NRA - FISHERIES 60

A REPORT ON THE 1992 STRATEGIC STOCK ASSESSMENT SURVEY OF THE UPPER DERWENT CATCHMENT AND THE RIVER MARRON WITH PARTICULAR REFERENCE TO SALMONID FISH

J K Atkins

May 1996

National Rivers Authority
Chertsey Hill
London Road
Carlisle
Cumbria
CA1 2QX

NRA/NW/FTR95/5

CONTENTS

ENVIRONMENT AGENCY

132186

CONTENTS (cont)

1. SUMMARY

Seventy sites in the Upper Derwent and Marron catchments were electrofished in 1992 to assess salmon and trout (Salmonid) populations.

The survey was targeted at fish normally less than two years old by selecting sites with a shallow riffle/pool structure. The deeper waters, of usually over 1 metre depth, which are normally associated with larger trout, were not surveyed; so it is essential to interpret the results for older brown trout with caution.

The densities of each age class of salmon and trout are presented on maps as abundance classes. Total Salmonid Density Indices are also presented.

Salmonid fish were present at all but three sites.

At 43 sites (61%) the total Salmonid Density Index was Class C or better, representing a healthy situation at these sites.

However at 27 (39%) the Total Salmonid Density Index was Class D or E, i.e. poor. For most of these, the low densities can be attributed to poor physical habitat, low summer flows, sampling difficulties and to low nutrient status and hence low productivity. At the remaining 16 there is concern about the low numbers especially on the River Derwent and tributaries in Borrowdale, the upper reaches of Trout Beck, the middle and lower reaches of both Newlands Beck and the lower reaches of the River Marron.

The highest salmonid (salmon and trout) densities were found on St John's Beck, Naddle Beck, the River Glenderamackin, Applethwaite Gill, plus Dash, Wythop, Blumer and Coal Becks and the upper reaches of the River Marron.

Salmon fry were present at 50 of the 70 sites surveyed, the streams with the highest densities were St John's Beck, the River Glenderamackin, Naddle Beck and Dash Beck. Production figures show that these streams are the principal salmon producing areas of the Upper Derwent.

Salmon Parr were distributed similarly to fry and, in common with other catchments surveyed, more sites supported the higher density classes for parr than they did for fry.

Several of the surveyed streams were stocked with salmon fry in 1991 and 1992, which means it is not possible to determine the natural population of salmon in these.

Trout fry densities were generally low with Class D or E at 58 sites. Estimated production figures for trout fry are much lower than for salmon fry. However Wythop Beck supported high trout fry densities at several sites and high densities were present at individual sites on a number of streams.

Older trout densities were high at more than 25% of the sites surveyed and populations were especially good on Dash, Coal, Wythop, Comb, Pow and Naddle Becks. Low densities were present at over 50% of the sites. However as stated above the survey did not target typical older trout habitat. Areas of concern include the lower River Marron and Trout Beck.

UPPER DERWENT CATCHMENT

FIG A

SHOWING SURVEY SITES

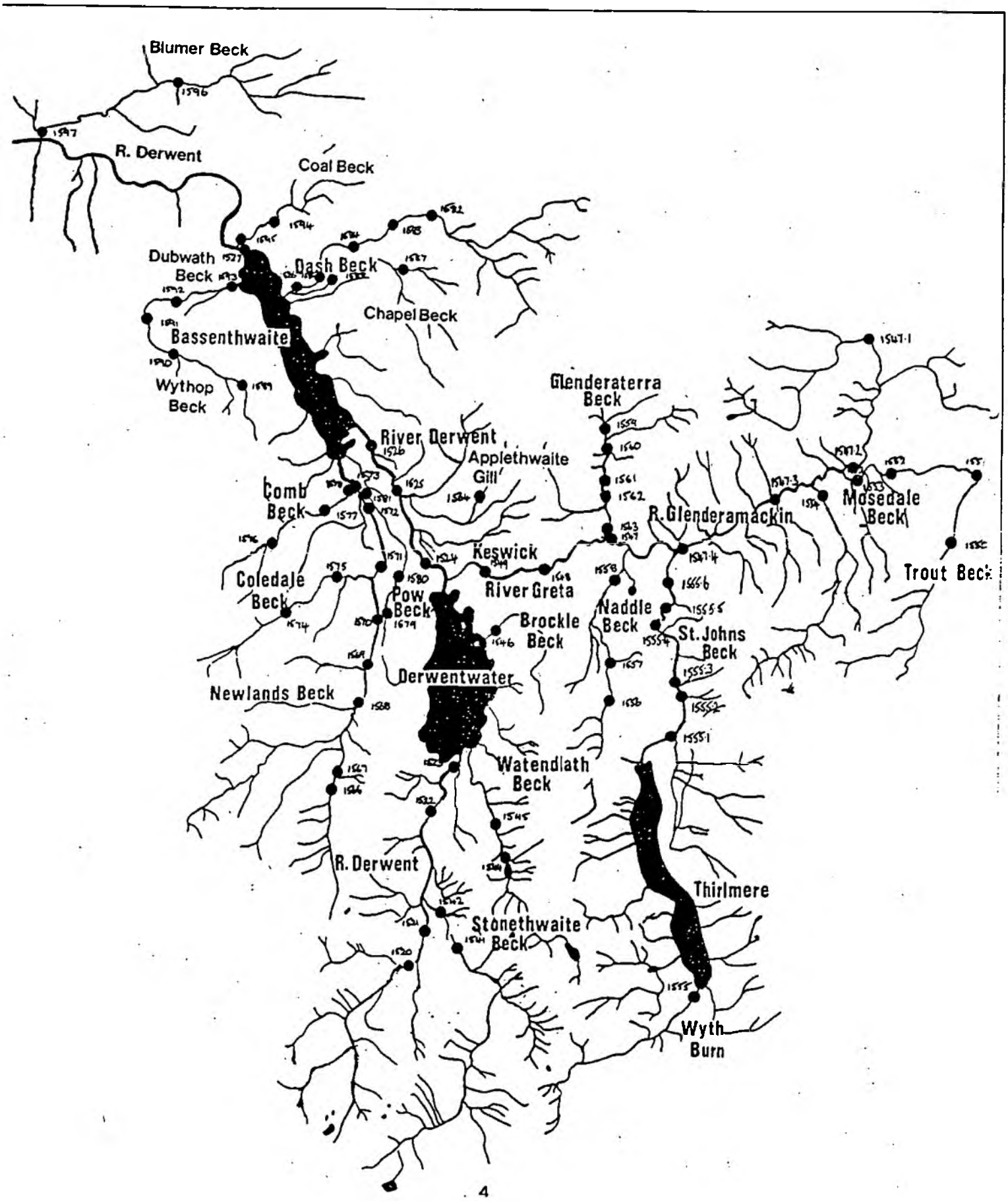
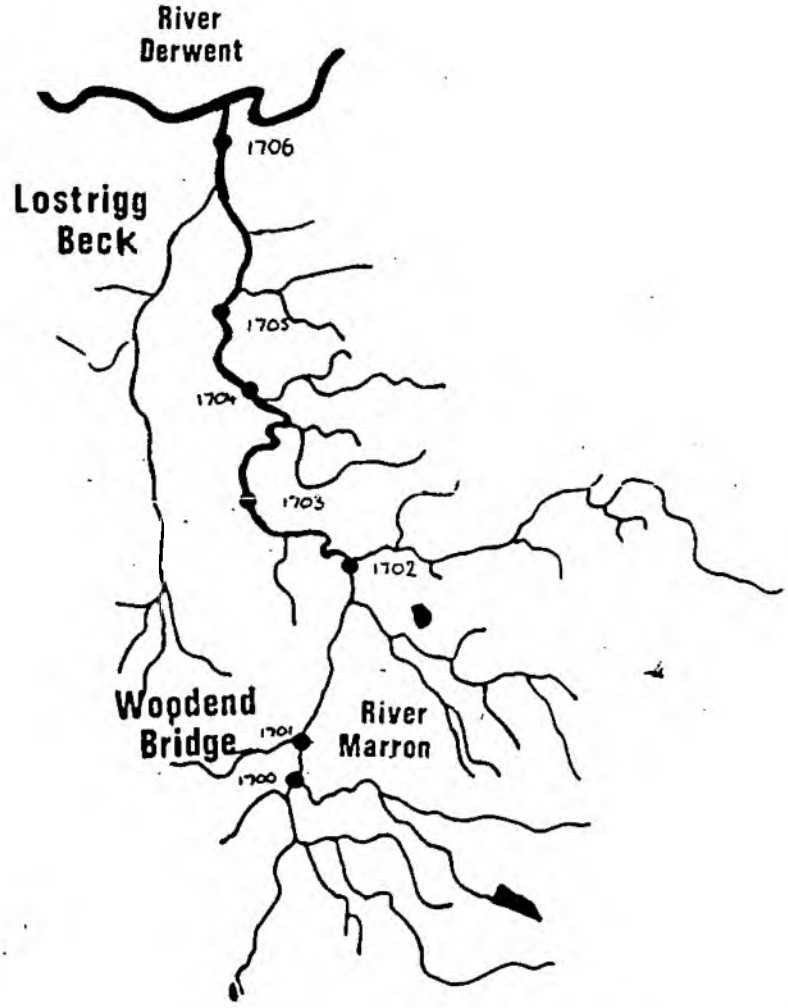


