RIVER CALDER RHS EVALUATION

FINAL REPORT

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FINAL REPORT

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1 EXECUTIVE SUMMARY

1.1 Project Background

1.1.1 Young Associates was commissioned by the Environment Agency (EA), North West Region, to collect and analyse River Habitat Survey (RHS) data in order to assess the possible causes of an observed decline in salmonid fisheries quality in the River Calder system, West Cumbria.

1.1.2 A total of 76 RHS sites were surveyed during February 1999, including the main stem and all significant tributaries of the R. Calder. The data were entered onto the RHS database by the EA and were then analysed to describe the habitat characteristics of the R. Calder, with a view to determining the possible causes of reduced salmonid densities.

1.1.3 These results were compared against the RHS data for the adjacent River Ehen and the salmonid populations of both systems were reviewed using the results of two fisheries surveys carried out in 1993 and 1998. The results of the RHS habitat analyses were reviewed in a national context using the UK RHS database (v. 2), and the review of salmonid populations was considered in a regional context using regional fisheries data.

1.2 Salmonid Fisheries of the Ehen and Calder

1.2.1 In terms of the abundance and distribution of salmonid fry and parr, it was found that the two rivers exhibit a relatively similar frequency and distribution of salmonid populations, although the R. Ehen has slightly higher absolute densities of both salmon and trout than the R. Calder. The greater number of salmonids in the Ehen was particularly evident when comparing the tributaries of the two rivers. The other major distinction was that the Ehen supports a more abundant trout population whilst a higher proportion of sites on the Calder support good salmon densities.

1.2.2 Tributaries perform a very important function in the maintenance of good salmonid populations in river catchments in that they are the prime areas of spawning and nursery activity, from where the juvenile fish drop down into the main river to mature. Adverse impacts on the tributaries of a catchment therefore have the potential to exert substantial impacts on the river system as a whole. However, the large number and geographical spread of the tributaries usually limit the extent of anthropogenic influence and it is unlikely that the majority of the tributaries would be adversely affected at the same time (unless human influences in the headwaters were very significant).

1.3 Habitat Characteristics

1.3.1 In order to determine whether observed differences in the salmonid populations of the R. Ehen and R. Calder are related to differences in the habitat characteristics of these systems, the following suite of parameters were used to describe and compare the river habitats at each RHS site: gradient, substrate, bank stability, water width, water depth, number of riffles and number of pools.

1.3.2 This analysis showed that, based on the above parameters, there were clear differences between the two river systems. The key difference between the systems was that there was a much higher proportion of coarse substrate (cobble, gravel and pebble) at sites on the R. Ehen. In the R. Calder the substrate was more varied, and included greater

proportions of bedrock and fine sediments (sand and silt) which are not beneficial to salmonid species.

1.3.3 The habitat preferences of salmonid fry, trout parr, salmon parr and spawning adults were identified, and specific searches of the RHS databases for the two rivers were conducted, to identify locations that were potentially favourable for each of these life stages. It was consistently found that the best sites were on the R. Ehen, and particularly the upper reaches of this river. This was primarily because of the coarser substrates in this river, which are more suitable for salmonid nursery and spawning grounds.

1.3.4 It should be noted, however, that this analysis does not take any account of the fact that at individual locations there will be complex interactions of many contributory factors, and further investigation may be warranted.

2 BACKGROUND AND OBJECTIVES

2.1 Introduction

2.1.1 Young Associates was commissioned by the Environment Agency (North West Region) to collect and analyse River Habitat Survey (RHS) data in order to assess the potential causes of an observed decline in salmonid fisheries quality in the River Calder system, West Cumbria. The study area includes the main channel of the R. Calder and all its significant tributaries, a total of over 70 km of channel length.

2.1.2 The aims of the project are to collect habitat information for the Calder catchment; to interrogate the data in terms of positive and negative salmonid habitat features; and to compare the habitats of the Calder with the neighbouring River Ehen catchment for which continuous RHS data have already been collected. Fish survey data for both catchments have also been used in the analysis. A final stage in the analysis was a comparison of the R. Calder data with national RHS and regional fisheries data, in order to set the results in a wider context.

2.1.3 This report presents the findings of the RHS survey and data analysis, and puts forward some suggestions for river habitat management which could be carried out to improve the salmonid fisheries quality of the Calder catchment.

2.2 Field Survey

2.2.1 Full RHS surveys, using the standard methods described in the River Habitat Survey, 1997 Field Survey Guidance Manual (Environment Agency, 1997) were undertaken at 76 sites in the Calder catchment. Figure 1 shows the locations of the survey sites, and the relation of the R. Calder and R. Ehen catchments. RHS sites were surveyed at 1 km intervals, and 'inter-reach' surveys were carried out between the RHS reaches. The latter included selected elements from the standard RHS form, and was designed to be completed as the surveyor walked between full RHS sites. Figure 2 shows the location of RHS survey sites on the Calder system.

2.2.2 The field survey was undertaken between 18th and 28th February 1999. An experienced RHS surveyor, Christopher Bates, carried out the surveys of all the RHS and inter-reach sites.

2.2.3 Despite the time of year and a wetter than average winter, flow conditions were at or near normal levels for much of the survey period. Some problems were experienced as a result of snow-fall during the early part of the survey, but the catchment is quite 'flashy' and flow conditions quickly returned to normal following the thaw. As far as possible, problems relating to flow condition were avoided by surveying smaller tributaries, which are less prone to spate flows, during wetter weather.

2.2.4 Other weather/season related problems included the occurrence of hill fog for several days at higher altitudes; and the short day length at this time of year. Several very minor tributaries shown on the OS 1:50,000 map could not be found on the ground, and were not therefore surveyed. At the downstream end of the Calder, the stretch of river through Sellafield Power Station was not surveyed as access was not possible. The lowest RHS site on the catchment is therefore just upstream of Sellafield.

2.2.5 During this survey a series of photographs were taken; the locations of these are given in Appendix 1 and illustrated in Figure 3.

2.3 Data Analysis

2.3.1 In order to identify the possible reasons for a reported decline in salmonid fisheries, the habitat characteristics and salmonid populations of the Calder were described and compared against those of the adjacent River Ehen. In addition, the habitats and fisheries populations of both rivers were reviewed in a regional context. For these analyses the following data (in Access 97 and Excel 97 formats) were obtained from the Environment Agency:

1. results of a continuous RHS survey of the River Ehen, carried out in July 1997, including map-derived, spot check and sweep-up data (see Figure 2 for RHS site locations);
2. the national RHS database (v. 2) showing the summary results from 5740 individual sites;
3. the results of salmonid surveys of both the Ehen and Calder rivers carried out in the summer and autumn of 1993 and 1998 (the fisheries survey locations are shown in Figure 4); and
4. the results of fisheries and RHS surveys from other rivers in the North West region.

2.3.2 Using these data and the results of the R. Calder RHS survey, the following four analyses were carried out:

1. The salmonid populations of the two systems were described and compared, using the results of the electric fishing surveys, in order to confirm that lower numbers have been recorded in the R. Calder.
2. Using the RHS survey results, the river and catchment characteristics of the Calder were described and compared against those of the adjacent Ehen, to determine the level of similarity between these two systems and therefore to assess the extent to which direct comparisons can be made between them.
3. The RHS databases for both the Ehen and the Calder were interrogated to identify the RHS sites exhibiting habitat characteristics that are known to be preferred by salmonid fry and parr.
4. Fisheries data and RHS information for a range of rivers across the North West were obtained and reviewed in order to identify differences in the habitat characteristics of rivers with good and poor salmonid populations. This information was then used to assess whether the fish populations of the Calder are typical for its specific habitat characteristics. This analysis is presented in Appendix 4.

3 RESULTS AND DISCUSSION

3.1 Fisheries Data

3.1.1 The salmonid populations of the Rivers Calder and Ehen were described and compared using the results of electric fishing surveys carried out in 1993 and 1998. Using the combined dataset for the 1993 and 1998 surveys, inter-system comparisons were made at the following three levels:

1. for all the sites surveyed on each river (i.e. the whole catchment);
2. for just the main stem river sites; and
3. for just the tributary sites.

3.1.2 For the purposes of this analysis the salmonid densities were assessed using the NRA National Fisheries Classification Scheme, which were grouped together to provide an indication of the proportion of sites supporting good salmonid densities (defined as Classes A-C), and sites supporting poor salmonid densities (defined as Classes D-F). The Class categories are detailed in NRA R&D Note 206. The data are presented in Tables 1 and 2 and the density classes at each survey site for small and big trout and salmon are illustrated in Figures 5 to 8.

3.1.3 Across the whole Ehen catchment the proportion of sites supporting good salmon populations (16.7% and 30% for 0+ and >0+ salmon respectively) was lower than the proportion of sites supporting good trout populations (51.7% and 56.7% for 0+ and >0+ trout respectively). The main stem of the river supported only 29.4% of good 0+ salmon populations, while the proportion of sites supporting good densities of >0+ salmon, 0+ trout and >0+ trout was 17.6%, 17.6% and 11.8% respectively. The main river sites therefore appear to provide the most suitable conditions for salmon fry.

3.1.4 The proportion of tributary sites supporting good salmonid densities was the inverse of the situation in the main river sites, with more sites (65.1%, 32.6% and 74.4%) supporting good densities of >0+ salmon, 0+ trout and >0+ trout. The proportion of sites with good 0+ salmon densities was 11.6%. This finding is to be expected because it is widely recognised that river tributaries support higher densities of trout and salmon than main rivers. This is because habitat diversity is generally greater and more suitable for juvenile salmonids in tributaries which, due to their narrow channel width, have a greater proportion of the surface area covered by undercut banks, overhanging vegetation and tree branches, submerged tree roots and in-stream debris. The cover and general habitat characteristics often provide more productive, and therefore smaller, territories for salmonids, increasing population densities.

3.1.5 The fishery data therefore indicate that there are higher densities of trout than salmon at the majority of the R. Ehen sites. The abundance of trout is typical of many rivers, where trout can often occupy habitat niches unavailable to salmon. A higher proportion of the main river sites supported good densities of 0+ salmon, while the tributaries were more suitable for >0+ salmon and 0+ and >0+ trout.

3.1.6 Across the whole R. Calder catchment the proportion of sites supporting good salmonid densities was identical for both 0+ salmon and trout (15%), but varied between 35% for >0+ salmon and 20% for >0+ trout. Therefore, neither species is particularly dominant in this river.

3.1.7 Along the main stem of the R. Calder, a higher proportion of sites supported good salmon densities (25% and 50% for 0+ and >0+ respectively) than supported good trout densities (8.3% for both 0+ and >0+). Within the R. Calder tributaries, a higher proportion of sites (25% and 37.5% for 0+ and >0+ respectively) supported good trout populations than supported good salmon populations (0% and 12.5% respectively for 0+ and >0+), suggesting that the tributaries provided habitat more suitable for trout.

Comparison of R. Ehen and R. Calder fisheries data

3.1.8 The proportion of sites supporting good densities of salmon of both age classes was very similar in both rivers, with proportions of 16.7% vs 15% for 0+ salmon in the R. Ehen and R. Calder respectively, and 30% vs 35% for >0+ salmon. The R. Ehen had a much higher proportion of sites supporting good trout populations than did the R. Calder (51.7% vs 15% for 0+ trout in the R. Ehen and R. Calder respectively, 56.7% vs 20% for >0+ trout). The data therefore indicate that on a catchment-wide basis the distribution of good salmon densities in the rivers was very similar, although a greater proportion of sites in the R. Ehen supported good densities of trout when compared with the R. Calder.

3.1.9 In the main stems of the rivers a similar proportion of sites supported good densities of 0+ salmon and >0+ trout in both rivers (29.4% vs 25% for 0+ salmon in the R. Ehen and R. Calder respectively, and 11.8% vs 8.3% for >0+ trout). The proportion of sites in the R. Ehen that supported a good density of 0+ trout was approximately double that of the sites in the R. Calder (17.6% vs 8.3%). However, the R. Calder provided a larger proportion of sites with good >0+ salmon densities (50% vs 17.6 %). More sites on the R. Ehen therefore support a good trout population, while more sites on the R. Calder provide habitat more suitable for >0+ salmon.

3.1.10 A higher proportion of tributary sites on the R. Ehen sustained good densities of both age classes of salmon and trout compared with the R. Calder tributaries. The differential between the two rivers was greatest for 0+ and >0+ trout, with 65.1% and 74.4% of the R. Ehen tributary sites supporting good densities of 0+ and >0+ trout respectively, compared with 25% and 37.5% of sites on the R. Calder tributaries. A higher proportion of the R. Ehen tributary sites therefore provided habitat suitable for salmonids in comparison with the R. Calder tributaries.

3.1.11 Finally, it is important to note that for the majority of those sites which were surveyed in both years there was a reduction in the salmonid densities between 1993 and 1998.

Table 1 Proportion of sites with salmonid densities defined by the National Fisheries Classification Scheme - River Calder

Whole Catchment				
Salmonid density class	**Proportion of sites (%)**			
	0+ Salmon	**0+ Trout**	**>0+ Salmon**	**>0+ Trout**
A	0	5	5	5
B	0	5	10	5
C	15	5	20	10
D	40	25	30	25
E	15	45	10	45
F	30	15	25	10
Total A-C	**15**	**15**	**35**	**20**
Total D-F	**85**	**85**	**65**	**80**
Main River				
Salmonid density class	**Proportion of sites (%)**			
	0+ Salmon	**0+ Trout**	**>0+ Salmon**	**>0+ Trout**
A	0.0	0.0	8.3	0.0
B	0.0	0.0	8.3	0.0
C	25.0	8.3	33.3	8.3
D	58.3	25.0	41.7	16.7
E	16.7	58.3	8.3	66.7
F	0.0	8.3	0.0	8.3
Total A-C	**25.0**	**8.3**	**50.0**	**8.3**
Total D-F	**75.0**	**91.7**	**50.0**	**91.7**
Tributaries				
Salmonid density class	**Proportion of sites (%)**			
	0+ Salmon	**0+ Trout**	**>0+ Salmon**	**>0+ Trout**
A	0.0	12.5	0.0	12.5
B	0.0	12.5	12.5	12.5
C	0.0	0.0	0.0	12.5
D	12.5	25.0	12.5	37.5
E	12.5	25.0	12.5	12.5
F	75.0	25.0	62.5	12.5
Total A-C	**0.0**	**25.0**	**12.5**	**37.5**
Total D-F	**100.0**	**75.0**	**87.5**	**62.5**

Table 2 Proportion of sites with salmonid densities defined by the National Fisheries Classification Scheme - River Ehen

Whole Catchment				
Salmonid density class	**Proportion of sites (%)**			
	0+ Salmon	**0+ Trout**	**>0+ Salmon**	**>0+ Trout**
A	0.0	23.3	6.7	20.0
B	1.7	10.0	8.3	15.0
C	15.0	18.3	15.0	21.7
D	16.7	18.3	11.7	18.3
E	31.7	16.7	23.3	11.7
F	35.0	13.3	35.0	13.3
Total A-C	**16.7**	**51.7**	**30.0**	**56.7**
Total D-F	**83.3**	**48.3**	**70.0**	**43.3**
Main River				
Salmonid density class	**Proportion of sites (%)**			
	0+ Salmon	**0+ Trout**	**>0+ Salmon**	**>0+ Trout**
A	0.0	0.0	0.0	0.0
B	5.9	0.0	0.0	0.0
C	23.5	17.6	17.6	11.8
D	29.4	35.3	11.8	29.4
E	41.2	29.4	52.9	29.4
F	0.0	17.6	17.6	29.4
Total A-C	**29.4**	**17.6**	**17.6**	**11.8**
Total D-F	**70.6**	**82.4**	**82.4**	**88.2**
Tributaries				
Salmonid density class	**Proportion of sites (%)**			
	0+ Salmon	**0+ Trout**	**>0+ Salmon**	**>0+ Trout**
A	0.0	32.6	9.3	27.9
B	0.0	14.0	11.6	20.9
C	11.6	18.6	11.6	25.6
D	11.6	11.6	11.6	14.0
E	27.9	11.6	14.0	4.7
F	48.8	11.6	41.9	7.0
Total A-C	**11.6**	**65.1**	**32.6**	**74.4**
Total D-F	**88.4**	**34.9**	**67.4**	**25.6**

3.2 Comparison of the Ehen and Calder Catchment Habitats

3.2.1 In order to describe and compare the habitat characteristics of the R. Ehen and the R. Calder, a series of habitat parameters were selected which were considered to be the key factors affecting riverine ecology and specifically, fish populations. The data for the R. Ehen and R. Calder RHS sites were compared using multivariate statistical analyses to compare the results from the two river systems.

3.2.2 The following eleven habitat features were selected: gradient, % bedrock, % boulder, % cobble, % gravel/pebble, % eroded cliff, % stable cliff, water width, water depth, the number of riffles and the number of pools. The values for substrates and bank stability (eroded or stable cliff) were calculated from the RHS spot check data and were expressed as percentage occurrence in the ten spot checks. The water depth, channel width and flow character (riffle and pool) values were taken from the overall RHS 'sweep-up' data and the gradient was taken from the map-derived records.

3.2.3 The two river systems were compared, using multivariate statistical analysis, to provide an objective and quantitative comparison based on the above criteria. Multivariate statistics facilitate the analysis of complex datasets by comparing the relative similarities of results from different sampling locations using a Normalised Euclidean Distance dissimilarity coefficient. The between-site differences are then described in graphical outputs (classification and ordination plots) which can be used objectively to divide the sample locations into generic habitat types. These multivariate comparative analyses were carried out using Plymouth Routines in Multivariate Ecological Research (PRIMER v.4). As PRIMER software cannot process large matrices it was necessary to reduce the size of the dataset, thus the sites with no water depth records were removed from the data prior to analysis and the remaining 111 sites were compared.

3.2.4 The dendrogram classification and multi-dimensional scaling (MDS) ordination plots produced by these analyses are presented in Figures 9 and 10. These figures show that there is a clear distinction, based on the factors tested, between the R. Ehen and the R. Calder sites. The sites from these two systems are clearly separated into two groups at a normalised Euclidean dissimilarity level of 5. The only exception to this was site 20827 from the R. Ehen which was included with the R. Calder sites and R. Calder Sites 21234 and 21280 which were clearly distinct from the rest of the dataset (Figures 9 and 10).

3.2.5 In order to identify the reasons for the disparity between the Ehen and Calder rivers, the mean values for each of the habitat parameters in each of the three major groups identified by the multivariate analysis were calculated and are presented in Table 3. In addition, in order to show the spatial changes in the substrate characteristics, the percentage coverage of each substrate type (*i.e.* bedrock, boulder, cobble/gravel/pebble and silt/sand) in the spot check samples at each survey site is shown in Figures 11 to 14.

Table 3 Mean and STD of habitat parameters for 3 groups of sites identified by multivariate analysis

		Gradient	% Bedrock	% Boulder	% Cobble	% Gravel /Pebble	% Silt	% Eroded Cliff	% Stable Cliff	Water Width	Water Depth	No. Riffles	No. Pools
Ehen Sites	Mean	5.5	0.0	0.3	28.7	58.9	0.0	5.0	44.7	13.8	0.4	4.4	0.1
	STD	3.6	0.0	1.6	27.4	34.0	0.0	8.6	21.5	3.6	0.1	1.5	0.3
	Max	25.0	0.0	10.0	100.0	100.0	0.0	30.0	90.0	26.0	0.7	7.0	1.0
	Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	7.5	0.0	2.0	0.0
Calder Sites	Mean	52.1	11.8	35.5	18.3	1.8	4.8	7.9	3.5	5.2	0.2	0.3	2.0
	STD	44.4	12.2	29.8	15.3	5.2	9.7	12.8	9.3	7.8	0.2	0.8	1.9
	Max	200.0	50.0	100.0	60.0	30.0	30.0	50.0	40.0	30.0	1.0	4.0	7.0
	Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0
Sites 21234 & 21280	Mean	11.8	0.0	15.0	10.0	0.0	55.0	0.0	10.0	0.4	0.1	0.0	2.0
	STD	16.6	0.0	7.1	14.1	0.0	21.2	0.0	14.1	0.2	0.0	0.0	2.8
	Max	23.5	0.0	20.0	20.0	0.0	70.0	0.0	20.0	0.5	0.1	0.0	4.0
	Min	0.0	0.0	10.0	0.0	0.0	40.0	0.0	0.0	0.3	0.1	0.0	0.0

3.2.7 From Table 3 and Figures 11 to 14 it is evident that there are several differences between the Ehen and the Calder rivers. The R. Calder sites have a more variable substrate than the R. Ehen, with a greater proportion of bedrock, boulders and silt. The R. Ehen, in contrast, primarily has a cobble, pebble and gravel substrate and no bedrock or silt were recorded. In part, this may reflect the greater range of conditions recorded on the R. Calder owing to the greater number of sites sampled; however, the difference between the systems is illustrated by Figure 13 which shows that the majority of the R. Ehen sites had 100% cobble or 100% gravel/pebble but maximum values of 60% and 30% were recorded on the R. Calder. The other major differences are that the R. Calder has a steeper gradient, a lower proportion of stable cliffs and fewer riffles.

