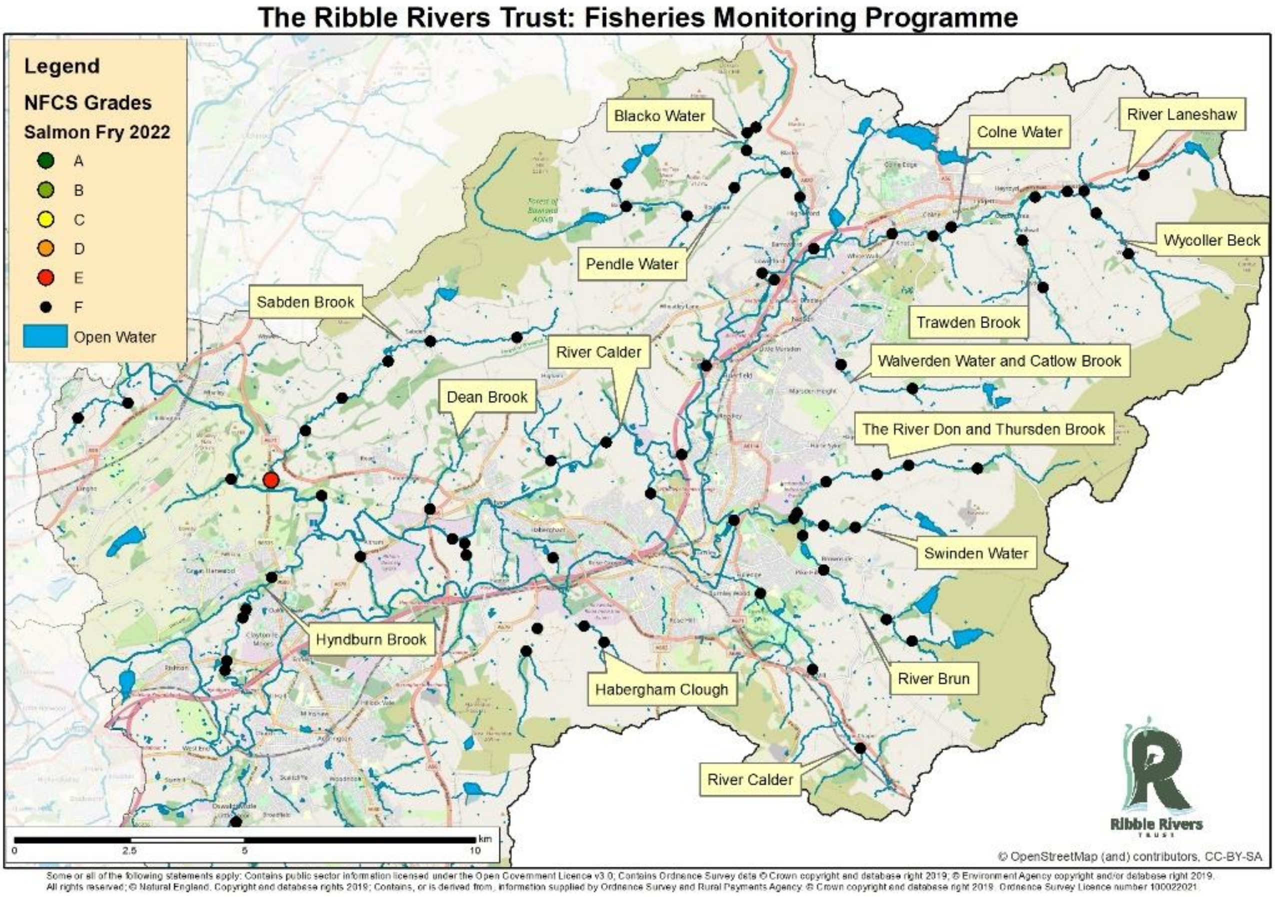


Figure 3.2.4: Atlantic salmon fry NFCS grades from Calder catchment surveys undertaken by the Trust in 2022.

3.2.2 Hodder Atlantic Salmon

From the sites which hold thirteen years of consecutive data there has been some variation across sites but with little change in the cumulative densities for 2022 (Figure 3.2.6). Density estimations were 0.67-110.2 fry/100m² for sites that hold the young-of-year and are mostly limited to areas above the confluence of Langden Brook and the main stem Hodder. On the Hodder catchment 32.5% of sites recorded salmon fry with most sites returning 'Poor' to 'Very Poor' NFCS grades.

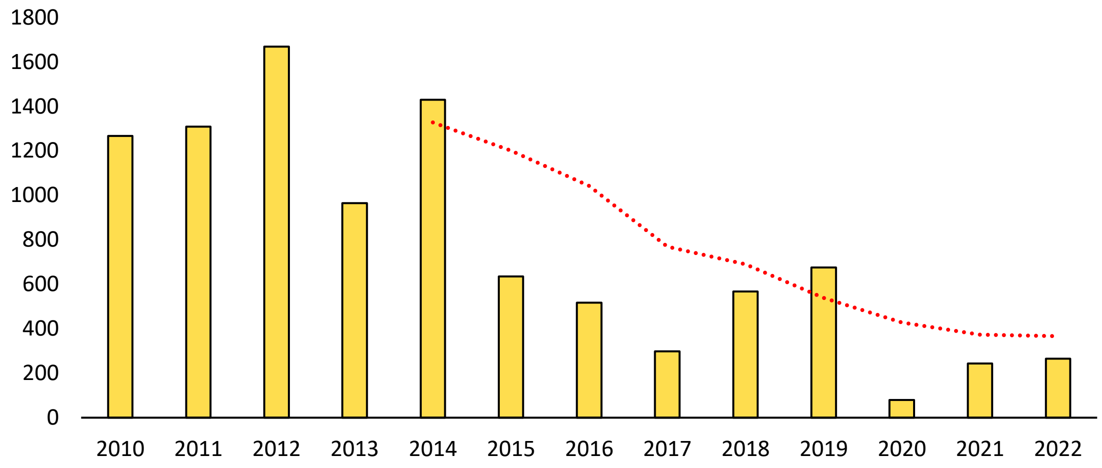


Figure 3.2.5: Cumulative Atlantic salmon fry densities on the Hodder catchment for 44 sites fish 2010 – 2022 including 5 year moving average.

A positive for 2022 is that salmon fry were recorded on Langden Brook after an absence in 2021. Sites on the main stem Hodder below Slaidburn and on the lower reaches of Croasdale Beck regularly see the highest densities of the year. The spawning of salmon on Easington Brook has been less consistent in the past six years in comparison to the period 2008-2016. The abundance of trout fry across all sites surveyed on the Easington waterbody, on average, also remains low.

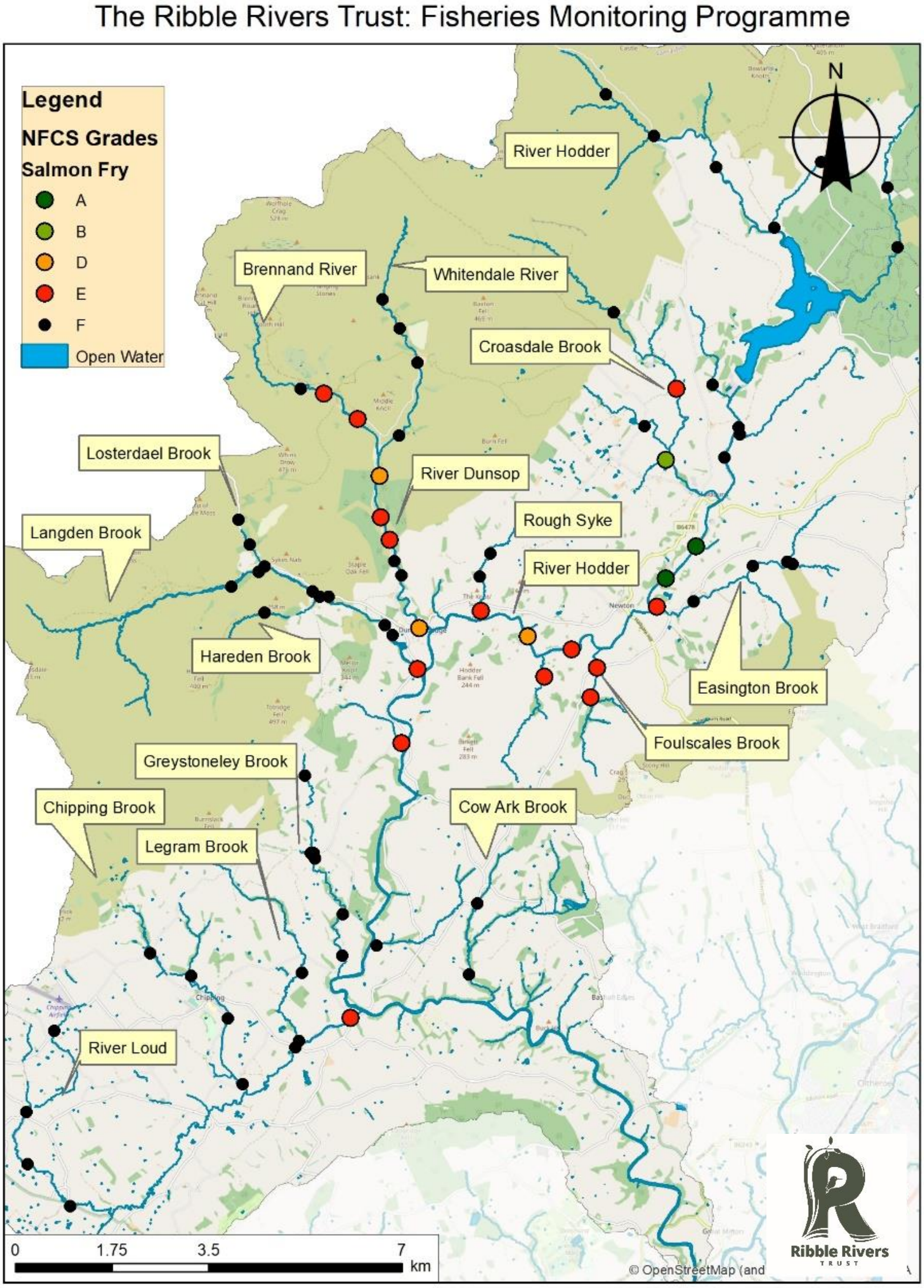


Figure 3.2.6: Atlantic salmon fry NFCS grades from Hodder catchment surveys undertaken by RRT in 2022.

