WESTCOUNTRY RIVERS TRUST ELECTROFISHING SURVEY REPORT- RIVER TAMAR 2020

TAMAR

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1. Introduction

1.1 Roadford Mitigation Fund

Through the Roadford Mitigation Fund, a key indicator of success is the potential to increase the local population of salmonid fish within the river and the number of sea trout and salmon smolts leaving the Tamar system. Therefore, the monitoring is targeted towards potential intervention sites to monitor pre and post works along with control sites to reflect year on year changes. In its third year of monitoring there is still insufficient data to draw any firm conclusions at this early stage of the project.

Rapid walkover assessments of the Tamar tributaries enabled improvements to be directed to habitat that could be enhanced and improved to increase successful salmonid recruitment through direct river improvements. These improvements included riparian tree works which involved managing the shade regime on riffle areas by clearing dense stands of trees, crown lifting or complete removal. Habitats are further improved though hinge cutting suitable size trees that are used to add material into the river edge, this has a multiple benefit effect by creating new refuge for fish, trapping silts and varying river flows. Other improvements included gravel cleaning which involves spawning gravels being cleaned of silt accumulation where silt aggradation is high, this allows gravels to be moved freely by spawning fish and increases the gravel matrix surface area for invertebrates to colonise lost habitat.

Therefore, the monitoring is targeted towards intervention sites to monitor pre and post works along with control sites to reflect year on year changes. A number of different tributaries were selected to meet the objectives of the project outline and highlight whether river improvement works were having a direct impact on salmonid recruitment over a multi-year monitoring and improvement programme. The rivers selected were as follows; Deer, Ottery, Inny, Penpont, Kensey, Lamberal (funded through a separate project), Lyd, Wolf and Tamar.

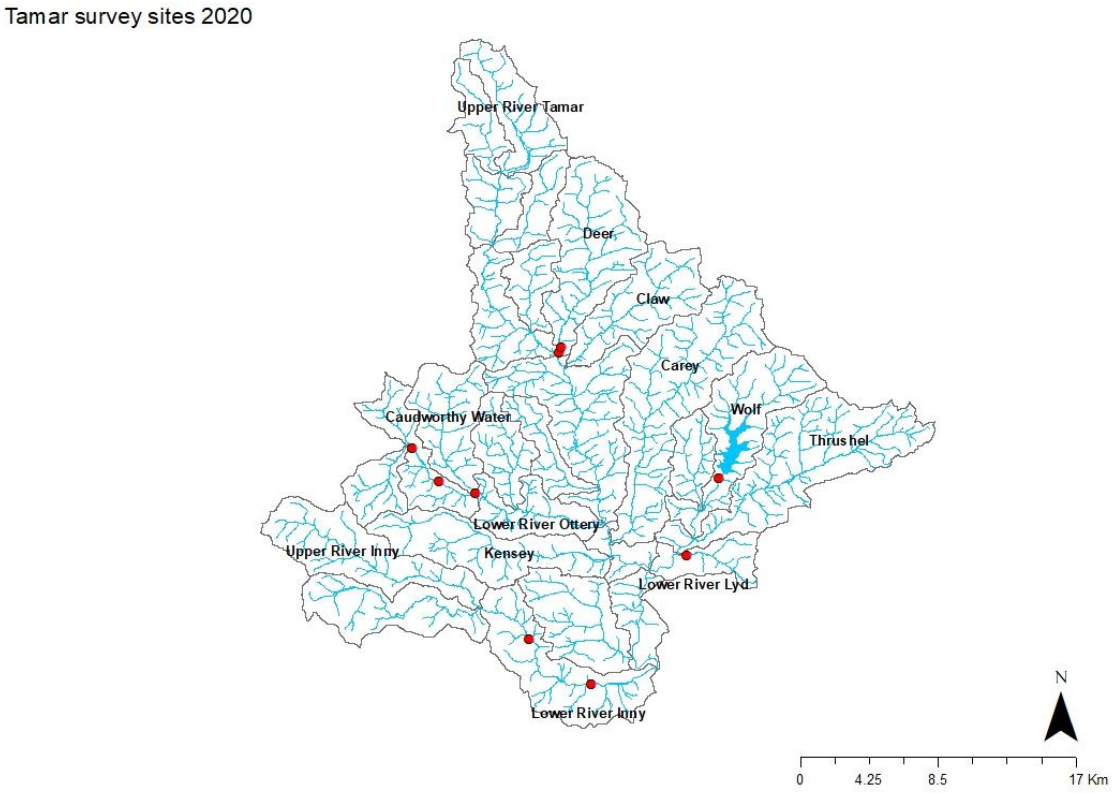

Figure 1: Survey site location map 2020.

1.2 General introduction to electro fishing

Electrofishing protocols

Electrofishing uses a controlled electric current to induce fish to swim into a hand net, and thereby be counted and assessed. When carried out correctly by experienced and qualified electro-fishers, it is not harmful to fish, and the fish are released back to the location where they came from. In upland streams and shallower sections of rivers an electrofishing backpack is used, and for deep rivers and lakes bankside equipment is needed.