FIG B

MARRON CATCHMENT

SHOWING SURVEY SITES



ACKNOWLEDGEMENTS

The work for this report was by no means a one person effort and there are several people to thank. In particular I thank the West Cumbria Bailiff team who despite such a significant change in their work approached the surveys willingly and professionally. I would like to thank Steve Douglas for his support and for comments on my draft. I also thank Amanda Cruddas, Helen Ashburner and Julian Parkin and Roy, my husband. Sarah Woof and Anne Beamish deserve a special thank you for typing this report and tolerating my frequent amendments so patiently.

2 INTRODUCTION

Under the Water Resources Act 1991 the Environment Agency (formerly the National Rivers Authority) has a responsibility to maintain, improve and develop fisheries. In order to help accomplish this the EA is collecting baseline data on fish populations. A strategic survey programme has been established with the primary aim of assessing juvenile salmonid populations using electrofishing methods. Salmonid fish include salmon (*salmo salar*) and both the migratory and residential forms of the trout (*salmo trutta*). It is not possible to distinguish between the forms of trout at the fry or parr stage. The survey was targeted at young salmonids (normally less than 2 years old) by selecting sites with a riffle/pool structure. The deeper waters associated with with larger trout were not surveyed as available methods are not effective. Consequently results for older trout populations should be interpreted with caution.

For the purposes of this survey the Upper Derwent is defined as the area of catchment which flows into Bassenthwaite Lake. Coal Beck and Blumer Beck were also included as were sites on the River Marron. The survey area is shown in Figures A and B.

Strategic surveys are being conducted throughout the N.R.A. and they have been run concurrently. The Strategic Survey is designed to be a rolling programme, initially surveying new catchments or parts of catchments, each year. The expected timetable of three years to complete the first survey of the Derwent and Ellen systems was met.

2.1 Description Of The Study Area

Upper Derwent

The main River Derwent arises on Seathwaite Fell in Borrowdale and flows through Derwentwater and Bassenthwaite Lake eventually joining the sea at Workington.

In Borrowdale the two main tributaries are Stonethwaite Beck and Watendlath Beck, the latter flows directly into Derwent Water. The largest tributary of the Upper Derwent is the River Greta which joins the Derwent in Keswick between Derwentwater and Bassenthwaite Lake. The major tributaries of the Greta are the River Glenderamackin, St John's Beck, Glenderaterra Beck and Naddle Beck. Pow Beck is also a major tributary of the Upper Derwent, it flows into upstream end of Bassenthwaite Lake.

St John's Beck and the River Glenderamackin have been the subject of detailed annual electrofishing surveys for several years as part of the National Juvenile Monitoring Programme. As this survey is on-going, these sites were surveyed using a slightly different method. The results are included in this report.

The Upper Derwent Catchment consists of Borrowdale volcanics and Skiddaw slates both of which are hard rocks. This has resulted in a low nutrient river. The Derwent is the only oligo-mesotrophic (i.e. low to medium nutrient) major river in England and as such is of National Conservation Importance.

River Marron

The Marron flows into the Derwent between Cockermouth and Workington near Bridgefoot. It's catchment lies over coal bearing rocks and the main tributary, Lostrigg Beck, has suffered extensive opencast coal extraction. Lostrigg Beck and other tributaries were not surveyed in 1992, but the whole Marron catchment was surveyed in 1994 and the those results will be presented in a separate report.

2.2 Site Selection

Sixty sites were fished including 7 on the River Marron and 4 on Blumer and Coal Becks. Ten sites were also fished on St John's Beck and the River Glenderamackin, as mentioned above, giving a total of 70 sites.