3.3 Positive and Negative Salmonid Habitats

3.3.1 The third stage in the comparative analysis of the R. Ehen and the R. Calder was to identify those sample locations which have habitat characteristics that are preferred by the fry and parr stages of salmon and trout, as well as habitat characteristics which are considered to be detrimental to these species. These 'positive' and 'negative' habitat characteristics were identified from the following sources:

- a study by Egglishaw and Shackley (1982) into the effects of water depth of salmonids;
- the results of previous electric fishing surveys carried out by Young Associates
- N. Chisholm of River Annan Fishery Board (*pers comm.*).

3.3.2 Based on the information from these sources, the following 'positive' habitat characteristics were identified:

Trout and Salmon fry habitat preferences:
water depth <20cm
flow type either riffle or run
substrate coarse gravel/cobble/boulder

Trout parr habitat preferences:
water depth - >25cm
flow type either slow glide or pool
substrate cobble/gravel
additional factors undercut banks, overhanging vegetation, submerged woody debris, submerged roots, rocks and debris;

Salmon parr habitat preferences:
water depth <50cm
flow type
usually run, riffle or cascade/rapids
substrate coarse boulders/cobbles especially with rocks and/or debris

Spawning habitat preferences:
water depth <40cm
flow type laminar flow at tail of pools or runs/glides
substrate - clean gravel

3.3.3 Using these criteria, and specifically the values for water depth, flow type and substrate, the RHS databases for both rivers were interrogated to identify sites which exhibit the most suitable habitat characteristics for salmonids.

3.3.4 The databases were also searched to identify the presence of the following 'negative' river characteristics:

Poor Habitat Types
substrate bedrock or silt
flow type low flow rate
channel braided or vegetation choked

Barriers to Migration
e.g. weirs, culverts, debris dams, waterfalls higher than 5m

Anthropogenic Impacts
e.g. discharges, abstractions, dredging, poor habitat management

3.3.5 Site locations exhibiting these positive and negative salmonid habitats are reviewed in the following sections.

Positive Habitats for Trout and Salmon Fry

3.3.6 In order to identify the sites which are most likely to favour trout and salmon fry in the Rivers Ehen and the Calder, the respective databases were interrogated to select out those sites which had water depths of less than 25 cm and either riffle or run flow conditions. These sites were selected from the dataset, and the percentage of cobbles, gravel and pebbles at each site was calculated from the spot check data. Any sites which, having met the criteria for either water depth or flow regime, had no coarse substrate at any spot check sites, were excluded. The remaining sites which met all three criteria for positive Trout and Salmon fry habitats are shown in Table 4.

3.3.7 From the interrogation of the R. Ehen database, 7 sites were identified which met all three positive habitat criteria, whereas there were 42 sites on the R. Calder. Table 4, however, shows that there were major habitat differences between the positive R. Ehen sites and those on the R. Calder. The R. Ehen sites had relatively high numbers of riffles and a large proportion (90-100%) of coarse substrate. In contrast, riffles only occurred at two of the R. Calder sites and there was generally a much lower coverage of coarse substrate (10-60%). Therefore, the suitability of habitat as nursery areas for salmon and trout fry was evidently greatest at the R. Ehen sites.

3.3.8 The location of the sites on both the R. Ehen and R. Calder which met all the criteria for positive Salmon and Trout fry habitats, as well as those which are identified as being potentially beneficial, are shown in Figure 15.

Positive Habitats for Trout Parr

3.3.9 In order to select the sites which are most likely to favour trout parr in the R. Ehen and the R. Calder, the respective databases were interrogated to find those sites which had water depths greater than 25cm, and glide or pool flow conditions. The presence of additional favourable factors such as the bank morphology, presence of overhanging boughs and underwater roots and the composition of the substrate were also identified from the summary data, and the percentage of coarse cobble/gravel substrate was calculated from the spot-check data.

3.3.10 The results of the data search for positive trout parr habitats are presented in Table 5, which shows that a total of 22 sites were identified which had relatively deep water, suitable glide and/or pool flow conditions and the presence of a cobble/pebble substrate

in at least one spot check site. A further 8 locations (3 on the R. Ehen and 5 on the R. Calder) were also selected by the data search but these had water depths which were recorded as '999' and were thus excluded from the analyses.

3.3.11 The results shown in Table 5 indicate that the habitat types most suitable for trout parr are more common in the R. Ehen than in the R. Calder. Although the R. Calder does have several sites where the habitat may be suitable, these are evidently less optimal than the R. Ehen sites, mostly because of the lower proportion of cobble, gravel and pebble substrates. The sites on the R. Calder also have less overhanging boughs, submerged tree roots, in-stream debris and fallen trees, all of which provide excellent habitat structure and diversity for trout parr. Appropriate habitat enhancement techniques are detailed in Section 4.

3.3.12 The location of the sites on both the Ehen and Calder rivers which meet all the criteria for positive trout parr habitats, as well as those which are identified as being potentially beneficial, are shown in Figure 16.

Positive Habitats for Salmon Parr

3.3.13 In order to select out those sites which are most likely to favour salmon parr, the RHS databases were interrogated to find those sites where the water depth was less than 50cm, where runs, cascades and/or rapids were recorded and where coarse substrate was present in at least one spot check location. For sites meeting these criteria, a record was also taken of the abundance of exposed boulders which are also deemed to be a favourable habitat feature for salmon parr. The sites identified from this analysis are shown in Table 6.

3.3.14 Owing to the less specific habitat criteria selected for this analysis in comparison with the previous analyses for fry and trout parr (i.e. a greater range of water depths and flow conditions are selected), a much larger number of sites (78) were identified as being suitable for salmon parr. The R. Ehen sites were once again shown to have a much higher coverage of coarse substrate and for this reason the quality of the habitat for salmon parr is perceived to be higher on this river.

3.3.15 The Calder, however, generally had more favourable flow conditions with most of the selected sites in this river having all three preferred flow conditions of cascades, rapids and runs (Table 6). In addition, the R. Calder sites generally had exposed boulders whereas these were only observed at a few of the selected R. Ehen sites. These factors mean that the Calder sites, while they may not provide ideal conditions for salmon parr, are likely to provide some usable habitat.

3.3.16 The location of the sites on both the Ehen and Calder rivers which meet all the criteria for positive salmon parr habitats, as well as those which are identified as being potentially beneficial, are shown in Figure 17.

Positive Habitat for Salmonid Spawning

3.3.17 In order to select out those sites which provide conditions that are most suitable for spawning salmonids, the RHS databases were interrogated to find those sites which had a water depth of less than 40 cm and where a gravel substrate was recorded in at least one spot check sample. For sites meeting these criteria, the presence of favourable flow

factors (i.e. pools, laminar flows, runs and/or glides) were noted. The sites identified from this analysis are shown in Table 7.

3.3.18 Table 7 shows that the sites on the R. Calder have a very small proportion of gravel substrates when compared with the sites on the R. Ehen, gravel being the prime substrate requirement for successful salmonid spawning. For this reason the best salmonid spawning sites were identified on the R. Ehen.

3.3.19 Table 7 also indicates that the R. Ehen has many sites where the flow depth, type and substrate composition combines to provide habitat that is likely to be suitable for spawning. Sites on the R. Calder with a suitable combination of habitat characteristics are far fewer, and the proportion of gravel in the substrate composition at the sites is far lower. In addition, four of the sites on the R. Calder have a water depth of less than 10 cm and may be unsuitable for spawning purposes. The clear lack of suitable spawning habitat on the R. Calder may be one reason for the relatively low salmon and trout densities in that river, as it would reduce the recruitment of juvenile fish and thus lead to lower population densities. The lack of potential spawning areas is also likely to ensure that the full potential of the nursery areas is not reached. Suitable habitat enhancement techniques are discussed below (Section 4).

3.3.20 The location of the sites on both the Ehen and Calder rivers at which the habitat characteristics are likely to favour salmonid spawning are shown on Figure 18.

Table 4 R. Ehen and R. Calder RHS sites which exhibit 'positive' habitat characteristics for salmon and trout fry

Site No.	NGR	Water Depth	No. Riffles	Runs	% Gravel Cobble, Pebble
R. Ehen Sites					
20809	NY084186	0.2	6	E	100
20810	NY082152	0.2	6	E	100
20811	NY079154	0.15	6	E	100
20815	NY068159	0.2	4	P	100
20819	NY055161	0.2	6	P	100
20820	NY051159	0.2	3	P	100
20861	NY074155	0.02	7	E	90
R Calder Sites					
21238	NY064065	0.08	0	E	20
21241	NY064075	0.12	0	E	30
21248	NY114118	0.07	0	E	40
21250	NY097103	0.15	3	E	10
21254	NY103107	0.15	0	E	20
21255	NY094103	0.2	0	E	20
21258	NY068109	0.15	0	E	40
21259	NY077112	0.2	0	E	10
21260	NY080114	0.1	0	E	20
21263	NY067122	0.1	0	E	20
21267	NY112097	0.15	0	E	40
21268	NY110095	0.07	0	P	10
21269	NY109097	0.1	0	E	30
21270	NY108097	0.07	0	E	30
21271	*	0.1	0	E	10
21272	NY091089	0.15	0	E	50
21273	NY077093	0.1	0	E	10
21274	NY094093	0.1	0	E	60

Site No.	NGR	Water Depth	No. Riffles	Runs	% Gravel, Cobble, Pebble
R Calder Sites (continued)					
21275	NY104092	0. 1	0	E	50
21276	NY103089	0.07	0	E	30
21277	NY098090	0.1	0	E	30
21278	NY084096	0.1	0	E	10
21279	NY082097	0.1	0	E	20
21280	NY079096	0.07	0	E	20
21319	NY074075	0.1	0	E	30
21320	NY066080	0.1	0	E	20
21322	NY068086	0.1	0	E	10
21325	NY067104	0.15	0	E	20
21326	NY073102	0.1	0	E	30
21329	NY064110	0.1	0	E	30
21330	NY058077	0.07	0	E	10
21331	NY060085	0.07	0	E	40
21332	NY085132	0.15	0	E	40
21333	NY093137	0.1	0	E	30
21334	NY085130	0.1	0	E	40
21335	NY094127	0.1	0	E	30
21336	NY083127	0.07	0	E	10
21337	NY075128	0.15	1	E	50
21339	NY084119	0.07	0	E	10
21341	NY085132	0.15	0	E	20
21342	NY079138	0.07	0	E	10
21343	NY078137	0.07	0	E	10

Red sites: most likely to favour salmon and trout fry parr because they meet all 'positive' habitat criteria and have a high number of riffles and 100% coarse substrate.
Blue sites: probably favourable to salmonid fry because they meet all 'positive' habitat criteria but have few riffles and/or a low proportion of coarse substrate.
Remaining sites: may be favourable to salmonid fry because of shallow water depth, presence of runs and presence of some coarse substrate, although no riffles are present and coverage of coarse substrate is relatively low

Table 5 R. Ehen and R. Calder RHS sites which exhibit 'positive' habitat characteristics for trout parr.

		Key Search Factors			Additional Factors							
Site No.	NGR	Water Depth (m)	Flow Type Glides	Flow Type Pools	% Cobble/ Gravel/ Pebble	Left Bank Vertical/ Undercut	Right Bank Vertical/ Undercut	Overhanging Boughs	Underwater Tree Roots	Debris	Fallen Trees	Exposed Boulders
R. Ehen Sites												
20808	NY086154	0.3	P		100	E	E	P	P	P	P	P
20812	NY076154	0.25	P		100	E	E	P	P	P	P	
20813	NY073157	0.4	P		100	E	E	P	P	P	P	
20814	NY071156	0.4	P		100	E	E	P	P	P	P	
20816	NY064159	0.3	P		100	E	E		P			
20817	NY062158	0.3	P		100	P	P			P	P	
20818	NY059161	0.3	P		90	P	E			P	P	P
20841	NY008092	0.4	P		80	P	P					
20842	NY005087	0.4	P	P	80		P	P		P	P	
20843	NY007084	0.5	P		70	P	P	P				
20844	NY008080	0.4	P		60	P	E	P	P	P		P
20850	NY008061	0.4	P		70							
20851	NY012058	0.6	P	P	90							
R. Calder Sites												
21233	NY035054	0.8	P	P	20	P	P	P	P			P
21237	NY057067	0.25	P		60			P	P	P	P	P
21247	NY104114	0.3		P	20	P	P			P	P	E
21249	NY093094	0.25		P	20	P	P					E
21251	NY102110	0.25	P	P	10	P	P					E
21252	NY103112	0.3		P	20	P	P					E
21257	NY064103	0.25		P	20	P	P					E
21261	NY067112	0.3		P	20	P	P					E
21323	NY065093	0.35	P		20	P	P		P	P	P	E

Red Sites: most likely to favour trout parr because they meet the criteria for water depth and flow Type, have 100% coarse substrate or some coarse substrate and 3 or more additional factors

Blue Sites: likely to favour trout parr because they have suitable flow type and depth, but have only 20-90% coarse substrate

Remaining Sites: may favour trout parr because they meet the criteria for water depth and flow type but they have <20% coarse substrate or no additional factors

Table 6 R. Ehen and R. Calder RHS sites which exhibit 'positive' habitat characteristics for salmon parr.

Site No.	Depth	% Coarse Substrate	Cas-cades	Rapids	Runs	Boul-ders
R. Ehen						
20808	0.3	100		P	E	P
20809	0.2	100			E	
20810	0.2	100			E	P
20811	0.15	100			E	
20812	0.25	100			P	
20813	0.4	100			E	
20814	0.4	100			E	
20815	0.2	100			P	P
20816	0.3	100			E	
20817	0.3	100			P	
20818	0.3	90		P	P	P
20819	0.2	100			P	P
20820	0.2	100			P	P
20821	0.3	100			P	
20822	0.3	100			P	
20824	0.4	80			P	
20825	0.4	100			P	
20826	0.5	100		P	P	P
20827	0.5	50		E	P	P
20828	0.4	100		P	P	P
20829	0.4	100		P	P	P
20830	0.5	80		P	P	
20831	0.5	80		P	P	
20839	0.4	70			P	
20840	0.5	60		P	P	
20841	0.4	80		P	P	
20842	0.4	80			P	
20843	0.5	70		P	P	
20844	0.4	80		P	P	P
20845	0.4	60		P	P	

Site No.	Depth	% Coarse Substrate	Cas-cades	Rapids	Runs	Boul-ders
R. Ehen (Continued)						
20846	0.5	60		P	P	
20847	0.5	40		P	P	
20850	0.4	70			P	
20861	0.02	90			E	
R. Calder Sites						
21237	0.25	60	P	P	E	P
21238	0.08	20			E	P
21241	0.12	30	P	E	E	E
21247	0.3	20	P	P	E	E
21248	0.07	40	P	P	E	E
21249	0.25	20	P	P	E	E
21250	0.15	10	P	P	E	E
21251	0.25	10	P	E	E	E
21252	0.3	20	P	E	E	E
21253	0.25	40	P	P	E	E
21254	0.15	20	P	P	E	E
21255	0.2	20	P	P	E	E
21256	0.35	40		P	E	E
21257	0.25	20	P	P	E	E
21258	0.15	40	P	E	E	E
21259	0.2	10	P	E	E	E
21260	0.1	20	P	P	E	E
21261	0.3	20	P	P	E	E
21263	0.1	20	P	P	E	P
21266	0.25	20	P	E	E	E
21267	0.15	40	P	P	E	E
21268	0.07	10	P	P	P	P
21269	0.1	30	P	P	E	P
21270	0.07	30	P	P	E	P
21271	0.1	10	P	P	E	P

Site No.	Depth	% Coarse Substrate	Cas-cades	Rapids	Runs	Boul-ders
R. Calder Sites (continued)						
21272	0.15	50	P	P	E	E
21273	0.1	10	P	P	E	E
21274	0.1	60	P	P	E	E
21275	0.1	50	P	P	E	P
21276	0.07	30	P	P	E	P
21277	0.1	30	P	P	E	P
21278	0.1	10	P	P	E	P
21279	0.1	20	P	P	E	P
21280	0.07	20	P	P	E	P
21317	0.25	10	P	P	E	E
21319	0.1	30	P	P	E	P
21320	0.1	20	P	P	E	E
21322	0.1	10	P	P	E	E
21323	0.35	20	P	P	E	E
21325	0.15	20	P	P	E	E
21326	0.1	30	P	P	E	P
21329	0.1	30	P	P	E	P
21330	0.07	10			E	P
21331	0.07	40			E	P
21332	0.15	40	P	P	E	E
21333	0.1	30	P	P	E	P
21334	0.1	40	P	P	E	P
21335	0.1	30	P	P	E	P
21336	0.07	10			E	P
21337	0.15	50	P	P	E	E
21339	0.07	10	P	P	E	P
21341	0.15	20	P	P	E	P
21342	0.07	10			E	P
21343	0.07	10			E	

Red Sites: most likely to favour salmon parr because they meet the criteria for water depth and flow type, and have 100% coarse substrate.
Blue Sites: likely to favour salmon parr because they have suitable flow type and depth, but have only 20-90% coarse substrate and/or 1 or more additional factors
Remaining Sites: may favour salmon parr because they meet the criteria for water depth, flow type and at least 1 additional factor but have <20% coarse substrate.

Table 7 R. Ehen and R. Calder RHS sites which exhibit 'positive' habitat characteristics for salmonid spawning grounds

Site No.	NGR	% Gravel and Pebble	Water Depth (m)	Pools	Laminar Flow	Runs	Glides
R. Ehen Sites							
20808	NY086154	70	0.3	0	?	E	P
20809	NY084186	70	0.2	0	?	E	P
20810	NY082152	100	0.2	P	?	E	P
20811	NY079154	100	0.15	0	?	E	P
20812	NY076154	100	0.25	0	?	P	P
20813	NY073157	70	0.4	0	?	E	P
20814	NY071156	100	0.4	0	?	E	P
20815	NY068159	90	0.2	0	?	P	P
20816	NY064159	100	0.3	0	?	E	P
20817	NY062158	80	0.3	0	?	P	P
20818	NY059161	60	0.3	0	?	P	P
20819	NY055161	100	0.2	0	?	P	P
20820	NY051159	100	0.2	0	?	P	P
20821	NY048157	90	0.3	0	?	P	0
20822	NY043154	90	0.3	0	?	P	0
20824	NY036148	80	0.4	0	?	P	0
20825	NY032145	100	0.4	0	?	P	0
20828	NY022142	40	0.4	0	?	P	0
20829	NY022137	20	0.4	0	?	P	0
20839	NY012099	50	0.4	0	?	P	0
20841	NY008092	40	0.4	0	?	P	P
20842	NY005087	50	0.4	P	?	P	P
20844	NY008080	50	0.4	0	?	P	P
20845	NY008076	50	0.4	0	?	P	0
20850	NY008061	60	0.4	0	?	P	P
20861	NY074155	90	0.02	P	?	E	P
R. Calder Sites							
21237	NY057067	10	0.25	0	-	E	P
21238	NY064065	10	0.08	0	-	E	P
21269	NY109097	10	0.1	P	-	E	0
21276	NY103089	10	0.07	P	-	E	0
21330	NY058077	10	0.07	P	-	E	P
21331	NY060085	10	0.07	P	-	E	0
21333	NY093137	20	0.1	P	-	E	P
21334	NY085130	10	0.1	P	-	E	P
21341	NY085132	10	0.15	P	-	E	0

Red Sites: most likely to favour salmonid spawning because they meet the criteria for water depth, have 100% gravel and pebble substrate, both run and glide flow conditions and occasionally pools

Blue Sites: likely to favour salmonid spawning because they meet the criteria for depth but have only 20-90% coarse substrate as well as both run and glide flow conditions

Remaining Sites: may favour salmonid spawning because they meet the criteria for water depth, there is a gravel and pebbles substrate present but at a low percentage (<20%)

Negative Habitat Characteristics

3.3.20 In order to determine whether there are any habitat characteristics of the R. Calder and/or the R. Ehen which are clearly detrimental to salmonid populations, the RHS databases were interrogated to find sites where perceived 'negative' impacts were present. The three categories of 'negative' impact identified in Section 2 (i.e. poor habitat, migration barriers and anthropogenic impacts) were reviewed in turn.

3.3.21 For this analysis it is important to note that many sites which have 'negative' characteristics may also have previously been identified as having 'positive' characteristics, and it is not possible to make any judgement, from the present evidence, about the extent to which these factors interact. However, this information will allow judgements to be made about the relative characteristics of the Ehen and Calder systems.

Poor Habitat Quality

3.3.22 Initially a database search was conducted to select out sites with the following habitat characteristics which are not favourable to salmonids:

- the presence of bedrock or silt substrate (based on at least 3 samples in the spot check sites, i.e. ≥30%);
- areas of low flow (i.e. ponded reaches and marginal deadwaters);
- vegetation choked channels and braided channels.

3.3.23 A total of 77 sites were found to have one or more of these habitat characteristics, of which 34 were from the Ehen and 43 were from the Calder. The full results of this search are shown as Appendix 2 and the number of sites in the two systems exhibiting each characteristic is shown in Table 8.