There are several approaches to electrofishing assessments in rivers; these are 1) quantitative, 2) area semi-quantitative, and 3) timed semi-quantitative methodologies. All three methods have their advantages and disadvantages.

Quantitative electrofishing is a thorough methodology that has the **advantage** of having the highest degree of accuracy of all methods. The main **disadvantage** of this approach is that it takes longer, and costs more, than other approaches. In this method, an area of river is netted off and the fish are removed from this defined stretch in multiple passes, until sufficient fish are removed to form a very accurate assessment of species and numbers. It is not required to remove all the fish from the area as the declining numbers of fish caught by each pass gives an accurate estimate of the total number of fish in the location. As the number of fish found in each pass declines, this is known as a 'depletion' methodology.

An **area-based semi-quantitative electrofishing** methodology follows the same process as quantitative electrofishing described above, however only a single pass is carried out. As multiple passes are not used, this is not a depletion methodology, and therefore cannot be considered to be quantitative. This method has the following **advantages**; it is quicker than a depletion methodology, it is able to detect multiple species, it can be used on virtually all sites, and it is reasonably accurate. Its **disadvantages** are that it is slower, and therefore costlier than a time-based methodology, and that it is not as accurate as a depletion-based methodology.

A **time-based semi-quantitative electrofishing** methodology differs from both approaches described above. Instead of limiting the *area* fished (by use of nets) it limits the amount of *time* used to fish to assess fish numbers. As no nets are deployed, this method is only used to assess salmonid fry, who are restricted to shallower section of upland streams and rivers. In deeper sections of large rivers fish can frequently avoid capture in this methodology, as there is no net to prevent escape. The **advantage** of this methodology are; it is extremely rapid, and therefore cost-effective, allowing for deployment across whole river catchments. The **disadvantages** of this approach are; it can only be used for salmonid fry numbers, and it is less accurate than netted approaches.

For an electrofishing methodology to have sufficient statistical power it requires a large number of sites to be fished in a fully-quantitative depletion methodology over a number of years. As such an effort is rarely practicable and will cost more than the habitat improvements it attempts to measure, this approach is rarely applied in the UK. This is possibly due to river managers in the UK having limited budgets and therefore it is accepted that the surveys undertaken will not statistically achieve 95% confidence, however these are an accepted compromise between accuracy and cost

Bearing in mind the limits of statistical power that these approaches usually have (as practically applied) it is important to consider the goals of a given electrofishing programme. In the case of WRT's catchment scale electrofishing programme the goal is to guide action to improve a salmon and trout stocks. The aim is to identify issues in specific geographic areas of the catchment, and to provide an *indication* as to if the actions taken on the catchment have had a positive effect on fish numbers. These various factors lead to a timed semi-quantitative approach being taken because the goal is; to fish a large number of sites over several consecutive years, covering most of the catchment to provide information as to how to best take action to improve the fish stocks for salmon and trout.

1.3 Life-cycle, bottlenecks and the Defend/Repair/Attack approach

Lifecycle and bottlenecks

Electrofishing programs can be used to identify issues that prevent salmonids from effectively completing their life-cycle, and then proposing solutions that are proportionate to the issue at hand. It is useful to adopt certain conceptual frameworks to each of these aims, and in this report, we will use two of these frameworks; the first that of 'habitat bottlenecks' describes the causes of issues in salmonid ecology, and second, that of 'Defend/Repair/Restore???' describes the appropriate habitat action depending on the ecological situation found at the site.

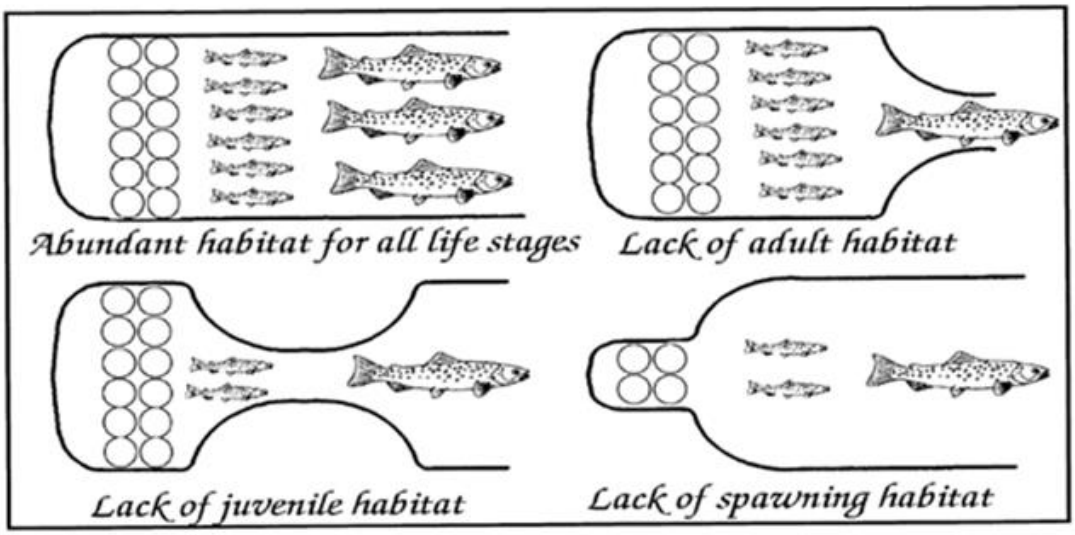

Figure 2. Diagrams defining salmonid habitat bottlenecks (Summers et. al., 1996).

