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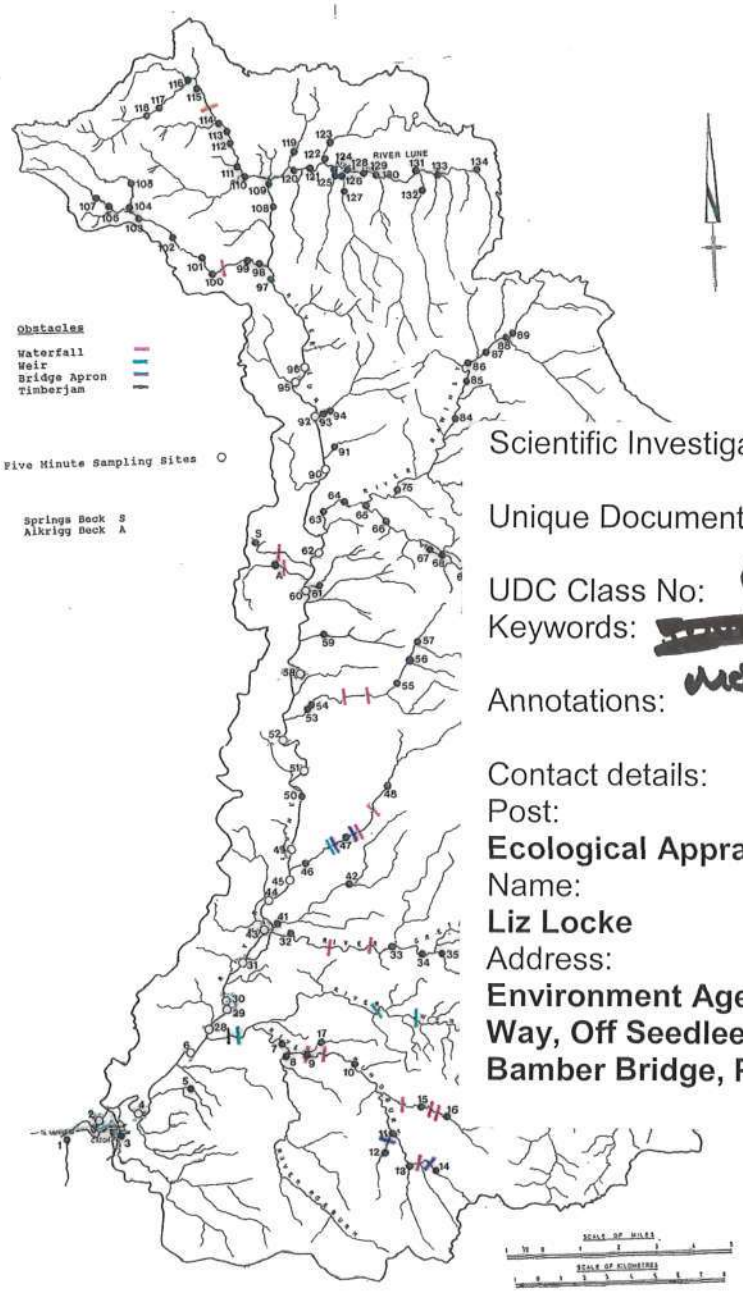
The River Lune Strategic Stock Assessment Survey With Particular Reference To Salmonids (1991)



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The River Lune Strategic Stock Assessment Survey 1991 With Particular Reference To Salmonids

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Summary

1. Sampling was carried out at 134 sites between July and September 1991. Nine species of fish were recorded namely salmon, trout, eel, dace, bullhead, stoneloach, minnow, stickleback, and lamprey.

2. The main areas for 0+ salmon production were the middle section of the Lune including Barbon Beck (sites 51- 60), and Birk Beck, Borrowdale Beck together with the upper reaches of the Lune (sites 98 -134).

   In other areas of the catchment salmon fry densities were low, only 23.5% of the sites sampled had minimum densities in excess of 22.5\100m^2.

3. Salmon parr densities were generally low with 64.9% of the sites in the catchment having minimum densities less than 10\100m^2. Borrowdale Beck (98-107) and Birk Beck (110-118) were the most productive subcatchments for 1+ salmon.

4. For the catchment as a whole 0+ trout densities were low. Of the sites sampled 71.2% had minimum densities less than 10\100m^2. There was some evidence to suggest that the distribution of fry was related to the size of the water course. Some of the smaller streams (less than 10m wide) were very productive e.g. Austwick Beck (23-25), Sally Beck (89) and Millhouse Beck (59) in comparison to larger water courses such as the Lune.

5. The distribution and abundance of trout parr was similar to that of trout fry with minimum densities of less than 10\100m^2 being recorded at 68.3% of the sites sampled. The River Clough (76-83) was one of the better subcatchments for trout parr.

6. A comparison of the results of the 1991 survey with that of the 1981-85 surveys revealed that salmon fry production in 1991 was similar to that in 1982 and 1983. These three years represent the most productive for 0+ salmon of the data record. 1984 was the most productive year for 1+ parr.

   0+ trout densities were recorded as poor in 1991 which is similar to that found over the 1981-85 period. Parr production was poor in 1991 as it was in 1981 and 1985.

7. The healthy densities of fry and parr in certain areas of the catchment namely Birk Beck (110-118), Borrowdale Beck (98-107) and Barbon Beck (53-57) could be accounted for by the stocking of fry in 1990 and 1991.

   However, not all stocked areas produced healthy populations e.g. Leck Beck (46-48).

Contents

The River Lune Strategic Stock Assessment Survey 1991 With Particular Reference To Salmonids

1. Introduction

The NRA is under obligation to maintain, improve and develop fisheries (Water Resources Act, 1991). In order to accomplish this, baseline information on the current status of stocks is essential. Such information can then be used for a variety of management purposes to fulfil it's statutory duties.

The Stock Assessment Task Group (1991) has identified some of the key applications of stock assessment and include:

1. To assess long term change.

2. To help conserve fish species.

3. To evaluate stocking programmes, habitat and water quality improvements.

4. To assess or predict the impact of activities which the NRA or outside organisations may have on fish populations.

5. To comment on the fisheries implications of developments when the NRA is a statutory consultee to planning authorities.

In the past stock assessment surveys were generally reactive in response to a particular problem e.g. a pollution incident and as such were limited in the information they provided. A programme of strategic stock assessment would be more beneficial, providing up to date information on the status and composition of the stock. On a national level this could reveal trends in population dynamics and enable comparisons to be made between key rivers and between regions.

The Stock Assessment Task Group (1991) has recommended annual strategic surveys for juvenile salmonids and triennial strategic surveys for coarse fish and non-migratory salmonids.

The aim of this pilot study was to gain information on species distribution and their relative abundance within the River Lune catchment, and to compare the findings with the surveys carried out between 1981-1985. This would provide valuable information on the current status of the stock and provide an indication of the resources required to conduct such strategic surveys on other river catchments in the North West Region.

In order to carry out a catchment wide survey in the time available (July to September) it was decided to adopt a

strategy of sampling a relatively large number of sites at a low level of accuracy.

2. Description of the study area

The River Lune descends from an altitude of 540m (N.G.R. NY 702013) and runs for approximately 87Km before entering Morecambe Bay. The catchment covers an area of approximately 1223Km^2. The land is used primarily as pasture for cattle and sheep, and also for hay and silage production.

A total of 134 sites was selected from the Lune catchment (Figure 1). These sites were chosen to be representative of the habitat available except in the main river where riffle habitat was selected. The catchment was divided into 13 subcatchments and these are shown in Table 1 together with the grid reference and dimensions of each site.

Three distinct geological features are evident. The upper reaches of the Lune (sites 109-134), Birk Beck (110-118), the Clough (76-83), and upper reaches of the Dee (70-74) flow over a Carboniferous limestone series (alternating limestones, sandstones and mudstones). The Lune and minor tributaries from site 52 to 108, together with Borrowdale Beck (98-107), the Rawthey (63-89) and lower section of the Dee (65-69) flow over Silurian slates, grits and flags (hard, inert and impermeable). The underlying geology of the lower Lune (2-49) and minor tributaries, together with the Greta (excluding site 38 and 40), tributaries of the upper Wenning (excluding site 25), the Hindburn (7, 9-17) and the Roeburn (8) is of a Carboniferous millstone grit series (alternating shales, mudstones and sandstones). There is some base flow from the sandstones.

Obstacles to migratory fish e.g. weirs can be an important factor affecting their distribution and abundance. Figure 1 shows some of the known barriers to fish movement in relation to the survey sites. The waterfall on Birk Beck (downstream of site 115), Barbon Beck (downstream of site 55), Aikrigg Beck (downstream of site A), and Springs Beck (downstream of site S) are impassable to migratory fish (J. Staveley, J. Burton, and A. Atkinson pers. comm.).

The 1991 biology survey of the river Lune catchment which was completed on 30/07/91 (Saxby, 1991) concluded that the catchment was predominantly clean and productive. 48 of the 66 sites sampled yielded an inferred NWC classification of 1A, 13 of the sites were classed as 1B. Of the remaining sites class 2 was inferred at 3 sites, class 3 at 1 site and class 4 at one site.

3. Methods

All of the 134 sites were sampled during the period July to September 1991 using pulsed DC electrofishing powered by a 1.5 KW Honda generator. All salmonids and any major coarse fish species (e.g. dace), eels, and lampreys were collected. For the minor coarse fish species (bullheads, stoneloaches, minnows and sticklebacks) numbers were estimated and placed into one of the following abundance categories: tens, hundreds, thousands per $100m^2$. The time taken to fish each site was recorded.

For those sites that were wadeable a section 50m long was fished once in an upstream direction in the absence of stop nets. Five measurements of the wetted width at each site were taken (one at every 10m interval) and the mean width recorded.

In the main river sampling was confined to areas of riffles. At these 20 sites, sampling was carried out for 5 minutes and concentrated solely on the 0+ salmonids. At 18 of these sites this procedure was repeated on adjacent sections to give a total of three 5 minute samples for that site. Sampling was carried out by fishing across the site from the bank until the depth of water (c. 1m) prevented any further fishing and then by moving longitudinally for a distance of 2m before resuming fishing in a lateral direction back to the bank. This was continued until 5 minutes were spent fishing. The length of the site was measured and the width estimated as being 2m (the distance travelled by the anode in performing one sweep).

All target fish (salmonids and major coarse fish species) were anaesthetised using phenoxyethanol and then measured to the nearest 0.5cm below. If the number caught exceeded 100 then a sub-sample of about 100 fish were measured.

For each target species the minimum density (number of fish caught divided by area, multiplied by 100) was calculated and in the case of a three times 5 minute fishing the mean minimum density per $100m^2$ was determined. All salmonids were separated into 0+, 1+ and >1+ age classes using the length frequency method. Each site was classified according to the density of fish recorded. The classification system used was developed for the rivers of the North West Region and is shown in Table 2.

The trout data from Aikrigg Beck (A) and Springs Beck (S) were obtained from another survey carried out during September 1991 and have been included (Figure 1). Eleven 50m sites on Aikrigg Beck and thirteen 50m sites on Springs Beck were fished between stop nets using the depletion method (2-5 successive removals). Population estimates were calculated using the Carle and Strub (1978) method. The average density over the reach was calculated as the sum of the population estimates at each

Fig.1 Sampling Sites And Known Obstacles To Migratory Fish In The River Lune Catchment 1991

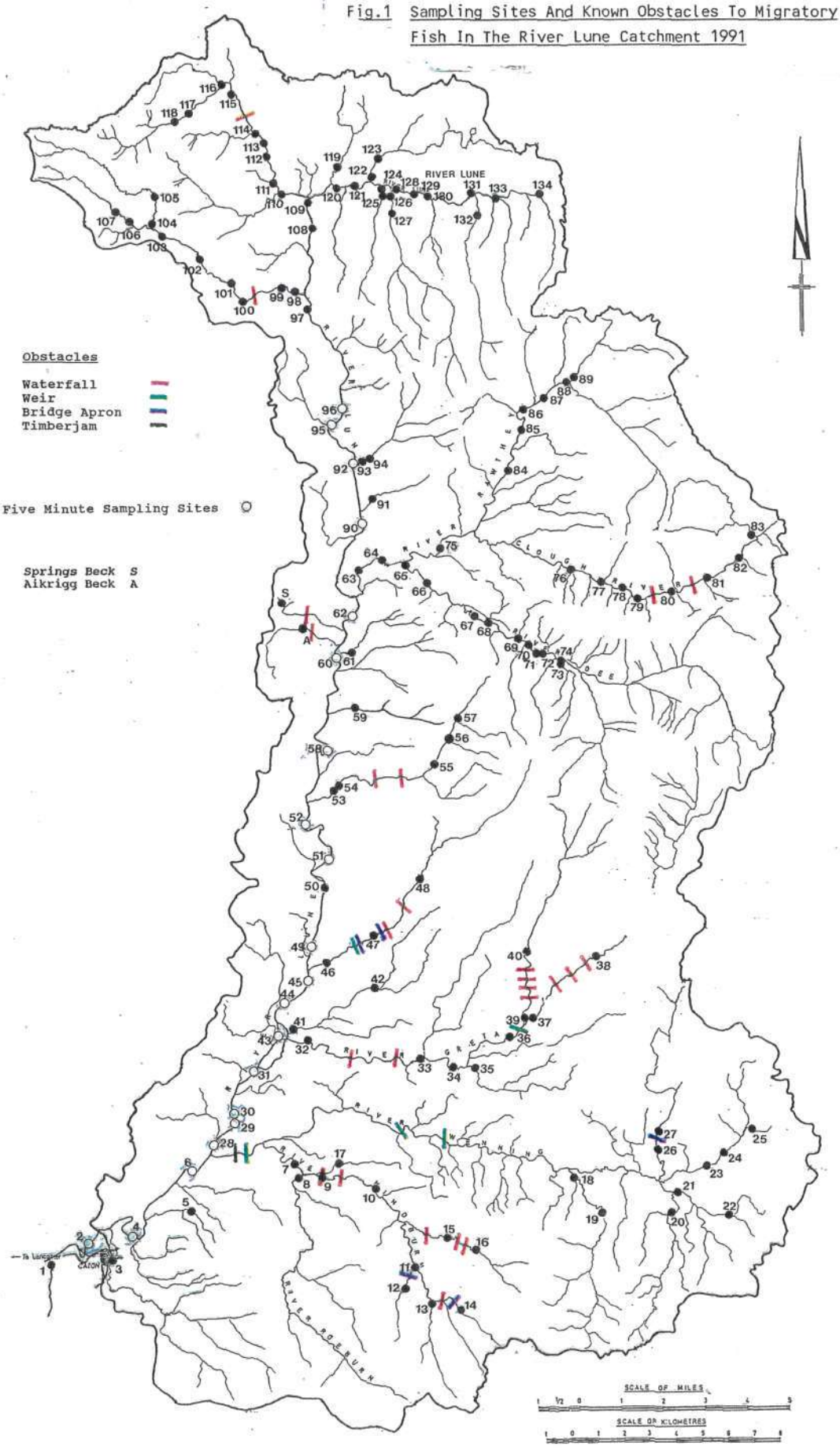

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Fig. 2 0+ Salmon Densities In The River Lune Catchment 1991