Table 8: Number of sites showing 'negative' habitat characteristics for salmonids

River	≥30% Bedrock	≥30% Silt	Braided Channel	Ponded Reach	Marginal Deadwater	Choked Channel
Ehen	1	0	2	4	34	0
Calder	9	8	7	19	16	6

3.3.24 In general, a greater number of the R. Calder sites showed these negative habitat features, although this will be because a larger number of sites were sampled from a greater range of conditions (i.e. both tributary and main stem sites) on the R. Calder than the R. Ehen. These results again indicate a difference in the substrate of the Ehen and the Calder systems. Several sites on the main river stem and the tributaries of the R. Calder have a bedrock substrate, whereas bedrock was only observed at one location on the R. Ehen (Site 20827). No silt was recorded on the R. Ehen either, but this is almost certainly because only the faster-flowing main stem of the river was sampled. This is evidenced by results from the R. Calder where the locations with ≥30% silt were almost exclusively situated in the tributaries (see Section 3.2). The choked channels, which were only recorded on the R. Calder, were similarly confined to the tributary sites.

3.3.25 As has been noted previously, there are differences between the rivers in the amount of bedrock and silt present. Areas of bedrock do not provide suitable habitat for salmonids as the flow is very fast and laminar and there are no crevices for the fish to take refuge in, or stones to hide behind. The invertebrate communities of bedrock areas are also often

poorer than areas with a mixed substrate, and thus the food resource for salmonids is also reduced. Areas of extensive silt deposition are a negative habitat characteristic for salmonids as the silt smothers the hard substrate and reduces both cover and the food resource potential of the affected areas. Smothering of gravel areas with silt also prevents successful salmonid spawning, incubation and hatching.

3.3.26 There appears to be no major difference between the rivers in terms of the occurrence of braided channels. Although more are present on the R. Calder than the R. Ehen, this may be because more sites were sampled. Sections of constantly moving braided channel are also a poor quality habitat for salmonids, particularly for spawning, as the unstable nature of the channel may cause eggs that are laid in redds to be covered over with a great depth of substrate or to be deprived of water by the migration of the channel.

3.3.27 There is no clear difference between the rivers in terms of still waters, with ponded reaches being more common on the Calder and marginal deadwaters being found throughout the Ehen. Ponded reaches are not good habitat for salmon, which require fast flowing, well-oxygenated water, although trout have a habitat preference for slower flowing water. Interestingly, the greatest number of 'negative' factors occur in Worm Gill, which suggests that this tributary of the R. Calder is likely to have the lowest potential for supporting salmonid populations.

Barriers to Migration

3.3.28 To show the locations which have possible barriers to migration, the database was searched for the following factors: major and minor weirs, culverts and waterfalls >5m high. The results of this search are shown as Appendix 3 and the locations of RHS sites which contain potential barriers are shown in Figure 19.

3.3.29 Appendix 3 indicates that there are potential barriers to the upstream migration of returning adult salmonids at a number of sites in each catchment. The R. Calder has a number of possible obstacles at the mouth of the river, including major weirs and water impounding dams, both of which are found in the first two RHS sites on the river. There is a possibility that these may affect the level of salmonid immigration to the river. Major waterfalls of greater than 5m height, which present probably the most significant obstacle, are only recorded at the end of tributaries and are therefore not considered to be a major factor. The majority of barriers on the R. Ehen are also found in the upper reaches of the river.

3.3.30 The extent to which these potential barriers to migration are actually affecting the migrations could only be assessed following a visual inspection of the various weirs, dams and culverts. However, salmon are present in both catchments above the majority of the obstructions, indicating that upstream migrations can still be completed.

Land Management

3.3.31 To determine the extent to which land management factors have influenced the habitats of the Ehen and Calder rivers the Habitat Modification (HMI) Scores derived by the Environment Agency were analysed. HMI scores are calculated by considering a suite of around 20 bank modification processes (such as bank reinforcement, poaching, resectioning) that are recorded in both the RHS spot checks and the sweep-up data. A score is assigned to each factor present and the resulting HMI score is expressed as the

cumulative value of these parameters. An overall modification category is assigned from the total score.

3.3.32 To illustrate the extent of bank modification on the Ehen and Calder, the HMI scores are superimposed on the respective RHS site positions in Figure 20. This Figure shows that there is a much greater level of modification on the R. Ehen when compare to the R. Calder, and that this is the case throughout the length of the surveyed main stem of the R. Ehen. The lower reaches of the R. Calder show similar levels of modification but, as expected, the tributaries at higher altitudes and steeper gradients, where anthropogenic influence is low, consistently receive HMI scores of less than 2. This illustrates a further clear difference between the Ehen and Calder catchments.

3.3.33 This overview would suggest that habitat modification may not be a critical factor in the decline in the salmonid populations of the R. Calder, but is more likely to be a significant factor on the R. Ehen. However, to confirm this would require a closer analysis of the specific processes involved and the interaction between these and the habitat characteristics of the system. For this reason, the potential influence of land management issues for the R. Calder are investigated in greater depth, and with greater reference to the habitat data, in Section 3.4.

3.4 Review of the Calder Catchment

3.4.1 The previous sections have illustrated that there are marked differences between the catchments of the Ehen and the Calder, although the fish populations are not greatly dissimilar. However, to investigate further the reasons for the observed decline in the fisheries of the Calder, the characteristics of this system were reviewed to provide an holistic description this catchment and the factors which may influence salmonid species. To provide this overview the RHS survey results are summarised in Table 9.

3.4.2 Table 9 indicates that tree lined banks and associated factors (overhanging boughs, exposed roots, underwater roots, and woody debris) were recorded at between 20-30% of the sites. These woodland sites were almost exclusively found in the lower reaches, from the confluence of the main stem and Worm Gill to the most seaward site (Site no. 21232). These conditions are generally favoured by salmonids, but any beneficial effects that these may have for the river's fisheries may well be negated by the lack of a suitable substrate in these areas. Table 9 also shows the number of sites at which the different substrate types were recorded in one or more of the spot check samples. This further confirms that the R. Calder is a bedrock, boulder and cobble dominated system, as these substrate types were recorded in 60-80% of all the survey sites. Gravel/pebble and silt deposits were only observed at 13% and 25% of the sites respectively (see also Figures 12 to 14).

3.4.3 The general lack of fine material is clearly the result of consistently strong flows throughout the length of the catchment, together with the natural geology of the area. This is indicated by the fact that runs, cascades and rapids were observed in 84 to 98% of all the sites. Due to these rapid flow conditions, silt deposition was primarily found at sites on the small tributaries outwith the influence of the flows experienced in the main channels (see Figure 14). This limited level of sediment deposition is confirmed by records from the sweep-up survey of discrete silt and sand deposits which show that these were present at only 2 and 3 sites respectively.

Table 9 River Calder Catchment Characteristics

Woodland Statistics (Sweep Up)		
	% E	% P or E
Tree Shading	10.53	28.95
Overhanging Boughs	0.00	19.74
Exposed Roots	2.63	22.37
Underwater Roots	0.00	21.05
Fallen Trees	0.00	13.16
Woody Debris	0.00	22.37

River Flow Types (Sweep Up)		
	% E	% P or E
Waterfall	0.0	51.3
Cascades	0.0	84.2
Rapids	19.7	90.8
Runs	97.4	98.7
Boils	0.0	9.2
Glides	1.3	25.0
Marginal Deadwaters	0.0	21.1
Pools	0.0	77.6
Riffles	0.0	11.8

Artificial Features (Sweep Up)			
	Total recorded	No. Sites	% Sites
Weirs Major	2	2	2.6
Sluices	0	0	0.0
Culverts	16	8	10.5
Bridges (Major)	0	0	0.0
Revetments	0	0	0.0
Outfalls	15	6	7.9
Fords	6	6	7.9
Deflectors	0	0	0.0

Substrate (Spot Check)		
	No. Sites	% Sites
% Bedrock	46	61
% Boulder	64	84
% Cobble	59	78
% Gravel/Pebble	10	13
% Silt	19	25

Land Use Statistics (Sweep Up)		
	% E	% P or E
Broadleaf	14	29
Coniferous	5	11
Moorland	33	42
Scrub	13	49
Rough Pasture	51	64
Tilled Land	0	4
Wetland	37	84
Open Water	0	1
Urban	0	12
Improved Grassland	9	9

Bank Profiles (Sweep Up)		
	% E	% P or E
Vertical/Undercut	9.21	85.53
Vertical and Toe	0.00	48.68
Steep	94.74	98.68
Gentle	10.53	86.84
Resectioning	0.00	15.79
Reinforced - Whole Bank	2.63	21.05
Poached	3.95	53.95
Set Back Embankment	0.00	0.00

Erosion (Spot check)		
	No. Sites	% Sites
0-10% Erosion	62	81.5
20-30% Erosion	9	11.8
40-50% Erosion	5	6.6
50-100% Erosion	0	0

Channel Features (Sweep Up)		
	% E	% P or E
Exposed Bedrock	1.32	65.79
Exposed Boulders	1.32	65.79
Unvegetated MCBs	5.26	32.89
Vegetated MCBs	1.32	14.47
Mature Island	1.32	3.95
Unvegetated SBs	1.32	42.11
Vegetated SBs	0.00	3.95

Silt/Sand Deposits (Sweep Up)		
	% E	% P or E
Discrete Silt Deposit	0.00	2.63
Discrete Sand Deposit	0.00	3.95

Habitat Modification Score (EA Score)			
	HMI		
Median	1.00		
Mean	1.34		

Vegetation (Spot Check)			
	mean %	median %	No. Sites
Amphibious	7.57	0	39
Bryophytes/Lichens	42.94	40	81
Emergent Broadleaf	3.04	0	12
Emergent Reeds/Sedges	41.55	30	77
Filamentous Algae	29.71	20	69
Floating Leaves (Rooted)	0	0	0
Free Floating	0	0	0
Submerged Broad-leaved	0	0	0
Submerged Fine-leaved	0	0	0
	1.94	200	12

3.4.4 In order to determine the degree of bank stability and the potential sources of silt and sand within the catchment, bank erosion is also summarised in Table 9. This information is calculated from the spot check surveys and shows the proportion of sites which had eroding banks as a percentage of the ten spot check samples. The results indicate that the majority of sites (81.5%) showed only 0-10% erosion, and of these 63% had no evidence of erosion in the spot checks. Approximately 18% of sites had between 20 and 40% erosion, and one site on main stem of the river (Site number 21240) had 50% erosion.

3.4.5 Many of the bank profiles were vertical and at 95% of sites there was an extensive occurrence of 'steep' banks. A large proportion of sites were found to have vertical and undercut banks, indicating that there has been removal of some sediment from the channel margins but, as discussed previously, this sediment is quite clearly flushed through the river and not allowed to settle. Around half (53%) of the sites display signs of poaching, but this is only recorded as extensive at 4% of sites.

3.4.6 The adjacent land use is characterised by rough pasture, wetlands (e.g. rush-dominated mires) and moorland with a lower cover of broadleaved woodland and scrub. There are small areas of improved grassland and coniferous woodland. With the exception of broadleaved woodland, these habitats do not provide good cover for fish in terms of overhanging vegetation or submerged roots and do not provide substantial additions of fish food items to the river.

3.4.7 Channel vegetation in the R. Calder is dominated by bryophytes and lichens, as would be expected in a river with high flow rates. Emergent reeds/sedges and filamentous algae are also present, and are typical of sites with a lower gradient (for example, many of the lower gradient moorland tributaries have channel vegetation dominated by soft-rush, *Juncus effusus*). Bryophyte-dominated vegetation can provide good invertebrate habitat which, in turn, provides good feeding conditions for salmonid fish. Emergent reed habitats can be good nursery areas for young fish, as they provide cover and shelter. Neither of these vegetation types is therefore a negative habitat factor for salmonid fish.

4 CONCLUSIONS AND RECOMMENDATIONS

4.1 From the analysis of the fisheries data, discussed earlier, it is apparent that the Ehen and Calder rivers do not support particularly good salmonid populations, although the R. Ehen appears to support better trout populations than the R. Calder. The salmon densities in both rivers are similar. The R. Ehen flows generally through a wide valley floor with a moderate gradient and an extensive network of moderate gradient tributaries, whilst the R. Calder flows through a much steeper, narrower valley with very short, steep tributaries. The R. Ehen is therefore much more likely to provide habitat that is more suitable for trout, as they prefer the run, glide or pool flow types typically associated with moderate gradient rivers. Conversely, salmon prefer faster flowing riffles and runs and the R. Calder is therefore more likely to support good population densities of salmon.

4.2 Given that the Ehen and Calder rivers, together with their surrounding landform, are rather dissimilar in nature, a direct comparison of their salmonid fisheries and river habitats may not be a sufficiently robust technique to identify the causes of the differences in the fisheries. Indeed comparisons between tributaries of the same catchment may provide information that is misleading, as habitat parameters are not the only factors affecting the densities of salmonids in rivers.

4.3 The Calder fish densities may be influenced by a number of factors identifiable by the RHS analysis, including a lack of spawning habitat and habitat suitable for salmon and trout fry and parr. Alternative contributory factors have not been identified owing to a lack of data, although the options have been discussed.

4.4 It is a natural situation for some rivers to have apparently good salmonid habitat and water quality yet still support relatively low population densities of salmonids. In such cases habitat modifications may slightly improve the salmonid densities if habitat is a limiting factor, although the river may never become a good fishery.

4.5 There is a possibility that habitat enhancement of the Calder could be used to improve the extent of suitable spawning habitat using the approaches detailed below:

- seeding of low velocity flow sections of the river with gravel to produce artificial spawning habitat;
- use of constriction points in the channel, perhaps constructed using large boulders, to increase the flow velocity, which will result in enhanced scouring of the substrate over a short distance and subsequent deposition of gravel slightly further downstream;
- initiating the deliberate erosion of sections of the bank throughout the length of the river in order to increase the input of gravel to the system;
- construction of small weirs to impound the flow and cause deposition of gravel.

4.6 However, it should be noted that the steep gradient of the R. Calder and the consequent rapid flow velocity may prevent the success of any attempts to enhance the gravel spawning areas through the effects of scouring.

4.7 Although many sites on the Calder provide habitat that may be suitable for salmon and trout fry, the habitat would appear to be sub-optimal due to the substrate composition and

lack of riffles. There is probably very little management that can be undertaken to increase the proportion of coarse substrate at the sites, as boulders and bedrock account for the majority of the substrates in the catchment. However, methods to reduce the flow velocity in an attempt to retain the smaller substrate components of gravel and cobbles may be possible, although on such a fast flowing river this approach is unlikely to be particularly effective, particularly on such a wide scale. The extensive management of the river to provide more suitable riffle flow patterns is also unlikely to be cost-effective or realistic on such a wide scale. In any case, such extensive habitat and flow modifications are likely to be short lived and cause problems such as increased bank erosion or flooding elsewhere in the catchment.

4.8 The availability of habitat suitable for trout parr was also limited in the Calder, predominantly by the substrate composition. Again, management of extensive areas of the river to optimise the substrate composition for salmonids is unlikely to be realistic or cost-effective. More realistic management techniques could include the provision of instream cover using the following techniques:

- Planting of trees and shrubs on the bank-side to stabilise eroding banks, resulting in undercut banks, submerged tree roots and overhanging vegetation and boughs.
- Placement of in-stream debris, woody material and fallen trees and logs to increase in-stream cover.

4.9 The habitat available to salmon parr was also less suitable in the R. Calder than in the Ehen, principally due to the lower proportion of suitable substrate. The modification of the substrates over such a wide area is not a feasible management objective.

4.10 Several alternative habitat enhancement techniques are also available for a wide range of applications, although their importance to the Calder catchment is likely to be limited owing to the extensive nature of the habitat modification required. Further definition of areas of habitat requiring enhancement would also be required before recommending that more detailed enhancement works are undertaken, and this would be gained by field visits to sites exhibiting habitats suitable for restoration/modification.

4.11 Although habitat differences have been identified between the two rivers that may account for the observed differences in the salmonid populations, it should be emphasised that many other factors have not been considered owing to a lack of information; foremost amongst these is water quality. Even though a river may have excellent salmonid habitat it may still support only limited salmonid populations if the water quality is not suitable. The provision of water quality data, together with macroinvertebrate survey data, would enable a more thorough analysis to be undertaken. Water quality aspects may be particularly important given that BNFL Sellafield discharges to the river, and may adversely affect the water quality in the lowest reaches. Accidental discharges may cause salmonid mortalities in the estuary at particular times of the year and may reduce the number of adult fish returning to spawn.

4.12 The impact of a historically small returning population of adults is also likely to contribute to a general decline in the fishery potential of a river. If the smolt run is small, and the number of returning adults is small, the spawning success is likely to be low, resulting in reduced recruitment and a continuation of the cycle. Any obstructions to upstream migrations may also exacerbate the problem of small number of returning adults by causing a proportion to return to the sea and enter a different river system.

Other factors that could exert an influence on the salmonid populations in the Calder include poaching and predation pressure, although these are unlikely to be significant enough to cause a catchment-wide decline in the fishery.

4.13 It is proposed that further investigations of the R. Calder could be implemented in order to identify whether the carrying capacity of the system has been reached, or whether a lack of recruitment is responsible for the depressed salmonid densities in the river. Such studies could involve the stocking of various sections of the main river and tributaries, and would provide data on whether the densities improved, remained static or declined, thus indicating whether the carrying capacity of the river has been reached naturally. However, it is suggested that a more rapid and cost-effective technique of further investigating the fisheries situation on the River Calder would be for a fisheries scientist to walk the length of the river and to use professional judgement to identify particular problem areas.

5 REFERENCES

Egglishaw, H. J. and Shackley, P. E., (1982) Influence of water depth on dispersion of juvenile salmonids, *Salmo salar* L. and *S. trutta* L., in a Scottish stream. J. Fish Biol, Vol 21, pp. 141-155.

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NRA, 1994. National Rivers Authority National Fisheries Classification Scheme: A Guide for Users. R&D Note 206.

Plymouth Routines in Multivariate Ecological Research (PRIMER v.4)