Sites were selected at approximately 1 km intervals where access was suitable. Wherever possible sites were selected to include riffles, both to target juvenile salmonid populations and to act as natural barriers at both ends of the site to restrict fish movement during the survey. The main exceptions to this were some sites on the main River Derwent and River Greta, where shallow riffles are uncommon.

2.3 Obstacles

Obstacles, for example, weirs and waterfalls, can act as important factors affecting the distribution of fish within a catchment. Figure 10 shows the weirs, cascades and waterfalls known to exist within the Upper Derwent Catchment.

2.4 Water Quality

The Summer 1992 macro-invertebrate water quality survey is shown in Appendices 4a and 4b. There were no water quality problems; most sites being Inferred Class 1A. Five sites were Inferred Class 1B which is also suitable for salmonid fish. Combe Gill and Langstrath Beck are normally Class 1A but the sites were suffering drought at the time of sampling which led to Inferred Class 1B. Pow Beck showed slight signs of enrichment although the habitat may also be restrictive to macro-invertebrates. On Coledale Beck possible influences include low nutrient status and mine drainage although site 1 is upstream of the mine. These sites are borderline 1A/B and should be capable of supporting salmonid fish.

3. METHODS

All sites sampled in 1992 were fished using an electracatch pulsed DC control box, powered by 650w Honda generator. Sites larger than 10m mean width were fished with two electrodes to maintain efficiency.

Most sites were fished once through in an upstream direction for approximately 50m without stop nets. However, two sites were fished multiple times between stop nets, both to assist the calibration of the 50m single fish method (without stop nets) and to collect data for the national project "Habscore" (Barnard and Wyatt 1995) which relates fish populations to characteristics of the physical habitat.

The first 'run' was used to calculate a minimum fish density and thus was considered comparable to the single fishing without stop nets used at other sites. The first 'run' data is used in this report.

All fish were collected except minor coarse fish ie. minnows, bullheads, stickleback and stoneloach. Salmonids and major coarse fish species were measured to the nearest 0.5m. Where the number of fish in any age class was high a sub-sample of 30 was taken for measuring and the numbers in each size class counted.

Notes on habitat features were recorded as was site length and the mean of 10 wet channel widths for each site (Appendices 5a, b and c).

For each target species and age class, densities were calculated from the raw data (See Appendix 1 for calculations) and these were expressed as "number of fish per $100m^2$ of wetted area". All sites were then assigned Abundance Classes (Table 1).

To maintain consistency with the methodology for the National Juvenile Monitoring Programme St John's Beck and the River Glenderamackin were fished between stop nets using 2 or 3 fishings, until an acceptable decline in catch was recorded. The population density estimate based on all fishings is used to obtain the density class in this report.

Table 1
Abundance Classes

Class	Density of Fry (n/100m^2)	Density of Parr (n/100m^2)
A	>100	>20.0
B	50.01 -100.00	10.01 -20.0
C	25.01 -50.00	5.01 -10.0
D	.0.01 - 25.00	0.01 -5.0
E	0	0

4 RESULTS BY SUBCATCHMENT

4.1 River Derwent

Three of the 7 main river sites selected were fished. This was due to high flow conditions. Two of the sites were at the top end of the catchment at Thorneythwaite (1520) and Longthwaite (1521) and one site was at Lodore (1523) u/s of Derwent Water.

Results

At Lodore (1523) no salmonid fish were caught although there were moderate numbers of eels and minnows.

At Longthwaite (1521) the fish density was poor; no trout were caught and salmon densities were extremely low(i.e. 3 fry and 3 parr caught).

The salmon parr density at Thorneythwaite (1520) was moderate (Class C) but salmon fry and trout densities were particularly low. Eels and minnows were present at both these sites.

Discussion

The site at Lodore (1523) was deeper than it appeared from the bank and was not suitable for electrofishing. Unidentified fish were seen swimming u/s ahead of the fishing equipment. Given the nature of the site the results do not reflect the fish community accurately. It was clearly not suitable for juvenile salmonids and the site will be deleted from the Strategic Survey Programme.

Redd counts conducted in 1990 and 1991 indicate comparatively few redds in the main Derwent upstream of Derwent Water. However these counts are likely to be an underestimate because the river bed is so clean that even newly cut redds are difficult to see.

However the level of recruitment is low and requires attention the low population level may not be high enough to sustain itself.

At Longthwaite (1521) efficiency was poor due to heavy rain and poor visibility. The stream bed provides good cover and higher densities would normally be expected. The low densities may be partly due to nutrient poor waters.

Although the Borrowdale area is naturally of low nutrient status and would therefore not be expected to support high fish densities the low fish populations in Borrowdale are of concern and need further study to be understood better. Acid rain has affected the upper reaches at Seathwaite for several years and caused problems for the fish farm sited there. Fish kills in the farm as a result of acid rain have become much less frequent and none have occurred for several years. This is likely to have been major problem for wild fish too but populations should slowly recover now the acid problem has ameliorated.

Flows are spatey and bed materials in some areas are mobile. It would be valuable to assess for how much of the area this is true. The flood defence works on Stonethwaite Beck have not helped (see under Stonethwaite Beck).

More survey sites are needed so that the fish populations in the Borrowdale part of the Derwent catchment can be assessed more fully.

4.2 Stonethwaite Beck

Both sites were fished.

Results

Salmonid densities were low both at Rosthwaite (1542) and Stonethwaite (1541). At Rosthwaite neither salmon nor trout fry were present.

Discussion

The low densities were probably due to flood defence works which have straightened Stonethwaite Beck thus increasing the gradient. This has resulted in fast and erosive flow conditions which are unsuitable for fish. The stream is also of low nutrient status.

4.3 Watendlath Beck

Two sites were fished; one immediately downstream of Watendlath Tarn (1544) and one approximately 1km downstream (1545).

Results

Neither salmon nor eels were recorded at either site; both sites being u/s of Lodore Falls. Trout fry densities were low at both sites but at Watendlath the number of parr and takeable trout was excellent (class A). Eight takeable trout were caught in the first fishing. Minnows were present at both sites in moderate numbers.

Discussion

At Watendlath cover was abundant, especially under the bridge. The site further d/s (1545 was fished in high flows and the efficiency was poor so the actual population will have been greater than that found.

4.4 Trout Beck

Four sites were fished on Trout Beck. The lower 3km consists of a series of cascades (Fig 10) which are an effective barrier to migratory fish. Most salmon in the upper reaches will be due to stocking. The upper reaches were stocked with 25,000 salmon in spring 1992 (Fig 7).

Results

In the upper reaches of Trout Beck the salmonid population was poor. At Rookin House (1550) 7 trout (145-220mm) were caught and one salmon parr. Loach and eel were present and minnows were abundant. There were no salmonid fry.