2. Methodology

2.1 Site selection

An assessment of previous electrofishing data on the Inny and Ottery catchments indicate that juvenile salmon densities are highest in the middle and lower catchment. Therefore, this is where the majority of interventions, such as gravel cleaning and riparian habitat works, are targeted and is reflected in the identified areas for electrofishing.

Three new sites, North Tamerton 1, North Tamerton 2 and Wiggaton 3 were selected for the 2020/2021 survey season and to receive intervention post surveys. This included six of the original sites which included the control site. Survey sites were selected to provide representative samples from distinct river reaches, characterised by habitat type and proximity to targeted restoration works. Multiple factors had to be considered when choosing sites for electrofishing surveys this included permission, access and equipment, riffle/spawning type habitat and whether it was considered a potential works site or control.

2.2 Survey protocol

Permissions for all sites were established before electrofishing surveys took place. Each site was electrofished by a two-person team. The voltage of the unit was set at each site depending on the water conductivity. The operatives fished continuously for a standard five minutes over suitable fry habitat without the use of stop nets. The fishing area was variable, and the length of fishing time was fixed. Fish were collected in a net and placed into a holding bucket before processing.

All salmonids were identified to species and fork length was measured and recorded. Numbers or density estimates were recorded for all other species captured. Any fry that were missed or escaped during electrofishing were assigned to either trout or salmon groups depending on the relative percentage of each species already recorded at the site.

Surveyors are all trained in electrofishing techniques and good animal husbandry to minimise the impact of the survey on the study area. Biosecurity measures were taken between catchments where equipment was disinfected.

2.3 Data Analysis

The results of the electrofishing survey are classified according to the methodology of Crozier and Kennedy (1994), displayed in Table 1, with each site being given an equivalent density classification compared to quantitative monitoring. This semi-quantitative methodology was designed by Crozier and Kennedy for both salmon and trout. Due to a large portion of historic data being quantitative it was not possible to make direct comparisons to the semi-quantitative data of 2020. However, in 2019 a calibration exercise was undertaken where a small number of sites were surveyed using the semi-quantitative methodology which enabled four of the nine sites to be compared. (see tables 4 & 5). The remaining sites, where direct comparisons were not possible, some general comparisons have been made.

Table 1 Semi-quantitative abundance categories for salmon fry (Crozier & Kennedy, 1994)

Density Classification	Semi-quantitative (n/5min fishing)	Quantitative (n 100m·2)
A (excellent)	>23	>114.7
B (good)	11-23	69.1-114.6
C (fair)	5-10	41.1-69.0
D (poor)	1-4	0.1-41.0
E (absent)	0	0

At each site individual fish length was measured and the data incorporated to create a bi-modal distribution graph to identify the split in 0+ and 1+ age groups of fish and use these values to assign a classification from A - E.

3. Results

3.1 All sites

In this instance, due to the reduced number of survey sites and change from quantitative to semi-quantitative methodology, the 2020 surveys did not produce the number of fish required for a legitimate distribution to be able to identify fry (0+) and parr (1+) (see figure 3 & 4). Therefore, data from last year's distribution was used as a threshold for this years' classifications for trout and salmon which was 105mm and 100mm respectively.