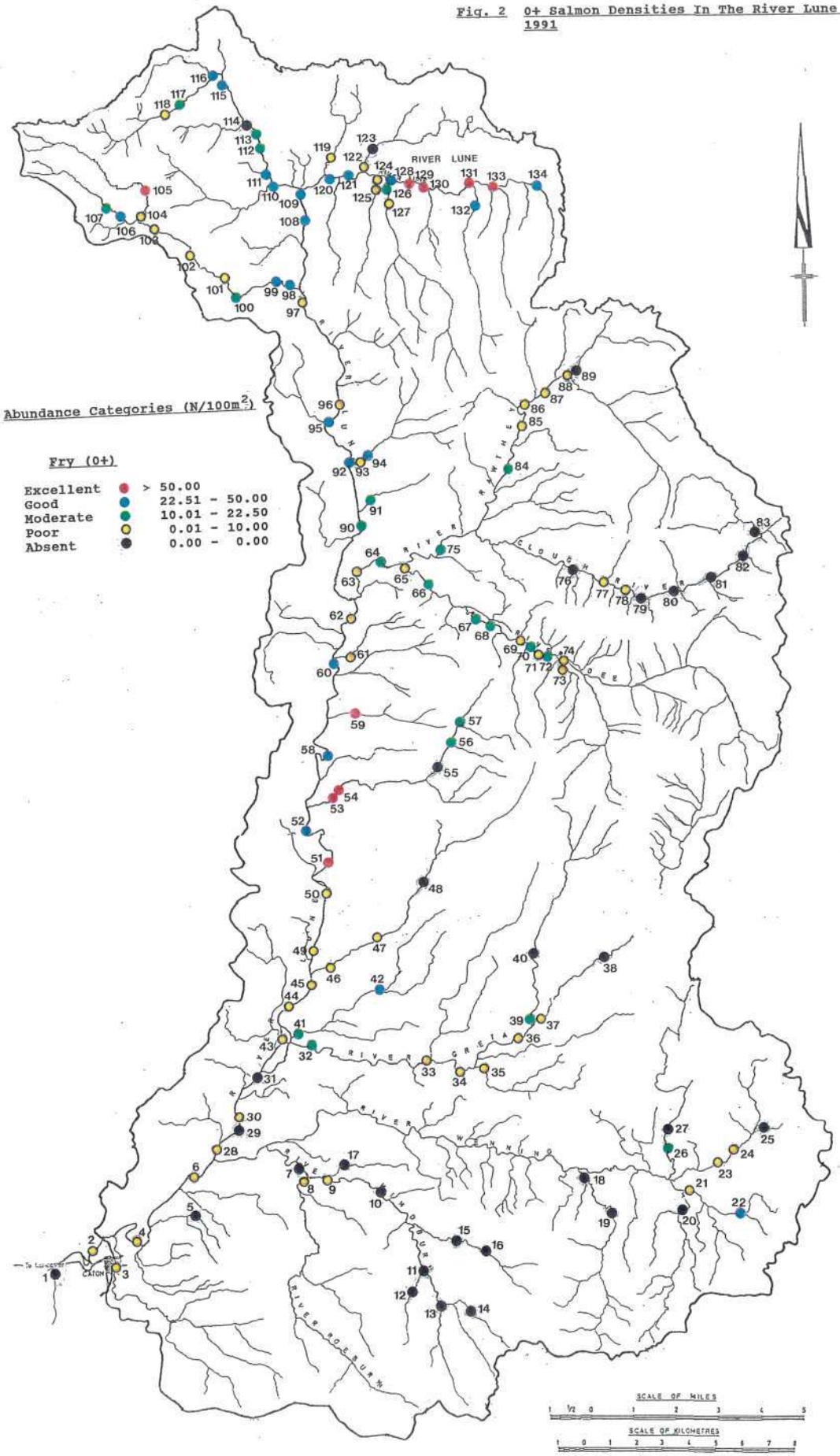


Fig. 3 1+ Salmon Densities In The River Lune Catchment 1991

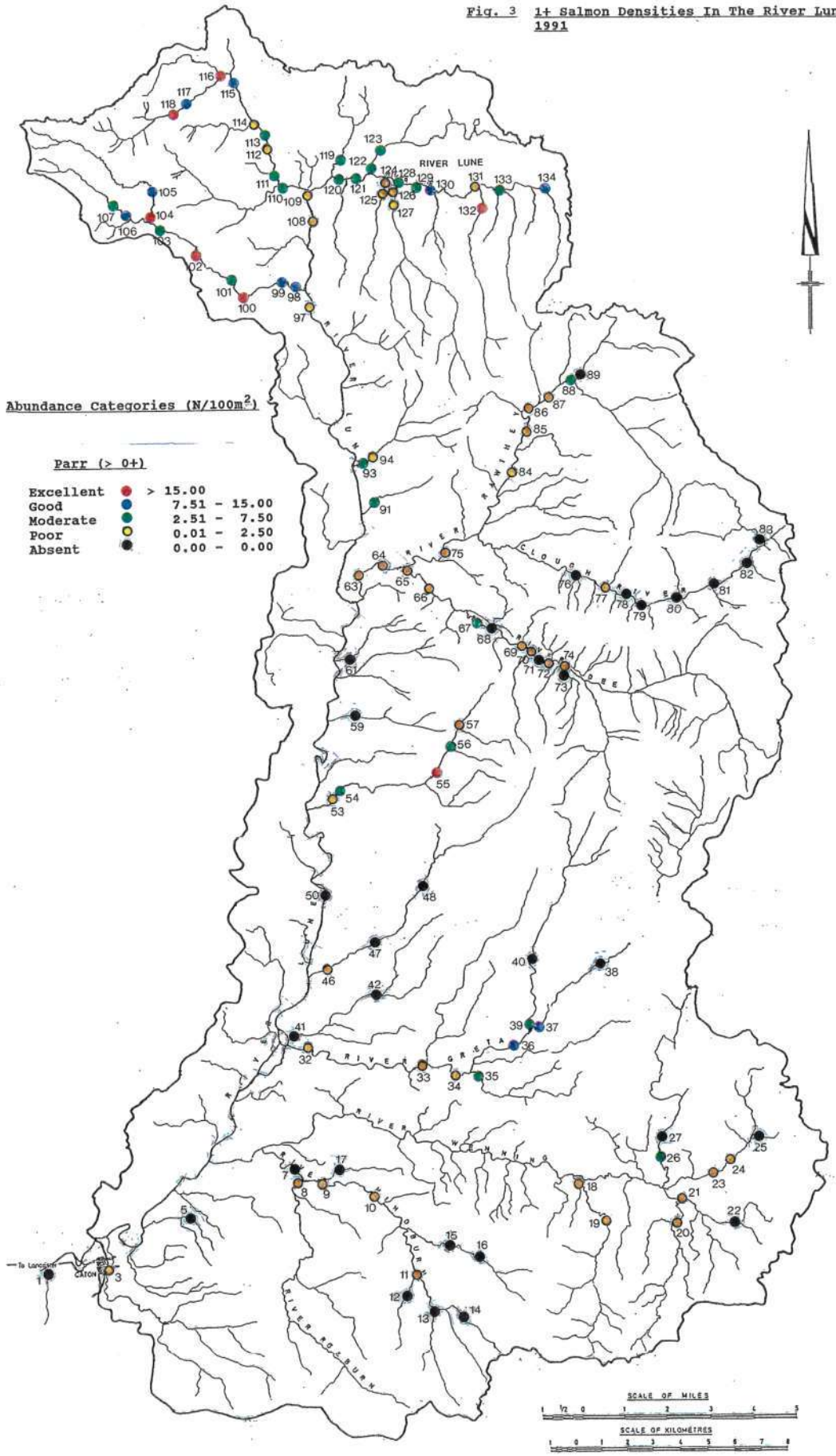


Fig. 4 0+ Trout Densities In The River Lune Catchment 1991

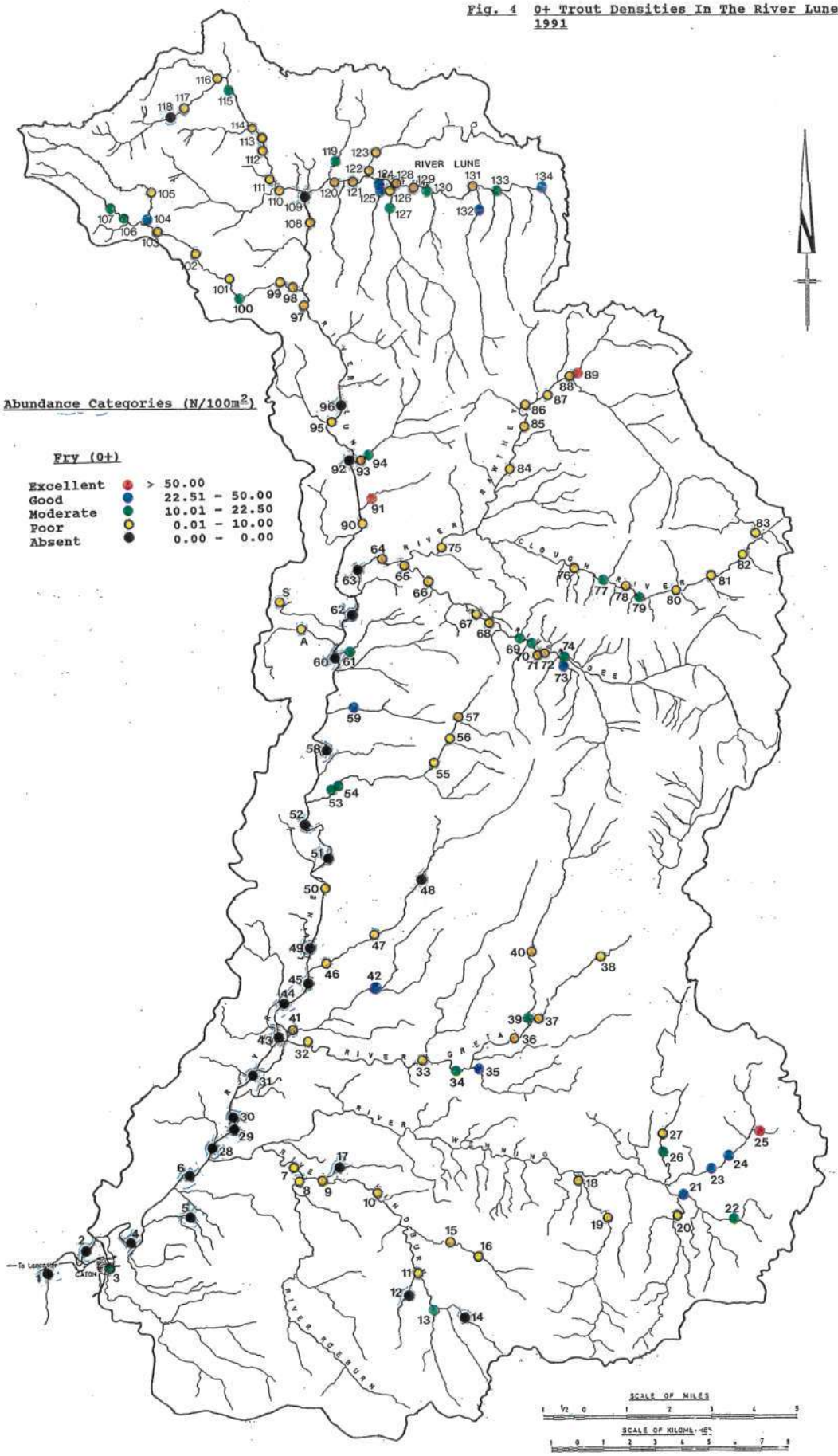
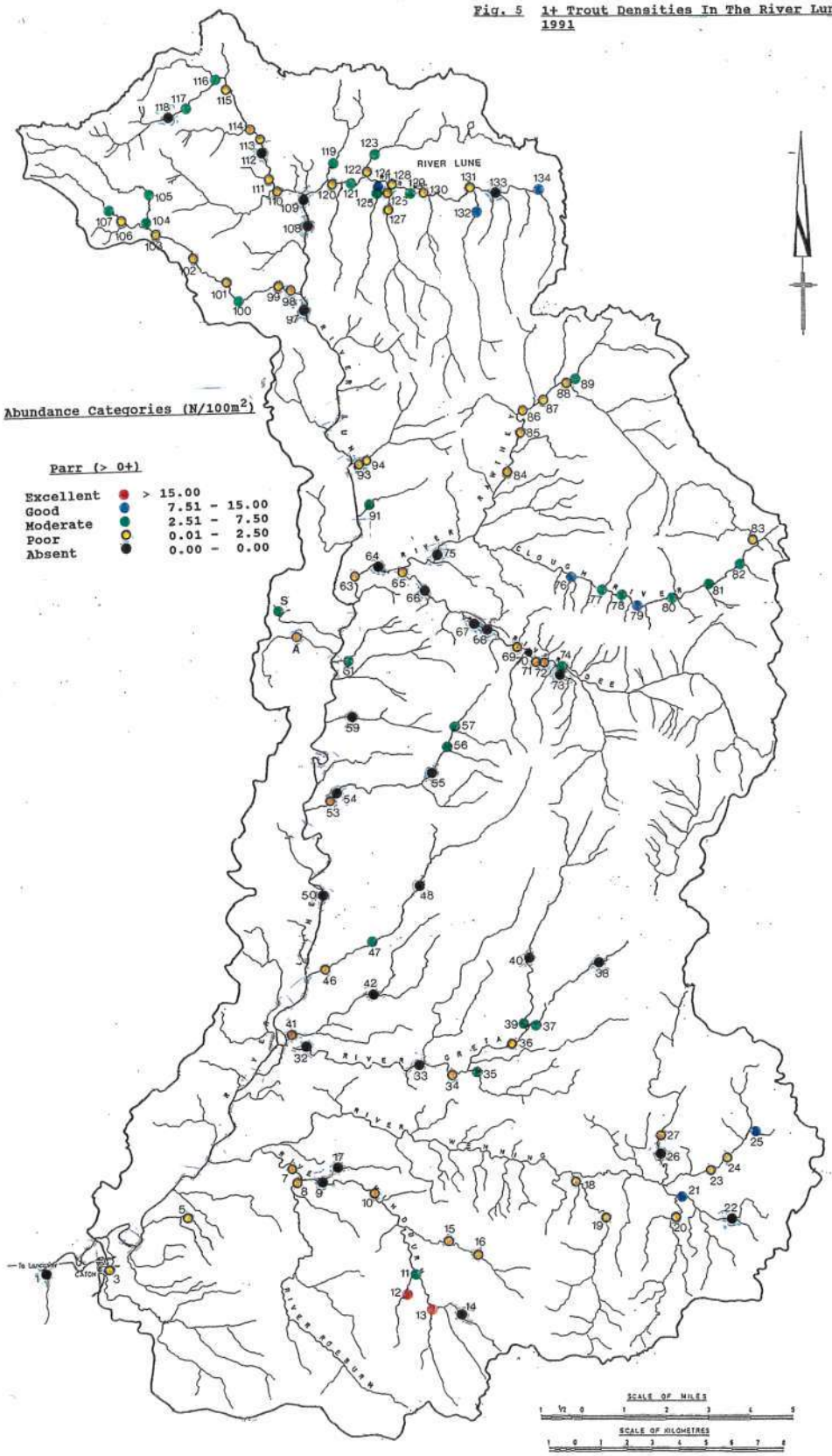