At Trout Beck Hotel (1551) the salmonid population was extremely low; one salmon fry, no trout fry and 4 older trout were caught. Loach were dominant (100-1000) and minnow were present.

Further downstream at 1552 excellent densities (Class A) of salmon parr were recorded. Salmon fry, trout fry and older trout were low in numbers all scoring Class D.

At the site upstream of the Glenderamackin (1553) the salmonid densities were all Class D, the salmon fry density being the highest.

Discussion

The salmon and trout population of especially the upper reaches of Trout Beck is at a low level, despite stocking of salmon in 1992. This is of concern. The only evidence found of the stocking was one fry at Trout Beck Hotel (1551). The cause of the low population needs to be investigated. The forest in the upper part of the catchment is managed by Forest Enterprise and was planted in the 1960s. Except for a short section the trees are planted well back from the stream and the instream habitat is excellent for young fish. Forest practice has been discussed with Forest Enterprise and no possible causes for the low fish populations throughout Trout Beck could be identified. The stream is silty and at least two significant sources have been identified. Drainage by Forest Enterprise should significantly reduce run off from a track which neighbours their Forest. At Rookin House Farm Ecologists found that the use of quad bikes in and across the river is causing erosion and siltation. The whole river corridor needs to be assessed.

Further d/s at 1552 the gear malfunctioned and then broke down. Efficiency was poor and so it can safely be assumed that the fish densities were higher than recorded. The site was fast flowing and bouldery, bed cover was abundant.

The salmon parr population can be assumed to be natural given that that particular year class had not been stocked.

The salmonid population upstream of the Glenderamackin (1553) was low but not sufficiently so to cause concern.

4.5 Mosedale Beck

Due to access problems there only one site was fished on Mosedale Beck.

Results

Surprisingly no trout were caught. The salmon fry density was mid-Class D (12.10 per $100m^2$) and the parr density Class C (6.11 per $100m^2$).

Moderate numbers of stone loach and 2 eels were recorded.

Discussion

Efficiency was poor; the equipment was not "holding" fish effectively. More fish would be expected at a site of this nature. More sites should be added to this stream for the next survey.

4.6 St John's Beck

St Johns Beck has been surveyed in 1974, 1983 and 1984 and annually from 1987 to 1994 as part of a National Juvenile Salmonid Monitoring Programme. This data will form a fuller report together with data from the Glenderamackin.

The Redd count maps (Figs 8 and 9) show that St John's is the prime salmon spawning stream in the Upper Derwent. No fish were stocked in 1991 or 1992.

All six sites were surveyed in 1992.

Results

For salmon fry density, three of the six sites yielded Class B, one Class C and two Class D.

For salmon parr (>0+) the sites at Bridge House (1555.4) and Wanthwaite Bridge (1555.5) yielded the highest densities, i.e. 21.30/100m^2 (Class A) and 12.00/100m^2 (Class B) respectively. Class C densities of parr were present at Legburthwaite (1555.1) and Low Bridge End (1555.2).

Salmon dominate the fish community; trout fry densities were all in Class D and >0+ densities only attained a high of Class C.

Discussion

As St John's was not stocked in 1991 or 1992 the survey reflects the natural situation. Compared with results from the rest of the Upper Derwent survey, St John's compares only with the Upper Glenderamackin, Naddle Beck and Dash Beck in terms of juvenile salmon densities. However Naddle Beck and the Glenderamackin were stocked which highlights the importance of St John's as a natural salmon fry nursery to the Upper Derwent.

The picture for Salmon parr (>0+) is similar; apart from St John's Beck the highest densities were recorded in Naddle, Newlands, Wythop, and Dash Becks which were all stocked with salmon fry in 1991.

Trout populations in St John's were low probably because the habitat is more suitable for salmon than trout.

4.7 River Glenderamackin

All four sites were surveyed as part of the same programme as the St John's survey.

Salmon fry were stocked in 1991 and 1992 (Figs 6 and 7).

Results

Salmon fry populations were high (Class B) at Mungrisedale (1547.1) and upstream of Trout Beck (1547.2), the density at Mungrisedale was 84.00/100m^2 ; the highest on 1992 Upper

Derwent Survey. Salmon fry yielded a high Class C at Townfield Bridge (1547.4).

Salmon parr (>0+) populations yielded Class B upstream of Trout Beck (1547.2) and C at Guardhouse (1547.3). Otherwise parr populations were low.

Trout densities were low (Class D) at all four sites.

Discussion

The high salmon densities were found in areas where fry stocking had been carried out in either 1991 or 1992. It is not possible to tell whether stocking has enhanced these densities or whether high densities would have occurred naturally. Only the Class C density at Townfield Bridge (1547.4) can be attributed with certainty to natural spawning.

The low trout densities are of concern.

The St John's and Glenderamackin report will put the 1992 results into context with former years.

4.8 Naddle Beck

Three sites were fished on Naddle Beck; Shoulthwaite (1556), Dalebottom (1557) and at NY 300239 (1558).

Naddle Beck was stocked in 1991 and 1992 (Figs 6 and 7). There is no redd count information.

Results

At Shoulthwaite (1556) excellent (Class A) trout and salmon >0+ populations were present. Fry populations were mid Class D for both salmon and trout.

Downstream at Dalebottom (1557) there were high densities of both salmon and trout fry (Classes B and C respectively) and Class B for both salmon and trout >0+.

At site 1558 salmon clearly dominated with Class B in both age classes. The trout population was poor (Class D) for both size classes.

Discussion

Naddle Beck was stocked with 10 000 salmon fry in 1991 and 15 000 in 1992. The juvenile densities appear to reflect the stockings although trout numbers were also high despite not being stocked. It is not possible to determine whether the densities have been enhanced by stocking or would have been naturally high.

It is important to survey this stream after several years of no stocking in order to assess the natural production of juvenile salmonids.

4.9 River Glenderaterra

In December 1991 there was a landslip upstream of Derwentfolds which resulted in large quantities of mud and rubble entering the Glenderaterra and washing downstream into the River Greta.

Five sites were established on the Glenderaterra but only 2 were fished in 1992 (1562, 1563); these were both downstream of the landslip due to access problems upstream past the landslip site.

In March 1993 sites 1561 and 1562 were fished. These were respectively 300m upstream and 200m downstream of the landslip and were fished without stop nets but with 2 and 3 fishings respectively. The aim was to examine the impact of the landslip.

The Glenderaterra was not stocked in 1991 or 1992.

For both surveys fry would be from redds of Autumn 1991 and parr from redds of autumn 1990.