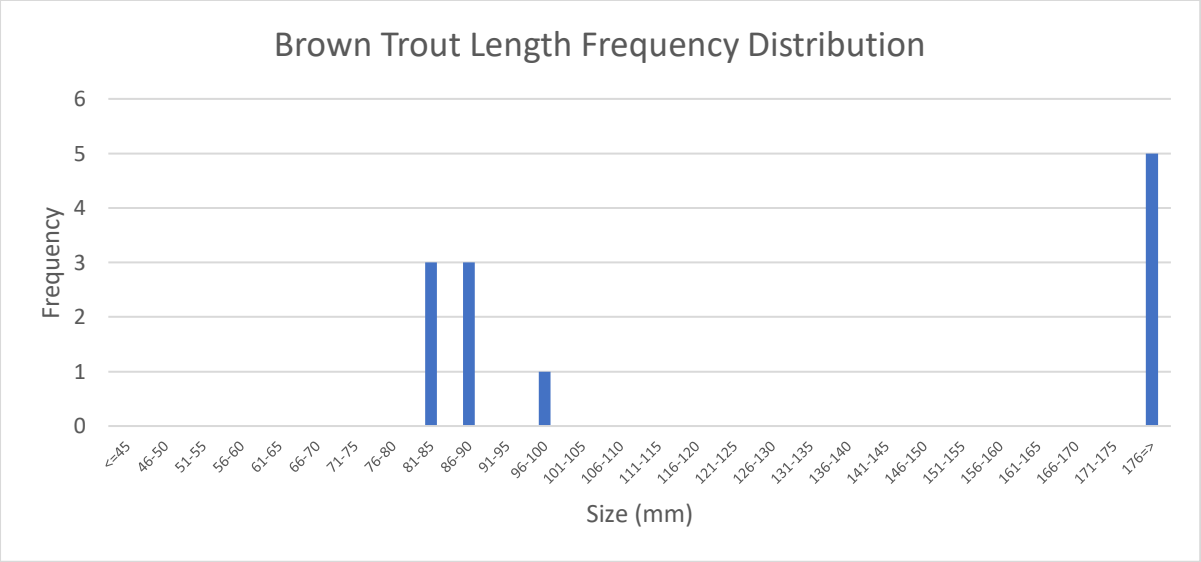

Figure 3: Brown trout length frequency distribution (2020)

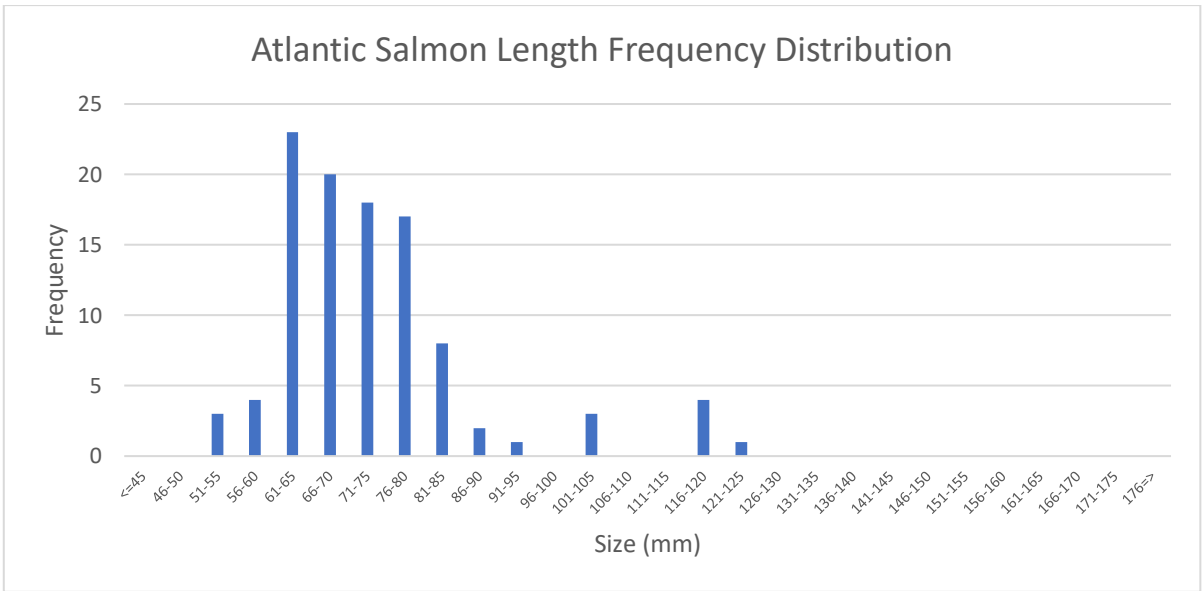

Figure 4: Atlantic salmon length frequency distribution (2020)

Table 2: Classification table for brown trout and Atlantic Salmon fry 2020.

Site name	River	Trout classification	Salmon classification
North Tamerton 1	Deer	E	E
North Tamerton 2	Deer	E	E
Wiggaton 3	Ottery	E	A - 32
Treburtle	Ottery	E	C - 7
Penheale	Ottery	D - 2	B - 18
Trekenner Mill Gravels	Inny	E	B - 13
Trekelland Control	Inny	E	A - 31
Colemans	Lyd	D - 1	B - 21
Roadford Reservoir DS	Wolf	D - 4	E

Both North Tamerton 1 & 2 on the river Deer both received an absent classification (E-0) for salmon and trout fry. Wiggaton 3 on the river Ottery received an absent classification (E-0) for trout fry and an excellent classification (A-32) for salmon fry. All three sites were new for 2020 so no comparisons can be made at this point. Colemans on the river Lyd received a poor classification (D-1) for trout fry and a good classification (B-21) for salmon fry. Roadford Reservoir DS on the river Wolf received a poor classification (D-4) for trout fry and an absent (E-0) classification for salmon fry.

Table 3: Comparison classification table for brown trout fry 2019 - 2020.

Site name	River	Trout classification 2019	Trout classification 2020
Treburtle	Ottery	E - 0	E - 0
Penheale	Ottery	E - 0	D - 2
Trekenner Mill Gravels	Inny	E - 0	E - 0
Trekelland Control	Inny	D - 2	E - 0

A number of sites had been subject to a 2019 calibration exercise, these were used as a direct comparison to the 2020 semi-quantitative fry data. Overall, trout classifications had remained almost identical to the 2019 results and were absent across most of the Inny and Ottery survey sites. The exception of Penheale which has increased from an absent classification (E – 0) in 2019 to a poor classification (D -2) with two fry being recorded in 2020 and Trekelland Control had declined from a poor classification (D – 2) of two fish in 2019 to an absent classification (E – 0) in 2020.