3.2.3 Ribble Atlantic Salmon

Densities of salmon fry have reduced significantly on the mid- to upper-Ribble catchment in 2022, with sites only holding 0.67-51 fry/100m² in comparison to 2021 where the density estimations were 1.5-171 fry/100m².

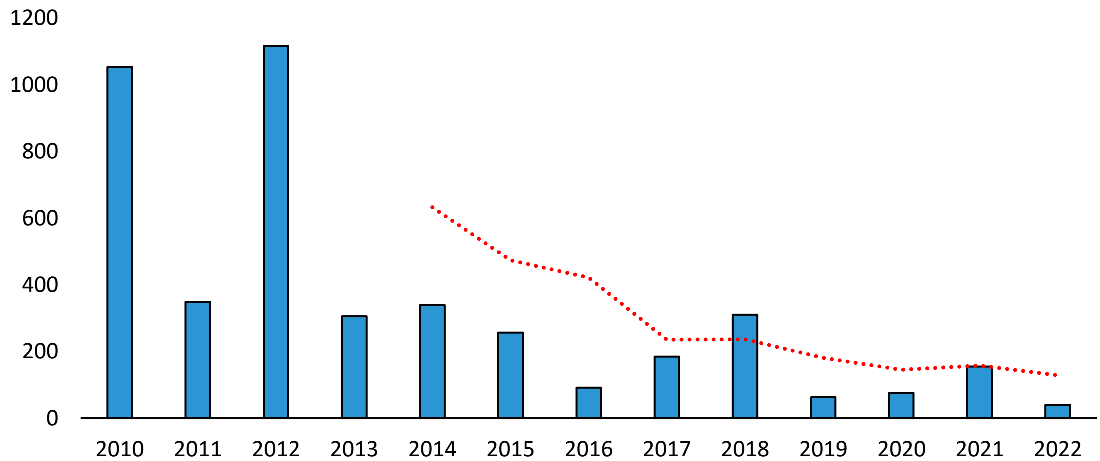


Figure 3.2.7: Cumulative Atlantic salmon fry densities on the Ribble catchment for 44 sites fish 2010-2022 including five year moving average.

The highest densities of salmon fry were recorded on the main stem Ribble below Gisburn (51 fry/100m²), which is less than half of that recorded on the Hodder catchment. Like previous years, Rathmell Beck has produced the highest densities on the upper catchment, but only above its confluence to the main Ribble. Most other sites returned 'Poor' to 'Very Poor' NFCS grades despite many areas holding excellent trout fry grades, indicating good habitat and water quality.

Areas of concern are on Swanside Beck waterbody, where the salmon population has dropped since 2015 and many sites are failing to provide consistently 'Good' NFCS grade salmon fry results. Skirden Beck waterbody is also an area of concern for both salmon and trout. This waterbody currently holds 'Bad' ecological status despite 'High' and 'Good' physico-chemical quality element in the latest (2019) cycle of Water Framework Directive surveys.

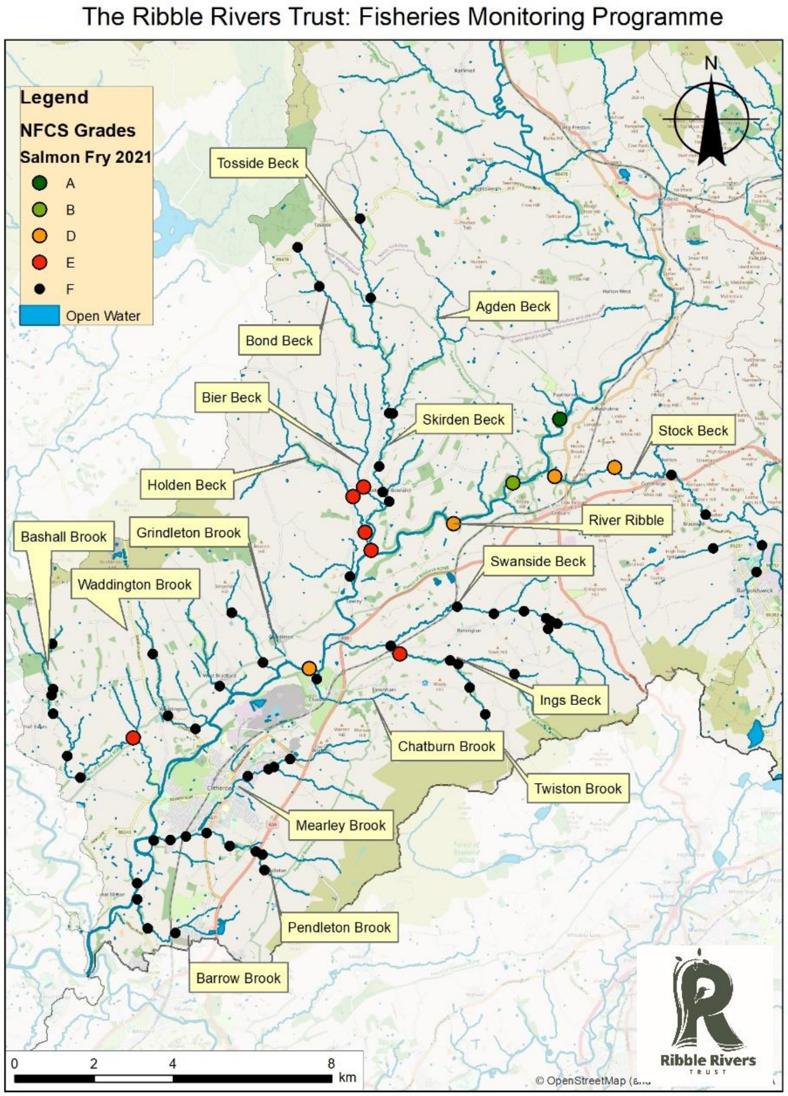


Figure 3.2.8: Atlantic salmon fry NFCS grades from Mid-Ribble catchment surveys undertaken by the Trust in 2021.

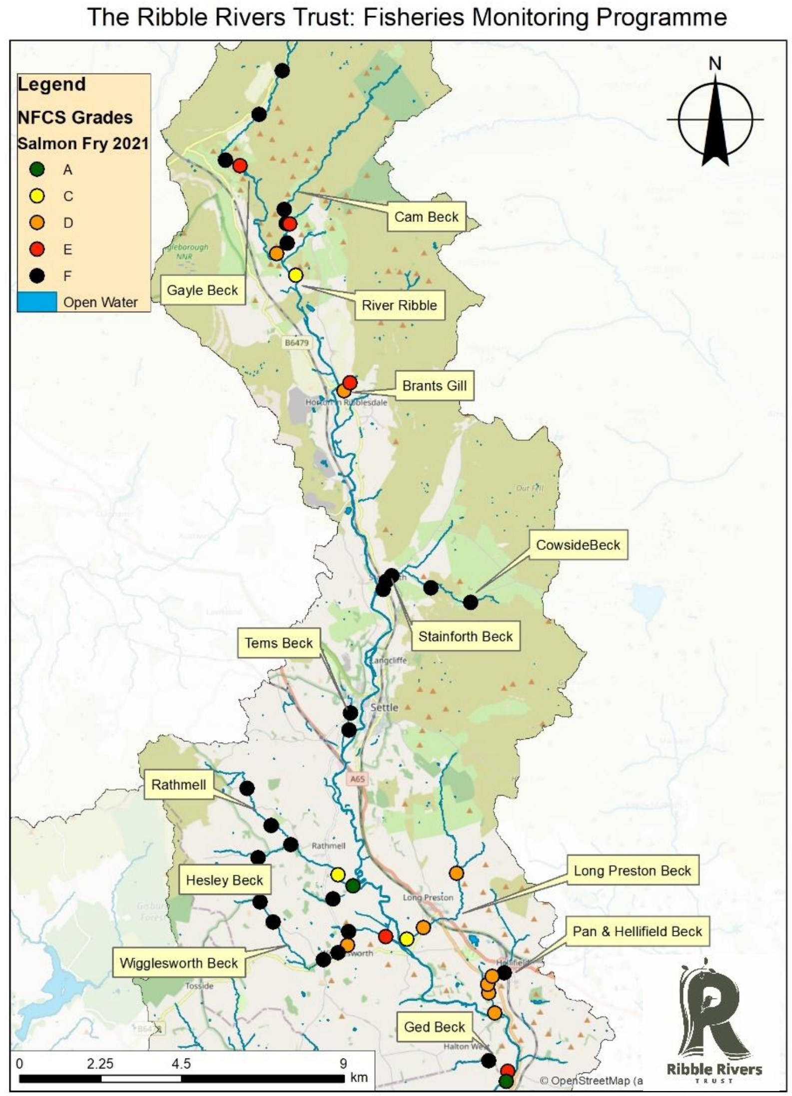


Figure 3.2.9: Atlantic salmon fry NFCS grades from Upper Ribble catchment surveys undertaken by the Trust in 2021.