Results

In 1992 the populations were low at both sites (Table 3). All salmonid densities were less than 10 per $100m^2$ and at Derwentfolds (1562) no salmon parr were recorded. No other fish species were recorded except for a small number of eels at Derwentfolds.

The March 1993 results are shown in Appendix 9. Trout densities were similar at both sites and higher than those recorded in Summer 1992. Salmon densities for both size classes were lower downstream of the landslip than upstream; salmon fry were not recorded at Derwentfolds (1562); the downstream site.

Discussion

The 1992 survey indicated that the River Glenderamackin supported low densities of salmonid fish at sites downstream of the landslip. However the influence of the landslip was not known. The March 1993 results indicate that the trout population was not affected but that the salmon population may have been reduced from a low density to a lower density by the landslip.

The absence of parr in 1992 and fry in 1993 at Derwentfolds is not explainable. They are clearly not the same age class.

4.10 River Greta

Due to high flows only the site at Brundholme (1547), u/s of the Glenderaterra, was fished out of a possible three.

Results

A small number of salmon fry (4) and parr (8) were caught together with 1 trout. Eel, loach and minnow were present.

Discussion

The site at Brundholme was bouldery, deep and difficult to fish and so the data is probably not a true reflection of the fish population. A new site needs to be selected for future surveys for safety reasons and to provide a more representative picture. There is only a limited choice of sites on the Greta which are suitable for electrofishing.

4.11 Applethwaite Gill

Results

The stream predominantly supported trout with no salmon recorded at Applethwaite (1564) and only low numbers at site 1565.

At Applethwaite (1564) trout parr dominated with a density of 24.19/100m^2 (Class A), while d/s at site 1565 trout fry were present at the highest density recorded in the Upper Derwent i.e. 101.3/100m^2 (Class A). Parr numbers were low at site 1565.

Discussion

Applethwaite Gill is a narrow stream the mean width being 1.3 and 1.7m at the 2 sites. This tends to result in higher densities due to factors such as the amount of bankside per unit area. The stream is obviously healthy for salmonid fish and it has not been stocked since 1989 so the populations are due to natural spawning.

4.12 Newlands Beck

All eight sites were fished on Newlands Beck. Sites on this stream range from stony upland sites to lowland canalized reaches upstream of Bassenthwaite Lake where land drainage works have not been sympathetic to fish populations. Keskadale Beck was stocked with salmon fry in 1991. Salmon spawn from Branthwaite to upstream of Low Snab but redd counts are low.

Results

Sites at the upstream end of the beck at Low Snab (1566) and Little Town (1567) and the site downstream of the A66 (1571) yielded the highest salmonid densities. Although fry densities were all Class D or E, the densities were higher at these three sites. The salmon parr density at Low Snab was particularly good yielding Class B. At the other 5 sites densities were poor; yielding no salmonids at site 1572 and only 1 trout fry at site 1573. At Little Braithwaite (1570) the stream dries up under low flows.

Discussion

The upper reaches of Newlands Beck (sites 1566 and 1567) supported healthy total salmonid populations. However from Ghyll Bank downstream the salmonid densities were low. The reason for this is not known at all sites although the drying of the stream at Low Braithwaite explains the low numbers of fish at that site.

Sites 1572 and 1573 are physically unsuitable for salmonid fish due to unsympathetic land drainage works, however four bed check weirs have been installed which should provide some holding areas for larger fish.

4.13 Coledale Beck

In the upper reaches of Coledale beck there is a disused Barytes mine which has been closed for several years. According to the records Coledale Beck has never been stocked.

Results

No salmonid fish were caught or seen at 1574 and at 1575 there was only a Class D density of >0+ trout.

Discussion

Fast flowing water reduced efficiency at site 1575 so the trout density would have been higher than recorded.

Passive leachate from the slag heaps and the mine are the likely cause of the low fish numbers in this stream. If the leachate ameliorates the fish population will only recover extemely slowly mainly because the population would be starting from such a low level. Experiments with caged fish have been conducted in the past but the fish did not survive.

There are no physical barriers for migratory fish to explain the absence of salmon but the stream is narrow and is therfore likely to be more suitable for trout.

4.14 Comb Beck

This stream is also known as Chapel Beck in the lower reaches.

According to the records this stream has never been stocked.

Results

No salmon were recorded at any of the three sites.

The trout population was particularly healthy at the visitor centre (1576) yielding Class C for fry and Class A for older fish. D/s the fry populations were low but >0+ trout yielded Classes B and C.

The lack of salmon is due to the barrier produced by two weirs on the aquaduct which carries Comb Beck over the A66 however the stream is narrow and may not be likely to utilized greatly by salmon if barriers were removed.

4.15 Dash Beck and Chapel Beck

The 7 sites on this system were all surveyed. The system was stocked with 60 000 salmon fry in 1991 i.e. 30k in both Dash and Chapel Becks (Fig 6). A 6ft waterfall d/s of site 1583 provides a partial barrier to migratory salmonids (Fig 10).

Results

The Dash Beck system produced high numbers of salmonids.

Sites 1582 and 1583 are u/s of the waterfall and salmon fry densities in mid-Class D show that salmon successfully spawned u/s of the fall. The salmon parr density was 36.56/100m^2 (Class A) i.e. the 2nd highest recorded for the Upper Derwent in 1992. At this site the trout populations were also excellent. Good trout densities were recorded at all sites on Dash Beck.

On Chapel Beck salmon were not recorded at Melibecks Bridge neither were trout fry. In Chapel (1588) juvenile salmon densities were high, i.e. fry and parr both Class B, but trout densities were low.

Discussion

The high salmon parr density on Dash Beck at site 1582 is probably artificially enhanced by the 1991 stocking, however such enhancement is less clear at site 1583 although the stocking did encompass this site.

On Chapel Beck at Melbeck bridge (1587) the absence of salmon parr is notable as this site was stocked in 1991. The reason for the lack of salmon is unclear. The habitat was not particularly suitable for salmonid fry although cover was abundant and a higher salmonid population was expected. Salmon redds were observed as far u/s as this site (1557) in autumn 1991 (Fig 9).

4.16 Wythop/Dubwath Beck

The upper part of this stream is called Wythop Beck and the lower part Dubwath Beck. All 5 sites were fished in 1992, i.e. four on Wythop and one on Dubwath. No redd count data are available. The upper reaches of Wythop Beck were stocked in 1991 (Fig 6) with 40K salmon fry influencing sites 1589 and probably 1590.

Results

The four sites on Wythop Beck yielded high salmonid densities, however at site 1593 on Dubwath Beck the density was low; only one trout fry and 2 salmon parr were caught.