Fig. 5 1+ Trout Densities In The River Lune Catchment 1991



site divided by the total area fished. These sites were then classified according to the system for quantitative data in Table 2.

4. Results

This survey took 102 man days to complete at an average of about 4 sites per day. The time taken to fish a site of 50m length varied from 5 minutes to 1 hour and 25 minutes depending on the number of fish present and the physical nature of the site.

The results of this survey are presented in Table 3 for salmonids and in Table 4 for other species. Figures 2, 3, 4 and 5 summarise the findings for the 0+ and 1+ salmon and trout.

4.1 Salmon 1991

4.1.1 0+ Salmon

The lower region of the Lune (downstream of site 50) supported few 0+ salmon (Figure 2). The Hindburn system was found to be very poor, 0+ salmon not being recorded at 9 of the 11 sites sampled. The Greta and tributaries of the upper Wenning were marginally better, 0+ salmon being absent at 22% (n=9) and 50% (n=10) of the sites respectively. At the remaining sites the densities were classed as poor to moderate. Upstream of site 50 to the confluence with Middleton Hall Beck (60) the main river and the tributaries proved to be highly productive with 7 out of the 11 sites being in the good to excellent categories.

Further upstream the tributaries Rawthey and Dee fall into the poor to moderate category while the Clough was virtually devoid of 0+ salmon at the sites sampled. Upstream of the confluence with the Rawthey were some of the most productive sites within the catchment. Of the 45 sites sampled 11% were classed as excellent and 38% as good.

The results for 1991 reveal that 60.5% of the sites sampled were categorised in the range absent to poor with 23.5% in the good to excellent category.

4.1.2 >0+ Salmon

Figure 3 shows the most productive sites for >0+ salmon were confined to the main river and tributaries upstream of the Rawthey confluence. Downstream of the Rawthey confluence sampling in the main river was limited to 5 minute samples. This technique is considered not to effectively sample this age class.

Low densities of >0+ salmon were recorded at the sites on the Hindburn (64% absent, 36% poor, n=11), tributaries of

the upper Wenning (30% absent, 60% poor, n=10), Greta (22% absent, 33% poor, n=9), Dee (30% absent, 60% poor, n=10), and Rawthey (11% absent, 78% poor, n=9), while the Clough was almost barren (88% absent, 12% poor, n=8). The best areas on the Lune itself were upstream of site 120 where 63% of sites were classed as moderate and 25% were good (n=8). The most productive areas of the catchment however were Borrowdale Beck (sites 98 to 107) and Birk Beck (sites 110 to 118). In the former case 30% of sites were classed as excellent, 40% good and 30% moderate (n=10), while in the latter case 22 % were excellent, 22% good, 33% moderate and 22% poor.

For the catchment as a whole the proportion of sites in the absent to poor category was 64.9% while only 14.9% of the catchment produced good to excellent densities of parr.

4.1.3 Microtagged juvenile salmon

Microtagged salmon parr were also recorded, one at each of the following sites: Kettles Beck (20), Hindburn (11), Greta (32, 33) and Birk Beck (117), the respective densities being 0.3, 0.2, 0.1, 0.4, and 0.2/100m^2.

4.2 Trout 1991

4.2.1 0+ Trout

Trout fry densities in the Lune catchment were generally very low, the paucity of fry in the main river downstream of site 109 being one of the most striking features (Figure 4). Fry were not recorded at 79% of these sites (n=24).

The rest of the catchment is characterised by poor densities of fry i.e. <10/100m^2. For each subcatchment the percentage of sites classified as poor were: Hindburn 64% (n=11); tributaries of the upper Wenning 40% (n=10); Greta 67% (n=9); Dee 60% (n=10); Clough 75% (n=8); Rawthey 78% (n=9); Lune upstream of site 109 50% (n=16); Birk Beck 78% (n=9); Borrowdale Beck 60% (n=10).

For the catchment as a whole only 11.4% of the sites could be classified as good to excellent while 71.2% of sites were classified as being in the range of absent to poor.

Although 0+ trout densities were generally poor some of the smaller streams were quite productive e.g. Austwick Beck (sites 23 to 25), Sally Beck (89), Crosdale Beck (91), Millhouse Beck (59), Keld Beck (73) and Aspland Beck (35). Small streams (< 10m wide) such as these may be the preferred habitat of trout fry.

4.2.2 1+ Trout

1+ trout distribution and abundance is shown in Figure 5. As was the case with fry the overall result is one of low densities. For each subcatchment the percentage of sites that were classified as absent and poor was as follows: Hindburn 73% (n=11); tributaries of the upper Wenning 80% (n=10); Greta 67% (n=9); Dee 90% (n=10); Clough 13% (n=8); Rawthey 89% (n=9); Lune upstream of site 109 50% (n=16); Birk Beck 78% (n=9) and Borrowdale Beck 60% (n=10).

Densities of parr in the Clough (76-83) were quite consistent, the majority of sites being classed as moderate (63%, n=8) and as such proved to be one of the better subcatchments for trout parr.

For the catchment as a whole only 7.9% of the sites sampled could be classified as good to excellent, 68.3% falling into the absent to poor category.

4.2.3 Microtagged juvenile sea trout parr

These stocked fish (1991) were recorded at sites on the Rawthey (86, 87, 88), Rais Beck (122), Ellergill Beck (124, 125) and Longdale Beck (126), the respective densities being 0.4, 3.7, 16.4, 0.9, 0.6, 0.6, and 0.6/100m^2.

4.2.4 >1+ Trout

The distribution and abundance of trout >1+ is shown in Table 3. In general, densities were low and the majority of fish were found in the tributaries and upper reaches of the Lune. As was the case with salmon parr in the main river the results are influenced by the sampling technique and the habitat preferences of older trout (deep sections being favoured over riffles).

4.2.5 Adult sea trout

A total of 21 adult sea trout were recorded during this survey, being found in the Clough (sites 76, 77, 78, 79), upper Lune (121, 128), Crookdale Beck (105), Borrowdale Beck (98, 102), and the Roeburn (8) at densities of 0.2, 0.5, 0.3, 0.3, 0.2, 0.2, 2.5, 0.2, 0.8, and 0.7/100m^2, respectively.

4.3 Sites lacking salmon and/or trout 1991

There were 5 out of the 134 sites which did not support either juvenile salmon or juvenile trout; Denny Beck (1), Clear Beck (17), Whitray Beck (14), Leck Beck (48) and the Lune at Arkholme (31).

The habitat at Denny Beck appeared suitable for salmonids, but siltation at the site would suggest a water quality problem. At Whitray Beck and Leck Beck the

absence may be related to habitat availability. In the latter case heavy floods can cause serious erosion and removal of gravel beds.

There were also some sites at which trout were present and no salmon namely Claughton Beck (5), two sites on the Hindburn (7 and 12), Crossdale Beck (15, 16), one site on Clapham Beck (27), one site on Austwick Beck (25), Kingsdale Beck (40), the Doe (38), Sally Beck (89) and six sites on the Clough (76, 79-83). The absence of juvenile salmon from some of these sites may be due to their inaccessibility to adult fish. In the case of Claughton Beck, where only one trout was recorded, sewage effluent is the likely cause of the poor salmonid densities.

Other than some of the main river sites, Wasdale Beck (118) was the only site which was exclusive to salmon, having particularly good densities.

4.4 Other species

In addition to the salmonid species bullheads, stoneloaches, minnows, eels, sticklebacks, lampreys and dace were also recorded (Table 4).

4.4.1 Bullheads

Bullheads were both numerous and well distributed in the catchment, being found in numbers of the order of 10's to 100's/100m^2 and occurring at 73% of the sites sampled (Table 4).

4.4.2 Stoneloach

Stoneloach were not as widely distributed (43% of sites) or as numerous as bullheads, there being whole subcatchments where none were recorded at the sites sampled e.g. Borrowdale Beck (98-107) and the Clough. Stoneloach were not recorded from some of the smaller becks in the upper subcatchment of the Lune e.g. Chapel Beck (119), Longdale Beck (126-127) and Rais Beck (122-123) (Table 4).

4.4.3 Minnows

The distribution and abundance of minnows in the Lune catchment is presented in Table 4. Compared to bullheads and stoneloaches they were neither abundant nor well distributed (27% of sites sampled), a feature perhaps of prevailing habitat and flow conditions. Of the 43 sites at which they were recorded 21 were from the main river Lune.

4.4.4. Eels

Eels were a fairly common species occurring at 72.2% of the sites sampled in the catchment. Densities were

generally low (Table 4), the middle and lower Lune being the most productive areas.

4.5 Minor species

Other species that were found included the three spined stickleback which was recorded at six sites (Table 4). Lampreys were similarly scarce being found at seven sites with densities not exceeding 1.1/100m^2 (Table 4).

Dace were only found at one site which was the Lune at Snab (6). These were 0+ fish with a density of 4.6/100m^2.

4.6 Sites where fish were not recorded

There were two sites sampled during the survey where no fish were recorded and these were the Lune at Arkholme (31) and Whitray Beck (14).

5. Discussion

The observed patterns of distribution and abundance of fish in the River Lune may be linked to a variety of environmental factors such as water quality, habitat, flow regimes, competition, and in the case of anadromous fish access to spawning grounds.

Examination of the biological data of the tributaries of the lower Lune (Saxby, 1991), where salmon densities were poor and trout densities only marginally better, shows that Clapham Beck (26-27), Austwick Beck (23-25), Fen Beck (21-22) and Keasden Beck (18-19) along with the Hindburn (7, 9-14, 17), Roeburn (8) and Crossdale Beck (15-16) were recorded as having good water quality and the streams highly productive in terms of macroinvertebrates. Thus it appears that factors other than water quality and stream productivity may account for the poor densities of fish recorded at these sites. However, this does not exclude the possibility of intermittent water quality problems.

The downstream site at Clapham Beck (26) and the upstream site at Fen Beck (22) were the only sites with salmon densities greater than 2.5/100m^2.

It is quite possible that obstructions to upstream migration namely waterfalls and the weir upstream of the Lune confluence (Figure 1) may be limiting the number of spawning fish entering the Hindburn system. In addition to this weir the two weirs on the Wenning may be having a similar effect in reducing the number of adults reaching the upper tributaries. Gardiner's (1989) study on the Tweed catchment showed pronounced differences in juvenile salmon densities commonly coincide with the presence of obstacles, even those that appeared to be minor ones. The densities of juveniles upstream of obstacles were found to be lower than at other sites.

In the case of Austwick Beck and Fen Beck interspecific competition between trout and salmon may be important as these sites are well populated with trout. Interspecific competition from brown trout has been found to affect growth and survival of young salmon (Kennedy and Strange, 1986) because they are territorial and generally thought to be more aggressive than salmon (LeCren, 1965). Indeed, Gardiner (1989) noted a weak relationship between salmon and trout densities, with high numbers of trout associated with lower numbers of salmon.

Trout densities in the lower Lune were, with the exception of the upper Hindburn and some of the tributaries of the upper Wenning, only marginally better than salmon densities. The results for the upper Wenning can be attributed to natural production, however the sites in the upper Hindburn have been enhanced with stocked sea trout, hence the contrast between these sites and the downstream sites (Figures 4 and 5). A total of 31,000 sea trout were stocked in the vicinity of sites 11, 12 and 13 in 1990 and 15,750 in the vicinity of site 13 in 1991.

The Greta system also registered as poor for salmon parr except at Ingleton (36, 37, 39) and Aspland Beck (35) where parr densities ranged from moderate to good. The two waterfalls at the lower end of the Greta and the weir downstream of Ingleton are some of the obstacles confronting migratory fish in this system (Figure 1). Upstream of Ingleton the two tributaries which join to form the Greta (Kingsdale Beck (40) and the Doe (38)) did not support any salmon fry or parr and it is likely that the waterfalls on both tributaries prove too difficult to negotiate.