3.3 Other Species

Bullhead (*Cottus gobio*) remain the dominant non-targeted species on the catchment found at 78.7% of sites with a mean site catch of 12.5 individuals (Figure 3.3.1 and 3.3.2). Stone loach (*Barbatula barbatula*) have been recorded at 51.9% of sites with an average of 11.3 individuals, and common minnow (*Phoxinus phoxinus*) at 37.2% of sites with a mean site catch of 12.3 individuals. A total of eleven non-salmonid fish species have been caught at survey sites in 2022 (Figure 3.3.1 and 3.3.2).

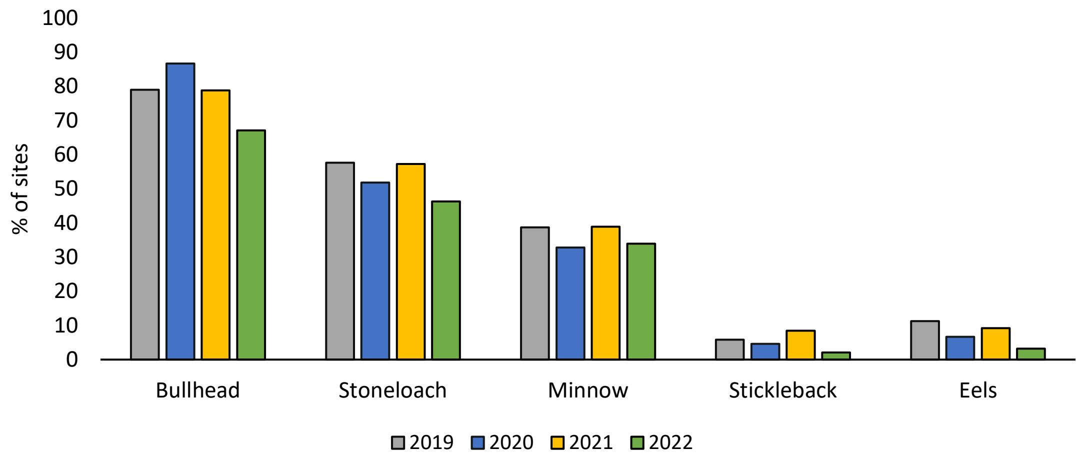


Figure 3.3.1: Dominant by-catch by species - % of sites fished 2018 to 2022.

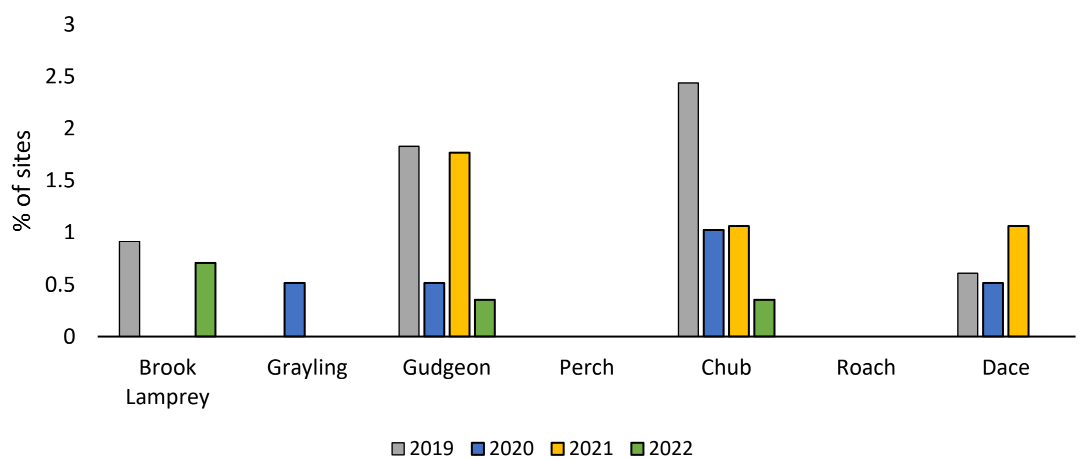


Figure 3.3.2: Accompanying by-catch by species - mean catch per site 2018 to 2022.

4.0 Discussion

With reports from the Met Office showing a milder than average winter, a warmer than average spring and the warmest summer on record (MetOffice,2022a,b&c), the Ribble catchment's 2022 brown trout and Atlantic salmon cohorts have had to endure a difficult start to life. This has been compounded by the driest year since 1976 (MetOffice,2022d) where the winter, spring and summer months have seen 93%, 76% and 62% of the 1991-2020 average UK rainfall respectively.

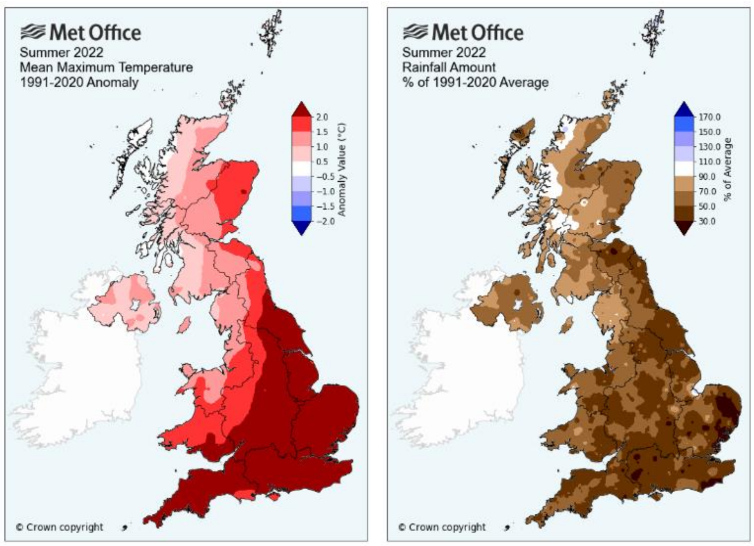


Figure 4.0.1: Met Office summer 2022 mean maximum temperature and rainfall amount.

With winter river levels of 2021/22 being more favourable for salmonid spawning, there has been a reduced potential for redd washout and less impactful flows during alevin emergence, than in years with comparative densities. (Figure 4.0.2).

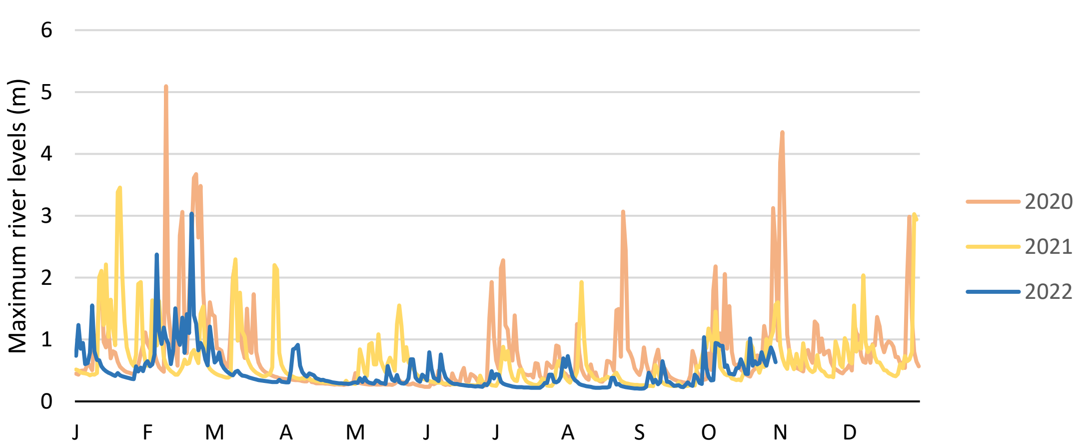


Figure 4.0.2: River Ribble max. level at New Jumbles Rock, downstream of Calder and Hodder confluence 2020-2022

Along with natural variation between years, a reduction in egg to fry survival for 2022 may point towards in-river temperatures being above that of optimal survival during incubation and early life-cycle stages. From fertilisation to hatching, the thermal range at which salmonid eggs survive in water is around 0-13°C for brown trout and 0-16°C for Atlantic salmon. When temperatures rise above 10°C, egg mortality and deformity rates markedly increase, and mortality rates hit 100% when temperatures are sustained above 14°C (Solomon & Lightfoot, 2008). The optimal survival during incubation to well-formed fry at first food intake is around 6-8°C. Salmon and trout alvine, whose embryos have been incubated towards their thermal limit, can additionally have lower body weight at hatching and depleted yolk reserves. With higher temperatures, metabolic demand and yolk depletion rates increase, this can affect later species traits and life-history events, such as growth rates, the ability to establish feeding territory, dispersal and smolt size (Jonsson & Jonsson, 2009, Arevalo *et al*, 2018).

Over the summer months the survey team worked through the warmest summer on record, with catchment air temperatures reaching +36°C with a UK recorded high of 40.2°C at Heathrow. When out surveying, the highest in-river temperature recorded by the team was 24.2°C on the main stem Ribble at 11am on 18th July. When working in these conditions, fish and staff welfare is paramount. No surveys were carried out when river temperatures reached 18°C and survey days were kept to the cooler hours. Water temperatures sustained above 18°C severely reduce the oxygen saturation by 2% per 1°C rise. With slow acclimatisation to warm water, the 1000-minute lethal temperature for salmonids is 26.7°C, and a seven-day value of 24.7°C (Solomon & Lightfoot, 2008). A quick change in water temperature of 5°C can also lead to serious mortalities. Additionally, sites that were impacted by heavy algal blooms or extreme low flows were surveyed at a later date when river and air temperature conditions improved.