Table 4: Comparison classification table for Atlantic salmon fry 2019 - 2020.

Site name	River	Salmon classification 2019	Salmon classification 2020
Treburtle	Ottery	E - 0	C - 7
Penheale	Ottery	B - 23	B - 18
Trekenner Mill Gravels	Inny	C - 5	B - 13
Trekelland Control	Inny	C - 10	A - 31

Overall, salmon fry classifications had increased over most of the Inny and Ottery survey sites with the exception of Penheale where although it had received a good classification (B) for both years the 2020 good classification (B-18) was at the mid-point where as the 2019 good classification (B-23) was at the highest point of a good classification (see table 1). Treburtle on the Ottery had increased from an absent classification (E-0) in 2019 to a fair classification (C-7) in in 2020. Trekenner Mill Gravels on the

Inny had also increased from a fair classification (C-5) in 2019 to a good classification (B-13) in 2020. Trekelland Control site on the Inny also increased from a fair classification (C-10) to an excellent classification (A-31) in 2020.

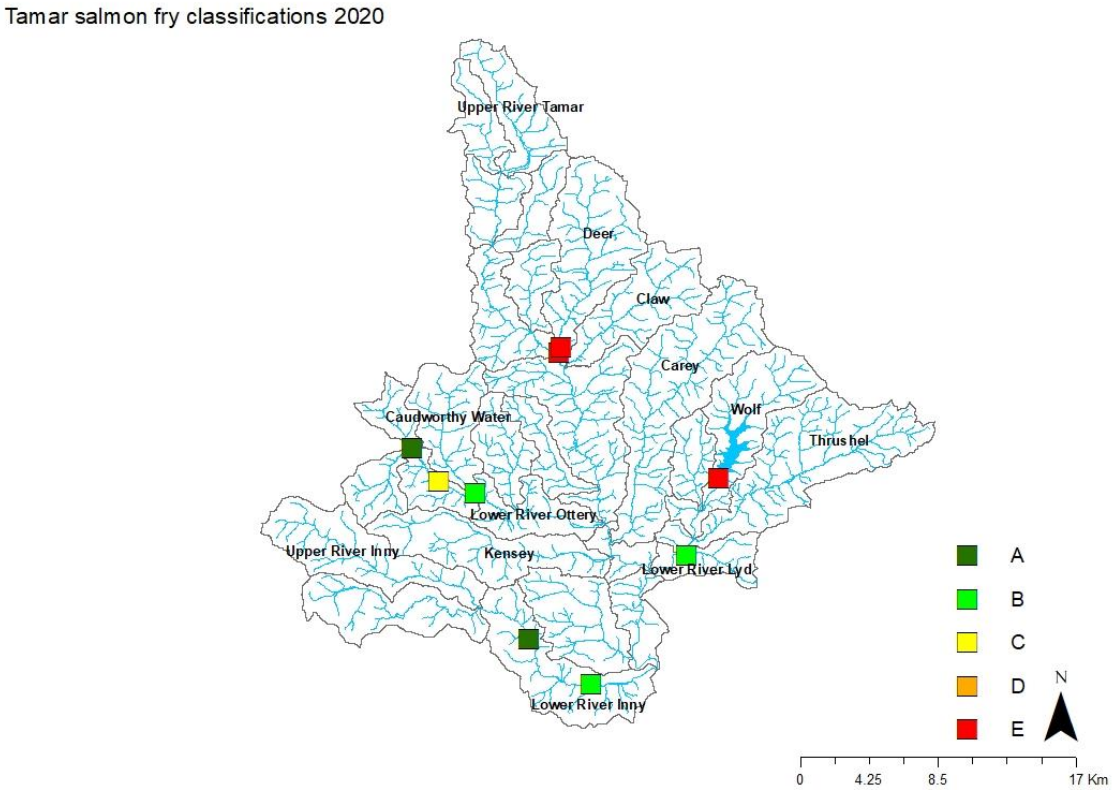

Figure 5: Salmon fry classification map.