The River Twiss site (39) is in the vicinity of a stocked zone (14,620 salmon fry, 1991) so it is possible that some of these fry were encountered in the 1991 survey as densities here were better than at other sites in the vicinity. A similar number of fish were stocked just above the River Doe site (37) in 1991 but made no significant impression during the survey.

Salmon fry were stocked in the Twiss (9,500) and Doe (9,236) in 1990 and may well explain the moderate to good results obtained for parr in 1991 at sites 36, 37, and 39 compared to nonstocked areas in the system. Similarly, 5,000 fry were stocked in Aspland Beck in 1990, the stocking zone being upstream of the 1991 sampling site and probably accounts for the moderate densities of parr recorded this year.

Incidently, trout densities were marginally better at those sites where salmon densities were good as opposed to sites with poor salmon densities.

Salmon fry densities at the two sites on Cant Beck (41, 42) were moderate to good, however parr were absent.

Water quality was reported as good although some enrichment is likely and this may have had an adverse effect on the survival of the 1990 year class of salmon. Cant Beck was infact stocked in 1991 with 20,831 salmon fry in a section which included one of the 1991 sampling sites (42) and must have supplemented any natural fry production, resulting in the good density of fry recorded there. The downstream site (41), although out of the stocked zone, may have benefited from fry being displaced downstream. 0+ Trout densities were poor except at the top site (42) where they were classed as good.

Good water quality was indicated for Leck Beck (46-48) but observed salmon densities were poor or absent. No salmon were recorded at the top site (48) which may be due to difficulty in accessing the upper reaches of the beck, having to contend with a weir, bridge apron and two waterfalls (Figure 1). These barriers to upstream movement of mature fish only partly describe the situation at Leck Beck.

One of the factors affecting fry and parr production in this beck is that it can suffer from heavy flash floods resulting in tremendous habitat disturbance with the possibility of 'washing out' fry. Hume and Parkinson (1987) observed that floods can be an important source of mortality in salmonid streams. Experimental studies by Heggenes and Traaen (1988) have demonstrated that newly emerged salmonid fry are susceptible to 'wash out' and downstream displacement during increased water velocities.

In 1991 40,940 salmon fry were stocked from site 46 to 47 of Leck Beck, but only poor densities of fry were found at these sites during the 1991 survey. There is no record of any stocking taking place in 1990 and since parr production was so poor in 1991 it seems to suggest that the natural production of this beck is limited. Trout densities were similar to that of salmon, none being found at the top site (48).

At Barbon Beck (53-57) water quality was good as was the habitat, however the area available for spawning salmon is limited to the area downstream of the two waterfalls (Figure 1) which may account for the absent to moderate densities of fry upstream of the falls (Figure 2). Sites 53 and 54 are situated in a section which was stocked with 19,376 salmon fry in 1991 and this has undoubtedly resulted in the excellent densities of fry observed in 1991 (Figure 2). Salmon parr densities upstream of the falls ranged from poor to excellent and since access for spawning is limited in this region the results are most likely attributable to the stocking of 50,000 salmon fry in 1990. Trout densities ranged from poor to moderate (Figures 4 and 5).

The site at Millhouse Beck (59) proved to be an excellent site for salmon fry production, however no parr were

recorded (Figures 2, 3). The habitat is perhaps more suited to fry than parr, being shallow. Heggenes (1990) notes that in small streams where the entire cross section may be of the shallow fast flowing habitat type, parr will move longitudinally to find more space in deeper regions. Another important factor may be flow, parts of Millhouse Beck are liable to dry up during the summer months so most parr probably leave the beck and enter the Lune. No trout parr were found either although fry production was good (Figure 4).

Middleton Hall Beck (61) was dominated by trout but densities were only moderate.

The River Dee, although classed as productive with good water quality, showed only poor to moderate densities of 0+ salmon and absent to moderate densities of 1+ salmon. A similar result was obtained for trout. There are no significant obstacles to migratory fish, however it is known that large areas of the river are prone to drying up every summer in particular above Barth Bridge (upstream of site 69)(A. Atkinson pers. comm.). Thus reducing the available habitat for fry and parr and increasing environmental stress in the form of increased temperature, reduced dissolved oxygen concentration and reduced cover.

The Rawthey and Clough systems do not appear to have any water quality problems, the biological results showing good water quality being maintained and the rivers being very productive (Saxby, 1991). River flow is maintained in summer , there being no evidence of drying up. Salmon fry and parr were poor or absent in the Clough. The fact that a small number of juvenile salmon were present at two of the eight sites indicates that spawning does take place, but is limited and/or the survival of young is poor. This is probably due to the limited availability of habitat (a substantial amount of exposed bed-rock exits) and also the two waterfalls may impede the upstream movement of adults. These falls may also restrict the movement of adult sea trout which were found at each of the four sites downstream of the first waterfall but were absent at the four sites upstream of the fall. As can be seen from Figure 5 the Clough seems to be one of the best subcatchments for trout parr.

The Rawthey was found to be only marginally more productive for salmon than the Clough . The situation was the same for trout except at Sally Beck (89) where salmon were absent but trout were abundant. The upper reaches of the Rawthey were stocked with microtagged sea trout parr (11,116) and some of these were recorded at the top three sites of the Rawthey (86-88) where densities ranged from 0.4 to 16.4/100m^2.

Crosdale Beck (91) yielded only moderate densities of juvenile salmon after having been stocked with 14,240 fry

in 1990 and 12,242 fry in 1991. By contrast, 0+ trout densities were excellent and parr densities moderate. The results for salmon at the Chapel Beck sites are indicative of the habitat at these sites with fry dominating the upstream site (94) (predominantly riffles) and parr the downstream site (93) (predominantly pools). A similar trend was shown for trout.

The upper reaches of the Lune (upstream of site 109) and its associated tributaries are some of the most productive salmonid rearing areas in the catchment. Water quality in general was reported to be very good although some of the tributaries namely Rais Beck (122, 123) and Chapel Beck (119) are susceptible to organic enrichment. This may account for the very low densities of fry recorded in these two becks in 1991. Ellergill Beck (124, 125) and Longdale Beck (126, 127) were particularly poor for fry and parr which may be due to intermittent organic enrichment however no water quality data is available to substantiate this.

With the exception of Bowderdale Beck (132) and Longdale Beck the natural production of salmon in this region has been enhanced by stocking. The main river and tributaries were heavily stocked in 1991 with about 40,000 fry near site 109 and 66,000 further upstream which shows some correlation with the high densities recorded during this survey. Rais Beck (122, 123) and Chapel Beck (119) were stocked with fry in 1990 (27,000 and 20,142 respectively) but only produced moderate densities of parr in 1991. Bowderdale Beck (132) was not stocked in 1990 but supported a good density of fry and excellent parr densities.

Juvenile sea trout were also planted out in 1991; 15,000 being stocked in the vicinity of sites 133 and 134 possibly enhancing the natural level of production at these sites (Figure 4). Bowderdale Beck (132) was not stocked but produced good densities of juvenile trout.

The two main tributaries on the north west of the Lune i.e. Birk Beck (110-118) and Borrowdale Beck (98-107) are good nursery streams for juvenile salmonids both with respect to water quality and habitat. In Borrowdale Beck migratory fish are partially impeded by a waterfall (Figure 1) but are able to penetrate the upper reaches as indicated by the presence of adult sea trout in Crookdale Beck (105), the largest of which was 57.5cm. Four of the Borrowdale sites were recorded as having poor densities of salmon fry but were classed as moderate to excellent for parr, the natural densities of parr being supplemented by the 1990 stocking programme. 23,000 salmon fry were stocked in Crookdale Beck in 1990 and a total of 104,125 in Borrowdale Beck. This stocking shows a good correlation with the densities of parr caught in 1991 (Figure 3).

Borrowdale Beck was stocked in 1991 which is to some extent reflected by the survey results. In Crookdale Beck 18,300 fry were planted giving excellent densities at site 105. Similarly, 13,000 fry were planted in the vicinity of sites 106 and 107 which were classed as moderate and good respectively. Downstream of Crookdale Beck 58,764 fry were stocked in 1991 but the 1991 survey sites in this region only registered as poor.

The distribution and abundance of salmon in Birk Beck (110-118) is strongly influenced by the presence of a waterfall (Figure 1) above which no natural spawning is known to take place (J. Staveley pers. comm.), but where conditions appear ideal for rearing salmon. Upstream of the waterfall 40,000 fry were stocked in 1991 accounting for the good densities observed at sites 115 and 116. No stocking took place downstream of the falls but densities were predominantly moderate to good possibly due to natural spawning being supplemented by movement of stocked fish out from the tributaries; Rampshowe Beck and Bretherdale Beck. The good to excellent parr densities upstream of the falls can be explained by the stocking of 16,300 fry in Wasdale beck (118) and 37,000 fry in the upper reaches of Birk Beck in 1990.

The catchment profiles for 0+ salmon over the 1981-1985 period show some distinct patterns which were evident in the 1991 data (Table 6) such as the poor performance of the Hindburn, Roeburn, tributaries of the upper Wenning, and Greta system. The majority of sites in these subcatchments were categorised in the absent to poor bracket over the period 1981-1985. The unproductive nature of the Clough is also evident in the historical data.

Table 5 shows that for the Lune catchment as a whole, in 1991 60.5% of the sites sampled were incorporated into the absent to poor bracket while 23.5% were placed in the range good to excellent. A similar result was obtained in 1982 and 1983. These figures represent the best years for fry production for the catchment, 1984 and 1985 being poorer while in 1981 94.1% of sites sampled ranged from absent to poor.

1+ salmon densities in 1991 were lowest at those sites highlighted as having very poor fry densities i.e. Hindburn, Roeburn, tributaries of the upper Wenning, Greta, and Clough. This is reflected in the 1981-85 data (Table 7). It is also evident that overall parr production in the catchment is limited with only a small percentage of sites in the subcatchments supporting high densities. Subcatchment 1 (Lune and tributaries upstream of site 109), 5 (Birk Beck and Borrowdale Beck) and 10 (Barbon Beck) proved to be the most productive areas over 1981-85 period and in 1991. Salmon parr were only rarely recorded in the lower Lune and lower middle Lune in 1991 which is likely to be an artifact of the sampling technique. The historical data shows that this region of

the Lune has never been very productive, the majority of sites being poor (Table 7).

The overall catchment data (Table 5) shows that parr production in 1991, 1982 and in 1985 was lower than that recorded in 1981, 1983 and 1984.

The main feature of the 1991 results for 0+ trout is that the major proportion of sites were classed as poor, the upper middle Lune, lower middle Lune and lower Lune being particularly prominent in this respect (Table 8). The low productivity of these main river sites is reflected in the data from all previous surveys between 1981 and 1985 (Table 8). This seems to suggest that either very little spawning takes place in the main river downstream of site 109 or the sampling has been ineffective. Although the reason is not known it is likely that trout prefer to spawn in the tributaries of the Lune as is evident in Austwick Beck (23-25), Middleton Hall Beck (61) and Crosdale Beck (91).

Table 5 summarises the productivity of 0+ trout in the catchment over the period 1981-85 and it shows a general trend of poor fry densities with 1981 being the worst year of the data set, all sites supporting fry being classed as poor or absent.

As was the case for trout fry few of the subcatchments in 1991 were dominated by 1+ trout although some sites within subcatchments did favour trout e.g. Austwick Beck (25) - Table 9. Parr densities were consistently poor during the 1981-85 period in the upper middle, lower middle and lower Lune possibly as a result of the fish being able to avoid capture by staying in deeper water (Gardiner, 1984; Heggenes, 1990). The most productive subcatchment was the Hindburn system (subcatchment 13) (Table 9).

The overall catchment analysis (Table 5) shows that 1981, 1985 and 1991 were the poorest years for trout parr production.

Intraspecific competition may be an important factor influencing juvenile salmonid distribution. Gaudin and Caillere (1990) observed that in the presence of bullheads trout fry showed a clear-cut increase in their natural downstream swimming behaviour. They suggest that segregation between the two species was the result of an avoidance behaviour, driving the trout fry to select areas where bullheads were either absent or relatively infrequent even if the environmental characteristics were unsuitable for them.

It is unlikely that eels may be limiting salmonid populations through competition and predation. Mann and Blackburn (1991) found in their study that eels had no measurable deleterious effect on salmonid recruitment. The level of predation was found to be very low and

resource partitioning was evident; the eels being largely benthic foragers, whereas the salmonids fed chiefly on mid-water and surface prey.
Although the survey was relatively extensive certain areas of the catchment were not covered. These were mainly the deeper and more inaccessible areas. Thus it was not possible to effectively sample for salmon and trout parr as well as for the coarse fish species.

6. Conclusion

The results of this survey suggest that the Lune catchment is not at its carrying capacity with respect to juvenile salmon and trout. This situation may arise from a below optimum number of spawners, however if the stock recruitment relationship is dome shaped (Elliott, 1985) then a surfeit of spawners would produce a similar result. Though the former is suspected it is not possible to say definitively that this is the cause.

The Greta, tributaries of the upper Wenning, and the Hindburn system are unproductive for salmon possibly due to obstacles to homing adults. Salmon become more abundant in the upper reaches and tributaries of the Lune with densities ranging from good to excellent. Many of these sites however were in areas stocked with salmon fry. The stocking programme in certain areas of the catchment appears to be successful as indicated by good to excellent parr densities, nonstocked sites in contrast were in general less abundant indicating a low level of natural production.

Although well distributed in all of the tributaries of the Lune 0+ trout densities were poor and 1+ densities predominantly poor to moderate. A similar situation was found to exist over the period 1981-1985. Stocking for sea trout in 1990/91 was not as extensive as for salmon but those sites which were stocked with sea trout in 1990 yielded good to excellent densities of 1+ parr.

7. Recommendations

(1) In view of the results obtained it is suggested that enhancement stocking continues. This should be carried out in those areas which proved to be successful stocking sites from the results of the 1991 survey. Leck Beck should not be stocked with fry because of the suspected 'wash out' effect. In this case consideration may be given to stocking with older age classes.

There is a need to investigate the suspected poor survival of salmon stocked fry in certain areas of the catchment.