Due to a warming climate, the river environment is becoming less thermally stable. With more stress due to increased temperatures and lower oxygen availability, salmonid populations would see higher mortalities during life-cycle stages. In response to elevated water temperatures, salmon and trout regulate their temperature by seeking out discreet areas of cooler water. Inflows from springs, confluence plumes from cooler tributaries, upwellings from the stream bed and riparian shading provide important refuge (Dugdale *et al*, 2013; Caissie, 2006). The Trust's tree planting programmes are helping to address in-river temperatures, with strategic planting along tributaries providing shade and shelter which ensures that refuge from higher temperatures is being created. Varied, dynamic river systems should have live trees along the banks and fallen and dead trees in the water. Without them, rivers become ecologically-simplified with a decrease in resources and increased competition, resulting in the loss of niche species and biodiversity.

The decline of Atlantic salmon has been geographically widespread and is well documented in academic papers. The major determining factor of Atlantic salmon fry numbers is driven by the number and size of returning adults. Spending more time at sea, allows for a greater size and higher fecundity but this runs a larger risk of mortality prior to reproduction. Over time the proportion of one-sea-winter to multi-sea-winter adult Atlantic salmon has seen variation. Since the 2000s, there has been a shift in the North East Atlantic population towards an increased proportion of later maturing individuals. Adult salmon are now tending to return to rivers at older ages and in poorer condition due to reductions in marine feeding opportunities limiting the growth and maturation potential of the fish (Gillson *et al*, 2022).

Egg deposition rates for the Ribble catchment are calculated by the EA through the modelling of rod catch data. This data takes into account the exploitation of adult salmon, the survival rates after catch and release and the weight and length data of captured salmon. With offsetting this data against Ribble Rivers Trust's own fisheries data, we can see that egg deposition trends follow that of fry densities in the catchment. Where egg deposition and fry densities differ (*e.g.* 2015 and 2020), there are other factors impacting egg to fry survival.

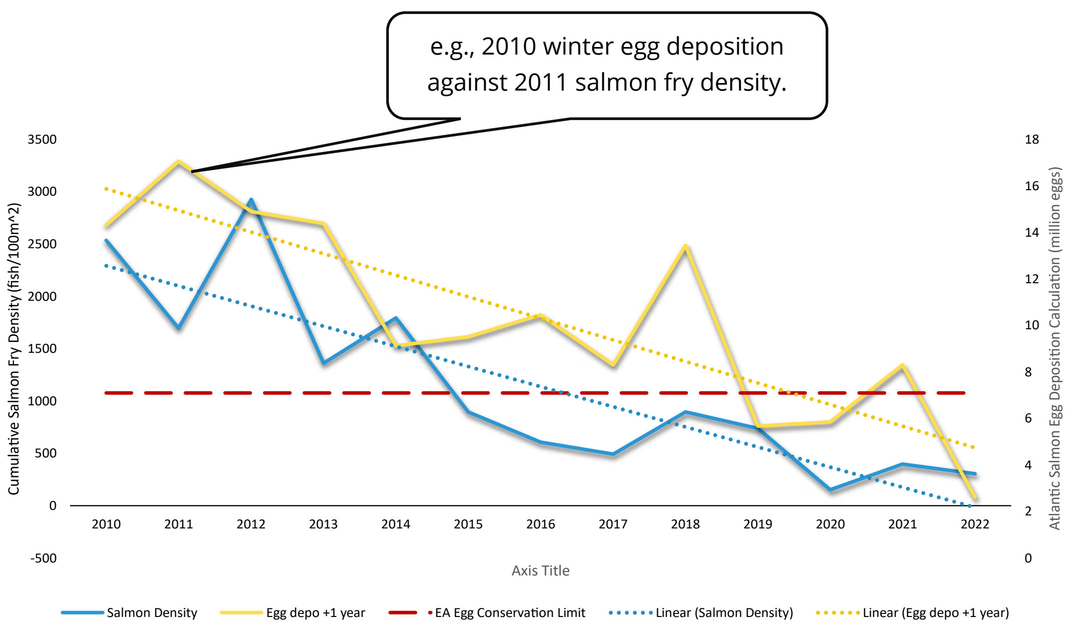


Figure 4.0.3: EA Atlantic salmon egg deposition (offset to match that year's fry population) and cumulative Atlantic salmon fry densities for sites holding sequential years data between 2010-2022 on the Calder, Hodder and Ribble catchments.

Extremes, particularly high flow events between spawning and fry emergence, are thought to be one of the main impacting factors of egg to fry survival. Where river levels exceeded previous records, heavy sediment movement will have washed out redds giving rise to high mortalities of undeveloped young that have poor swimming ability.

To ensure the future of Atlantic salmon within the Ribble catchment, freshwater management and habitat restoration is paramount. The Trust's contribution towards salmon populations is within the freshwater, early life-cycle stages. This is to ensure that the number of fish that survive to smolt in good condition are sufficient to provide a strong returning spawning population.

4.1 Salmon populations on the Hodder

When reviewing the longer-term data series, sites on Whitendale, Brennand and Dunsop waterbodies are not included in the metric as they do not hold successive results for salmon. Data is also limited for Chipping and Langden Brook where all sites have not been surveyed in all years. Comparison of mean density estimations of salmon fry on Whitendale, Brennand and Dunsop waterbodies shows that the wider catchment trends of salmon populations reflect that of sites not included within the continuous thirteen-year dataset (Figure 4.0.4).

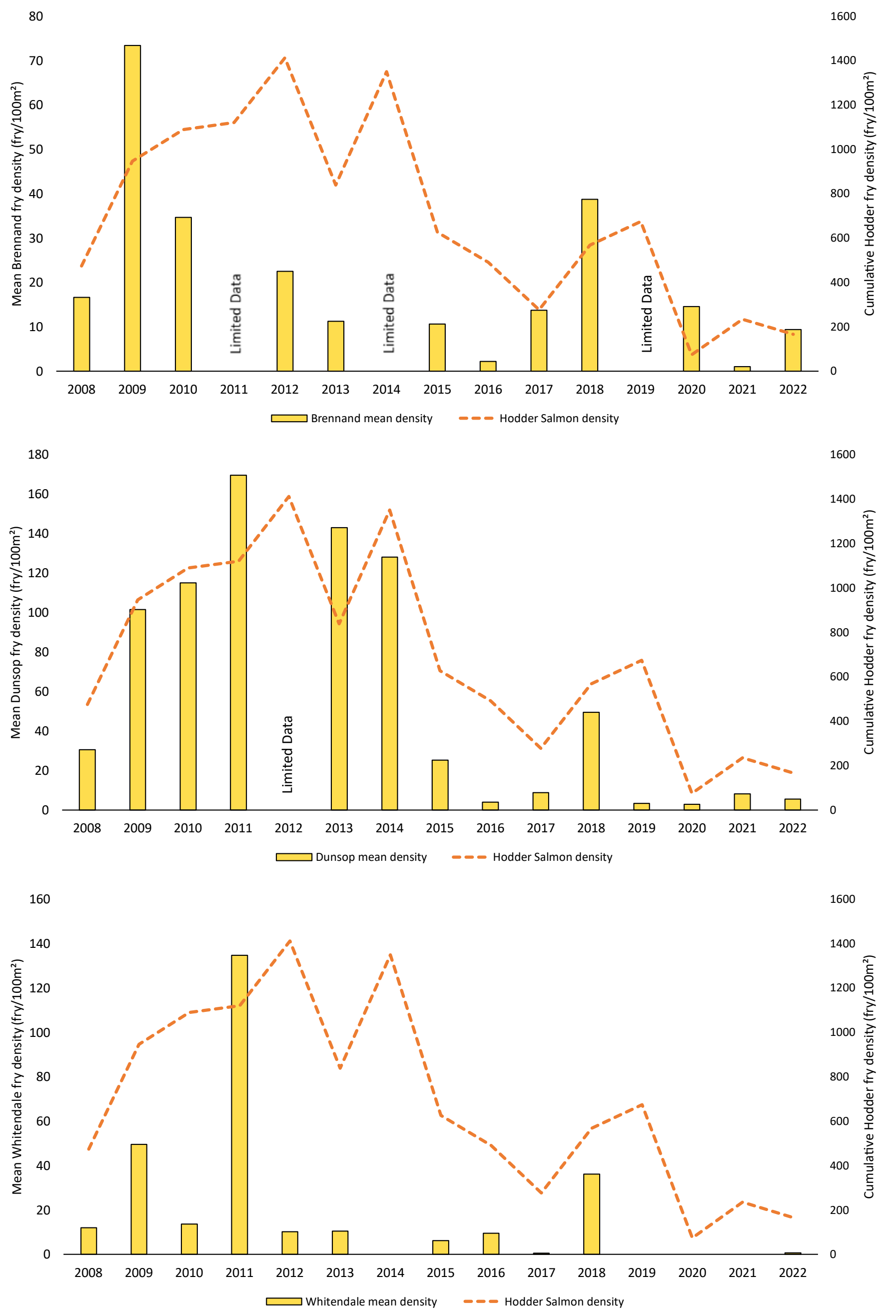


Figure 4.1.1: Mean density estimations of Atlantic salmon on the Rivers Brennand, Dunsop and Whitendale.

4.2 Gravel Movement

The Hodder catchment is an important source of water abstraction that allows United Utilities to provide water for many households. One of the environmental costs of abstraction is from the impounding structures, which limit the availability and transport of gravels within the system. The loss of gravel changes the hydrological regime of a river and has the potential of reducing salmonid productivity by limiting the spawning and nursery habitat. As part of the network of abstraction points, Langden Brook features a gravel trap which is part of United Utilities infrastructure. In the summer of 2022, the Trust worked with the Hodder Consultative, United Utilities and the EA to transport trapped gravels and re-seed the river downstream of the intake at Langden. With over 1,000 fish rescued and relocated away from the works, the Trust's contractors, Wade Group, extracted and moved 1,500 tonnes of gravel which would then be redistributed in-river by high waters ready for spawning time (Figure 4.0.5). In the future, the Trust hopes to carry this work out more frequently, as well as at other key locations within the catchment to mitigate against disrupted river processes and provide good spawning habitat for salmon and trout.