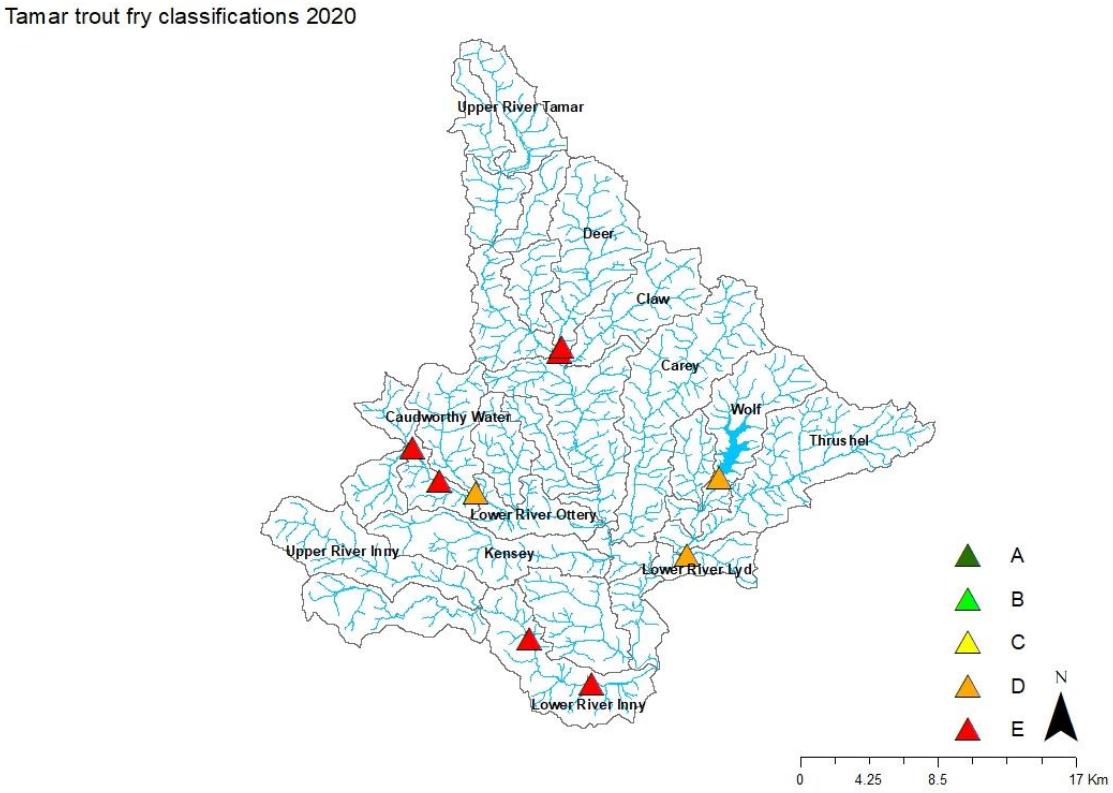

Figure 6: Trout fry classification map.

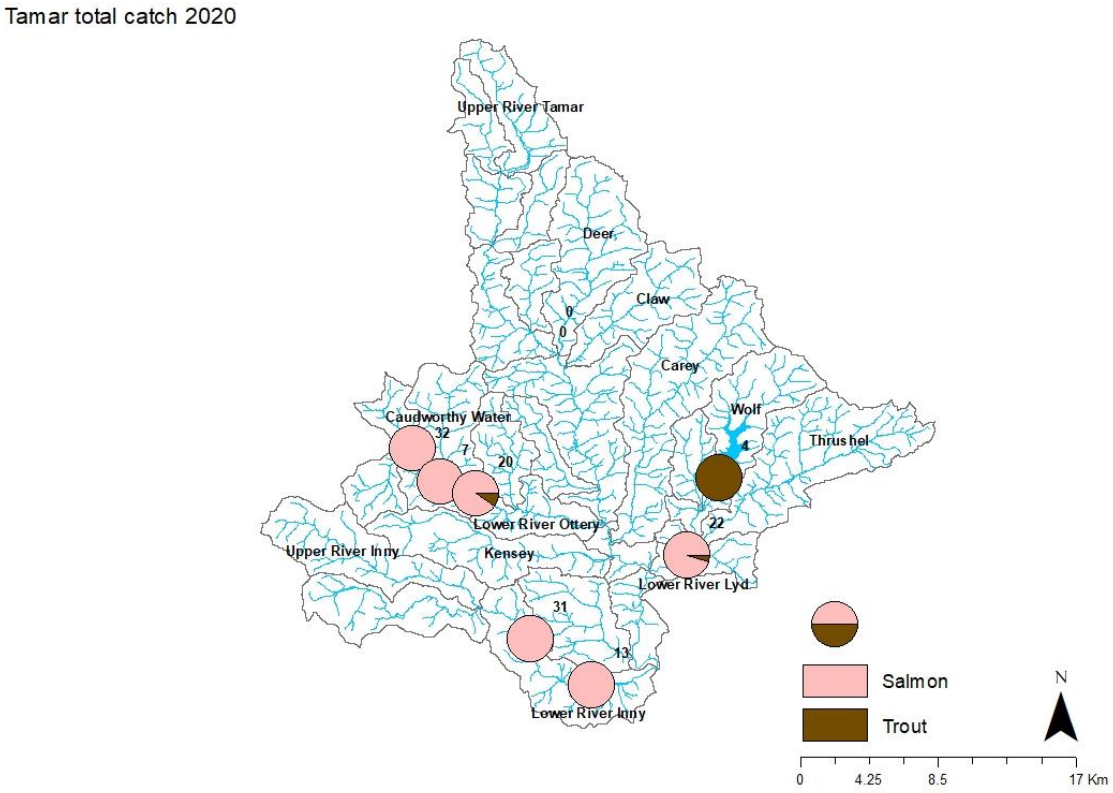

Figure 7: Trout and Salmon total catch map.