FIGURES

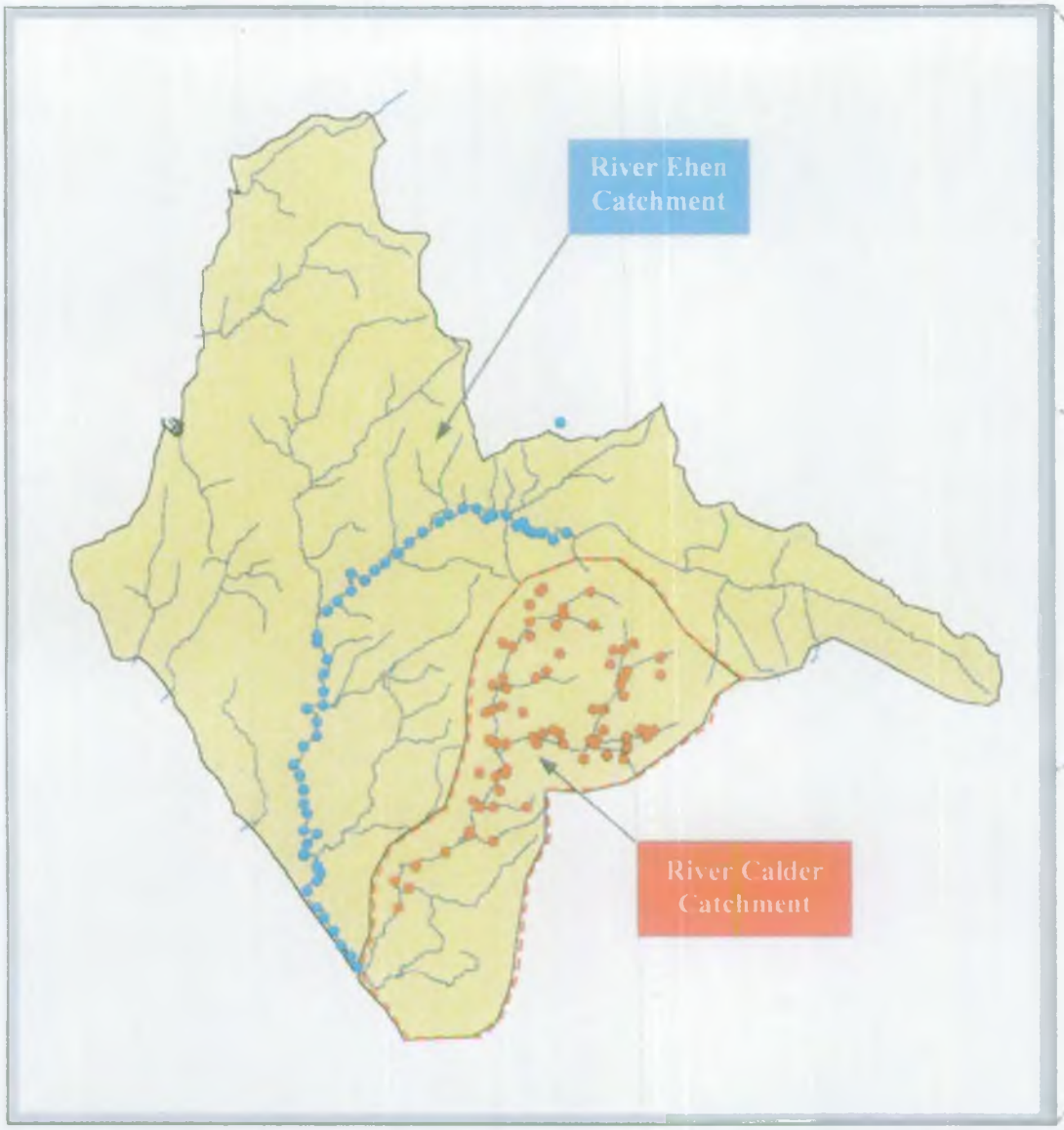

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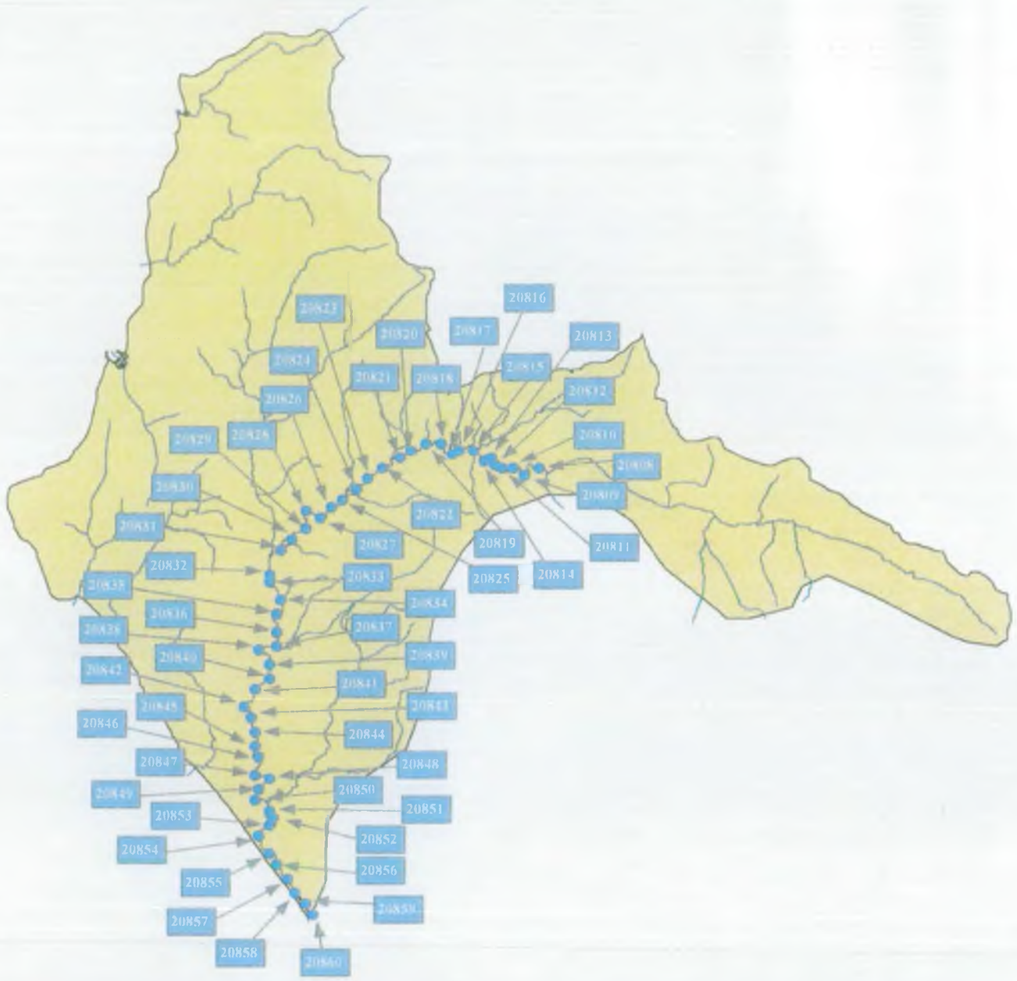
Figure No.: 1

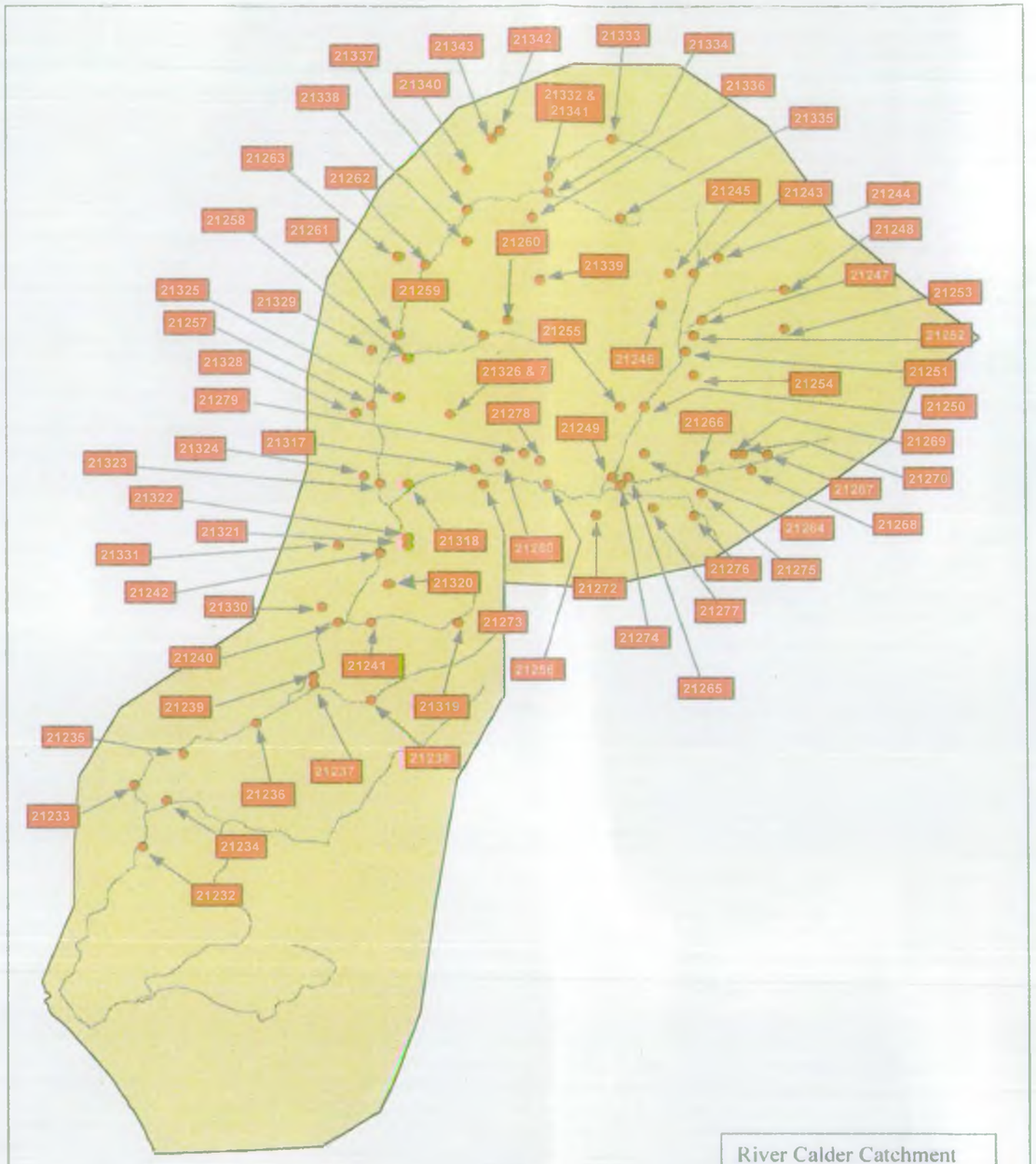
Project No.: A3601

Title:

Location plan of the River Ehen and River Calder catchments.



River Ehen Catchment



River Calder Catchment

Young Associates The Long Barn Chester Road Tattenhall Chester CH3 9AH Tel 01829 770077 Fax 01829 770079	Figure No.: 2 Project No.: A3601	Title: RHS site locations on the R. Ehen and R. Calder

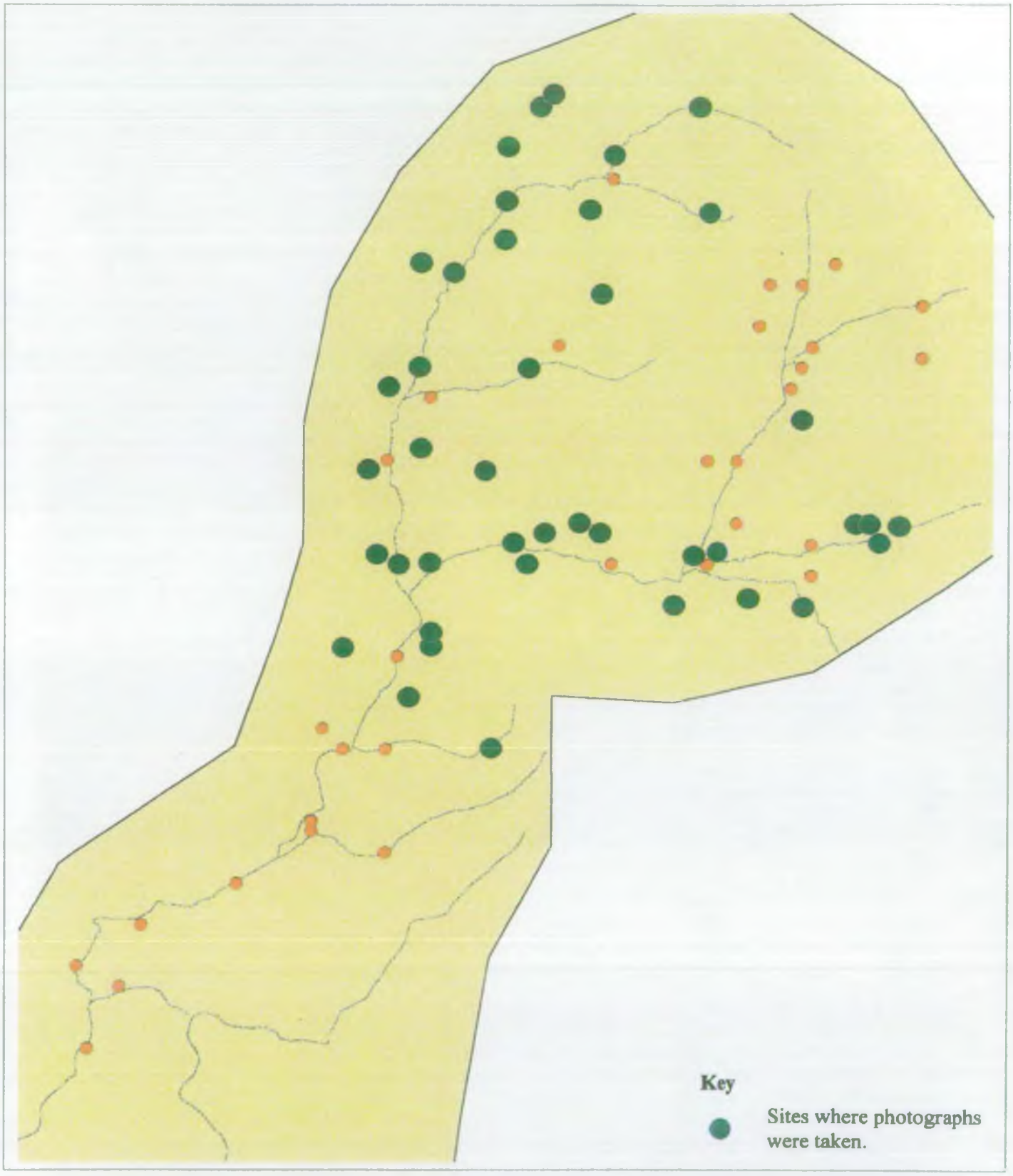


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Figure No.: 3

Project No.: A3601

Title:
Sites at which photographs were taken for R. Calder RHS survey.

River Ehen Catchment

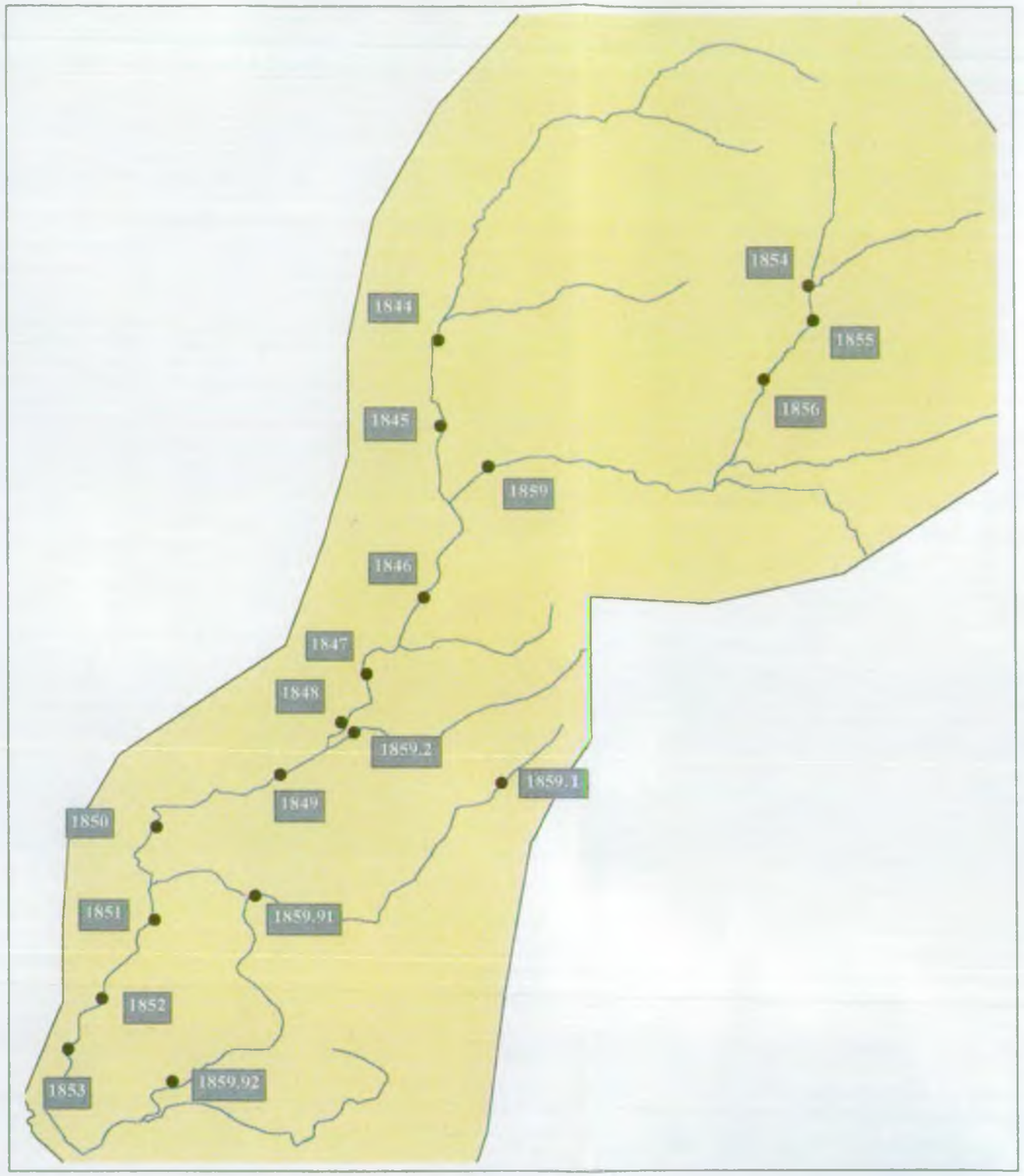

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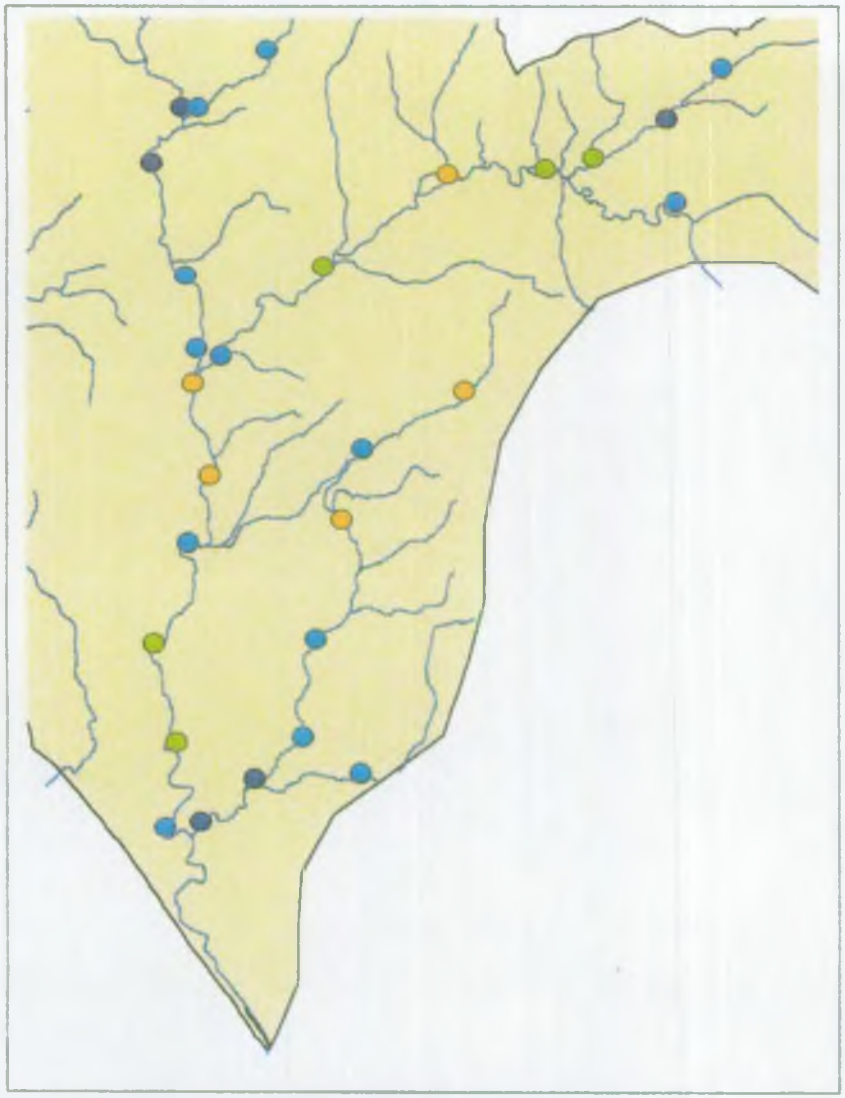
Figure No.: 4

Project No.: A3601

Title:
Site locations for R. Ehen and R. Calder 1993 and 1998 fisheries surveys.



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River Calder Catchment

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Figure No.: 5

Project No.: A3601

Title:
Salmonid density classes for small salmon at R. Ehen and R. Calder fisheries sites.