Salmon fry densities were low or absent at all sites except at The Close (1592) where the density narrowly missed Class C at 24.69/100m^2. Salmon parr densities were high on the 2 most upstream sites, Class B and A respectively, but low or absent at the remaining three.

Trout fry densities yielded Class B at 3 sites and D at 2 sites including Eskin (1590) whereas trout >0+ were found at high densities in the 3 upper sites, (Classes B, A and C respectively) but only Class D at Netherscale and E in Dubwath.

Minor coarse fish were absent from the 3 most upstream sites but minnow were present at The Close and abundant in Dubwath Beck, where loach and stickleback were also present. Eels were present at all sites.

Discussion

At sites in the vicinity of salmon fry stocking in 1991 (1589,1590) salmon parr (1991 fry) densities appear to be enhanced when compared with parr densities at unstocked sites. Evidence of stocking enhancement is also supported by the low densities of 1992 fry, suggesting that natural recruitment is low.

Wythop Beck is productive for trout but the reason for the low >0+ densities at 1591 and 1592 is unclear. It may be due to lack of suitable habitat.

The low salmonid population recorded at Dubwath is probably due to the lack of suitable habitat for juvenile salmonids; the site was deep, slow flowing and silty. The deep water and lack of natural barriers was also unsuitable for electro-fishing. A suitable site could not be found in this part of the stream and the site should be removed from the strategic survey programme because it is not possible to survey it effectively.

4.17 Coal Beck

Both sites on Coal Beck were surveyed; i.e. u/s of the caravan site and u/s of the confluence with the Derwent. Coal Beck was stocked with 3 000 salmon fry in 1991 u/s of the top site (1594). There is no redd count data.

Results

Coal Beck supports excellent trout populations at both sites, but especially so u/s of the confluence with the Derwent (1595) where the fry density was 93.75/100m^2 and the >0+ density was 66.1/100m^2. This >0+ density is second only to Naddle Beck at Shoulthwaite (1556) for the Upper Derwent survey.

Salmon densities were low; fry being absent u/s of the caravan site at 1594.

Discussion

Coal Beck is principally a trout stream but a low population of juvenile salmon is also present. The reason for the lack of 0+ salmon at site 1594 is not known.

4.18 Blumer Beck

Both sites on Blumer Beck were surveyed; one near Linkeldsfield (1596) and one at Isel Hall (1597). Redd count data (Figs 8 and 9) show that sea trout and salmon spawned in 1991 and that salmon spawn throughout the Blumer Beck catchment. The beck has not been stocked since 1977.

Results

Trout were more abundant than salmon at both sites. The salmonid population at site 1596 was particularly good; yielding Class A for trout >0+, Class C for trout 0+ and Class B for salmon >0+. The salmon fry density was low at 2.51/100m^2.

Salmonid densities were lower d/s at Isel Hall (1597). Salmon parr were not recorded and all other densities yielded only Class D.

Discussion

Blumer Beck supports good trout densities in the upper reaches, however the reason for the low numbers d/s are not clear. It is also not clear why the stream appears to only support a low salmon population.

4.19 River Marron

The seven sites established on the River Marron in 1991 were all fished in 1992. On future surveys, as in 1994, sites on the tributaries will be included.

Salmon fry were stocked in 1990 and 1992 (Fig 16) into Snary, Black and Wisenholme Becks.

Redd count data show that salmon spawn along the whole length of the River Marron, and in some years the majority of redds are found upstream of Ullock.

Results

The river contained a healthy population of salmonids at the three sites upstream of Ullock and poor populations from Branthwaite downstream.

An exceptional trout fry density was present at Asby (1700): the highest for the 1992 Derwent survey. Excellent numbers of older trout (>0+) were also present which also yielded Class A.

Salmon and trout fry populations near Wright Green (1701) were high, Classes B and C respectively, and at Ullock (1702) the salmon fry population yielded Class C.

At the remaining 4 sites, i.e. from Branthwaite downstream, the density for each species and age class was Class D.

The Total Salmonid indices (fig 15) were A or B at the top three sites but only D from Branthwaite downstream.

Data from a similar survey in 1991 (Appendix 6c) shows that the exceptional trout fry densities did not occur at Asby (1700) in 1991 but Class A for salmon fry was recorded at Wright Green.

The four sites from Branthwaite downstream appear to have declined in terms of salmonid density between the 1991 and 1992 surveys (Fig 16 - 20 and Appendix 6d). In 1991 Class B and C populations of >0+ trout were present at all sites u/s of Lostrigg Beck. In 1992 the >0+ trout population had dropped to Class D from Branthwaite (1703) downstream. The decline in total salmonid density is due to the decline in >0+ trout as other salmonid age classes were low in this reach on both surveys.

Discussion

The Marron is capable of supporting exceptional densities of salmon and trout fry at sites in the upper reaches. This appears to be independent of stocking in the tributaries as the highest salmon fry densities were recorded in 1991 when there was no stocking.

The poor population from Branthwaite downstream requires follow up work to try to identify the cause.

5 OVERVIEW

The survey results show that there are areas of high salmonid (salmon and trout) densities for example St. John's Beck, Naddle Beck, the Glenderamackin, Applethwaite Gill plus Dash, Wythop, Blumer and Coal Becks and the upper River Marron. There are also areas of low salmonid density for example Borrowdale, the middle and lower reaches of Newlands Beck, Glenderaterra Beck, Trout Beck, Coledale Beck and the lower reaches of the River Marron plus several individual sites.

The natural situation is confused by the stocking of salmon fry into many of these streams.

The areas of concern are Borrowdale, the upper reaches of Trout Beck, Mosedale Beck, Newlands Beck from Ghyll Bank downstream and the Marron from Branthwaite downstream. Further work is required to try to determine the causes of the low fish populations in these streams.

Table 3 shows the breakdown of density classes for the Upper Derwent and Marron.

Table 3

The number of sites in each Density Class for each species of salmonid and age category.

	Salmon 0+	Salmon >0+	Trout 0+	Trout >0+	Total Salmonid
A	0	6	2	14	13
B	9	9	4	6	16
C	4	10	6	7	14
D	37	24	44	36	24
E	20	21	14	7	3

5.1 Salmon 0+ (Figs 1 and 11)

High densities (Class C and above) were recorded in St. John's Beck, Naddle Beck and at sites on Dash Beck, the Glenderamackin and the Marron. Apart from the 20 sites where salmon fry were not recorded, all other sites had low densities (Class D).