4. Discussion

Now in its third year, the Roadford Mitigation Program (RMP) has a growing electrofishing dataset comprising of robust fully quantitative data with the addition of the modified semi-quantitative methodology data. A total of 9 semi-quantitative sites were surveyed in the Tamar catchment in 2020.

The report of 2019 compared the results of 2018 with the different work interventions employed at that site i.e. gravel cleaning, riparian tree works, combination sites and control sites. However, due to the COVID restrictions in place at the time of the 2020 surveys a modified semi-quantitative approach was employed, that could be more safely delivered. As these surveys are time based and not area based, the data is not directly comparable with quantitative data. Therefore, no comparison graphs were generated this year, but some general comparisons have been made where there were obvious changes in densities, but this is to be viewed with some caution. In 2019, a small number of sites were subject to a calibration exercise where the first 'run' of the conventional quantitative surveying was timed for five minutes to allow a semi-quantitative classification to be appointed along with the remaining quantitative classifications. These were used to at least allow some direct comparisons of survey sites to be made with some of the 2020 sites.

Both North Tamerton 1 and 2 within the Deer catchment were new sites for 2020 and were absent of all salmonids and also any minor species i.e loach, bullhead minnow etc. This site suffered from a significant fish kill incident in 2018, that would temporarily reduce fish populations and have a knock on effect for some time. Low numbers were anticipated due to this event, but a complete absence further highlights the need for significant intervention to recruit fish back into this stretch. This will act as a baseline to determine if intervention in the form of riparian tree works, scheduled for 2021, funded through the Deer Enforcement Undertaking will have had an impact on recruiting more trout and salmon fry when surveying resumes next year.

Wiggaton 3 on the river Ottery was also a new survey site for 2020 which produced no trout fry but did receive an excellent salmon classification. It is often believed that when salmon have successfully spawned in suitable spawning habitat and a large number of fry occupy the area this often results in trout being out competed and having to relocate to another part of the river. This site has been selected for riparian tree works and improved shade regimes in 2021 so further monitoring will determine how effective the interventions have been. Treburtle was also absent of any trout fry and produced a fair classification for salmon fry. This site had a pre survey intervention of riparian shade management and has improved from an absent to a fair classification which is two classifications higher. Also, it may take time for some sites to establish and for successful spawning to occur within the area so continued monitoring may see a steady increase. Although there was no trout fry present, other species such as grayling were captured within the survey area possibly taking preference to the new shade regimes throughout the survey site. Penheale was the only survey site on the river Ottery that recorded a small number of trout fry and although there were some pre-survey riparian tree work interventions it was still a poor classification with only two fry being recorded. Salmon were classified as good which may explain why there were lower numbers of trout. Salmon are considered to have a stronger preference for areas of light, and it may be that these lighter areas through shade works are having a greater benefit to salmon. Further walkover surveys may be beneficial to highlight whether

there are other external factors effecting trout populations in these sub catchments. Small data sets such as this year's survey are likely to have greater degrees of error than larger, more accurate surveys. Therefore caution is recommended to avoid over-interpreting this result.

Trekenner Mill Gravels on the river Inny was also absent of any trout fry but did score a good classification for salmon fry. The site was gravel cleaned in 2018, rested in the 2019 schedule of works and surveyed in 2020 to see if the resting period aided recruitment of different organisms. Initial gravel cleaning of an area can displace and disturb invertebrates that may be present and can take some time to re-establish themselves and colonize the cleaned gravels but gradually improves from its pre works state. Again, this site has increased from a fair classification to a good classification which would suggest that the gravel cleaning has increased the available spawning gravel available. However, further monitoring is needed to determine the effectiveness over a larger number of sites over several years to help guide future planning of gravel cleaning sites. Trekelland Control was also absent of any trout fry and considering this is the control site and trout fry were captured in 2019, albeit a poor classification this may suggest that trout in general have had a poor year and will be at lower numbers at all sites across the surveyed sub catchments. The control sites are important to consider as they act as a base line for each year, where there should only be environmental and naturally occurring differences in spawning success and habitat. It may be beneficial to add addition control sites on the main surveying tributaries to aid in highlighting trends of trout and salmon densities when more sites are surveyed in 2021.

The Colemans site on the river Lyd received a poor classification for trout with only one fry being caught and a good classification for salmon. This is similar to the 2019 results even though they aren't directly comparable the site is usually salmon fry dominant but has in previous surveys produced some low numbers of trout fry. The site was subject to a large amount of riparian tree work and tree shear before the 2020 surveys but is unlikely to show any substantial benefit this year.

Roadford Reservoir DS on the river Wolf was absent of salmon fry and received a poor classification of trout fry in both the 2019 and 2020 surveys. It is not unusual for survey sites that are in close proximity of reservoirs to not perform optimally due to the habitat change over time which may not be suitable for fry, lack of spawning gravel due to the poor connectivity of the river and lack of fresh material entering the system, especially if there are low numbers of feeder tributaries. However, this site did undergo a gravel augmentation during 2019 and although initial results have not improved fish numbers this sort of intervention can take several seasons to establish and for gravels to be transported and settle out, in turn creating more suitable fry habitat and in time aid in improving recruitment of invertebrates and spawning success.