Key

A
B
C
D
E
F

River Ehen Catchment

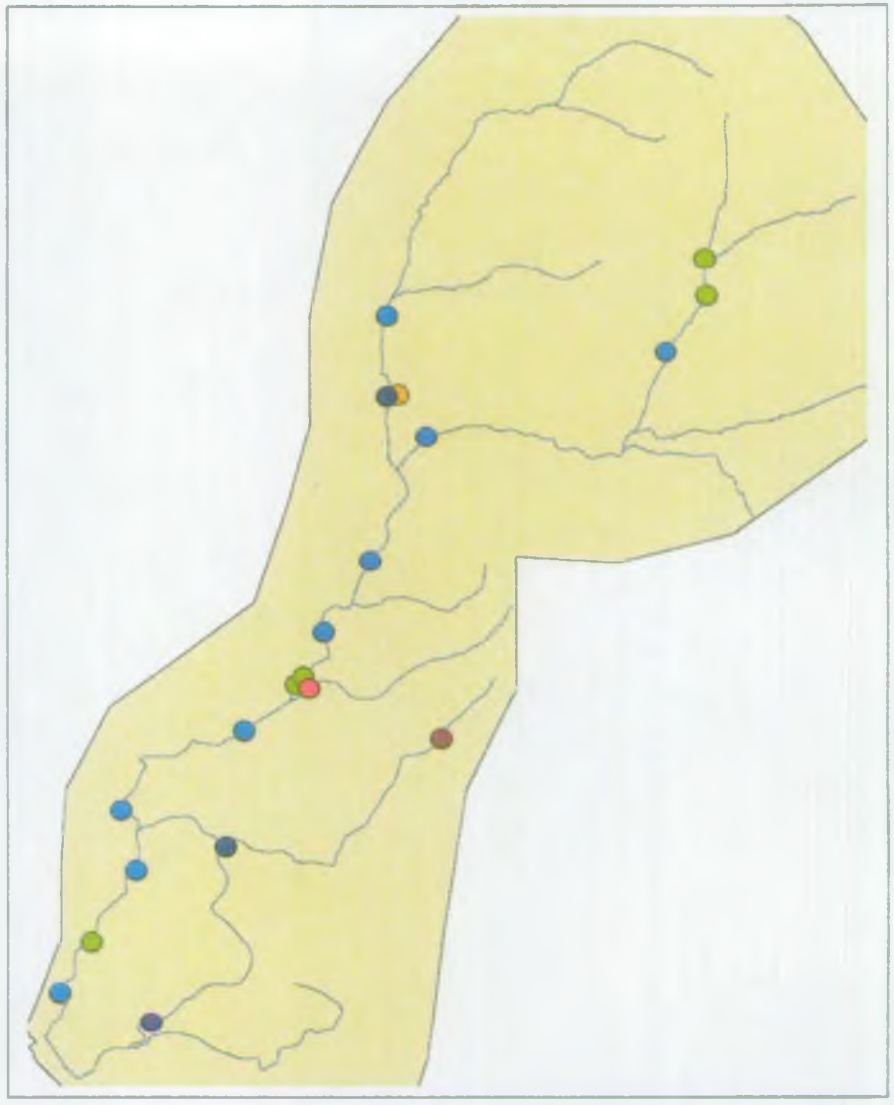

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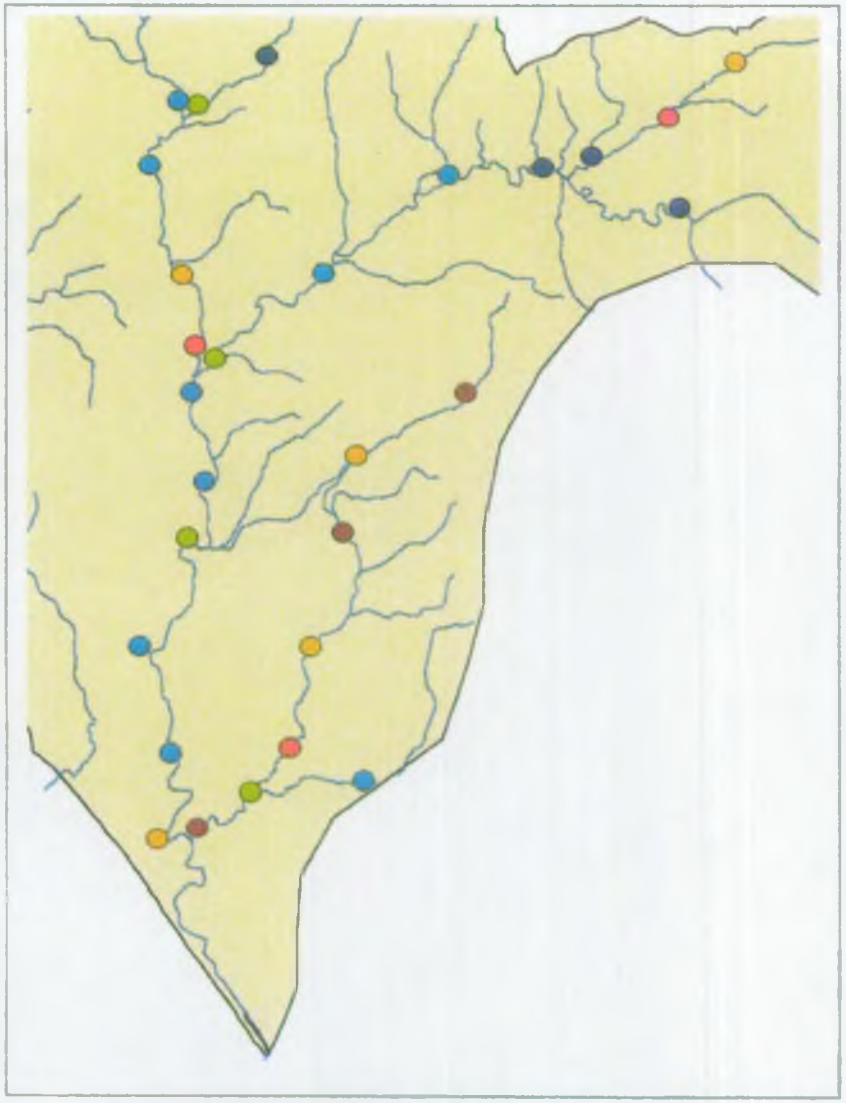
Figure No.: 6

Project No.: A3601

Title:
Salmonid density classes for small trout at R. Ehen and R. Calder fisheries sites.

Key
A
B
C
D
E
F



River Ehen Catchment

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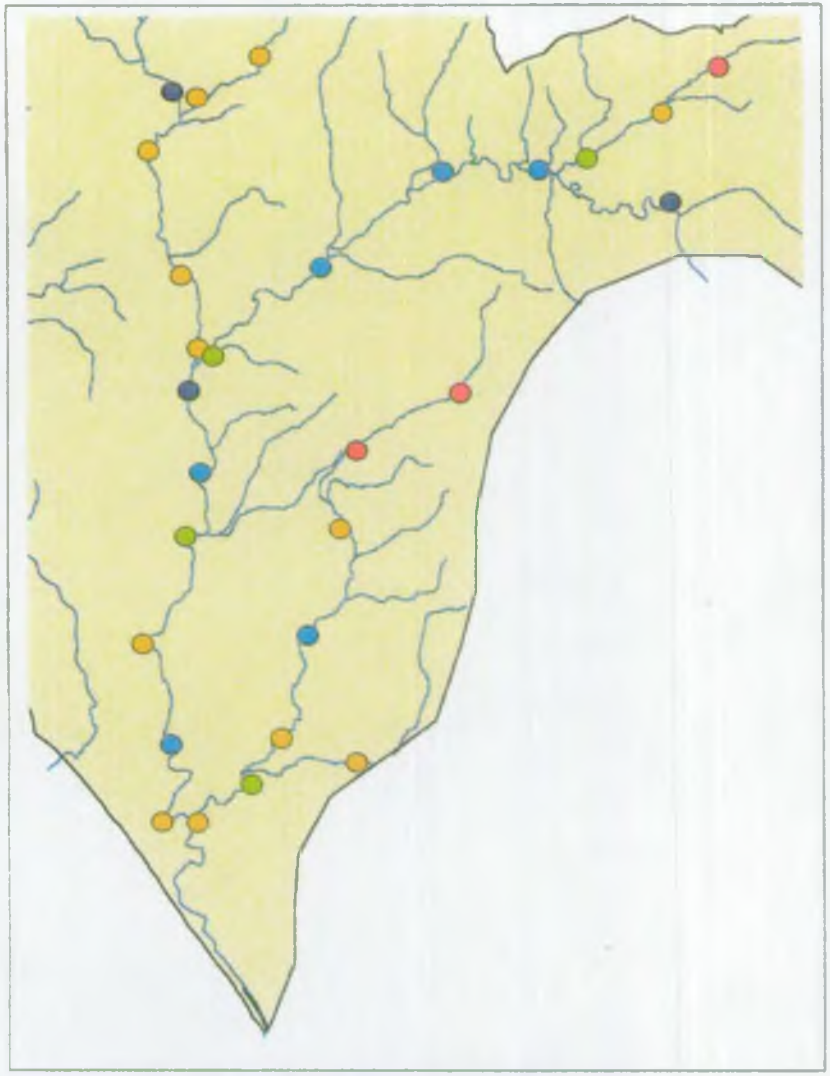
Figure No.: 7

Project No.: A3601

Title:
Salmonid density classes for big salmon at R. Ehen and R. Calder fisheries sites.

Key

A		D	
B		E	
C		F	



River Ehen Catchment

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Figure No.: 8

Project No.: A3601

Title:
Salmonid density classes for big trout at R. Ehen and R. Calder fisheries sites.

Key

A
B
C
D
E
F

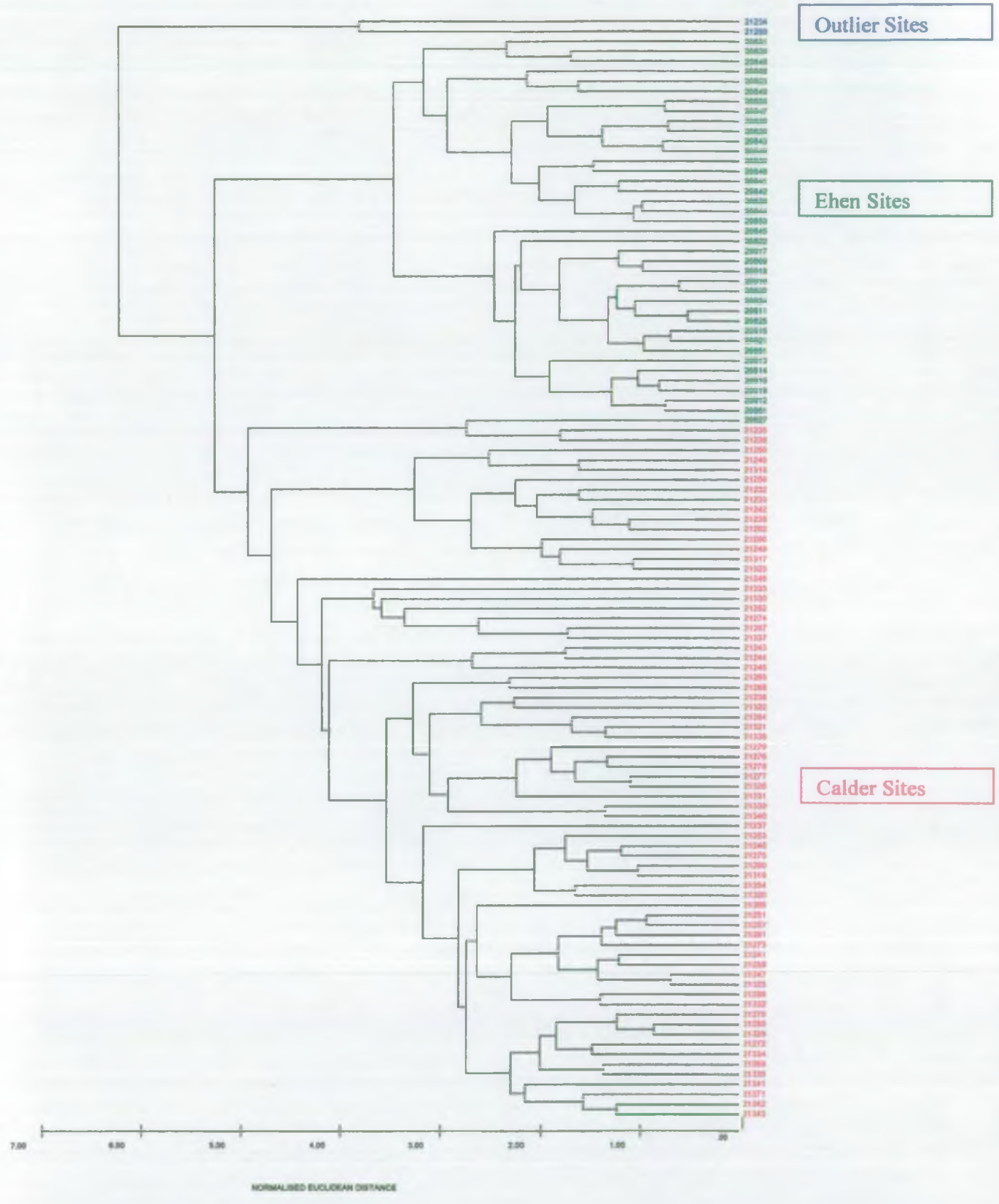

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Figure No.: 9

Project No.: A3601

Title:
Dendogram Classification plot showing relative similarity of R. Calder and R. Ehen RHS sites, based on habitat characteristics.

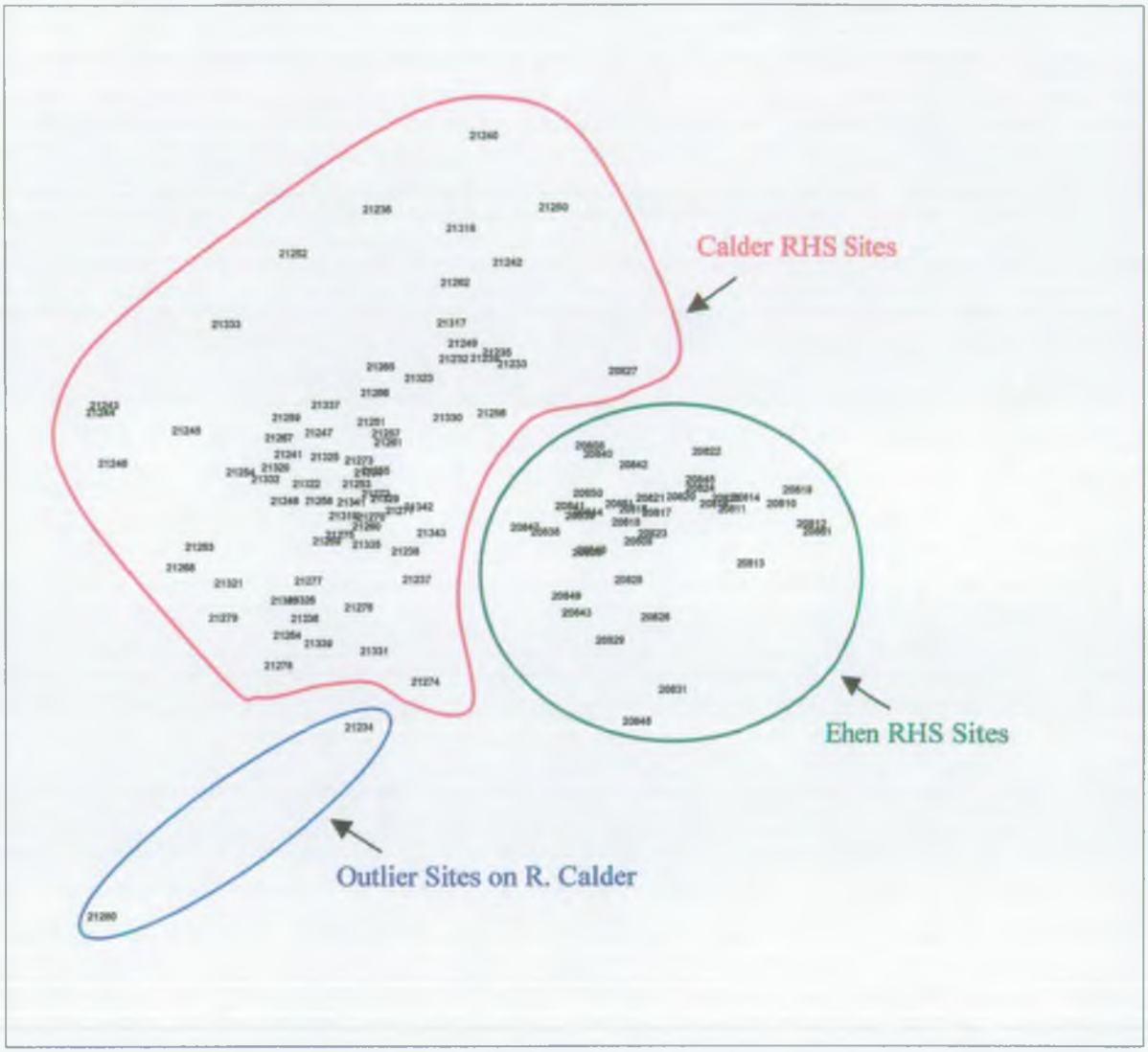

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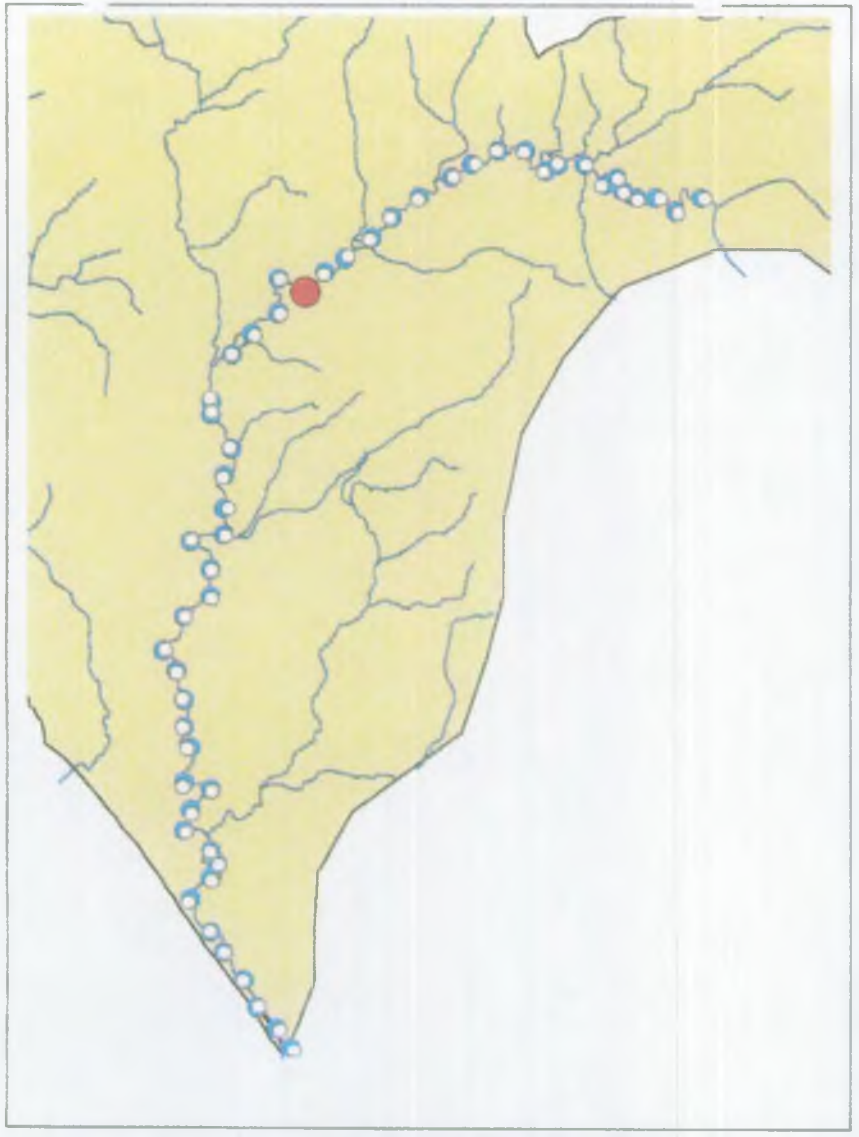
Figure No.: 10

Project No.: A 3601

Title:
MDS Ordination plot showing relative similarity of R. Calder and R. Ehen RHS sites, based on habitat characteristics.