(2) The classification system used in this study needs to be evaluated and this should be carried out in conjunction with the National Research and Development project (number D01(90)2 244) on the Development of a Fisheries Classification System currently being investigated by WRc.

(3) The method used to calibrate the semi-quantitative technique used assumed a probability of capture of 0.75 and 0.5 for 1+ and 0+ salmonids. This does need further investigation, and verification.

(4) The status of trout in the Lune needs to be addressed in more detail to determine the factors responsible for the poor level of recruitment apparent in the 1991 survey and from the historical data record.

(5) A survey of the main river in particular the deeper regions not sampled in the 1991 study should be carried out to provide information on the status of >0+ salmonids and other species in the Lune.

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Table 1

The Subcatchments of the River Lune

Site	Site name	Grid Ref.	Width(m)	Length(m)	Area(m2)
Lune and tribs. u/s Tebay (1)					
134	Lune Newbiggin	NY 702053	2.00	50.0	100.0
133	Lune Wath	NY 685052	4.52	50.0	226.0
132	Bowderdale B. Village Br.	NY 677046	4.24	50.0	212.0
131	Lune Potlands	NY 676053	7.60	50.0	380.0
130	Lune Kelleth Br.	NY 659052	10.90	50.0	543.0
129	Lune Midfield	NY 652053	6.04	50.0	302.0
128	Lune Rayne Br.	NY 644055	8.60	50.0	430.0
127	Longdale B. Beck's Field	NY 644047	5.36	50.0	268.0
126	Longdale B. A685 Br.	NY 643053	7.02	50.0	351.0
125	Ellergill B. Below Fm.	NY 641053	3.60	50.0	180.0
124	Ellergill B. Gaisgill	NY 639056	3.26	50.0	163.0
123	Rais B. Fawcett Mill	NY 638066	4.90	50.0	245.0
122	Rais B. Rais Gill Hall	NY 635058	4.02	50.0	201.0
121	Lune Bankers Pool	NY 630055	8.54	50.0	427.0
120	Lune Tebay Br.	NY 622056	15.38	50.0	769.0
119	Chapel B. Orton	NY 623064	5.56	50.0	278.0
Upper middle Lune (2)					
109	Lune D/S Birk B.	NY 612057	20.08	50.0	1004.0
108	Lune Roundthwaite	NY 614040	14.82	50.0	741.0
97	Lune Borrowbridge	NY 611008	19.10	50.0	955.0
96	Lune Fleetholme	SD 624968			84.8 *
95	Lune Beckfoot	SD 619963			74.0 *
92	Lune Howgill Fm.	SD 628949			78.4 *
90	Lune Bridge End	SD 632924			85.7 *
62	Lune Park Wood	SD 627889			34.7 *
Lower middle Lune (3)					
61	Middleton Hall B.	SD 625875	2.26	50.0	113.0
60	Lune Middleton Hall B.	SD 620874			44.0 *
59	Millhouse B.	SD 624854	2.20	50.0	110.0
58	Lune Kingfisher Pool	SD 616836			37.8 *
52	Lune Underley	SD 608810			34.5 *
51	Lune Casterton	SD 617796			32.9 *
50	Lune Devils Br.	SD 615784	21.14	40.6	1057.0
Lower Lune (4)					
49	Lune Yew Tree Fm.	SD 611762			72.7 *
45	Lune Whittington Est.	SD 609748			94.0 *
44	Lune Lane Foot Fm.	SD 603743			86.0 *
43	Lune Arkholme Broomfield	SD 598729			80.7 *
42	Cant B. Collingholme Fm.	SD 636747	3.74	50.0	187.0
41	Cant B. Tunstall	SD 606733	6.12	50.0	306.0
31	Lune Arkholme Lower Reaches	SD 587715			66.2 *
30	Lune U/S Loyn Br.	SD 581699			73.5 *
29	Lune D/S Loyn Br.	SD 582696			128.0 *
28	Lune Gressingham	SD 573687			172.0 *
6	Lune Snab	SD 563677			66.0 *
5	Claughton B.	SD 561662	1.24	50.0	62.0
4	Lune Aughton	SD 543653			81.8 *
3	Artle B. Caton	SD 534644	7.92	46.5	368.3
2	Lune Halton Green	SD 524650			90.0 *
1	Denny B. Denny Lane	SD 503644	2.96	50.0	148.0

Table 1 (Cont.)

Site	Site name	Grid Ref.	Width(m)	Length(m)	Area(m2)
Birk B. and Borrow B. (5)					
118	Wasdale B. A6 Br.	NY 559081	3.82	50.0	191.0
117	Birk B. D/S Br.	NY 565084	5.06	50.0	253.0
116	Birk B. Above Falls	NY 578095	5.28	50.0	264.0
115	Birk B. Salterwath	NY 583092	6.04	50.0	302.0
114	Birk B. Rampshowe	NY 591076	7.92	50.0	396.0
113	Birk B. Scout Green	NY 594074	10.46	50.0	523.0
112	Birk B. Steps	NY 596068	8.82	50.0	441.0
111	Birk B. Greenholme	NY 598057	6.38	50.0	319.0
110	Birk B. D/S Bretherdale B.	NY 601054	6.10	50.0	305.0
107	Borrowdale B. High House	NY 537047	4.80	50.0	240.0
106	Borrowdale B. Borrowdale Head	NY 543043	4.06	50.0	203.0
105	Crookdale B. Hause Foot	NY 553054	4.78	50.0	239.0
104	Crookdale B. U/S Confluence	NY 552042	6.34	50.0	317.0
103	Borrowdale B. Breasthigh Rd.	NY 554037	13.78	50.0	689.0
102	Borrowdale B. High Borrowdale	NY 569031	8.02	50.0	401.0
101	Borrowdale B. Low Borrowdale	NY 583018	10.14	50.0	507.0
100	Borrowdale B. U/S Br.	NY 587013	6.14	50.0	307.0
99	Borrowdale B. Near Barn	NY 602016	10.54	50.0	527.0
98	Borrowdale B. A685 Br.	NY 606015	10.32	50.0	516.0
Chapel B. and Crosdale B. (6)					
94	Chapel B. Chapel	SD 634951	6.06	50.0	303.0
93	Chapel B. Luffman Fm.	SD 631948	4.40	50.0	220.0
91	Crosdale B. Branthwaite	SD 637936	3.12	50.0	156.0
R. Rawthey (7)					
89	Sally B. Foot Br.	SD 716983	3.10	50.0	155.0
88	Rawthey Rawthey Br.	SD 713979	9.52	50.0	476.0
87	Rawthey Narthwaite Fm.	SD 703973	9.10	50.0	455.0
86	Rawthey Low Haygarth Fm.	SD 695968	15.36	50.0	768.0
85	Rawthey High Wardses	SD 696961	6.90	50.0	345.0
84	Rawthey Crook Holme	SD 690946	10.10	50.0	505.0
75	Rawthey Clowes Weir	SD 663915	10.04	50.0	502.0
64	Rawthey Ingmire Stickle	SD 638912	17.76	50.0	888.0
63	Rawthey Steak's Pool	SD 630907	18.54	50.0	927.0
R. Clough (8)					
83	Clough Clough	SD 784918	7.32	50.0	366.0
82	Clough Knudmaning Fm.	SD 779910	8.72	50.0	436.0
81	Clough Medcalfe's Tip	SD 765903	8.46	50.0	423.0
80	Clough Garsdale	SD 751897	8.26	50.0	413.0
79	Clough Far Ho.	SD 739895	7.64	50.0	382.0
78	Clough Aygill Fm.	SD 734898	7.86	50.0	393.0
77	Clough Birkrigg	SD 726902	7.84	50.0	392.0
76	Clough Newbridge	SD 714906	10.80	50.0	540.0
R. Dee (9)					
74	Dee Church Br.	SD 709871	11.22	50.0	527.0
73	Keld B. Dent	SD 708871	4.14	50.0	207.0
72	Dee U/S Hell Hole	SD 702874	12.62	50.0	631.0
71	Dee Hell Hole	SD 700874	7.14	50.0	357.0
70	Dee Spring	SD 696877	8.98	50.0	449.0
69	Dee Barth Br.	SD 694879	13.30	50.0	665.0
68	Dee Wood Br.	SD 681886	17.48	50.0	874.0

Table 1 (Cont.)

Site	Site name	Grid Ref.	Width(m)	Length(m)	Area(m2)
67	Dee Island	SD 676888	6.18	50.0	309.0
66	Dee Rashmill	SD 658900	11.20	50.0	560.0
65	Dee Rawthey Confluence	SD 648909	12.66	50.0	633.0
	Barbon B. and Leck B. (10)				
57	Barbon B. Source	SD 663836	3.20	50.0	160.0
56	Barbon D/S Fork	SD 664841	5.46	50.0	273.0
55	Barbon B. Foot Br.	SD 657829	9.26	50.0	463.0
54	Barbon B. A 683	SD 621824	7.14	50.0	357.0
53	Barbon B. Cattle Barrier	SD 620823	7.96	50.0	398.0
48	Leck B. Spring Bank Wood	SD 653788	5.90	50.0	295.0
47	Leck B. Cowan Br.	SD 634766	8.44	50.0	422.0
46	Leck B. Nether Burrow	SD 614756	11.02	49.5	545.5
	R. Greta (11)				
40	Kingsdale B. U/S Raven Ray	SD 695760	11.78	50.0	589.0
39	Twiss Coach Depot	SD 694734	8.24	50.0	412.0
38	Doe Dalehouse	SD 722758	9.60	50.0	480.0
37	Doe Waterfalls Car Park	SD 697734	6.34	50.0	317.0
36	Greta A65 Br.	SD 688727	9.14	50.0	457.0
35	Aspland B. Park Foot	SD 673717	3.10	50.0	155.0
34	Greta Fourlands Hill	SD 665716	10.80	50.0	540.0
33	Greta Burton In Lonsdale	SD 654720	10.90	50.0	545.0
32	Greta Wrayton	SD 609727	16.58	50.0	829.0
	Tribs. of Upper Wenning (12)				
27	Clapham B. Clapham	SD 744693	15.42	50.0	771.0
26	Clapham B. Crina Fm.	SD 744684	6.10	50.0	305.0
25	Austwick B. Wood End Fm.	SD 780693	1.78	50.0	89.0
24	Austwick B. Austwick	SD 770684	7.06	50.0	353.0
23	Austwick B. A65 Br.	SD 764678	6.48	50.0	324.0
22	Fen B. Lawkland	SD 772659	1.22	50.0	61.0
21	Fen B. Waters Br.	SD 752668	1.78	50.0	89.0
20	Kettles B. Lanshaw Fm.	SD 749661	5.42	50.0	271.0
19	Keasden B. Turner Ford	SD 724660	8.00	50.0	400.0
18	Keasden B. Clapham Wood House	SD 713674	5.76	50.0	288.0
	R. Hindburn and R. Roeburn (13)				
17	Clear B. Millhouses	SD 621681	1.10	50.0	55.0
16	Crossdale B. Moorcock Rd. Br.	SD 674646	2.44	50.0	122.0
15	Crossdale B. Craggs Fm.	SD 662652	5.00	50.0	250.0
14	Whitray B. Whitray	SD 668624	4.90	50.0	245.0
13	Hindburn Sementation Br.	SD 656626	5.90	50.0	295.0
12	Mill B. Thrushgill	SD 647634	4.04	50.0	202.0
11	Hindburn Stare End Br.	SD 649641	11.66	50.0	583.0
10	Hindburn Furness Ford Br.	SD 635671	13.96	50.0	698.0
9	Hindburn Mealbank Br.	SD 614675	14.50	50.0	725.0
8	Roeburn Wray	SD 606676	12.10	50.0	605.0
7	Hindburn Hindburn Br.	SD 604681	15.02	50.0	751.0

* Five minute fishings

Table 2

Abundance categories (N/100m^2) for juvenile salmon and trout

Semi-quantitative

	Fry (0+)	Parr (>0+)
Excellent	>50.00	>15.00
Good	22.51-50.00	7.51-15.00
Moderate	10.01-22.50	2.51- 7.50
Poor	0.01-10.00	0.01- 2.50
Absent	0.00	0.00

Quantitative

	Fry (0+)	Parr (>0+)
Excellent	>100.00	>20.00
Good	50.01-100.00	10.01-20.00
Moderate	25.01- 50.00	5.01-10.00
Poor	0.01- 25.00	0.01- 5.00
Absent	0.00	0.00