Figure 4.2.1: Ribble Trust and EA electric fishing teams catching and relocating fish on Langden Brook before gravel introduction (top left); gravels introduced along bank for redistribution in high flow events (bottom left); remaining gravels after first October high flow event (right).

4.3 Works on the upper-Ribble

Ged Beck has been historically straightened along the southern edge of the Black Plantation, near Halton West, North Yorkshire. With the clear-felling of the Black Plantation and the creation of a new native riparian woodland corridor, it is proposed to re-meander the straightened reach. The re-meandering will mostly follow the original course of the beck, the abandoned channel of which is still present within the plantation. Re-meandering will improve the geomorphology of the Beck, promoting pool-riffle sequences which are largely absent in the straightened section. This, in combination with the addition of large woody debris, will increase habitat availability for invertebrates and fish. The longer flow path will increase conveyance time and channel storage, contributing to reduced flood risk downstream. Together with the felling of commercial conifers, the planting of new woodland and the exclusion of livestock, this scheme will have multiple environmental and societal benefits.

Figure 4.3.1: Ged Beck habitat improvement design plan

4.4 Wigglesworth Beck: Aqueduct Repairs

Wigglesworth Beck has a historic aqueduct which conveys its waters over the drainage system that forms the Long Preston Deeps floodplain. Over the last five years, the aqueduct has been leaking water through its base into the drainage ditch below. This leak has caused a section of Wigglesworth Beck to completely dry up during low flows, impacting its ecology. Over the summer of 2022 the Trust repaired the aqueduct to prevent further deterioration of the structure, ensuring that water remains in the Beck, providing resilience to its aquatic communities especially during low flow events.

Figure 4.4.1: Wigglesworth Beck aqueduct repairs summer 2022.

4.5 Education and Engagement

Through the 'Trout in the Classroom' project, pupils (and teachers) can truly experience the magical world of brown trout during their Spring Term (January-March). Trust staff visit each school taking part to set up all the equipment they need before delivering 100 brown trout (triploid) eggs for the pupils to care for. By raising the trout from eggs and watching them develop and grow before releasing the fry into their local river, young people learn about the importance of caring for our rivers for all the wildlife that they support. All our school sessions are carefully planned to involve multiple aspects of the curriculum, such as Science, English, Geography and Art, and 'Trout in the Classroom' is no exception. We have seen some wonderful and creative ways in which schools are able to use the project to link into every aspect of their teaching. During 'Trout in the Classroom' 2022, we worked with twelve schools from Clitheroe, Bolton, Oswaldtwistle, Burnley, Chorley, Blackburn and Dunsop Bridge, engaging around 390 pupils. Most schools pay for the project themselves, but some were lucky enough to receive funding from the Church and Oswaldtwistle Rotary Club, Friends of Towneley Park and the Hodder Consultative.

Figure 4.5.1: Ribble Rivers Trust - 'Trout in the Classroom' 2022.

4.6 Loud Phosphate and NFM

The River Loud is located on the boundary of the Ribble and the Lune and Wyre catchments. This sub-catchment is currently classified as 'Moderate' under the Water Framework Directive classifications, with phosphate as one of the failing elements. This reason for failure falls under diffuse pollution and point source pollution from domestic properties and agriculture.

Under the previous Asset Management Plan, United Utilities carried out investigations into the Chipping Brook and the River Loud sub-catchments. This was to review the apportionment of phosphate to sources and to aid in identifying the most appropriate approach to tackling these reasons for Water Framework Directive failures.

United Utilities and the Trust have developed a concept for a catchment-wide project to address the flood risk to Chipping Sewage Treatment Works and deliver reductions in phosphate load in the catchment. The proposed project seeks to develop a catchment action plan, which is farmer owned and will deliver natural flood management (NFM), reduce diffuse pollution from agriculture and improve water quality for aquatic plants and animals (particularly phosphate).

Phosphate reduction in the Loud sub-catchment will be achieved through farm advice; free and confidential visits which focus on finding opportunities, both within yard infrastructure and green infrastructure, to reduce phosphate and increase NFM. This work will be incentivised through a 'payments by results' approach, based on good soil and nutrient management results. Monitoring for the work will provide baseline and intervention data through water quality sampling using aquatic invertebrates, water chemistry, and habitat assessments.

Figure 4.6.1 Loud catchment looking towards Fair Snape Fell and Chipping.

4.7 Areas to Focus Catchment and River Management

From observed trends across the wider catchment, the most notable drop in salmonid productivity has been since 2015. By plotting sites that have not produced a 'Fair' NFCS grade or above in the past seven years, waterbodies of concern have been highlighted.

4.7.1 Calder Catchment

Walveden Water is regularly named as a struggling tributary due to its heavily modified condition and poor water quality. It is fragmented by two reservoirs and impacted by historical industry and modern development. Short-term improvement is unlikely due to the extent of the issues. However, there are other areas that have the potential to be enhanced with the right investment and strategy. The long-term sustainability of Atlantic salmon on the Calder catchment is dependent on seeing improvements within the River Hynburn and Sabden Brook. As the only two tributaries in which salmon are repeatedly recorded, year-on-year decline for this area could see salmon become locally extinct without intervention.

4.7.2 Hodder Catchment

The Loud Catchment is an important target area for the Trust with much of its works focused on improving land management and water quality. With new partnership working with United Utilities, funding has become available to reduce phosphate loading within the catchment to improve water quality. This will be coupled with natural flood management schemes to create additional habitat. For Atlantic salmon, stronghold waterbodies should be investigated to pinpoint improvement opportunities. Brennand, Croasdale, Dunsop and Langden waterbodies are crucial for the long-term sustainability of Atlantic salmon.

4.7.3 Ribble Catchment

For investigation, Bashall Brook, Stock Beck and the Skirden waterbody (Figure 4.0.9) have been flagged for water quality issues due to industrial farming, poor nutrients management and utilities. It is suggested that additional monitoring to pinpoint root causes is carried out. This could be in the form of an invertebrate 'BioBlitz' before the Trust's Land Management Team then engaged with landowners.

In the upper reaches of the Ribble, Cam and Gayle Becks make up the headwaters. Habitat restoration works are ongoing within this area and partnership working on a sub-catchment scale is helping to bring about change.

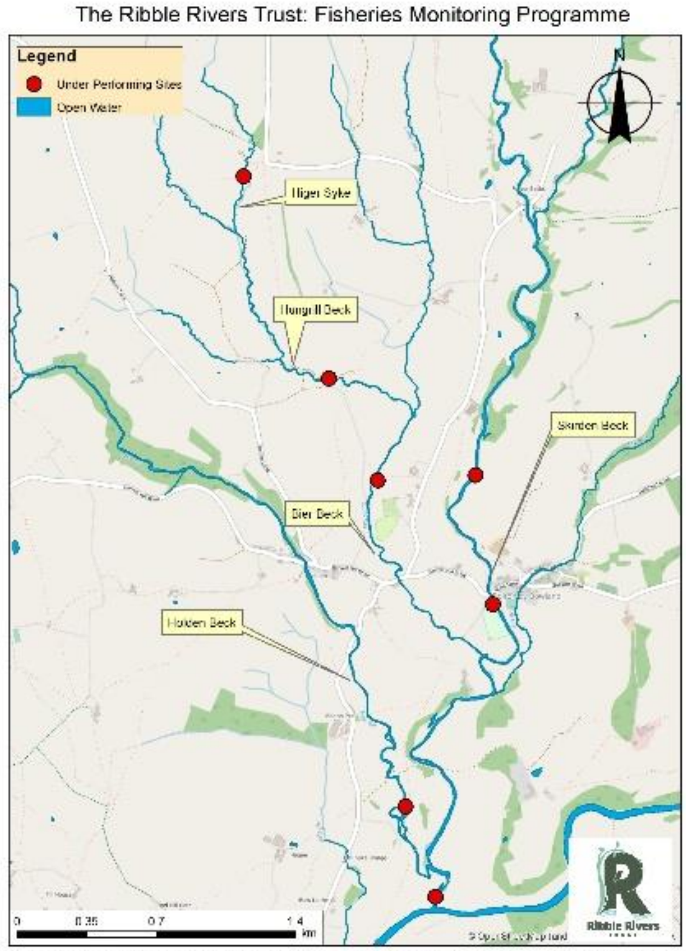


Figure 4.7.1: Skirden waterbody with sites that have not produced above a 'Poor' grade for both salmon and trout.