River Ehen Catchment

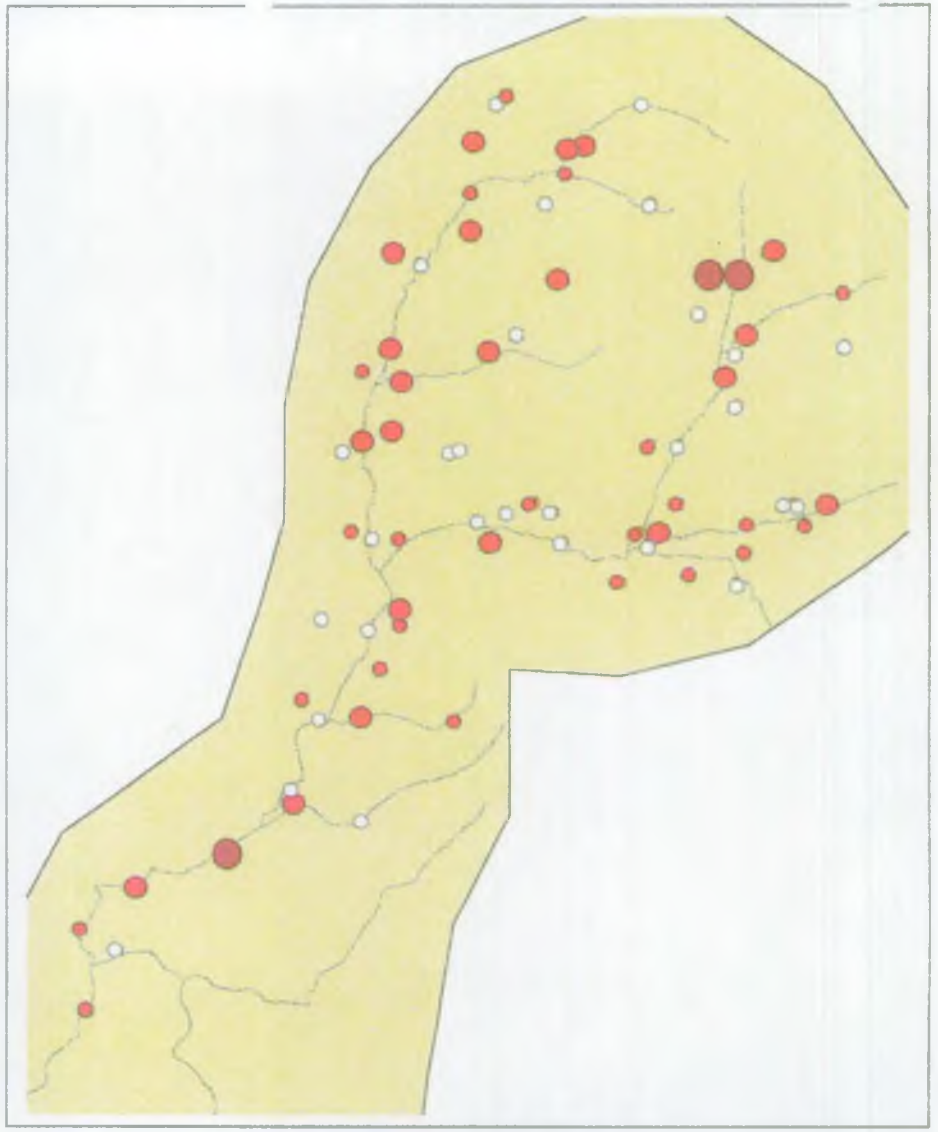


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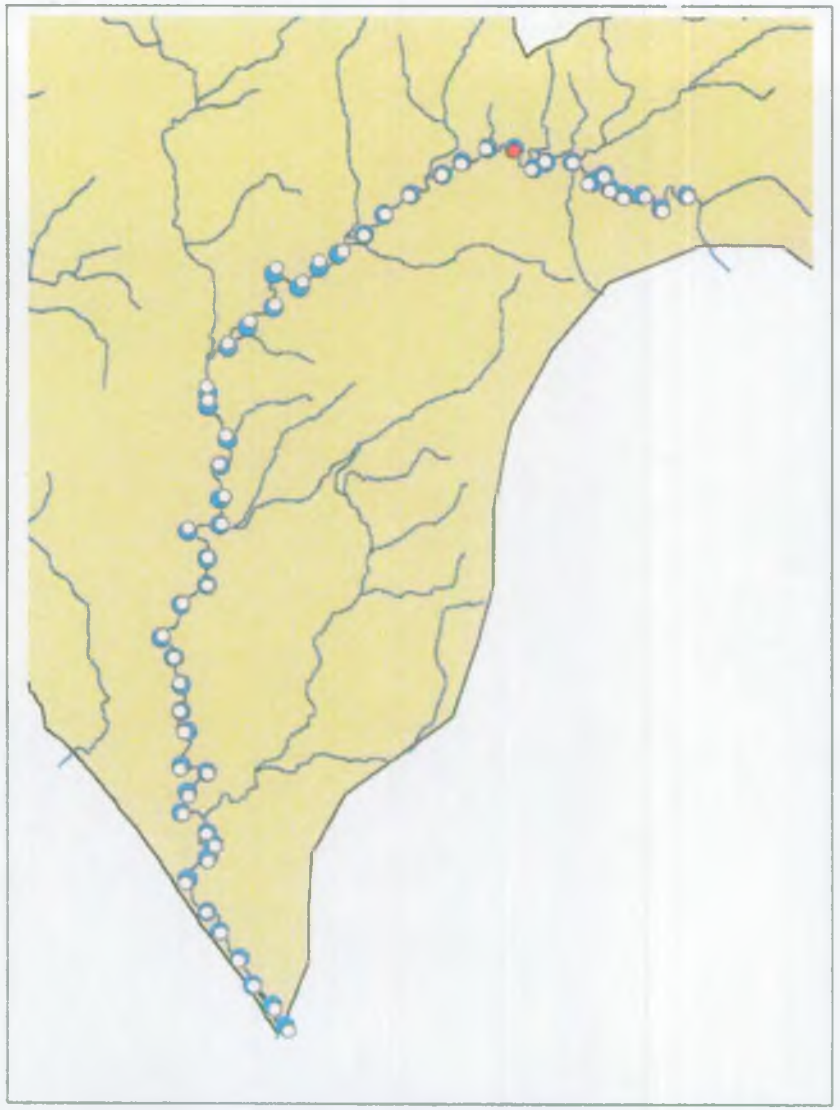
Figure No.: 11

Project No.: A3601

Title:
Amount of **bedrock** at R. Ehen and R. Calder RHS sites (expressed as a percentage of the ten spot check records)

Key
>30%
11-30%
1-10%
0%



River Ehen Catchment

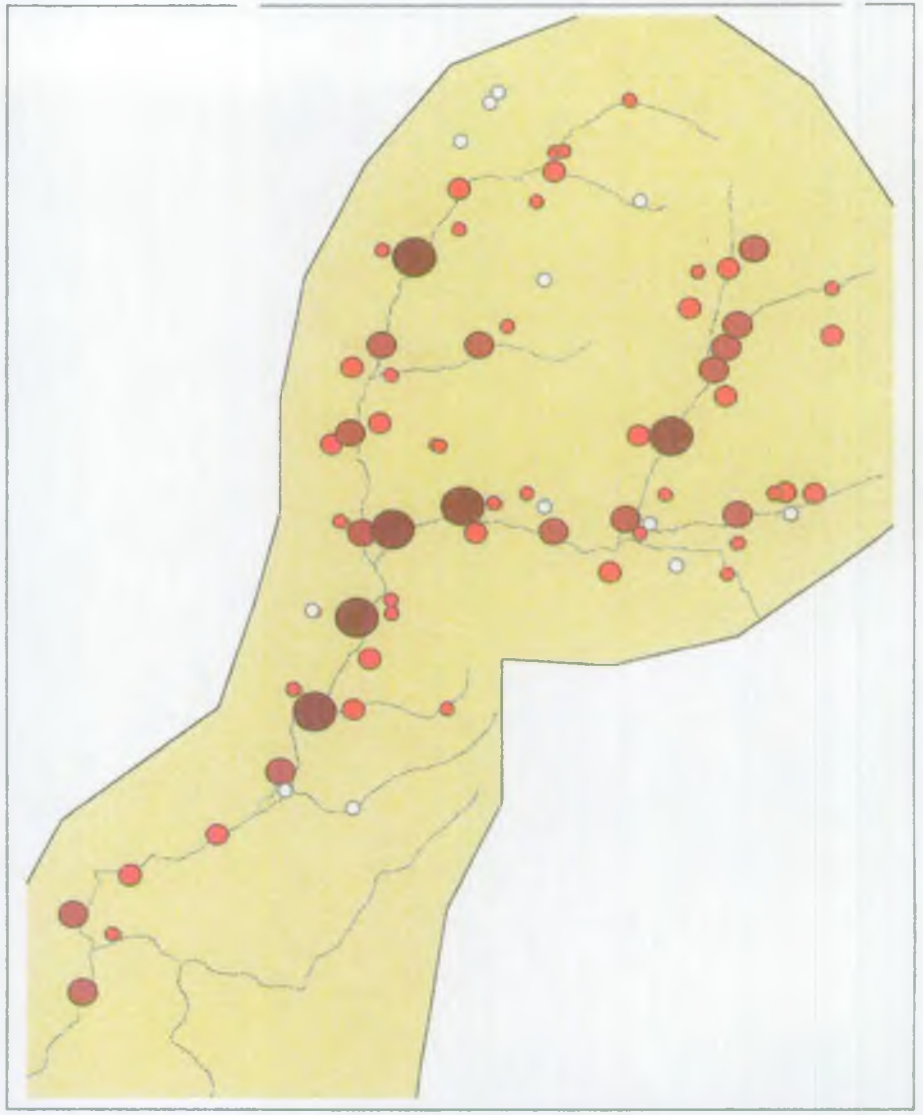


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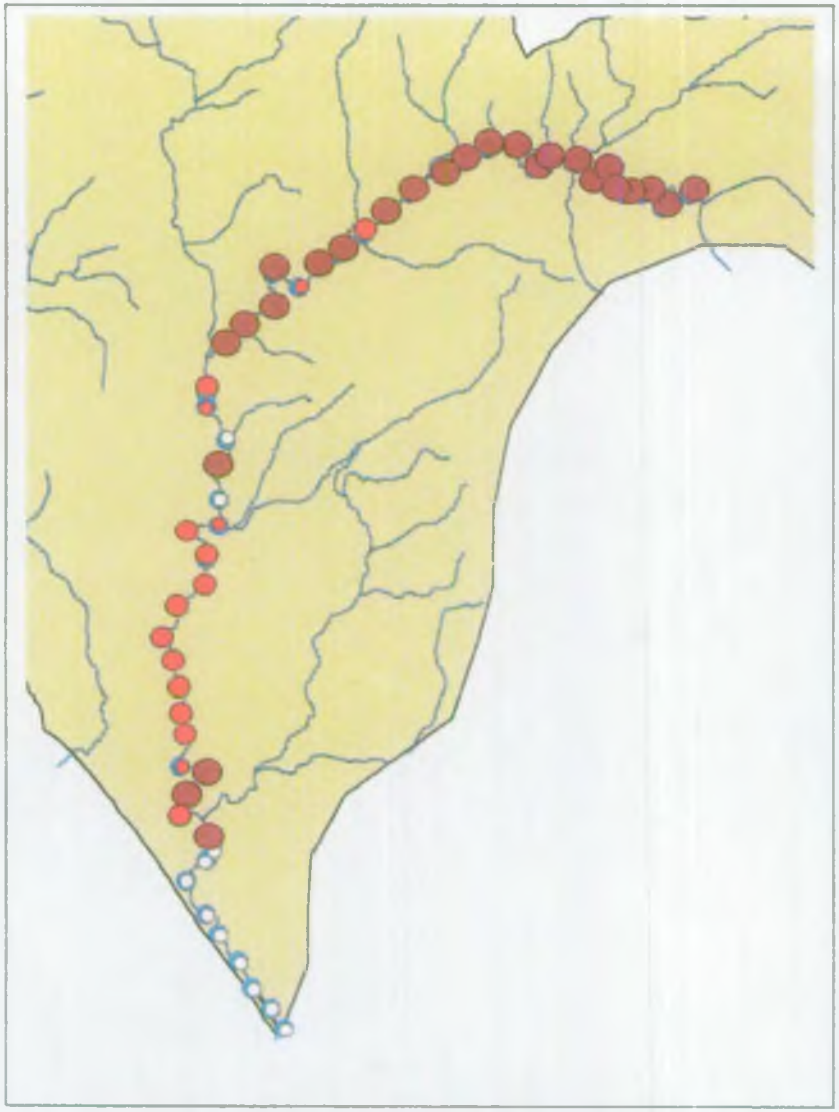
Figure No.: 12

Project No.: A3601

Title:
Amount of **boulder** at R. Ehen and R. Calder RHS sites
(expressed as a percentage of the ten spot check records)

Key
>80%
51- 80%
21-50%
1-20%
0%



River Ehen Catchment

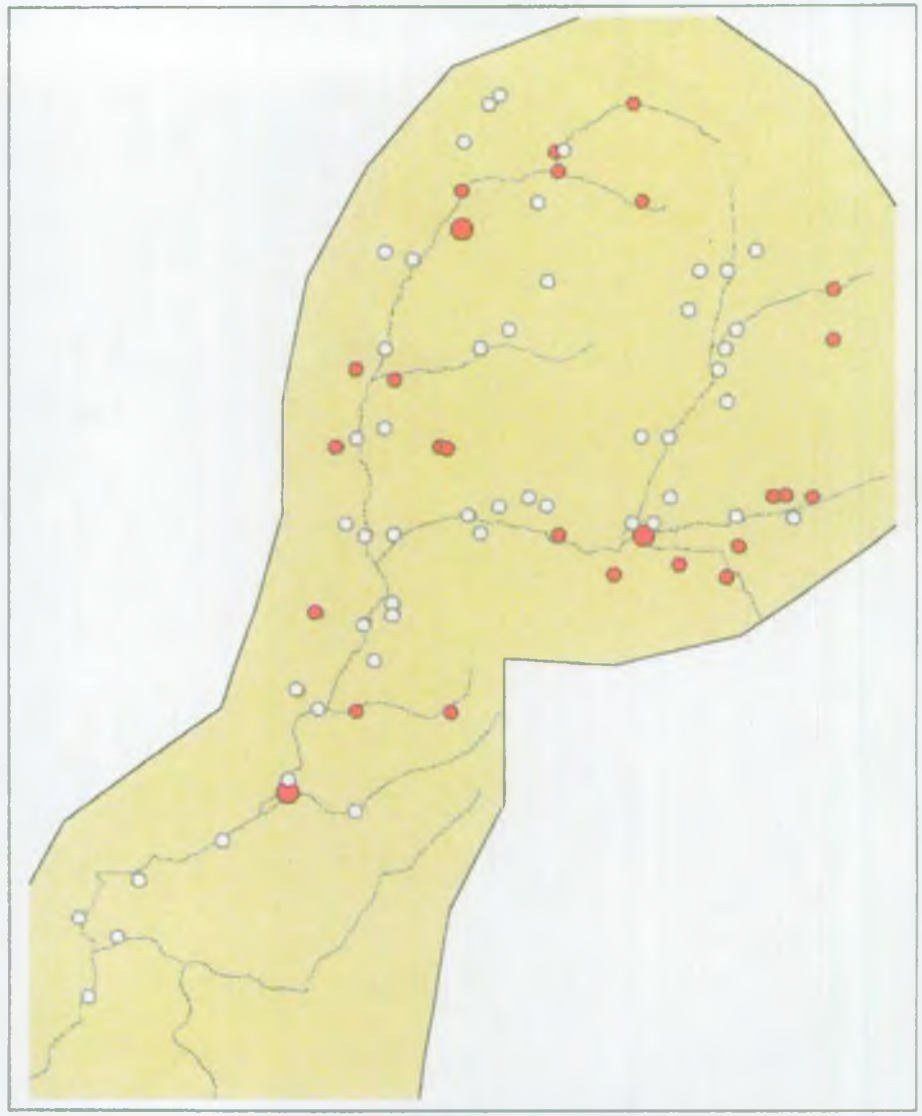


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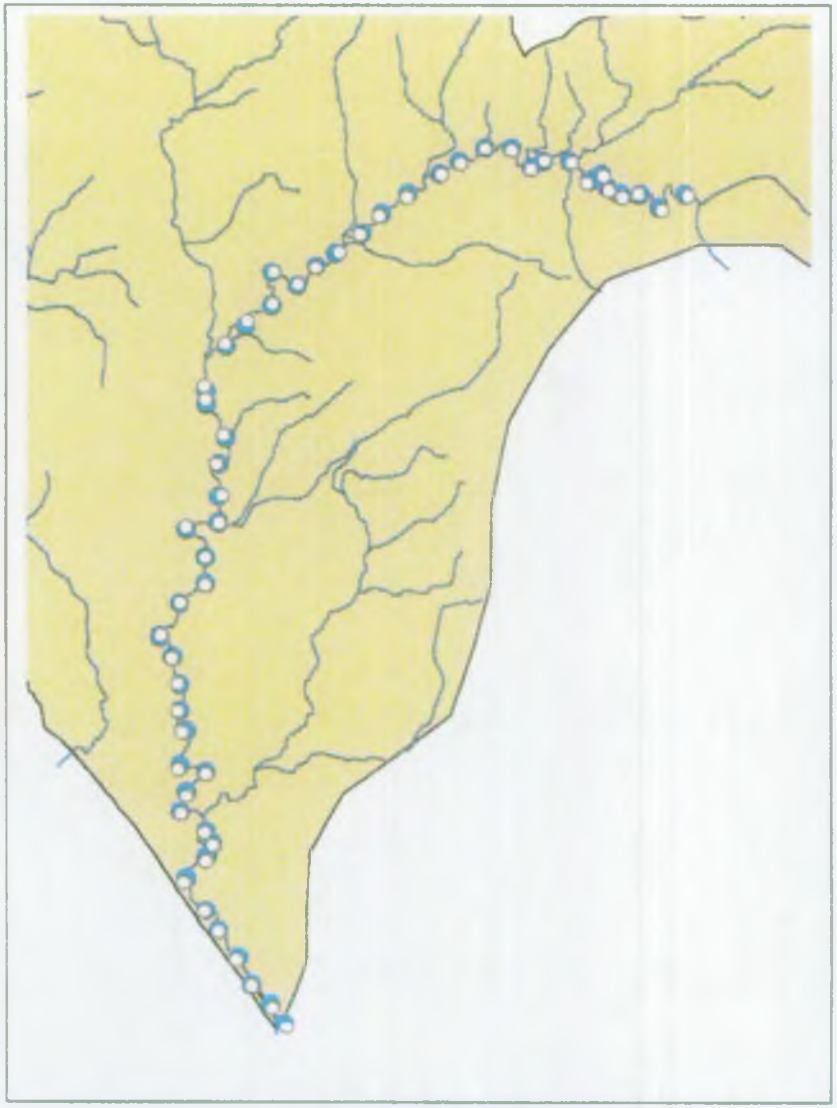
Figure No.: 13

Project No.: A3601

Title:
Amount of **Cobble / Gravel / Pebble** at R. Ehen and R. Calder RHS sites (expressed as a percentage of the ten spot check records)