Table 3

Juvenile salmonid (minimum) densities (N/100m2) in the Lune 1991

Site	Site name	Salmon		Trout		
Lune and tribs. u/s Tebay (1)		0+	1+	0+	1+	>1+
134	Lune Newbiggin	23.0	15.0	49.0	10.0	4.0
133	Lune Wath	52.6	6.6	14.6	0.0	0.4
132	Bowderdale B. Village Br.	25.0	16.0	24.1	9.4	1.4
131	Lune Potlands	72.9	2.1	5.0	0.8	6.1
130	Lune Kelleth Br.	52.9	8.7	10.5	1.8	1.8
129	Lune Midfield	58.9	5.9	5.3	3.6	2.3
128	Lune Rayne Br.	26.1	5.8	3.9	1.4	2.8
127	Longdale B. Beck's Field	2.2	2.2			
126	Longdale B. A685 Br.	12.5	1.7	9.9	0.6	1.4
125	Ellergill B. Below Fm.	2.2	1.1	41.1	6.7	0.6
124	Ellergill B. Gaisgill	1.2	0.6	28.8	11.7	3.7
123	Rais B. Fawcett Mill	0.0	5.3	0.4	3.3	0.8
122	Rais B. Rais Gill Hall	8.9	5.5	3.5	0.9	1.5
121	Lune Bankers Pool	35.6	5.4	2.8	4.2	1.2
120	Lune Tebay Br.	44.2	2.6	0.5	0.4	0.0
119	Chapel B. Orton	0.4	3.9	17.6	3.9	1.4
Upper middle Lune (2)						
109	Lune D/S Birk B.	33.4	0.5	0.0	0.0	0.3
108	Lune Roundthwaite	25.8	2.2	1.4	0.0	0.0
97	Lune Borrowbridge	6.7	0.4	0.2	0.0	0.0
96	Lune Fleetholme	3.5	3.2	0.0	0.0	0.0 *
95	Lune Beckfoot	29.7	4.1	2.3	1.4	1.4 *
92	Lune Howgill Fm.	36.0	1.3	0.0	0.0	0.0 *
90	Lune Bridge End	11.7	1.7	0.7	0.0	1.2 *
62	Lune Park Wood	0.9	0.0	0.0	0.0	0.0 *
Lower middle Lune (3)						
61	Middleton Hall B.	4.4	0.0	11.5	4.4	0.0
60	Lune Middleton Hall B.	30.0	0.0	0.0	0.0	0.0 *
59	Millhouse B.	64.5	0.0	46.4	0.0	0.0
58	Lune Kingfisher Pool	24.0	0.0	0.0	0.0	0.0 *
52	Lune Underley	43.5	0.0	0.0	0.0	0.0 *
51	Lune Casterton	76.1	0.0	0.0	0.0	0.0 *
50	Lune Devils Br.	8.6	0.0	0.1	0.0	0.0
Lower Lune (4)						
49	Lune Yew Tree Fm.	0.4	0.0	0.0	0.0	0.0 *
45	Lune Whittington Est.	8.5	0.0	0.0	0.0	0.0 *
44	Lune Lane Foot Fm.	4.3	0.0	0.0	0.0	0.0 *
43	Lune Arkholme Broomfield	7.8	0.0	0.0	0.0	0.0 *
42	Cant B. Collingholme Fm.	29.4	0.0	42.0	0.0	0.5
41	Cant B. Tunstall	12.4	0.0	2.6	0.3	0.0
31	Lune Arkholme Lower Reaches	0.0	0.0	0.0	0.0	0.0 *
30	Lune U/S Loyn Br.	2.7	0.0	0.0	0.0	0.0 *
29	Lune D/S Loyn Br.	0.0	0.0	0.0	0.0	0.0 *
28	Lune Gressingham	0.9	0.0	0.0	0.0	0.0 *
6	Lune Snab	0.5	0.0	0.0	0.0	0.0 *
5	Claughton B.	0.0	0.0	0.0	1.6	0.0
4	Lune Aughton	0.4	0.0	0.0	0.0	0.0 *
3	Artle B. Caton	4.9	1.9	13.0	0.3	0.0
2	Lune Halton Green	0.4	1.5	0.0	0.0	0.0 *
1	Denny B. Denny Lane	0.0	0.0	0.0	0.0	0.0

Table 3 (Cont.)

Site	Site name	Salmon		Trout		
Birk B. and Borrow B. (5)		0+	1+	0+	1+	>1+
118	Wasdale B. A6 Br.	0.5	23.6	0.0	0.0	0.0
117	Birk B. D/S Br.	13.0	14.0	0.4	3.0	2.8
116	Birk B. Above Falls	39.4	29.2	1.5	2.7	1.9
115	Birk B. Salterwath	34.4	9.9	15.6	0.6	0.0
114	Birk B. Rampshowe	0.0	1.8	5.3	0.8	0.5
113	Birk B. Scout Green	19.5	3.6	1.3	0.5	0.2
112	Birk B. Steps	12.7	0.7	2.9	0.0	0.0
111	Birk B. Greenholme	22.9	4.4	1.9	1.3	1.3
110	Birk B. D/S Bretherdale B.	33.4	3.9	2.6	0.3	0.0
107	Borrowdale B. High House	12.9	7.1	10.8	3.8	0.0
106	Borrowdale B. Borrowdale Head	23.2	10.8	14.8	2.5	0.0
105	Crookdale B. Hause Foot	56.9	13.8	8.4	6.7	2.5
104	Crookdale B. U/S Confluence	7.3	18.3	22.7	3.5	0.0
103	Borrowdale B. Breasthigh Rd.	10.0	7.1	2.2	1.3	0.3
102	Borrowdale B. High Borrowdale	6.7	16.7	2.9	1.8	0.8
101	Borrowdale B. Low Borrowdale	7.3	3.4	3.6	0.8	0.6
100	Borrowdale B. U/S Br.	3.3	17.9	15.9	3.9	0.0
99	Borrowdale B. Near Barn	8.7	7.8	5.1	1.9	0.8
98	Borrowdale B. A685 Br.	22.5	10.3	2.9	1.4	1.7
Chapel B. and Crosdale B. (6)						
94	Chapel B. Chapel	36.3	1.7	14.9	0.7	0.3
93	Chapel B. Luffman Fm.	5.5	3.2	8.6	1.4	1.4
91	Crosdale B. Branthwaite	19.9	7.1	55.1	6.4	0.0
R. Rawthey (7)						
89	Sally B. Foot Br.	0.0	0.0	56.0	3.2	0.0
88	Rawthey Rawthey Br.	1.9	3.6	0.2	1.5	0.0
87	Rawthey Narthwaite Fm.	0.2	2.4	1.7	0.4	0.2
86	Rawthey Low Haygarth Fm.	2.3	0.1	6.9	0.7	0.3
85	Rawthey High Wardses	10.0	2.3	2.6	1.1	0.0
84	Rawthey Crook Holme	14.0	0.2	0.9	1.2	0.0
75	Rawthey Clowes Weir	12.0	2.0	0.6	0.0	0.0
64	Rawthey Ingmire Stickle	18.2	0.2	0.2	0.0	0.0
63	Rawthey Steak's Pool	7.3	0.4	0.0	0.2	0.0
R. Clough (8)						
83	Clough Clough	0.0	0.0	0.8	0.3	0.0
82	Clough Knudmaning Fm.	0.0	0.0	2.3	4.8	1.2
81	Clough Medcalfe's Tip	0.0	0.0	9.2	5.7	0.5
80	Clough Garsdale	0.0	0.0	4.6	4.1	0.2
79	Clough Far Ho.	0.0	0.0	13.0	11.0	0.8
78	Clough Aygill Fm.	1.0	0.0	1.8	5.0	2.5
77	Clough Birkrigg	4.8	0.3	13.5	6.6	1.3
76	Clough Newbridge	0.0	0.0	3.8	8.9	1.2
R. Dee (9)						
74	Dee Church Br.	0.9	0.4	14.6	4.5	0.0
73	Keld B. Dent	1.9	0.0	33.3	11.0	0.5
72	Dee U/S Hell Hole	10.1	1.6	7.9	0.9	0.0
71	Dee Hell Hole	5.3	0.0	9.2	0.3	0.0
70	Dee Spring	11.1	0.7	15.0	0.0	0.0
69	Dee Barth Br.	3.2	1.8	5.7	1.5	0.6
68	Dee Wood Br.	19.0	0.0	2.6	0.0	0.0

Table 3 (Cont.)

Site	Site name	Salmon		Trout		
		0+	1+	0+	1+	>1+
67	Dee Island	21.0	3.2	1.9	0.0	0.0
66	Dee Rashmill	14.0	1.3	0.2	0.0	0.0
65	Dee Rawthey Confluence	3.6	1.3	0.5	0.3	0.8
	Barbon B. and Leck B. (10)					
57	Barbon B. Source	22.5	1.9	0.6	4.4	2.5
56	Barbon D/S Fork	22.3	7.3	0.7	3.7	0.0
55	Barbon B. Foot Br.	3.2	16.0	0.7	0.0	0.2
54	Barbon B. A 683	96.0	6.2	18.0	0.0	0.0
53	Barbon B. Cattle Barrier	64.0	2.5	15.0	0.5	0.3
48	Leck B. Spring Bank Wood	0.0	0.0	0.0	0.0	0.3
47	Leck B. Cowan Br.	0.2	0.0	4.3	3.1	1.2
46	Leck B. Nether Burrow	7.5	0.6	0.4	0.2	0.0
	R. Greta (11)					
40	Kingsdale B. U/S Raven Ray	0.0	0.0	1.7	0.0	0.2
39	Twiss Coach Depot	13.3	6.1	11.2	4.4	1.2
38	Doe Dalehouse	0.0	0.0	0.6	0.6	0.4
37	Doe Waterfalls Car Park	1.3	7.9	4.4	5.9	2.5
36	Greta A65 Br.	6.6	7.7	2.8	0.4	1.5
35	Aspland B. Park Foot	0.6	2.6	34.5	3.2	0.7
34	Greta Fourlands Hill	0.6	0.4	22.0	2.7	0.0
33	Greta Burton In Lonsdale	2.0	1.7	3.3	0.0	0.0
32	Greta Wrayton	18.5	0.1	0.1	0.0	0.0
	Tribs. of Upper Wenning (12)					
27	Clapham B. Clapham	0.0	0.0	4.5	0.7	0.3
26	Clapham B. Crina Fm.	18.7	5.9	18.6	0.0	0.0
25	Austwick B. Wood End Fm.	0.0	0.0	219.0	11.2	0.0
24	Austwick B. Austwick	2.6	0.3	32.3	0.9	0.0
23	Austwick B. A65 Br.	4.9	0.6	35.8	0.9	0.0
22	Fen B. Lawkland	29.5	0.0	13.0	0.0	0.0
21	Fen B. Waters Br.	3.4	1.1	24.0	9.5	0.0
20	Kettles B. Lanshaw Fm.	0.0	0.4	8.4	1.9	0.7
19	Keasden B. Turner Ford	0.0	0.5	3.0	2.0	1.8
18	Keasden B. Clapham Wood House	0.0	0.3	2.4	0.7	0.7
	R. Hindburn and R. Roeburn (13)					
17	Clear B. Millhouses	0.0	0.0	0.0	0.0	0.0
16	Crossdale B. Moorcock Rd. Br.	0.0	0.0	7.4	0.8	2.5
15	Crossdale B. Craggs Fm.	0.0	0.0	3.2	0.4	1.6
14	Whitray B. Whitray	0.0	0.0	0.0	0.0	0.0
13	Hindburn Sementation Br.	0.0	0.0	11.2	16.0	0.0
12	Mill B. Thrushgill	0.0	0.0	0.0	20.3	0.5
11	Hindburn Stare End Br.	0.0	0.7	9.4	2.6	0.0
10	Hindburn Furness Ford Br.	0.0	0.4	1.0	1.6	0.0
9	Hindburn Mealbank Br.	1.7	0.1	0.9	0.0	0.0
8	Roeburn Wray	2.3	2.2	4.3	1.5	0.5
7	Hindburn Hindburn Br.	0.0	0.0	0.1	0.3	0.1

* Five minute fishings

Table 4

Relative abundance of non salmonid species in the Lune catchment 1991

Site	Site name	Bullheads	Stoneloaches	Minnows	Sticklebacks	Lampreys	Eels	
Lune and tribs. u/s Tebay (1)								
134	Lune Newbiggin	*						
133	Lune Wath	**			*		0.9	
132	Bowderdale B. Village Br.	*					0.9	
131	Lune Potlands	**	*					
130	Lune Kelleth Br.	**	*				0.2	
129	Lune Midfield						1.7	
128	Lune Rayne Br.	*	*	*			3.9	
127	Longdale B. Beck's Field	*						
126	Longdale B. A685 Br.	*					1.9	
125	Ellergill B. Below Fm.	*					1.7	
124	Ellergill B. Gaisgill							
123	Rais B. Fawcett Mill	*			*		0.4	
122	Rais B. Rais Gill Hall	*					4.9	
121	Lune Bankers Pool	*	*	*	*		0.7	
120	Lune Tebay Br.	**	**	*	*		0.1	
119	Chapel B. Orton	*	*				0.7	
Upper middle Lune (2)								
109	Lune D/S Birk B.	**	**	*	*		0.9	
108	Lune Roundthwaite	**	*	*			1.4	
97	Lune Borrowbridge	*	*	*			0.3	
96	Lune Fleetholme	*	*	*			0.4	$
95	Lune Beckfoot	*	*				2.7	$
92	Lune Howgill Fm.	*	*	*			2.9	$
90	Lune Bridge End		*				3.5	$
62	Lune Park Wood		**				1.9	$
Lower middle Lune (3)								
61	Middleton Hall B.	*		*			7.9	
60	Lune Middleton Hall B.	*	*	*			11.4	$
59	Millhouse B.	*	*				1.8	
58	Lune Kingfisher Pool	*	*	*			13.2	$
52	Lune Underley	*		*			0.1	$
51	Lune Casterton	*	*				3.0	$
50	Lune Devils Br.	*	*	*			1.7	
Lower Lune (4)								
49	Lune Yew Tree Fm.	*	*	*			4.6	$
45	Lune Whittington Est.						4.3	$
44	Lune Lane Foot Fm.	*	*	*			1.9	$
43	Lune Arkholme Broomfield	*	*	*			1.6	$
42	Cant B. Collingholme Fm.	**						
41	Cant B. Tunstall	*	*	**	*	0.3	0.7	
31	Lune Arkholme Lower Reaches							$
30	Lune U/S Loyn Br.	*	*				1.4	$
29	Lune D/S Loyn Br.	*	*					$
28	Lune Gressingham	*	**				0.9	$
6	Lune Snab	*	**	*			13.6	$
5	Claughton B.	*						
4	Lune Aughton	*	**	*			4.5	$
3	Artle B. Caton	*	*				6.5	
2	Lune Halton Green					1.1	8.9	$
1	Denny B. Denny Lane						14.2	

Table 4 (Cont.)