5.0 References

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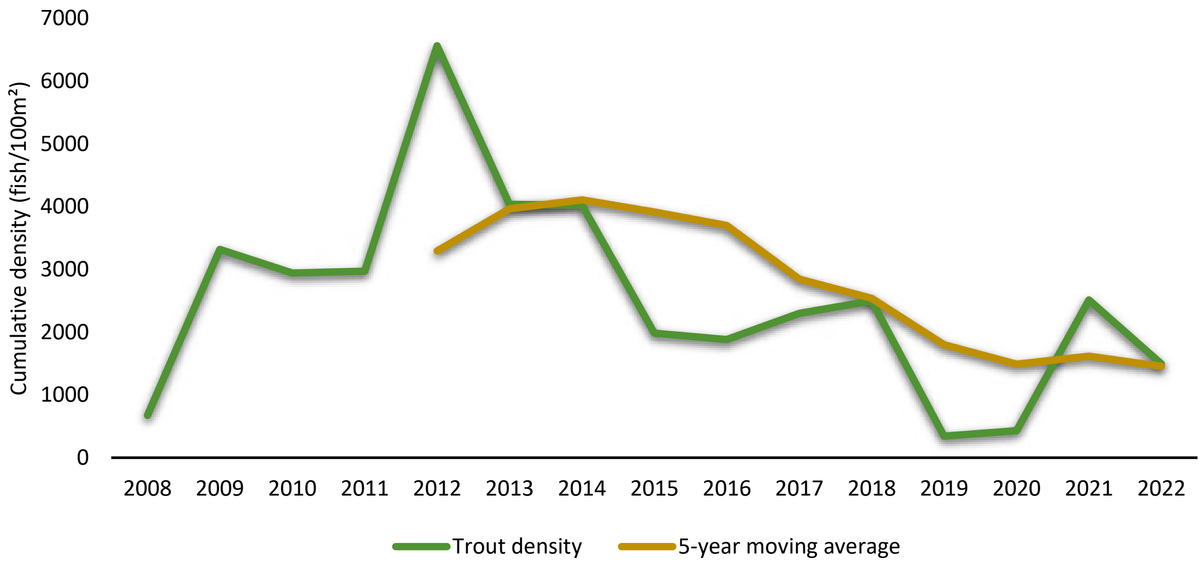
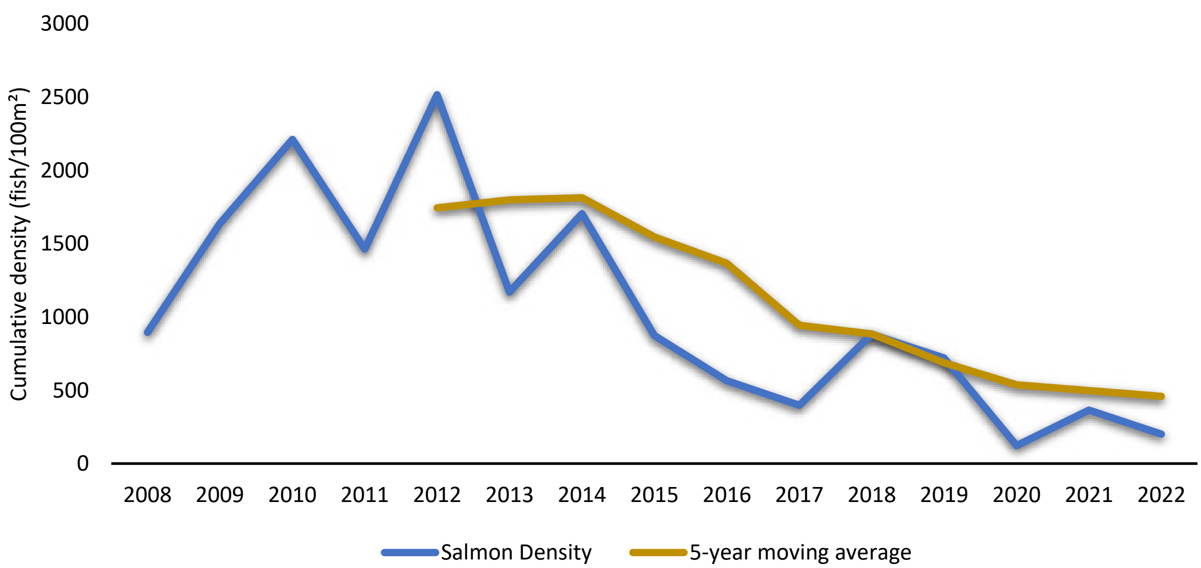
6.0 Appendices

6.1 Appendix A

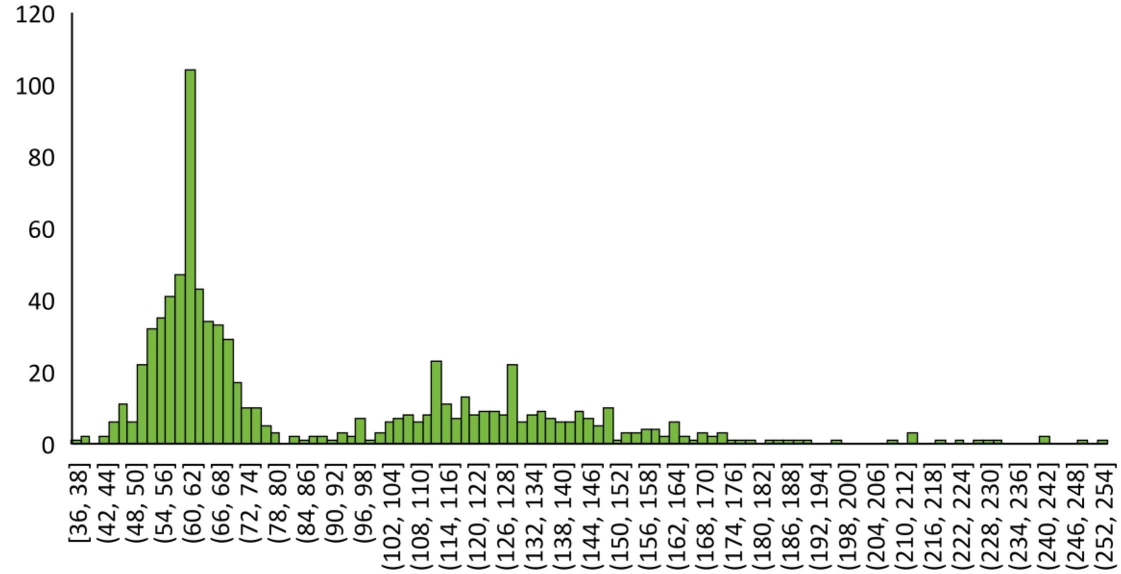


Appendix A.1: Cumulative brown trout fry densities on the Ribble catchment for 87 sites fish 2008-2022 including five year moving average.

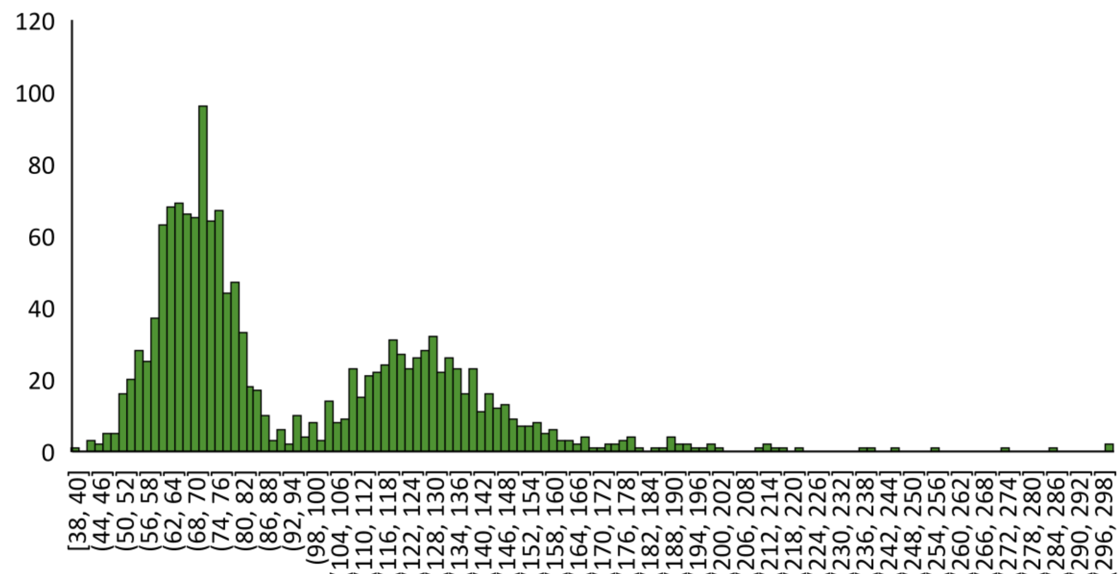


Appendix A.2: Cumulative Atlantic salmon fry densities on the Ribble catchment for 87 sites fish 2008-2022 including five year moving average.