Key
- 81-100%
- 51-80%
- 21-50%
- 0-20%



River Ehen Catchment

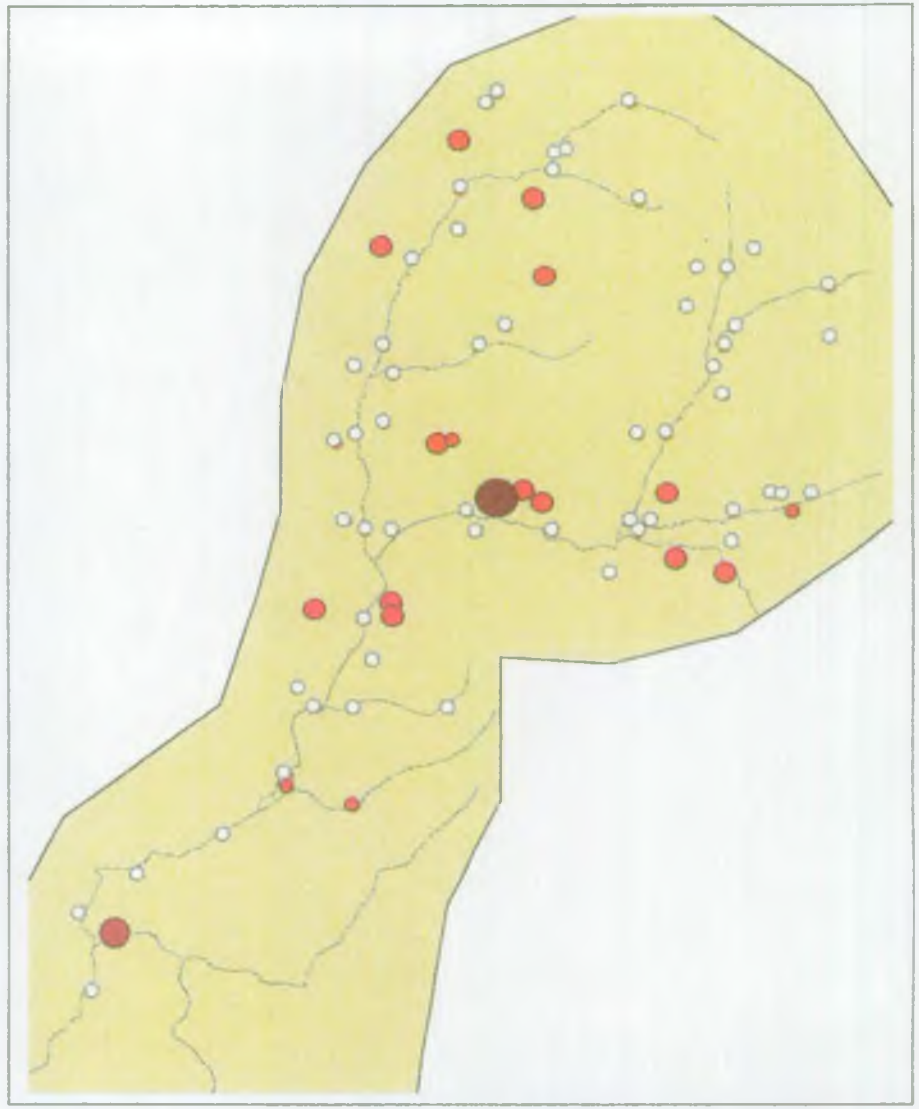


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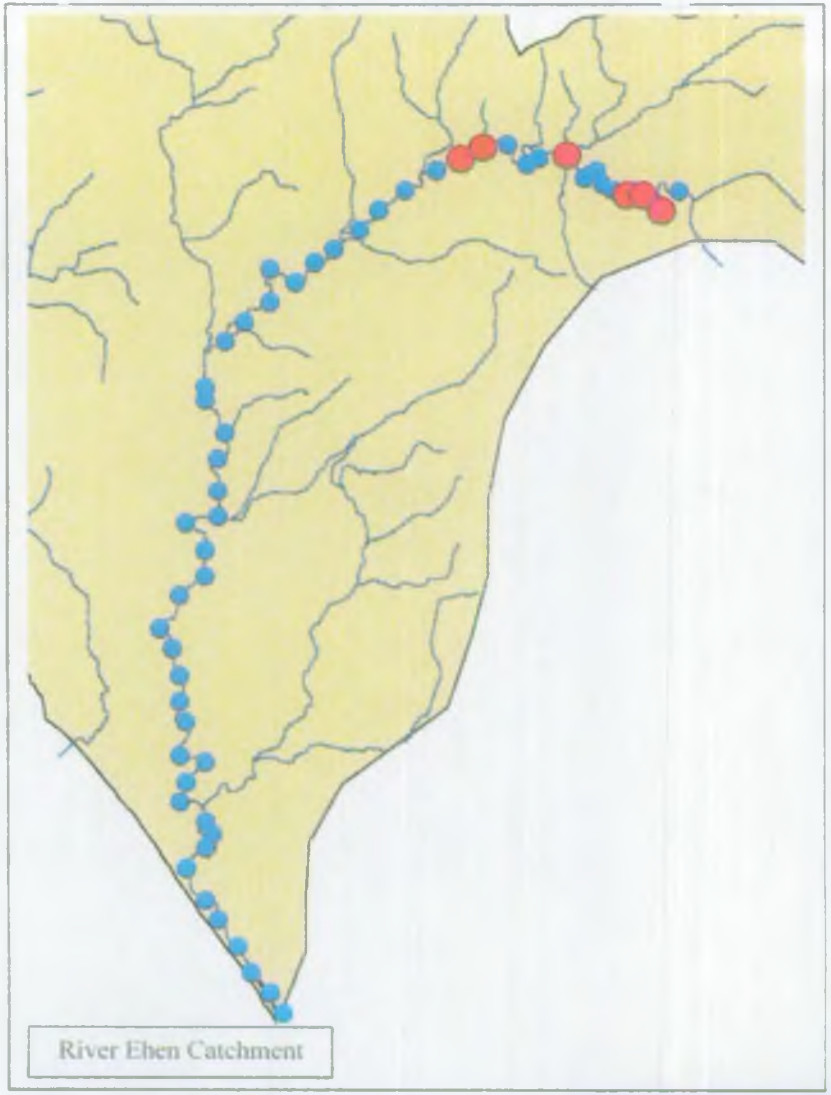
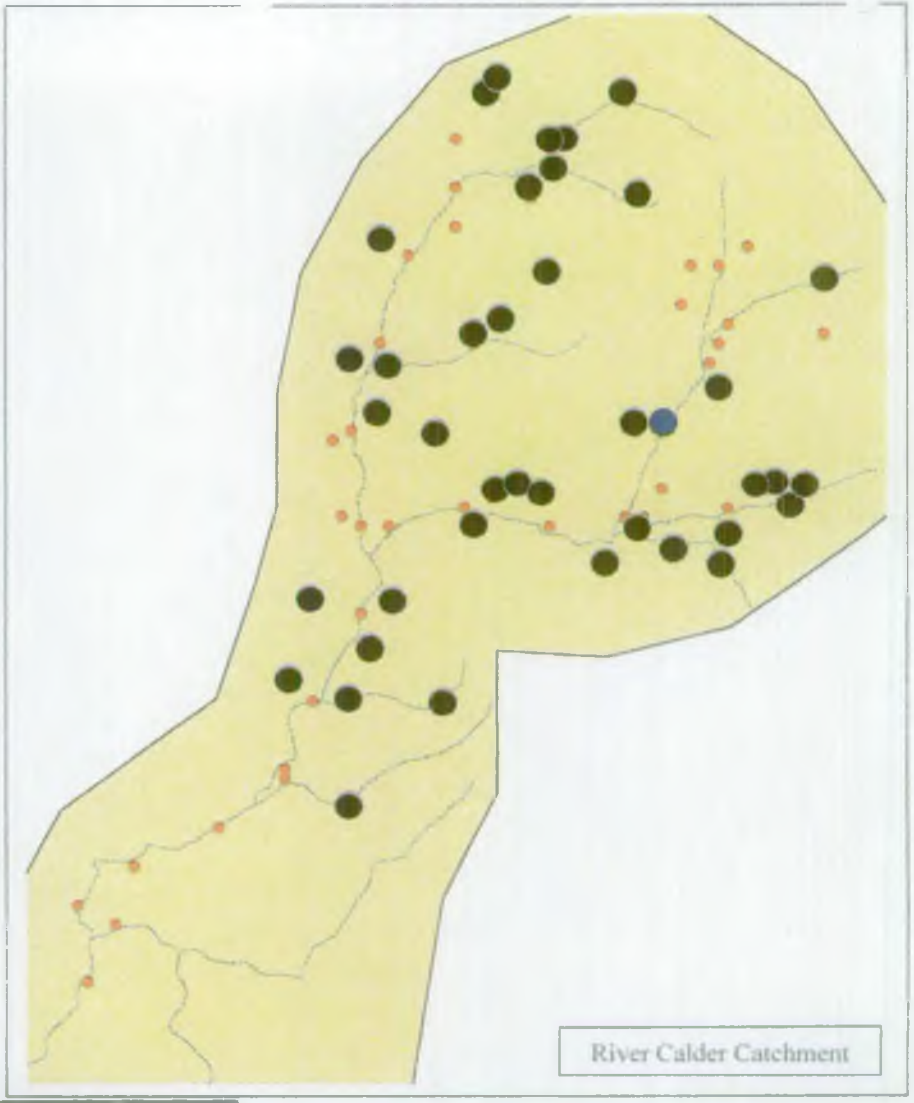
Figure No.: 14

Project No.: A3601

Title:
Amount of **sand and silt** at R. Ehen and R. Calder RHS sites
(expressed as a percentage of the ten spot check records)

Key
- >50%
- 31-50%
- 11-30%
- 1-10%
- 0%





Key

- Most likely to favour salmon and trout fry.
- Probably favourable to salmon and trout fry.
- May be favourable to salmon and trout fry.

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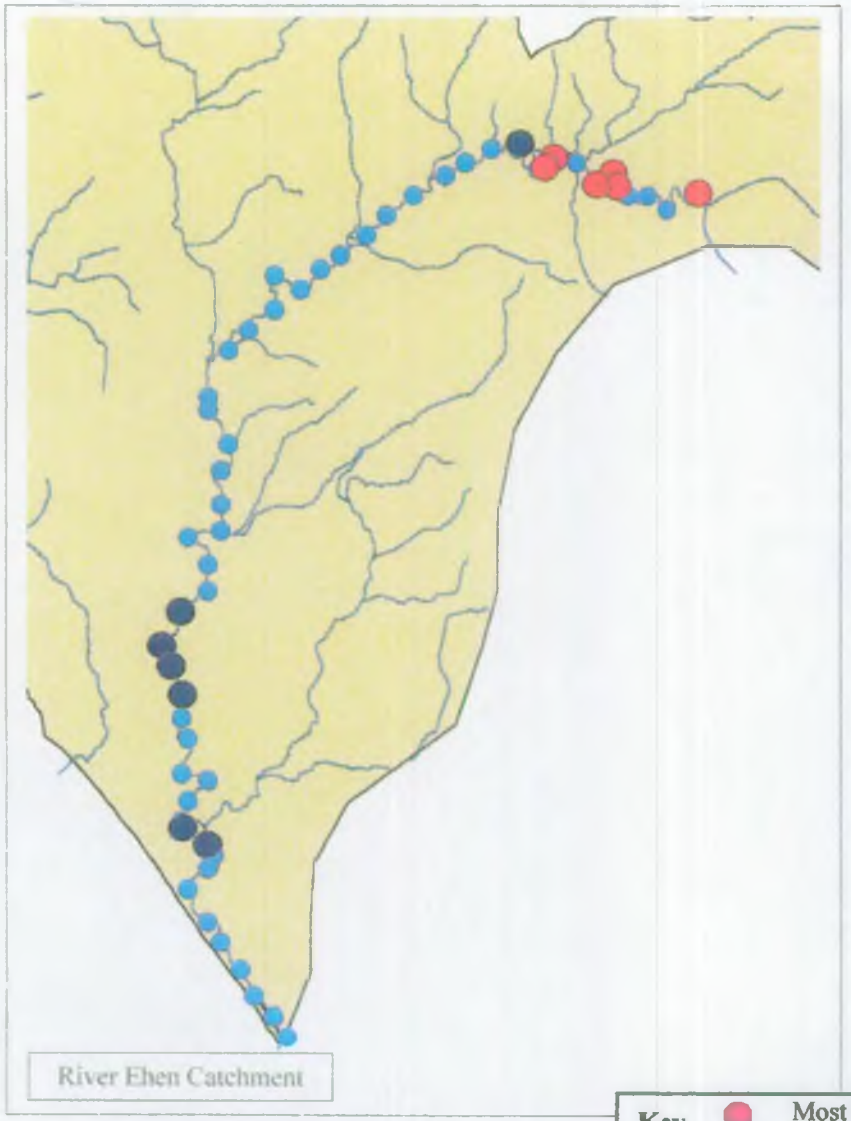
Figure No.: 15

Project No.: A3601

Title:

RHS site locations where the habitat characteristics are likely to favour trout and salmon fry (based on water depth, flow type and substrate).



Key

- Most likely to favour trout parr.
- Probably favourable to trout parr.
- May be favourable to trout parr.

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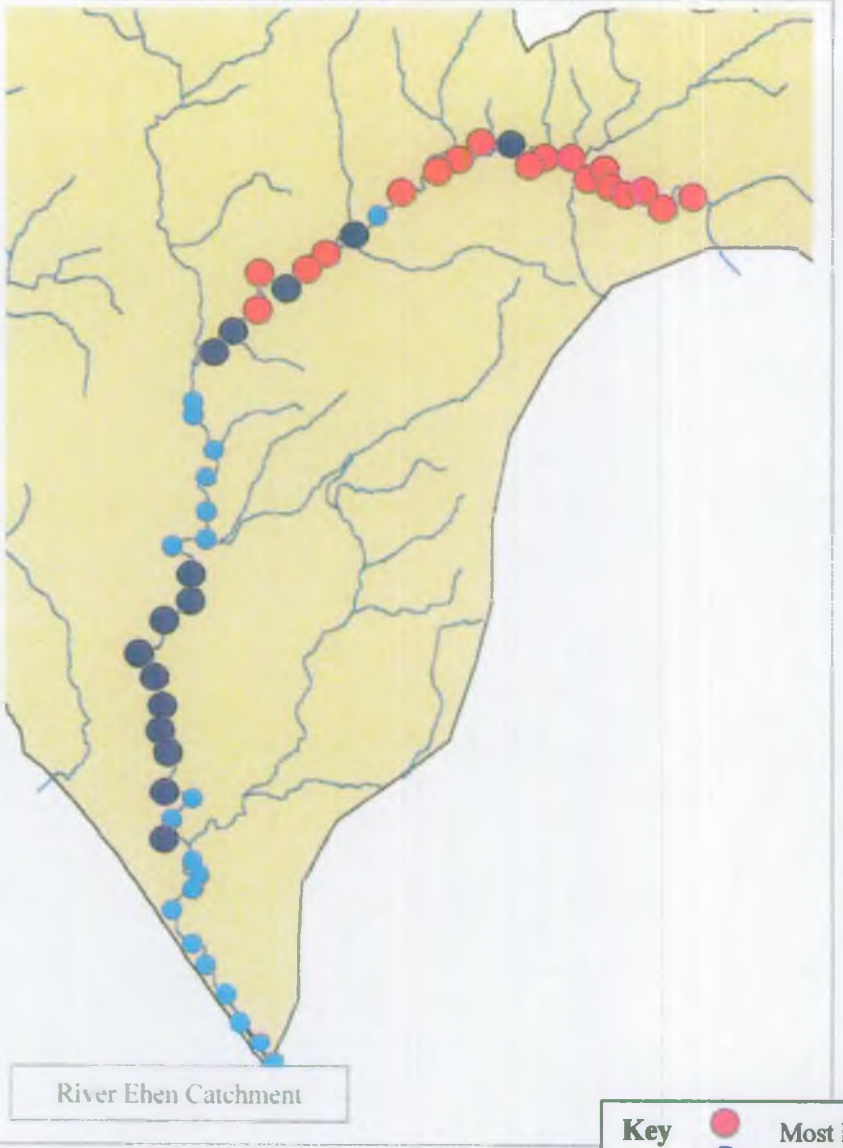
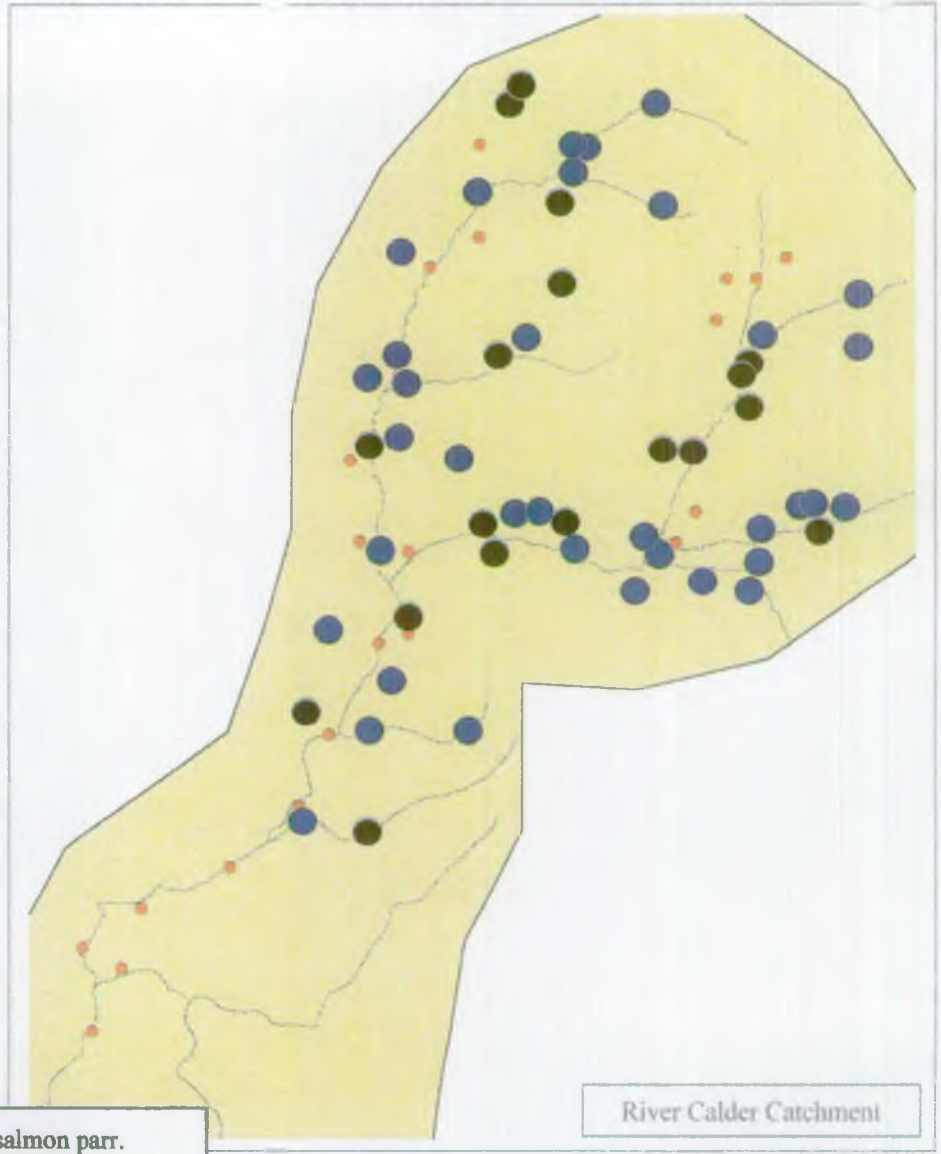
Figure No.: 16

Project No.: A3601

Title:

RHS site locations where the habitat characteristics are likely to favour trout parr (based primarily on water depth, flow type additional channel morphology and vegetation characteristics).





Key

- Most likely to favour salmon parr.
- Probably favourable to salmon parr.
- May be favourable to salmon parr.

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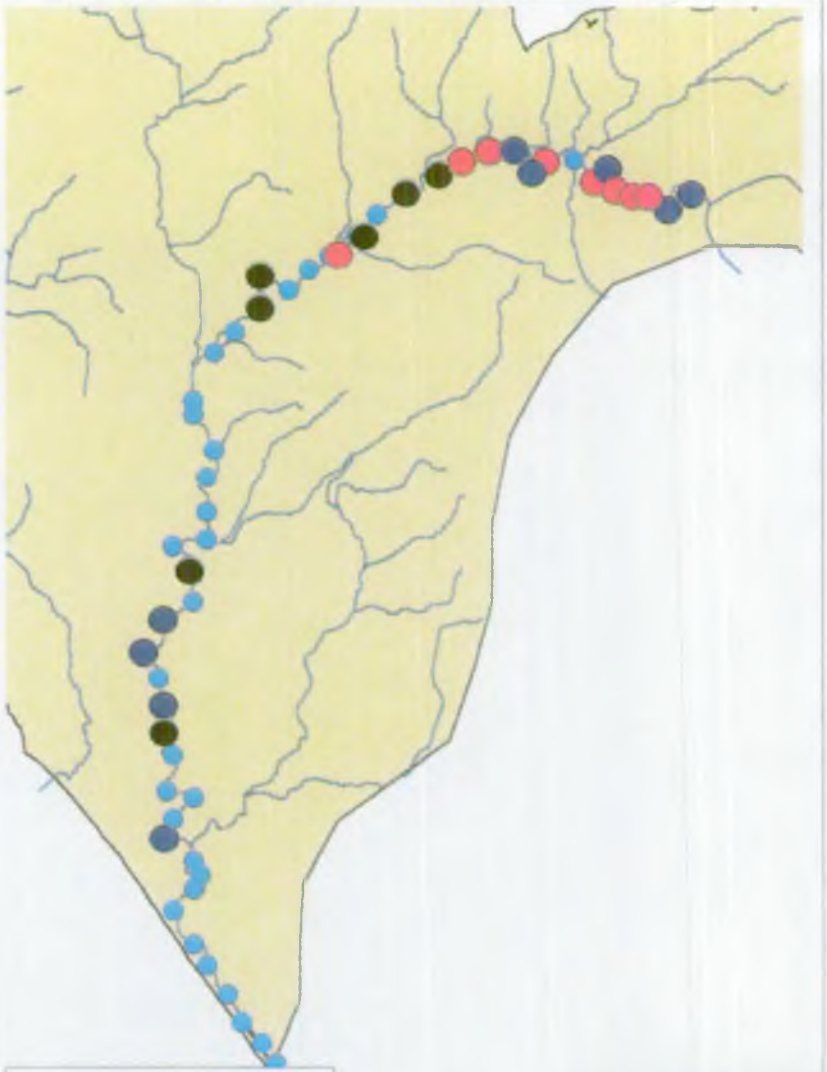
Figure No.: 17

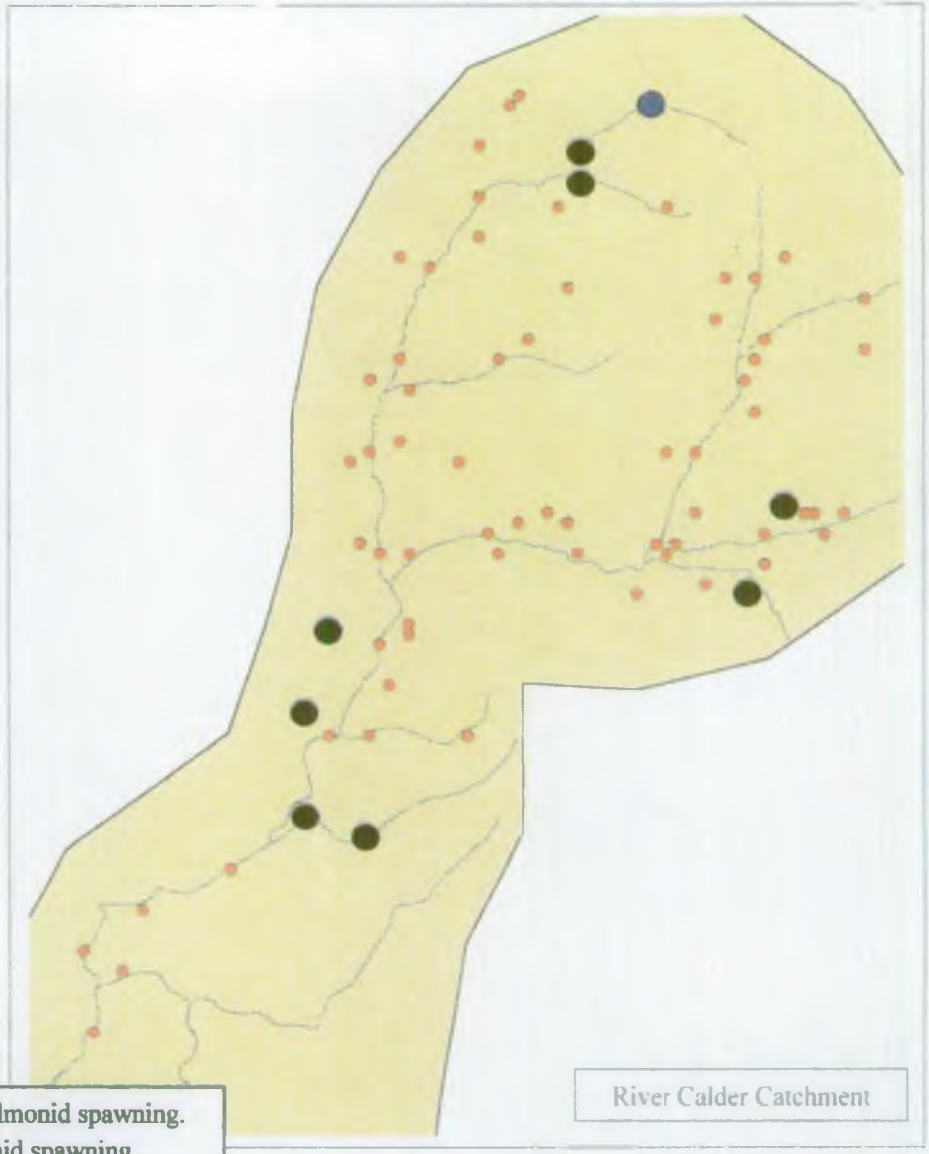
Project No.: A3601

Title:

RHS site locations at which the habitat characteristics are likely to favour salmon parr (based primarily on water depth, flow type and additional channel morphology and vegetation characteristics).