Site	Site name	Bullheads	Stoneloaches	Minnows	Sticklebacks	Lampreys	Eels
Birk B. and Borrow B. (5)							
118	Wasdale B. A6 Br.						
117	Birk B. D/S Br.						
116	Birk B. Above Falls						
115	Birk B. Salterwath	*		*			
114	Birk B. Rampshowe	*	*				0.3
113	Birk B. Scout Green			**			1.7
112	Birk B. Steps	*	*	**			0.5
111	Birk B. Greenholme	*	*	*			0.3
110	Birk B. D/S Bretherdale B.	*	*	*			2.9
107	Borrowdale B. High House	*					0.4
106	Borrowdale B. Borrowdale Head	*					
105	Crookdale B. Hause Foot						
104	Crookdale B. U/S Confluence	*					0.3
103	Borrowdale B. Breasthigh Rd.	*					0.7
102	Borrowdale B. High Borrowdale						0.3
101	Borrowdale B. Low Borrowdale	**					
100	Borrowdale B. U/S Br.	*					
99	Borrowdale B. Near Barn						0.4
98	Borrowdale B. A685 Br.	*					0.2
Chapel B. and Crosdale B. (6)							
94	Chapel B. Chapel						0.3
93	Chapel B. Luffman Fm.	*					2.3
91	Crosdale B. Branthwaite	*					1.3
R. Rawthey (7)							
89	Sally B. Foot Br.						
88	Rawthey Rawthey Br.	*					
87	Rawthey Narthwaite Fm.						0.2
86	Rawthey Low Haygarth Fm.	**					
85	Rawthey High Wardses	*					0.6
84	Rawthey Crook Holme	*	*				
75	Rawthey Clowes Weir	*	*	*			3.6
64	Rawthey Ingmire Stickle						1.9
63	Rawthey Steak's Pool	**	*				1.2
R. Clough (8)							
83	Clough Clough						
82	Clough Knudmaning Fm.	*					
81	Clough Medcalfe's Tip	*					
80	Clough Garsdale	*					
79	Clough Far Ho.	*					0.3
78	Clough Aygill Fm.	*					0.5
77	Clough Birkrigg	*					
76	Clough Newbridge	*					
R. Dee (9)							
74	Dee Church Br.	**					
73	Keld B. Dent						
72	Dee U/S Hell Hole	*					
71	Dee Hell Hole	*					
70	Dee Spring	**	*			0.2	3.6
69	Dee Barth Br.	**	*	*		0.3	1.4
68	Dee Wood Br.	**	**	*		0.3	

Table 4 (Cont.)

Site	Site name	Bullheads	Stoneloaches	Minnows	Sticklebacks	Lampreys	Eels
67	Dee Island	**	**				0.3
66	Dee Rashmill	**	*	*			1.4
65	Dee Rawthey Confluence						2.1
	Barbon B. and Leck B. (10)						
57	Barbon B. Source						
56	Barbon D/S Fork	*					0.4
55	Barbon B. Foot Br.						0.2
54	Barbon B. A 683	*					0.8
53	Barbon B. Cattle Barrier	**	*				3.0
48	Leck B. Spring Bank Wood	*					0.3
47	Leck B. Cowan Br.	*	*				2.1
46	Leck B. Nether Burrow	*	*	**			0.1
	R. Greta (11)						
40	Kingsdale B. U/S Raven Ray	*					
39	Twiss Coach Depot	*	*				0.2
38	Doe Dalehouse	*	*				
37	Doe Waterfalls Car Park	*					1.3
36	Greta A65 Br.	**	*	*			0.2
35	Aspland B. Park Foot	*	*				
34	Greta Fourlands Hill						0.7
33	Greta Burton In Lonsdale	*	*	*			0.7
32	Greta Wrayton	*	*				1.1
	Tribs. of Upper Wenning (12)						
27	Clapham B. Clapham	*					3.5
26	Clapham B. Crina Fm.	**	*				1.6
25	Austwick B. Wood End Fm.	**					2.3
24	Austwick B. Austwick	**				0.3	3.4
23	Austwick B. A65 Br.	***	*				6.2
22	Fen B. Lawkland		*				
21	Fen B. Waters Br.	**	**	**			5.6
20	Kettles B. Lanshaw Fm.	**	**	*		0.4	1.5
19	Keasden B. Turner Ford	*					0.8
18	Keasden B. Clapham Wood House						3.1
	R. Hindburn and R. Roeburn (13)						
17	Clear B. Millhouses		*	*			9.1
16	Crossdale B. Moorcock Rd. Br.						11.5
15	Crossdale B. Craggs Fm.						0.4
14	Whitray B. Whitray						
13	Hindburn Sementation Br.						0.3
12	Mill B. Thrushgill						
11	Hindburn Stare End Br.						0.3
10	Hindburn Furness Ford Br.						0.9
9	Hindburn Mealbank Br.	*	*	*			2.1
8	Roeburn Wray	**	*	*			3.6
7	Hindburn Hindburn Br.						0.7

* 10's/100m2
** 100's/100m2
*** 1000's/100m2
Lampreys and eels are given in N/100m2
$ Five minute fishings

Table 5

Percentage Classification of the Lune catchment according to the densities of juvenile salmon and trout 1981-1985 and 1991

	Year	Number of sites	Absent	Poor	Moderate	Good	Excellent
0+ Salmon							
	1981	51	33.3	60.8	3.9	1.9	0.0
	1982	79	13.9	49.4	20.3	8.9	7.6
	1983	77	23.4	38.9	18.2	15.6	3.9
	1984	76	25.0	57.9	9.2	3.9	3.9
	1985	76	23.7	51.3	13.2	6.6	5.3
	1991	134	21.9	38.6	15.9	16.7	6.8
1+ Salmon							
	1981	51	15.7	41.2	21.6	15.7	5.9
	1982	79	21.8	46.2	17.9	11.5	2.6
	1983	77	15.6	51.9	12.9	11.7	7.8
	1984	76	11.8	34.2	18.4	17.1	18.4
	1985	76	19.7	56.6	13.2	9.2	1.3
	1991	114	28.1	36.8	20.2	8.8	6.1
0+ Trout							
	1981	51	43.1	56.9	0.0	0.0	0.0
	1982	79	21.8	55.1	15.4	2.6	5.1
	1983	77	6.5	68.8	11.7	11.7	1.3
	1984	76	11.8	59.2	14.5	5.3	9.2
	1985	76	14.5	72.4	2.6	6.6	3.9
	1991	134	19.7	51.5	17.4	9.1	2.3
1+ Trout							
	1981	51	37.3	45.1	9.8	7.8	0.0
	1982	79	30.4	39.2	11.4	12.7	6.3
	1983	77	24.7	40.3	18.2	14.3	2.6
	1984	76	14.5	43.4	18.4	13.2	10.5
	1985	76	13.2	65.8	13.2	6.6	1.3
	1991	114	25.4	42.9	23.7	6.1	1.8

Table 6

Percentage Classification of the Lune Subcatchments for 0+ salmon 1981-1985 and 1991

Subcatchment	Year	Number of sites	Absent	Poor	Moderate	Good	Excellent
1 Lune and tribs. u/s Tebay	1981	7	42.9	28.6	14.3	14.3	0.0
	1982	13	15.4	23.1	23.1	38.5	0.0
	1983	13	23.1	23.1	15.4	23.1	15.4
	1984	13	7.7	61.5	23.1	0.0	7.7
	1985	12	8.3	33.3	33.3	16.7	8.3
	1991	16	6.3	31.3	6.3	31.3	25.0
2 Upper middle Lune	1981	3	0.0	100.0	0.0	0.0	0.0
	1982	6	0.0	100.0	0.0	0.0	0.0
	1983	6	0.0	100.0	0.0	0.0	0.0
	1984	6	16.7	66.7	16.7	0.0	0.0
	1985	6	16.7	83.3	0.0	0.0	0.0
	1991	8	0.0	37.5	12.5	50.0	0.0
3 Lower middle Lune	1981	4	0.0	100.0	0.0	0.0	0.0
	1982	5	0.0	60.0	20.0	0.0	20.0
	1983	5	0.0	80.0	20.0	0.0	0.0
	1984	5	0.0	100.0	0.0	0.0	0.0
	1985	5	0.0	80.0	0.0	20.0	0.0
	1991	7	0.0	28.6	0.0	42.9	28.6
4 Lower Lune	1981	5	0.0	100.0	0.0	0.0	0.0
	1982	5	0.0	60.0	40.0	0.0	0.0
	1983	5	0.0	40.0	20.0	40.0	0.0
	1984	5	0.0	100.0	0.0	0.0	0.0
	1985	5	0.0	60.0	40.0	0.0	0.0
	1991	11	18.2	81.8	0.0	0.0	0.0
5 Birk B. and Borrow B.	1981	3	66.7	33.3	0.0	0.0	0.0
	1982	6	0.0	50.0	0.0	33.3	16.7
	1983	6	0.0	50.0	50.0	0.0	0.0
	1984	6	16.7	83.3	0.0	0.0	0.0
	1985	6	0.0	66.7	16.7	0.0	16.7
	1991	19	5.3	26.3	26.3	36.8	5.3
6 Chapel B. and Crosdale B.	1981	0					
	1982	2	50.0	0.0	0.0	0.0	50.0
	1983	2	0.0	50.0	0.0	50.0	0.0
	1984	2	0.0	50.0	0.0	50.0	0.0
	1985	2	50.0	0.0	50.0	0.0	0.0
	1991	3	0.0	33.3	33.3	33.3	0.0
7 Rawthey	1981	4	50.0	50.0	0.0	0.0	0.0
	1982	4	0.0	50.0	50.0	0.0	0.0
	1983	5	0.0	20.0	60.0	0.0	20.0
	1984	5	0.0	60.0	20.0	20.0	0.0
	1985	5	0.0	80.0	20.0	0.0	0.0
	1991	9	11.1	55.6	33.3	0.0	0.0

Table 6 (Cont.)

Subcatchment	Year	Number of Sites	Absent	Poor	Moderate	Good	Excellent
8 Clough	1981	3	100.0	0.0	0.0	0.0	0.0
	1982	3	33.3	33.3	33.3	0.0	0.0
	1983	3	66.7	33.3	0.0	0.0	0.0
	1984	3	33.3	66.7	0.0	0.0	0.0
	1985	3	66.7	33.3	0.0	0.0	0.0
	1991	8	75.0	25.0	0.0	0.0	0.0
9 Dee	1981	4	25.0	50.0	25.0	0.0	0.0
	1982	4	0.0	25.0	50.0	0.0	25.0
	1983	4	0.0	75.0	25.0	0.0	0.0
	1984	4	25.0	50.0	0.0	25.0	0.0
	1985	4	25.0	50.0	0.0	25.0	0.0
	1991	10	0.0	50.0	50.0	0.0	0.0
10 Barbon B. and Leck B.	1981	5	20.0	80.0	0.0	0.0	0.0
	1982	5	0.0	60.0	0.0	0.0	40.0
	1983	5	0.0	0.0	20.0	80.0	0.0
	1984	5	20.0	20.0	20.0	0.0	40.0
	1985	5	0.0	60.0	0.0	20.0	20.0
	1991	8	25.0	25.0	25.0	0.0	25.0
11 Greta	1981	3	0.0	100.0	0.0	0.0	0.0
	1982	6	0.0	60.0	0.0	0.0	40.0
	1983	7	42.9	28.6	28.6	0.0	0.0
	1984	6	33.3	50.0	16.7	0.0	0.0
	1985	6	33.3	66.7	0.0	0.0	0.0
	1991	9	22.2	55.6	22.2	0.0	0.0
12 Tribs. of upper Wenning	1981	1	0.0	100.0	0.0	0.0	0.0
	1982	6	16.7	83.3	0.0	0.0	0.0
	1983	4	25.0	75.0	0.0	0.0	0.0
	1984	4	75.0	26.0	0.0	0.0	0.0
	1985	5	60.0	20.0	20.0	0.0	0.0
	1991	10	50.0	30.0	10.0	10.0	0.0
13 Hindburn and Roeburn	1981	5	80.0	20.0	0.0	0.0	0.0
	1982	5	60.0	0.0	40.0	0.0	0.0
	1983	5	80.0	20.0	0.0	0.0	0.0
	1984	5	100.0	0.0	0.0	0.0	0.0
	1985	5	60.0	40.0	0.0	0.0	0.0
	1991	11	81.8	18.2	0.0	0.0	0.0

Table 7

Percentage Classification of the Lune Subcatchments for 1+ salmon 1981-1985 and 1991

Subcatchment	Year	Number of sites	Absent	Poor	Moderate	Good	Excellent
1 Lune and tribs. u/s Tebay	1981	7	0.0	28.6	28.6	28.6	14.3
	1982	13	0.0	30.8	46.2	15.4	7.7
	1983	13	7.7	30.0	15.4	23.1	23.1
	1984	13	7.7	15.4	38.5	7.7	30.0
	1985	12	0.0	66.7	16.7	16.7	0.0
	1991	16	0.0	31.3	50.0	12.5	6.3
2 Upper middle Lune	1981	3	0.0	66.7	33.3	0.0	0.0
	1982	6	0.0	100.0	0.0	0.0	0.0
	1983	6	0.0	100.0	0.0	0.0	0.0
	1984	6	0.0	16.7	33.3	16.7	33.3
	1985	6	0.0	66.7	16.7	16.7	0.0
	1991	3	0.0	100.0	0.0	0.0	0.0
3 Lower middle Lune	1981	4	0.0	100.0	0.0	0.0	0.0
	1982	5	20.0	80.0	0.0	0.0	0.0
	1983	5	40.0	60.0	0.0	0.0	0.0
	1984	5	0.0	40.0	40.0	20.0	0.0
	1985	5	0.0	100.0	0.0	0.0	0.0
	1991	1	100.0	0.0	0.0	0.0	0.0
4 Lower Lune	1981	5	20.0	80.0	0.0	0.0	0.0
	1982	5	60.0	40.0	0.0	0.0	0.0
	1983	5	40.0	60.0	0.0	0.0	0.0
	1984	5	0.0	80.0	20.0	0.0	0.0
	1985	5	20.0	80.0	0.0	0.0	0.0
	1991	0	0.0	0.0	0.0	0.0	0.0
5 Birk B. and Borrow B.	1981	3	0.0	0.0	66.7	33.1	0.0
	1982	6	0.0	33.3	16.7	50.0	0.0
	1983	6	0.0	0.0	16.7	50.0	33.3
	1984	6	0.0	16.7	16.7	50.0	16.7
	1985	6	0.0	50.0	16.7	33.3	0.0
	1991	19	0.0	10.5	31.6	31.6	26.3
6 Chapel B. and Crosdale B.	1981	0					
	1982	2	0.0	50.0	50.0	0.0	0.0
	1983	2	0.0	50.0	0.0	50.0	0.0
	1984	2	0.0	0.0	0.0	0.0	100.0
	1985	2	0.0	0.0	50.0	0.0	50.0
	1991	3	0.0	33.3	66.7	0.0	0.0
7 Rawthey	1981	4	0.0	25.0	25.0	25.0	25.0
	1982	4	0.0	75.0	0.0	25.0	0.0
	1983	5	0.0	80.0	0.0	0.0	20.0
	1984	5	0.0	20.0	40.0	20.0	20.0
	1985	5	0.0	60.0	40.0	0.0	0.0
	1991	9	11.1	77.8	11.1	0.0	0.0