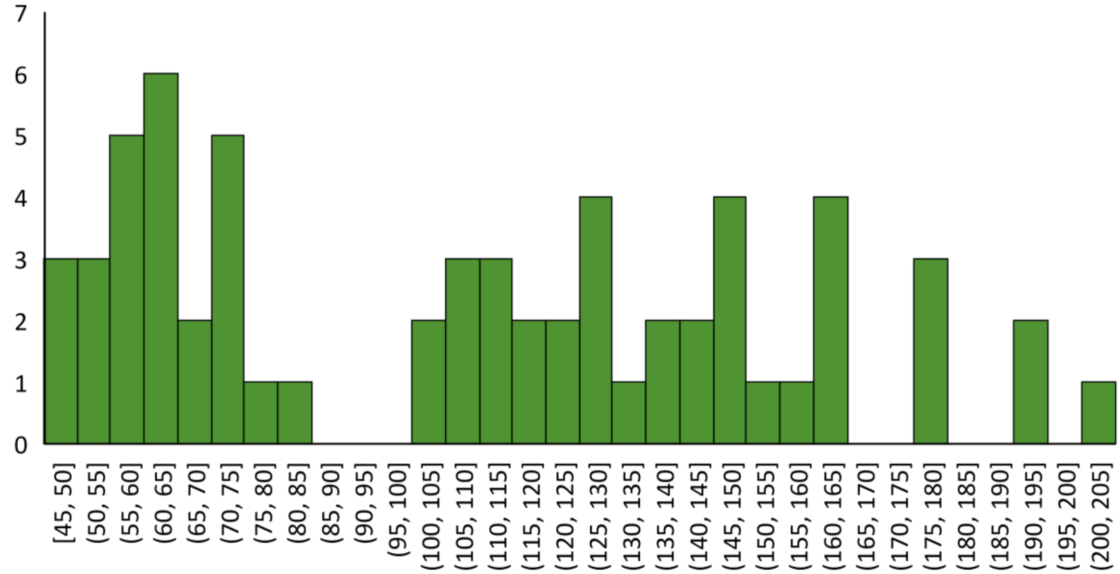
6.2 Appendix B



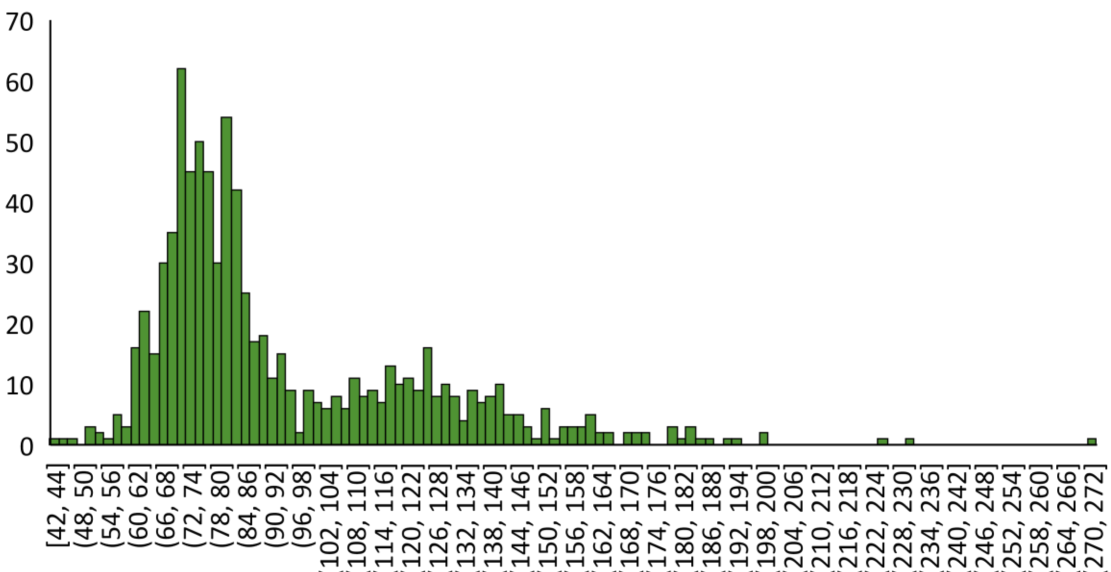
Appendix B.1: Fork length histogram of all brown trout captured on the Calder catchment 2022. Maximum fork length for 0-year trout = 90mm at time of survey.



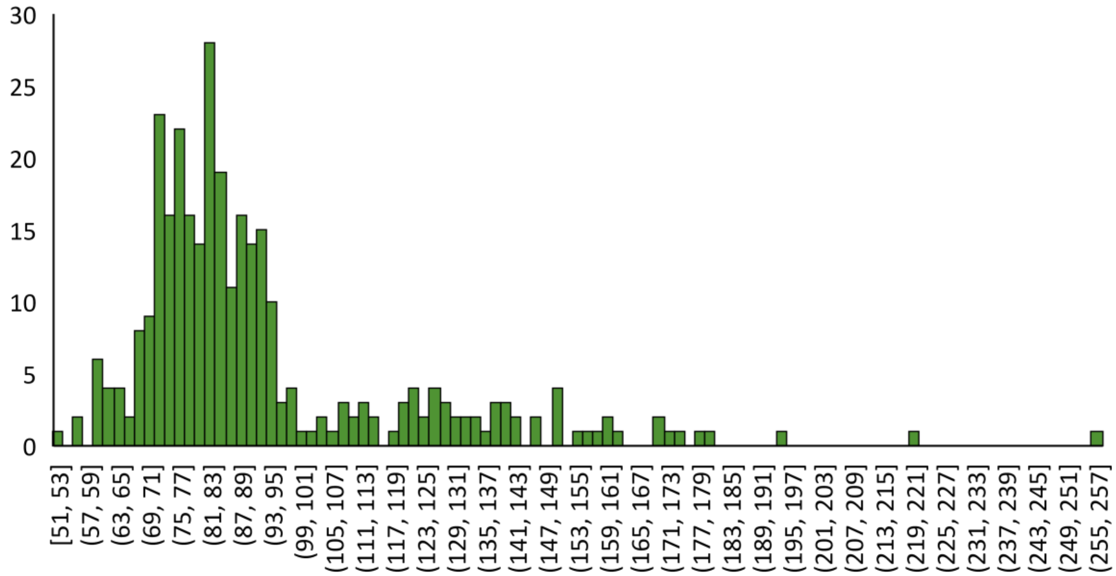
Appendix B.2: Fork length histogram of all brown trout captured on the Hodder catchment 2022. Maximum fork length for 0-year trout = 95mm at time of survey.



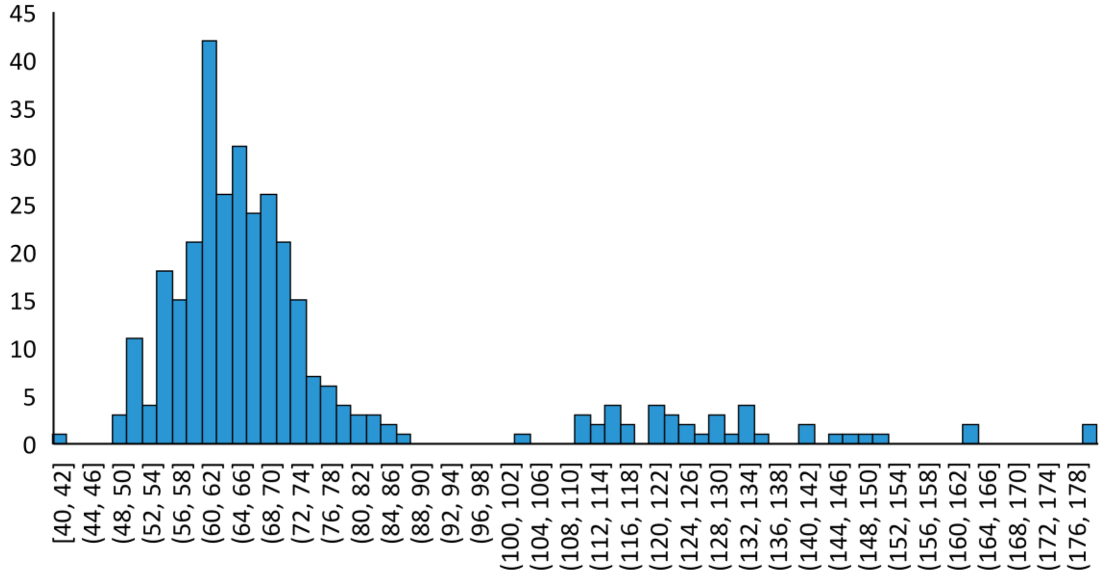
Appendix B.3: Fork length histogram of all brown trout captured on the Lower Ribble catchment 2022. Maximum fork length for 0-year trout = 85mm at time of survey.



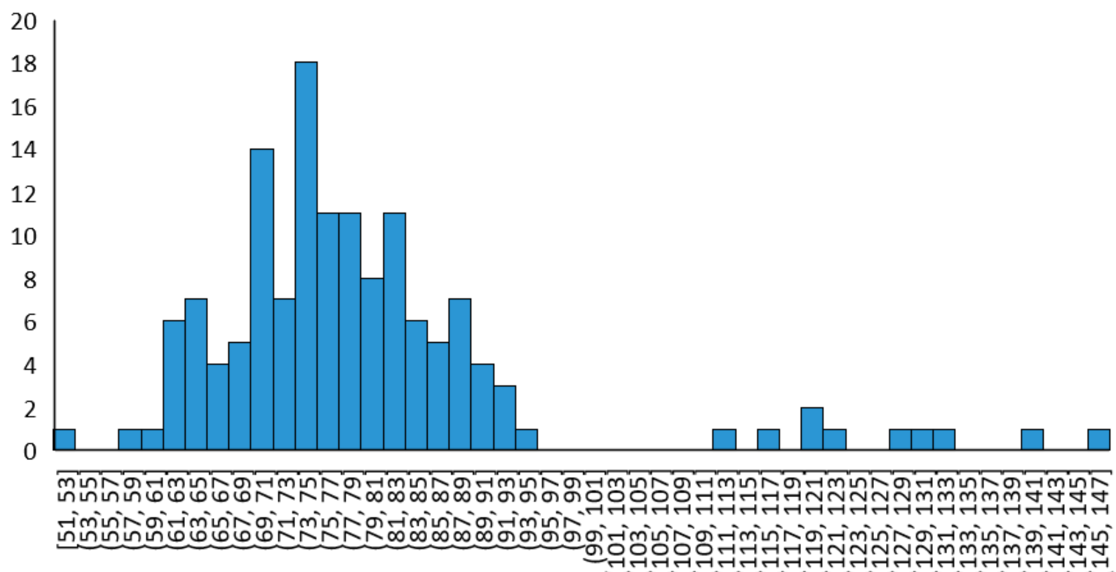
Appendix B.4: Fork length histogram of all brown trout captured on the Mid-Ribble catchment 2022. Maximum fork length for 0-year trout = 95mm at time of survey.