Stocking data for 1992 (Fig 7) and redd count data for 1991 (Fig9) indicates that the high densities on St. John's Beck and Dash Beck are due to natural spawning. The Glenderamackin and Naddle Beck were stocked with salmon fry in 1992 which confuses interpretation of the situation. It is not possible to determine if the high densities on these streams were due to enhancement by stocking or if they would have been naturally high.

Historic data from the Glenderamackin at Mungrisedale (1547.1) shows that densities are normally low and it is probable that stocking enhanced the density at this site.

The stocking of Trout Beck with 25 000 salmon fry in the upper reaches in 1992 (Fig 7) appears to have failed almost completely. No salmon fry were recorded at Rookin House (1550) and only one was caught at Trout Beck Hotel (1551).

5.2 Salmon Parr (Figs 2 and 12)

High densities (Class C and above) were recorded on the Glenderamackin, St. John's Beck, Naddle Beck, Dash Beck, Wythop Beck and the Upper Marron as well as at individual sites on Newlands Beck, Blumer Beck, Upper Borrowdale and Trout Beck.

Lower Densities (Class D) were recorded at most sites in Borrowdale, on Newlands Beck, the Glenderaterra, Applethwaite Gill and Coal Beck.

Parr were absent from 21 sites.

The high densities on St. John's Beck and at individual sites in Borrowdale, on Blumer Beck and possibly Lower Dash Beck are due to natural spawning. At other high density sites the salmon parr density may or may not have been enhanced by stocking.

5.3 Salmon Distribution

Salmon were recorded at most sites below impassable falls or cascades. It appears that salmon are utilising most of the available catchment naturally but the picture is confused by the salmon stocking programme. Salmon were not recorded at 14 sites, 7 of which were upstream of barriers.

5.4 Trout Fry 0+ (Figs 3 and 13)

The highest densities were recorded on the River Marron at Asby and on Applethwaite Gill (both Class A). High densities were also recorded on Wythop Beck and at individual sites on Coal Beck, Blumer Beck, Comb Beck, Pow Beck and Naddle Beck.

Low densities were present at most other sites but trout fry were not recorded at 14 sites, of these Trout Beck and Coledale Beck are of particular concern.

5.5 Trout >0+ (Figs 4 and 14)

Fourteen sites had Class A densities of >0+ trout. Populations were especially good on Dash Beck, Coal Beck, Wythop Beck, Comb Beck and Pow Beck and Naddle Beck.

Sites with high densities (Class A and B) were also present on Applethwaite Gill, Watendlath Beck, Wyth Burn and the upper reaches of the River Marron.

Low densities were recorded at most other sites. Trout >0+ were not recorded at 7 sites. Trout were absent from 4 sites, these were on Coledale Beck, Newlands Beck, Mosedale Beck and the River Derwent at Longthwaite.

5.6 Stocking Effectiveness

It is not possible to evaluate the effectiveness of the stocking programme from this data. Some stocked reaches (e.g. Naddle Beck) have produced high densities of salmon, but may have produced these naturally. In other stocked reaches, such as Trout Beck, stocked salmon appear to have disappeared or declined to very low numbers.

6 PRODUCTION BY REACH

To manage a fishery effectively it is important to know the numbers of fish produced in different parts of the catchment. A large stream area producing a low density is likely to produce more fish than a small area yielding a high density. The calculations are based upon stream areas (length x width) multiplied by fish densities. The lengths used normally extend 0.5km upstream of the most upstream site on each reach. The widths are those measured during the survey. Notes and assumptions are presented in Appendix 3. On most streams there is still a significant length upstream of the top site which is therefore not included in the production estimates. This may be significant, particularly for trout fry production which tend to occur in smaller streams. Data for salmon and trout are shown in Tables 4 and 5 respectively.

6.1 Salmon (Table 4)

The main salmon fry producing areas were:-

River Glenderamackin	35.2%
St. John's Beck	28.1%
Naddle Beck	14.1%

In total they account for 77% of the estimated production in 1992.

For salmon parr the main producing areas were:-

River Glenderamackin	14.8%
St. John's Beck	22.3%
Naddle Beck	13.0%

These account for 61% of the estimated parr production in 1992.

It is important to note that this does not include unsurveyed streams.

Shearer (1984a) estimates that survival from parr to 2+ smolt is approximately 50% and that survival at sea is 20-30% for grilse. If these estimates are applied to total parr numbers this would yield 12 thousand smolts and an estimated grilse return of 2396 to 3594 from the Upper Derwent system.

However, work in Northern Ireland (Kennedy, in Solomon 1983) estimates the smolt to grilse survival to range from 3-13%. For this data this would yield 359 to 1557 grilse.

How these survival estimates relate to fish from the Upper Derwent is unknown.

It would not be valid to calculate these figures for the River Marron as no tributaries were included in the 1992 survey.

Salmon Fry/Parr Ratio (Table 4)

There is a need for caution when comparing the abundance of one year class (e.g. fry) with another (e.g. parr) to infer survival from one to another. This is because year class strengths naturally vary greatly. However such a discussion can be useful and the following discussion assumes that natural year class strength is constant.

The abundance category system used in the N.R.A. North West is based on a significant background of survey data and is based on the assumption that 1 in 5 fry survive to become parr, ie. a parr/fry ratio of 0.2.

The overall parr/fry ratio for this survey was 0.32 but ratios for individual streams ranged from 0.13 to 5.62.

If stocking is successful it would be expected to affect these ratios by boosting the numbers of the year class stocked. However for streams stocked with fry in 1991 (i.e. the parr year class) the parr/fry ratios ranged from 0.13 to 5.62 with a mean of 1.49. The ratios for non-stocked streams ranged from 0.25 to 4.85 also with a mean of 1.49. A Mann-Whitney U-test did not find a significant difference between stocked and unstocked streams in terms of the ratio of parr to fry. However the effectiveness of stocking is a complex study and it is not possible from this data to assess how effective stocking has been.

Work conducted in the North West to investigate stocking effectiveness is the subject of a report from our Regional Fisheries Scientists (Farooqi and Aprahamian 1995).

6.2 Trout (Table 5)

The total estimated trout fry production was less than half that for salmon fry. However the number of older trout was slightly higher than that for salmon parr. It is important to note that older trout numbers and parr numbers are not strictly comparable because the trout population will consist of a larger range of age classes. The older trout number will be an underestimate because they principally inhabit deeper waters which were not part of this survey.