River Ehen Catchment



River Calder Catchment

Key

- Most likely to favour salmonid spawning.
- Likely to favour salmonid spawning.
- May favour salmonid spawning.

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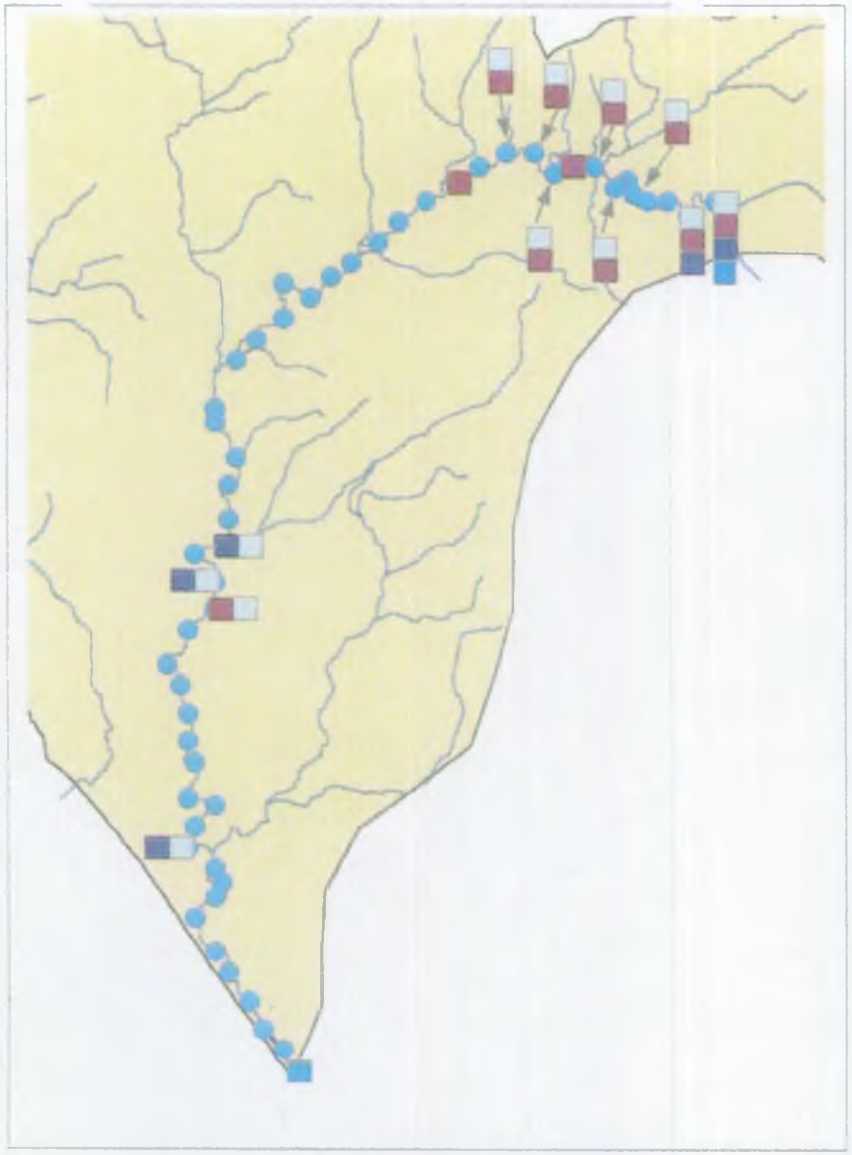
Figure No.: 18

Project No.: A3601

Title:

RHS site locations at which the habitat characteristics are likely to favour salmonid spawning (based primarily on water depth, flow type, and substrate).



River Ehen Catchment

River Calder Catchment

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Figure No.: 19

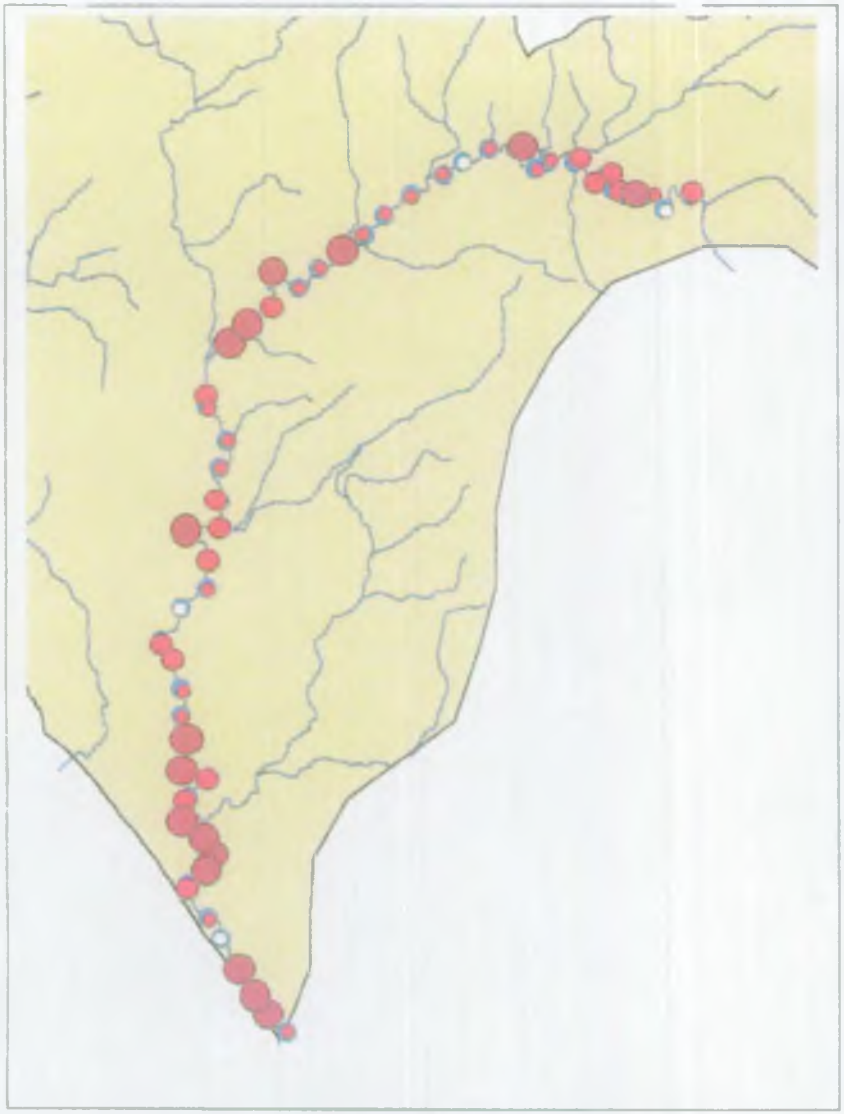
Project No.: A3601

Title:

RHS site locations where potential barriers to salmonid migration exist.

Key

- Waterfalls >5m
- Major weirs
- Weirs Intermediate
- Culverts
- Water Impounding Dam
- Outfalls



River Ehen Catchment

River Calder Catchment

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Figure No.: 20

Project No.: A3601

Title:
Habitat Modification Scores at RHS sites on the R. Ehen and R. Calder

Key
- >21 (4)
- 11 – 20 (3)
- 3 – 10 (2)
- 0 – 2 (1)

APPENDICES

Appendix 1

List of photographs taken during the R. Calder RHS Survey

River Calder RHS Photographs - Film 1 (yellow numbers)

Photograph no.	Site number	Grid reference	Description
1	21319	NY 074 076	Stone Pike
2	21320	NY 066 080	Un-named tributary; narrow channel, with soft-rush
3	21321	NY 068 085	Stords; narrow channel with exposed boulders
4	21322	NY 068 087	Swaninson Knot; small channel with some shading
5	21318	NY 068 093	Worm Gill; wide channel with exposed boulders
6	21317	NY 077 095	Worm Gill; wide channel with boulder mid channel bar
7	21273	NY 078 093	Scalderskew Wood downstream; narrow channel with exposed boulders
8	21272	NY 091 089	Scalderskew Wood upstream; exposed boulders and dry stone wall
9	21249	NY 093 092	Un-named tributary; large eroding cliff and exposed boulders.
10	21249	NY 094 093	Caw Gill; fairly small channel with floodplain
11	21277	NY 098 090	Caw Gill, southern tributary, downstream; narrow channel with large exposed boulders and bedrock
12	21276	NY 103 092	Caw Gill, main stem; narrow channel through rough pasture with soft-rush
13	21276	NY 103 089	Caw Gill, southern tributary, upstream; narrow channel with small waterfall over boulder
14	21267	NY 112 097	Cawfell Beck; small channel with boulders
15	21268	NY 110 095	Cawfell Beck, southern tributary; exposed boulders
16	21269	NY 109 098	Cawfell Beck, northern tributary upstream; narrow, steep gradient channel with freefall and chute flow over boulders
17	21270	NY 108 098	Cawfell Beck, northern tributary downstream; narrow, steep gradient channel with freefall and chute flow over boulders
18	21254	NY 103 094	Cawfell Beck; exposed boulders, eroded cliff and point bar
19	21265	NY 095 094	Cawfell Beck; straight channel with exposed boulders and bedrock
20	21278	NY 083 096	Un-named tributary; steep gradient with freefall and chute flow
21	21279	NY 082 096	Un-named tributary; narrow channel through soft-rush
22	21280	NY 079 096	Un-named tributary; narrow channel through soft-rush
23	21323	NY 065 093	River Calder; wide channel with exposed boulders
24	21324	NY 063 093	Un-named tributary with adjacent broad-leaved woodland
25	21328	NY 062 102	Un-named tributary; fairly straight channel through rush-pasture
26	21325	NY 067 103	Town Bank; exposed boulders and rush-pasture
27	21326	NY 072 102	Town Bank, southern tributary; narrow channel with exposed boulders
28	21259	NY 076 106	Town Bank, northern tributary; narrow channel through rush-pasture, eroding cliff in distance
29	21323	NY 065 097	River Calder (sweep-up site); bedrock and boulder channel with chute flow and pool
30	21331	NY 060 085	Strudda Bank; narrow, vegetated channel through rush-pasture with poached bank
31	21329	NY 064 110	Gill Farm; narrow channel
32	21332	NY 085 133	Black Pots; boulder-strewn channel and chute flow

River Calder RHS Photographs - Film 2 (red numbers)

Photograph no.	Site number	Grid Reference	Description
1	21333	NY 097 136	Black Pots; narrow channel with exposed boulders
2	21335	NY 094 127	River Calder; 2m wide, shallow channel
3	21335	NY 094 127	River Calder; narrow straight channel
4	21335	NY 094 127	View across rough pasture into Calder valley, looking east
5	21336	NY 083 127	Un-named tributary; small channel near source with soft-rush
6	21337	NY 075 128	River Calder; eroding cliff and point bar
7	21338	NY 075 124	Latterbarrow Moss; small channel in deep 'vee' valley
8	21339	NY 084 119	Latterbarrow Moss, northern tributary; narrow channel with chute flow over bedrock
9	21262	NY 070 120	River Calder; boulder-strewn channel in middle distance
10	21261	NY 067 112	River Calder; wooded bedrock gorge and exposed boulders
11	21261	NY 067 112	River Calder; wide channel through rough pasture, with exposed boulders
12	21263	NY 068 122	Un-named tributary; steep gradient, narrow channel with chute flow over boulders
13	21340	NY 075 133	Blakeley Raise; narrow channel
14	21332	NY 085 132	Un-named tributary; small narrow channel
15	21342	NY 079 135	Un-named tributary; waterfall over bedrock
16	21343	NY 078 137	Un-named tributary; shallow gravel/pebble/cobble channel

Appendix 2

R. Ehen and R. Calder RHS sites exhibiting 'negative' habitat characteristics for salmonids

APPENDIX 2 R. EHEN AND R. CALDER RHS SITES EXHIBITING 'NEGATIVE' HABITAT CHARACTERISTICS FOR SALMONIDS

Site no.	NGR	% Bedrock	% Silt	Braided Channel	Ponded Reaches	Marginal Deadwater	Choked Channel
20808	NY086154				P	P	
20809	NY084186					P	
20810	NY082152					P	
20811	NY079154					P	
20812	NY076154					P	
20813	NY073157					P	
20814	NY071156					P	
20815	NY068159					P	
20816	NY064159					P	
20817	NY062158					P	
20818	NY059161					P	
20820	NY051159					P	
20821	NY048157					P	
20822	NY043154					P	
20823	NY039151					P	
20825	NY032145					P	
20827	NY026140	40				P	
20829	NY022137					P	
20833	NY012122					P	
20834	NY015117					P	
20835	NY014113					P	
20840	NY012095					P	
20841	NY008092					P	
20842	NY005087					P	
20845	NY008076					P	
20846	NY009073					P	
20847	NY008068					P	
20848	NY012067					P	
20852	NY013056					P	
20854	NY009051				P	P	
20855	NY012046			P	P	P	
20856	NY014043			P	P	P	
20858	NY019035					P	
20861	NY074155					P	
21232	NY036046				P		
21233	NY035054			P			
21234	NY039052		40				
21235	NY041058	30					
21236	NY050062	50			P		
21238	NY064065					P	
21240	NY060075					P	
21241	NY064075	30				P	
21242	NY065084					P	
21243	NY103120	40				P	
21244	NY106122	30					
21245	NY100120	40				P	

Site no.	NGR	% Bedrock	% Silt	Braided Channel	Ponded Reaches	Marginal Deadwater	Choked Channel
21246	NY099116					P	
21248	NY114118					P	
21249	NY093094			E	P	P	
21250	NY097103			E	P	P	
21251	NY102110				P		
21252	NY103112			P		P	
21255	NY094103				P		
21256	NY085093					P	
21259	NY077112	30					
21262	NY070121			P			
21264	NY097097		30				1
21266	NY104095			P		P	
21268	NY110095				E	P	1
21275	NY104092				P		
21276	NY103089				P		1
21277	NY098090				P		1
21278	NY084096		30		P		1
21279	NY082097				P		
21280	NY079096		70		P		1
21317	NY076095			P			
21319	NY074075				P		
21321	NY068085		30				
21323	NY065093				P		
21324	NY063094				P		
21328	NY062102					P	
21330	NY058077				P	P	
21331	NY060085		30				
21332	NY085132	30					
21336	NY083127		30				
21339	NY084119		30		P		
21340	NY075133	30			P		
	Total No.	10	8	9	23	50	6

Appendix 3

R. Ehen and R. Calder RHS sites containing potential barriers to salmonid migration

APPENDIX 3 R. EHEN AND R. CALDER RHS SITES WHICH HAVE POTENTIAL BARRIERS TO SALMONID MIGRATION

SITE NO	NGR	Waterfalls >5m	Weirs Major	Weirs Intermediate	Culverts	Water Impounding Dam
R. Ehen Sites						
20808	NY086154		1	3		P
20809	NY084186		1	1		P
20812	NY076154			3		P
20814	NY071156			1		P
20815	NY068159			2		P
20816	NY064159			1		
20817	NY062158			1		P
20818	NY059161			2		P
20819	NY055161			1		P
20821	NY048157			1		
20837	NY014104		1			P
20839	NY012099		1			P
20840	NY012095			1		P
20850	NY008061		1			P
20860	NY024029					
20861	NY074155					P
R. Calder Sites						
21232	NY036046		1			P
21233	NY035054		1			P
21234	NY039052				1	P
21235	NY041058					
21238	NY064065				1	
21239	NY057068					
21241	NY064075					
21244	NY106122	P				
21245	NY100120	P				
21246	NY099116	P				
21247	NY104114	P				
21272	NY091089				9	
21279	NY082097				1	
21320	NY066080				1	
21321	NY068085				1	
21322	NY068086				1	
21330	NY058077				1	

Appendix 4

Analysis of fisheries data in a regional context

ADDENDUM TO
RIVER CALDER RHS EVALUATION

FINAL REPORT

REVIEW OF FISHERIES AND RHS DATA FOR NORTH WEST RIVERS

A1 FISHERIES AND RHS DATA FOR NORTH WEST RIVERS

A1.1 As a final analysis for the River Calder RHS evaluation a broad review of the RHS and fisheries surveys results for rivers in the north-west region was carried out. The aim of this study was to compare the salmonid populations of these rivers based on the National Fisheries Classification Scheme and to identify from RHS surveys of these rivers the habitat characteristics which drive any observed between-river differences in the salmonid populations.

A1.2 Analysis was carried out on RHS and fisheries data provided by the Environment Agency for rivers in the southern and central areas of the north-west region. It was found that the RHS data were primarily obtained from the main stem of these rivers whereas fisheries data were collected from tributaries. This meant that the data were not directly comparable making definitive interpretations very difficult. In addition the majority of rivers were of poor quality with respect to the salmonid populations such that the between-system differences were limited which would make it difficult to clearly determine the habitat drivers for salmonid densities.

A1.3 In the light of these observations the analysis was confined to a broad ranging overview of the data and the conclusions of this analysis for the central area and southern area rivers are described the following sections.

Southern Arc Rivers (Bollin - Wirral tributaries)

A1.4 The vast majority of these rivers support very poor densities of salmonids, with the majority of populations being classified as D-F by the National Fisheries Classification (NRA, 1994). Indeed, of the sites for which both RHS and fishery data are available (Table A), with the exception of trout parr, all of the sites had poor salmonid densities. For trout parr 92% of sites had poor densities, while 8% had good densities, although these were limited to Class C. When assessing the entire regional fisheries database the very occasional location did support a good density of one age class of one species of salmonid, usually trout, while even fewer locations supported a good density of both age classes of one species. No sites supported good densities of both salmon and trout.

Table A: Salmonid density classification for sites on the Rivers Bollin - Wirral tributaries

Salmonid density class	No. of sites with density of salmonids			
	0+ salmon	0+ trout	>0+ salmon	>0+ trout
A	0	0	0	0
B	0	0	0	0
C	0	0	0	2
D	0	0	0	1
E	0	0	0	7
F	26	26	26	16
Total A-C	0	0	0	2
Total D-F	26	26	26	24
% A-C	0	0	0	7.7
% D-F	100	100	100	92.3

A1.5 The tributaries appear to support slightly better densities of salmonids than the main river stem, although the available RHS data was confined to the main stem of each catchment. There are therefore no directly comparable locations with both good salmonid populations and RHS data.

Central Area Rivers (Allt - Ribble)

A1.6 The overall salmonid densities in these rivers was also very poor, generally ranging from D-F as classified by the National Fisheries Classification Scheme (Table B), although several sites on the Hodder, Lune and Ribble catchments supported good densities of salmonids. These locations usually only supported good densities of one salmonid species, usually trout, while a very small number of sites supported good densities of both salmon and trout. For sites with both RHS and fishery data, with the exception of salmon fry, all sites supported only poor salmonid densities. However, 11% of the sites supported good densities (Class C) of salmon fry, while 89% supported poor densities.

A1.7 The corresponding RHS data relate predominantly to main river sites, while the better salmonid densities were located almost entirely in the tributaries. There are therefore no RHS data for sites supporting good salmonid populations.

A1.8 The lack of RHS data for the tributaries precludes any detailed analysis of the RHS data in an attempt to identify habitat characteristics associated with good salmonid densities. A brief generalised description of the broad habitat characteristics of the main river sites has been provided below, although this has been based on a subjective interpretation of the RHS data rather than a detailed scientific assessment, an approach which is justified by the lack of relevant data.

Table B Salmonid density classification for sites on the Rivers Allt - Ribble

Salmonid density class	No. of sites with salmonid density			
	0+ salmon	0+ trout	>0+ salmon	>0+ trout
A	0	0	0	0
B	0	0	0	0
C	2	0	0	0
D	0	0	1	1
E	7	6	5	3
F	9	12	12	14
A-C	2	0	0	0
D-F	16	18	18	18
% A-C	11.1	0	0	0.0
% D-F	88.9	100	100	100.0

Broad habitat descriptions

Southern Arc Rivers (Bollin - Wirral tributaries)

A1.9 These rivers appear to be typically slow, sluggish rivers with a glide-run flow pattern and generally soft depositing substrate. They have a mean depth of 30cm and flow through relatively impacted industrial areas where anthropogenic influences on the river channel, in the form of weirs, culverts, industrial structures, sewage treatment

works and channel modifications are frequent. These rivers are typical of more lowland situations with a meandering channel, embankments and a gentle gradient and do not generally provide habitat particularly suitable for salmonids, although some trout habitat may be available.

Central Area Rivers (Allt - Ribble)

A1.10 These rivers are similar in form to the rivers described above, with a gentle gradient, sluggish flow consisting of a glide-run pattern, meandering through lowland habitats. Many of the sites had evidence of channel modifications including resectioning, overdeepening, dredging, embankment and weirs. These rivers would not be expected to provide habitat suitable for salmonids, although some trout habitat may be available. However, this is likely to be sub-optimal when compared with cleaner, faster flowing upland streams.