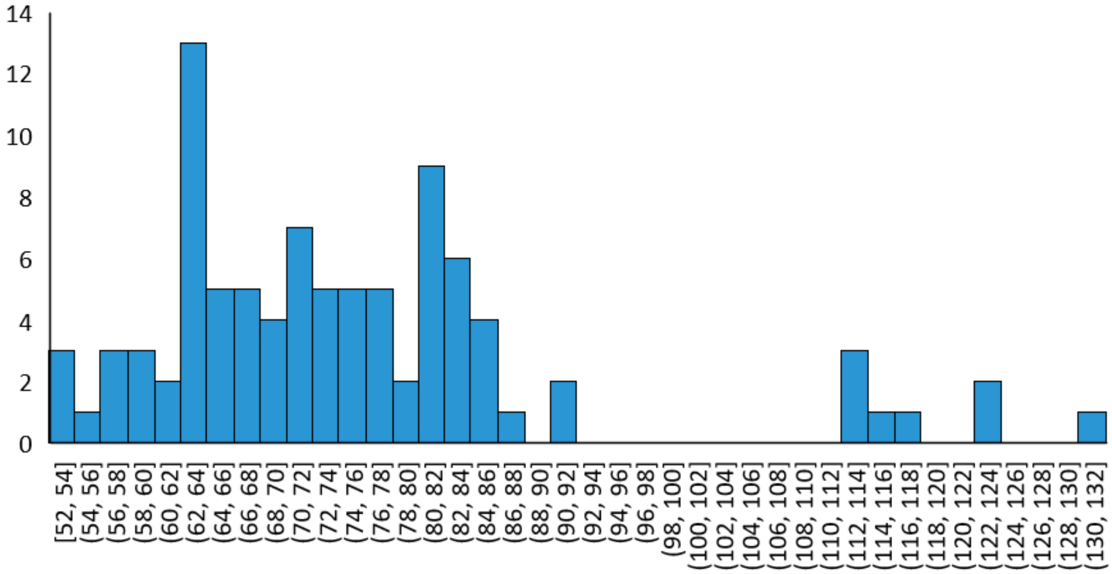
Appendix B.5: Fork length histogram of all brown trout captured on the Upper Ribble catchment 2022. Maximum fork length for 0-year trout = 98mm at time of survey.



Appendix B.6: Fork length histogram of all Atlantic salmon captured on the Hodder catchment 2022. Maximum fork length for 0-year salmon = 90mm at time of survey.

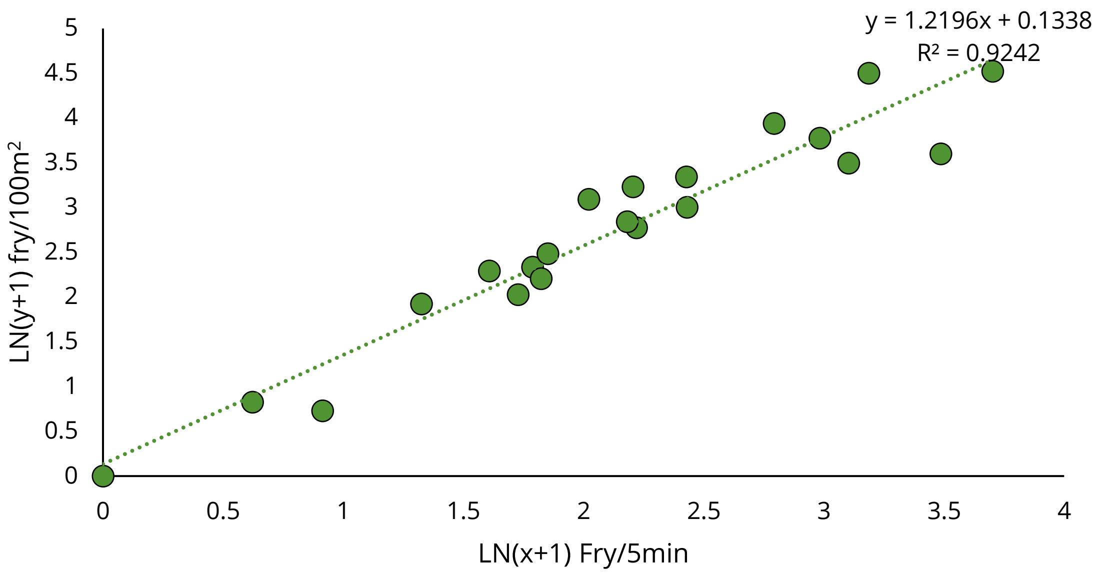


Appendix B.7: Fork length histogram of all Atlantic salmon captured on the Mid-Ribble catchment 2022. Maximum fork length for 0-year salmon = 95m at time of survey.

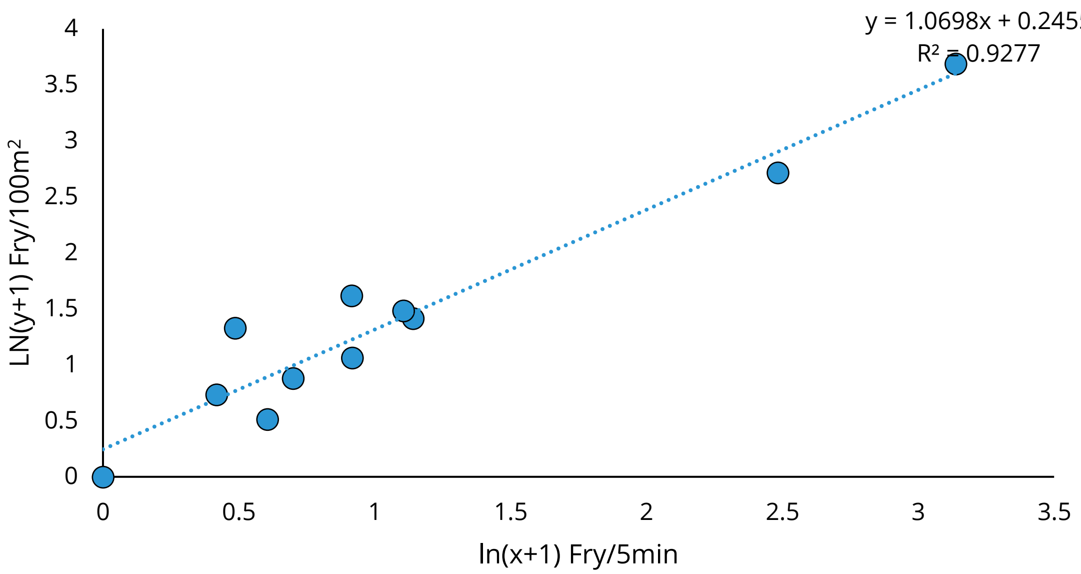


Appendix B.8: Fork length histogram of all Atlantic salmon captured on the Upper Ribble catchment 2022. Maximum fork length for 0-year salmon = 95mm at time of survey.

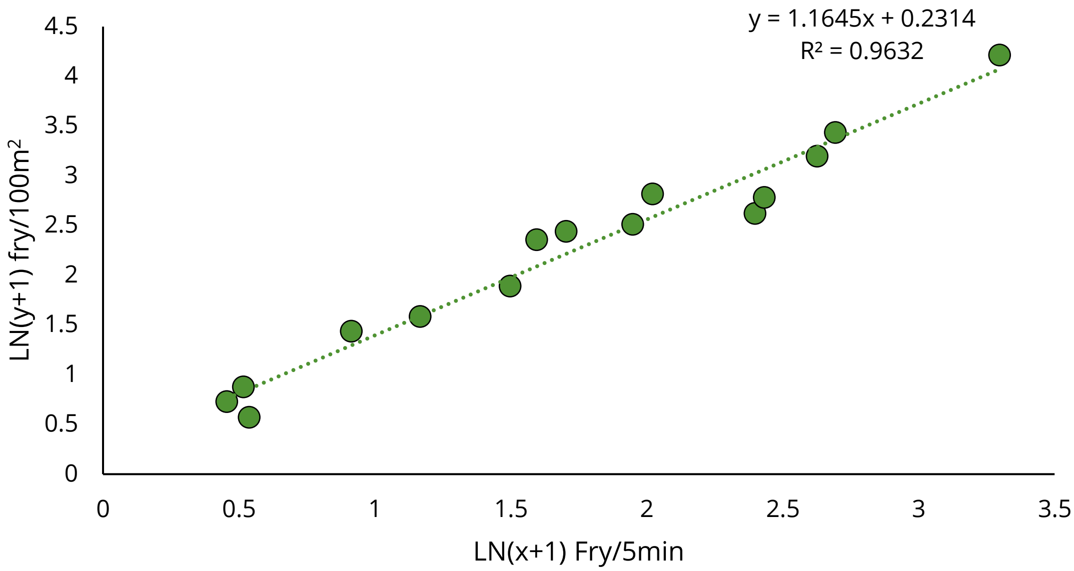
6.3 Appendix C



Appendix C.1: Brown trout quantitative fry population relationship between semi-quantitative (five minutes fry capture) and quantitative electric fishing results (Fry per 100 square) that is LN+1 transformed. Fitted linear regression for 0 + salmonids is produced where Ln (y + 1) = 0.9242 + 1.2196 Ln (x + 1).



Appendix C.2: Atlantic salmon quantitative fry population relationship between semi-quantitative (five minutes fry capture) and quantitative electric fishing results (Fry per 100 square) that is LN+1 transformed. Fitted linear regression for 0 + salmonids is produced where Ln (y + 1) = 0.2455 + 1.0698 Ln (x + 1).



Appendix C.3: Brown trout quantitative parr population relationship between semi-quantitative (five minutes parr capture) and quantitative electric fishing results (Parr per 100 square) that is LN+1 transformed. Fitted linear regression for 0 + salmonids is produced where Ln (y + 1) = 0.2314 + 1.1645Ln (x + 1).