Overall, the Tamar catchment appears to have had a poor year for trout fry recruitment with three sites out of the nine surveyed receiving poor classifications of 1, 2 and 4 individuals and the remaining six sites were all absent of trout fry. This may be a result of the modified survey technique, as a fully quantitative survey will capture a more diverse range of river habitat such as varying flows and depths. Displacement of trout fry is common when salmon fry are present due to interspecies competition. The time sensitive nature of semi-quantitative surveys forces surveyors to focus their efforts on 'prime' fry habitat. Salmon fry recruitment has increased significantly from 2019 to 2020 based off of the four sites that were able to be compared which gives merit to the ongoing intervention work at these sites.

Riparian tree works seem to have had the most positive response for recruitment with good and excellent numbers of salmon being found at sites where the shade regime had been improved on sites in the Ottery, Inny and Lyd. Consideration should be given to the potential 'honey pot' affect where fish move in on an area of preferential habitat. Although this theory would suggest a movement of individuals rather than an increase in abundance, the simple choice to migrate into these areas that have been subjected to riparian management shows that the work and habitat available is beneficial and preferential.

Gravel cleaning has not generated such good results with densities staying at similar levels or in some cases decreasing. However, continuous monitoring of sites may show a steady increase in time after the initial disturbance, as there is strong evidence supporting the detrimental effects of silt loading in river substrates. It is also probable that gravel cleaning shall have a varied impact in different catchment types, with differing geomorphology. The same applies for the gravel augmentation on the river Wolf. Instant improvements are not usually observed but over time as the gravel settles and attracts more invertebrates and fish are successfully spawning positive results should be observed in future surveys.

To conclude, although basic comparisons were able to be made and classifications produced for each site and the semi-quantitative data producing a 'snap shot' of the surveyed sub catchments recruitment performance, direct comparisons were not able to be made for all historic sites. Usually quantitative surveys are used to determine age structure and incorporates many habitat types during the survey. This may explain some of the absent and low numbers of trout fry recorded due to only riffle areas being fished. Due to the dry summer and water levels being low some juvenile trout may have been outcompeted by salmon and moved into less favourable habitat and being missed from the survey. It is also worth noting that the quantitative methodology is more thorough than its semi-quantitative counterpart and the NFCS classification table requires a larger number of fish to obtain higher classifications so although this year's numbers appear better, future years quantitative surveys will be comparable and more evaluations can be made on the effectiveness of ongoing improvement interventions.

5. Recommendations

The initial data from 2018, 2019 and 2020 can be used to elucidate which interventions are likely to have the greatest impact on fish populations and help to define the types of future works undertaken in the catchment.

The gravel cleaning on the Inny, however, did not appear to have a significant impact on fry numbers and it may be that, sediment is not a limiting factor in the Inny catchment. Therefore, the early evidence would suggest that efforts on the Inny should be concentrated on riparian shade management as these works are likely to have the greatest impact on fish, with reduced use of gravel cleaning. For the Ottery catchment data from this year (2020) shall help to inform what types of works are likely to have the greatest impacts on that individual catchment.

The fisheries data gathered each year will help to provide guidance on the Roadford mitigation proposal and can be used to ensure that the most appropriate interventions are undertaken on each specific sub-catchment, which should ensure the greatest increase in salmonid numbers. Other than riparian tree management and gravel cleaning, the following interventions are recommended:

- ***Gravel augmentation:*** Targeted in areas where the gravel matrix has been changed through impoundment such as reservoirs. Also, potentially where gravels are in a poor state and artificial type gravel beds can be introduced, particularly in the upper Tamar catchment

- ***Erosion Control***: Fencing, tree planting and effective marginal habitat management will reduce erosion. However, where specific areas of high pressure and vulnerability are identified, erosion protection measures such as woody debris installation, environmentally sensitive revetments, and strategic tree planting would be advantageous.

- ***In-Channel Habitat Restoration***: Installation and construction of habitat enhancing features, including woody debris introduction, flow manipulation with groins and kickers, bank reprofiling for marginal zonation, strategic tree planting, gravel introduction and riffle creation, and historic channel restoration. Advanced management usually applied post success of other recommended actions.

Delivered through other Tamar Projects

- ***Fencing:*** Riparian zones identified as receiving significant livestock access, with apparent habitat degradation, should be fenced to limit trampling and bank side poaching. Precautions should be taken to ensure livestock can access drinking water supply. Effective buffer strips dependant on site characteristics is advised.

- ***Farm Advice***: A key management strategy for the protection and enhancement of riverine systems. Approaching and working with local agricultural businesses to offer guidance on best environmental practice, and the use of grants for application of the recommended actions outline

6. Acknowledgments

Westcountry Rivers Trust would like to thank all landowners who gave us permission to undertake surveys on the River Deer, Ottery, Inny, Lyd and Wolf catchments, Launceston Angling Association who gave permission to survey. Also, a big thanks to SWW, the TTFA and EA for their support and partnership for this work.