Table 7 (Cont)

Subcatchment	Year	Number of sites	Absent	Poor	Moderate	Good	Excellent
8 Clough	1981	3	66.7	0.0	33.3	0.0	0.0
	1982	3	66.7	33.3	0.0	0.0	0.0
	1983	3	0.0	100.0	0.0	0.0	0.0
	1984	3	33.3	66.7	0.0	0.0	0.0
	1985	3	0.0	100.0	0.0	0.0	0.0
	1991	8	87.5	12.5	0.0	0.0	0.0
9 Dee	1981	4	0.0	25.0	50.0	25.0	0.0
	1982	4	0.0	50.0	50.0	0.0	0.0
	1983	4	0.0	50.0	50.0	0.0	0.0
	1984	4	0.0	50.0	25.0	25.0	0.0
	1985	4	25.0	75.0	0.0	0.0	0.0
	1991	10	30.0	60.0	10.0	0.0	0.0
10 Barbon B. and Leck B.	1981	5	0.0	0.0	40.0	40.0	20.0
	1982	5	0.0	20.0	20.0	40.0	20.0
	1983	5	0.0	40.0	40.0	20.0	0.0
	1984	5	0.0	0.0	20.0	20.0	60.0
	1985	5	0.0	20.0	40.0	40.0	20.0
	1991	8	25.0	37.5	25.0	0.0	12.5
11 Greta	1981	3	0.0	66.7	0.0	33.3	0.0
	1982	6	20.0	60.0	20.0	0.0	0.0
	1983	7	28.6	57.1	0.0	14.3	0.0
	1984	6	33.3	0.0	0.0	50.0	16.7
	1985	6	50.0	33.3	16.7	0.0	0.0
	1991	9	22.2	66.7	11.1	0.0	0.0
12 Tribs. of upper Wenning	1981	1	20.0	80.0	0.0	0.0	0.0
	1982	6	50.0	33.3	16.7	0.0	0.0
	1983	4	50.0	50.0	0.0	0.0	0.0
	1984	4	50.0	50.0	0.0	0.0	0.0
	1985	5	40.0	60.0	0.0	0.0	0.0
	1991	10	30.0	60.0	10.0	0.0	0.0
13 Hindburn and Roeburn	1981	5	80.0	20.0	0.0	0.0	0.0
	1982	5	60.0	20.0	20.0	0.0	0.0
	1983	5	40.0	40.0	20.0	0.0	0.0
	1984	5	60.0	40.0	0.0	0.0	0.0
	1985	5	80.0	20.0	0.0	0.0	0.0
	1991	11	63.6	36.4	0.0	0.0	0.0

Table 8

Percentage Classification of the Lune Subcatchments for 0+ trout 1981-1985 and 1991

Subcatchment	Year	Number of sites	Absent	Poor	Moderate	Good	Excellent
1 Lune and tribs. u/s Tebay	1981	7	0.0	100.0	0.0	0.0	0.0
	1982	13	7.7	53.9	30.8	0.0	7.7
	1983	13	7.7	38.5	23.1	30.8	0.0
	1984	13	0.0	46.2	23.1	7.7	23.1
	1985	12	8.3	66.7	0.0	16.7	16.7
	1991	16	0.0	50.0	25.0	25.0	0.0
2 Upper middle Lune	1981	3	100.0	0.0	0.0	0.0	0.0
	1982	6	0.0	100.0	0.0	0.0	0.0
	1983	6	0.0	100.0	0.0	0.0	0.0
	1984	6	0.0	100.0	0.0	0.0	0.0
	1985	6	16.7	83.3	0.0	0.0	0.0
	1991	8	50.0	50.0	0.0	0.0	0.0
3 Lower middle Lune	1981	4	100.0	0.0	0.0	0.0	0.0
	1982	5	100.0	0.0	0.0	0.0	0.0
	1983	5	20.0	80.0	0.0	0.0	0.0
	1984	5	40.0	60.0	0.0	0.0	0.0
	1985	5	60.0	40.0	0.0	0.0	0.0
	1991	7	57.1	14.3	14.3	14.3	0.0
4 Lower Lune	1981	5	100.0	0.0	0.0	0.0	0.0
	1982	5	80.0	20.0	0.0	0.0	0.0
	1983	5	40.0	60.0	0.0	0.0	0.0
	1984	5	80.0	20.0	0.0	0.0	0.0
	1985	5	80.0	20.0	0.0	0.0	0.0
	1991	11	100.0	0.0	0.0	0.0	0.0
5 Birk B. and Borrow B.	1981	3	0.0	100.0	0.0	0.0	0.0
	1982	6	0.0	66.7	33.3	0.0	0.0
	1983	6	0.0	83.3	0.0	16.7	0.0
	1984	6	0.0	50.0	33.3	16.7	0.0
	1985	6	0.0	83.3	16.7	0.0	0.0
	1991	19	5.3	68.4	21.1	5.3	0.0
6 Chapel B. and Crosdale B.	1981	0					
	1982	2	0.0	0.0	50.0	0.0	50.0
	1983	2	0.0	50.0	0.0	50.0	0.0
	1984	2	0.0	0.0	0.0	0.0	100.0
	1985	2	0.0	0.0	0.0	50.0	50.0
	1991	3	0.0	33.3	33.3	0.0	33.3
7 Rawthey	1981	4	50.0	50.0	0.0	0.0	0.0
	1982	4	0.0	100.0	0.0	0.0	0.0
	1983	5	0.0	100.0	0.0	0.0	0.0
	1984	5	0.0	80.0	20.0	0.0	0.0
	1985	5	0.0	100.0	0.0	0.0	0.0
	1991	9	11.1	77.8	0.0	0.0	11.1

Table 8 (Cont.)

Subcatchment	Year	Number of sites	Absent	Poor	Moderate	Good	Excellent
8 Clough	1981	3	0.0	100.0	0.0	0.0	0.0
	1982	3	0.0	33.3	0.0	33.3	33.3
	1983	3	0.0	66.7	33.1	0.0	0.0
	1984	3	0.0	0.0	66.7	0.0	33.3
	1985	3	0.0	100.0	0.0	0.0	0.0
	1991	8	0.0	75.0	25.0	0.0	0.0
9 Dee	1981	4	50.0	50.0	0.0	0.0	0.0
	1982	4	25.0	25.0	50.0	0.0	0.0
	1983	4	0.0	75.0	0.0	25.0	0.0
	1984	4	0.0	50.0	25.0	0.0	25.0
	1985	4	0.0	100.0	0.0	0.0	0.0
	1991	10	0.0	60.0	30.0	10.0	0.0
10 Barbon B. and Leck B.	1981	5	20.0	80.0	0.0	0.0	0.0
	1982	5	20.0	60.0	20.0	0.0	0.0
	1983	5	0.0	80.0	20.0	0.0	0.0
	1984	5	0.0	60.0	40.0	0.0	0.0
	1985	5	0.0	100.0	0.0	0.0	0.0
	1991	8	12.5	62.5	25.0	0.0	0.0
11 Greta	1981	3	66.7	33.3	0.0	0.0	0.0
	1982	6	40.0	60.0	0.0	0.0	0.0
	1983	7	14.3	71.4	0.0	14.3	0.0
	1984	6	0.0	100.0	0.0	0.0	0.0
	1985	6	0.0	100.0	0.0	0.0	0.0
	1991	9	0.0	66.7	22.1	11.1	0.0
12 Tribs. of upper Wenning	1981	1	0.0	100.0	0.0	0.0	0.0
	1982	6	0.0	83.3	0.0	0.0	16.7
	1983	4	0.0	75.0	0.0	0.0	25.0
	1984	4	25.0	25.0	0.0	50.0	0.0
	1985	5	0.0	60.0	0.0	40.0	0.0
	1991	10	0.0	40.0	20.0	30.0	10.0
13 Hindburn and Roeburn	1981	5	20.0	80.0	0.0	0.0	0.0
	1982	5	0.0	40.0	40.0	20.0	0.0
	1983	5	0.0	20.0	60.0	20.0	0.0
	1984	5	0.0	100.0	0.0	0.0	0.0
	1985	5	0.0	80.0	0.0	20.0	0.0
	1991	11	27.3	63.6	9.1	0.0	0.0

Table 9

Percentage Classification of the Lune Subcatchments for 1+ trout 1981-1985 and 1991

Subcatchment	Year	Number of sites	Absent	Poor	Moderate	Good	Excellent
1 Lune and tribs. u/s Tebay	1981	7	0.0	85.7	0.0	14.3	0.0
	1982	13	7.7	46.2	38.5	7.7	0.0
	1983	13	15.4	46.2	15.4	23.1	0.0
	1984	13	7.7	46.2	15.4	30.8	0.0
	1985	12	8.3	75.0	16.7	0.0	0.0
	1991	16	6.3	43.8	31.3	18.8	0.0
2 Upper middle Lune	1981	3	100.0	0.0	0.0	0.0	0.0
	1982	6	50.0	50.0	0.0	0.0	0.0
	1983	6	50.0	50.0	0.0	0.0	0.0
	1984	6	33.3	66.7	0.0	0.0	0.0
	1985	6	0.0	100.0	0.0	0.0	0.0
	1991	3	100.0	0.0	0.0	0.0	0.0
3 Lower middle Lune	1981	4	100.0	0.0	0.0	0.0	0.0
	1982	5	100.0	0.0	0.0	0.0	0.0
	1983	5	100.0	0.0	0.0	0.0	0.0
	1984	5	80.0	20.0	0.0	0.0	0.0
	1985	5	20.0	80.0	0.0	0.0	0.0
	1991	1	100.0	0.0	0.0	0.0	0.0
4 Lower Lune	1981	5	100.0	0.0	0.0	0.0	0.0
	1982	5	100.0	0.0	0.0	0.0	0.0
	1983	5	100.0	0.0	0.0	0.0	0.0
	1984	5	40.0	60.0	0.0	0.0	0.0
	1985	5	40.0	60.0	0.0	0.0	0.0
	1991	0	100.0	0.0	0.0	0.0	0.0
5 Birk B. and Borrow B.	1981	3	0.0	100.0	0.0	0.0	0.0
	1982	6	0.0	83.3	0.0	16.7	0.0
	1983	6	0.0	33.3	50.0	16.7	0.0
	1984	6	0.0	50.0	33.3	16.7	0.0
	1985	6	0.0	100.0	0.0	0.0	0.0
	1991	19	10.5	57.9	31.6	0.0	0.0
6 Chapel B. and Crosdale B.	1981	0					
	1982	2	0.0	50.0	50.0	0.0	0.0
	1983	2	0.0	0.0	0.0	0.0	100.0
	1984	2	0.0	0.0	0.0	0.0	100.0
	1985	2	0.0	0.0	0.0	50.0	50.0
	1991	3	0.0	66.7	33.3	0.0	0.0
7 Rawthey	1981	4	25.0	75.0	0.0	0.0	0.0
	1982	4	25.0	75.0	0.0	0.0	0.0
	1983	5	20.0	40.0	40.0	0.0	0.0
	1984	5	0.0	60.0	40.0	0.0	0.0
	1985	5	0.0	60.0	40.0	0.0	0.0
	1991	9	22.2	66.7	11.1	0.0	0.0

Table 9 (Cont.)

Subcatchment	Year	Number of sites	Absent	Poor	Moderate	Good	Excellent
8 Clough	1981	3	0.0	100.0	0.0	0.0	0.0
	1982	3	0.0	33.3	0.0	0.0	0.0
	1983	3	0.0	33.3	0.0	33.3	33.3
	1984	3	0.0	0.0	33.3	0.0	66.7
	1985	3	0.0	33.3	66.7	0.0	0.0
	1991	8	0.0	12.5	62.5	25.0	0.0
9 Dee	1981	4	50.0	50.0	0.0	0.0	0.0
	1982	4	50.0	25.0	0.0	25.0	0.0
	1983	4	25.0	50.0	0.0	25.0	0.0
	1984	4	25.0	25.0	25.0	0.0	25.0
	1985	4	50.0	25.0	0.0	25.0	0.0
	1991	10	50.0	40.0	10.0	0.0	0.0
10 Barbon B. and Leck B.	1981	5	20.0	40.0	20.0	20.0	0.0
	1982	5	20.0	60.0	20.0	0.0	0.0
	1983	5	20.0	80.0	0.0	0.0	0.0
	1984	5	0.0	40.0	0.0	40.0	20.0
	1985	5	40.0	20.0	20.0	20.0	0.0
	1991	8	37.5	25.5	37.5	0.0	0.0
11 Greta	1981	3	66.7	33.3	0.0	0.0	0.0
	1982	6	66.7	16.7	0.0	16.7	0.0
	1983	7	14.3	57.1	28.6	0.0	0.0
	1984	6	0.0	66.7	16.7	16.7	0.0
	1985	6	16.7	66.7	0.0	16.7	0.0
	1991	9	44.4	22.2	33.3	0.0	0.0
12 Tribs. of upper Wenning	1981	1	0.0	0.0	100.0	0.0	0.0
	1982	6	0.0	33.3	33.3	33.3	0.0
	1983	4	0.0	75.0	0.0	0.0	25.0
	1984	4	25.0	25.0	50.0	0.0	0.0
	1985	5	0.0	80.0	20.0	0.0	0.0
	1991	10	20.0	60.0	0.0	20.0	10.0
13 Hindburn and Roeburn	1981	5	0.0	0.0	60.0	40.0	0.0
	1982	5	0.0	20.0	0.0	40.0	40.0
	1983	5	0.0	40.0	20.0	40.0	0.0
	1984	5	0.0	0.0	40.0	40.0	20.0
	1985	5	0.0	40.0	40.0	20.0	0.0
	1991	11	27.3	45.5	9.1	0.0	18.2