The main trout fry producing areas were :-

St. John's Beck	13.5%
Applethwaite Gill	11.2%
Dash Beck	10.8%
Wythop Beck	19.5%
Blumer Beck	10.7%

Table 4

Upper Derwent Survey 1992
Salmon Production Figures by Reach
(S indicates that the year class was stocked)

	Fry		Parr		Parr/Fry Ratio
Derwent u/s Derwent Water	648		1108		1.71
Stonethwaite Beck	104		504		4.85
Glenderamackin	26740	S	3542	S	0.13
Greta	394		846		2.15
Trout Beck	1190	S	1710		1.44
Mosedale Beck	1145		578		0.50
St. John's Beck	21346		5345		0.25
Naddle Beck	10683	S	3109	S	0.29
Glenderaterra	315		109		0.35
Applethwaite Gill	263		96		0.37
Newlands Beck	4158		1512	S	0.36
Pow Beck	178		338		1.90

Table 4 (Continued)

Upper Derwent Survey 1992
Salmon Production Figures by Reach
(S indicates that the year class was stocked)

	Fry	Parr		Parr/Fry Ratio
Dash Beck	3517	2632	S	0.75
Chapel Beck	2713	556	S	0.20
Wythop Beck	2211	1156	S	0.52
Coal Beck	21	118	S	5.62
Blumer Beck	373	700		1.88
TOTAL	**75999**	**23959**		**0.32**
River Marron	8236	2297		0.28

Table 5

Upper Derwent Survey 1992
Trout Production Figures by Reach

	Fry	Older Trout	Older Trout / Fry Ratio
Derwent u/s Derwent Water	42	40	0.95
Stonethwaite Beck	93	356	3.83
Watendlath Beck	270	2340	8.67
Glenderamakin	1765	865	0.49
Greta	0	85	-
Trout Beck	215	1252	5.82
Wyth Burn	229	464	2.03
St. John's Beck	4606	1852	0.40
Naddle Beck	2205	1834	0.83
Glenderaterra Beck	556	221	0.40
Applethwaite Gill	3822	434	0.11
Newlands Beck	2127	1073	0.50

Table 5 (Continued)

Upper Derwent Survey 1992
Trout Production Figures by Reach

	Fry	Older Trout	Older Trout / Fry Ratio
Coledale Beck	0	185	-
Comb Beck	747	1987	2.66
Pow Beck	1182	2181	1.85
Dash Beck	3687	4395	1.19
Chapel Beck	381	694	1.82
Wythop Beck	6691	1087	0.16
Dubwath Beck	57	0	-
Coal Beck	1903	1680	0.88
Blumer Beck	3675	2110	0.57
TOTAL	**34253**	**25135**	**0.73**
River Marron	7893	2372	0.30

7 STREAM REACHES OF CONCERN (Recommendations)

7.1 River Derwent and tributaries in Borrowdale

The low fish populations are of concern and given the large amount of stream and river area is of importance to the Derwent system as a whole. The low numbers may be due to a number of factors including acid rain during the 1980s and erosive spatey flows.

Acid rain episodes have become less frequent and it is several years since one caused problems at the fish farm at Seathwaite. It is likely that the fish population will naturally slowly recover. The river is naturally of low nutrient status and would not be expected to support exceptionally high densities.

Anyone who has seen the river in Borrowdale will know how clean the stones are. This makes redd counting difficult as there is little contrast even when redds are newly cut. Redds will therefore be missed and counts will be an underestimate.

In spatey rivers the floods are often highly erosive; a highly mobile river bed is not hospitable to fish. The extent of mobile bed is not known.

Recommendations

1. More sites should be surveyed in Borrowdale during the next Strategic Survey

2. The habitat should be assessed especially with regard to the stability of the bed material.

7.2 Trout Beck

The salmon and trout population, of especially the middle reaches of Trout Beck, was found to be at a low level, despite stocking of salmon in 1992. This is of concern. The only evidence found of the stocking was one fry at Trout Beck Hotel (1551). The cause of the low population needs to be investigated.

The coniferous forest in the upper part of the catchment is managed by Forest Enterprise and was planted in the 1960s. Except for a short section the trees are planted well back from the stream and the instream habitat is excellent for young fish. Forest practice has been discussed with Forest Enterprise and no possible causes for the low fish populations throughout Trout Beck could be identified.

The following work is recommended to try to determine the status of the fish population further upstream and the cause of the low population found during this survey.

1. To assess the current population at the sites fished in 1992 and at other parts of Trout Beck (Thornsgill Beck) the following sites should be electro-fished.

Recommended site list - Trout Beck:

Site Number	Site	NGR
-	By Cockley Moor	NY 376 228
-	Within forest	NY 377 235
-	Within Forest	NY 382 233
-	D.S. Forest	NY 382 246
1550	At Rookin House	NY 382 253
-	At Troutbeck	NY 386 262
1551	At Troutbeck Hotel	NY 389 270
-	Nr Gill Head Farm	NY 380 270
1552	At NY 370269	NY 370 269
1553	U.S. Glenderamackin	NY 358 267

2. The data should be related to the habitat at the site using either Habscore or the NRA National Fisheries classification scheme.

3. If populations are found to still be low a macroinvertebrate survey should be conducted to determine water quality and food availability.

Update

The follow up survey was conducted in June 1995 and although older trout were present in reasonable numbers no fry were found. Two sites of significant silt input have been identified and we are working towards removing/reducing these inputs.

7.3 Newlands Beck

Due to the low densities found during the survey, and to the low numbers of recorded redds, 7.6K salmon fry were stocked from Low Snab at NY231190 to Braithwaite at NY241240 in November 1994. These fish were from Akebank. During autumn and winter 1994/95 a section of Newlands Beck downstream of Braithwaite was being respiled by the Flood Defence department. This work included the addition of bed check weirs to retain gravel and create deeper water and the placement of large boulders to cause scour and hence cover for fish. The additional cover will hopefully encourage fish to spawn in this reach.

Recommendations

1. The sites listed below should be electrofished in 1995 to assess the status of the salmonid stocks in the light of the 0+ parr stocked in November 1994.

2. A macroinvertebrate survey should be conducted if fish populations are low to determine water quality and food availability.

3. The sites from 1571 downstream should be electrofished in 1996 to assess whether or not the habitat improvements have resulted in recruitment in the newly worked section.

4. The extent that Newlands Beck dries up in drought conditions should be recorded.

5. Redd counting on Newlands Beck should be given a high priority, especially downstream of the A66 on the newly worked section.

Update

The follow up electro fishing survey was carried out in summer 1995. High densities of both salmon and trout were found at all sites downstream to Stair but downstream Newlands Beck driesd completely for long sections during the drought. The sffectiveness of the improvements in the section newly worked by Flood Defence could not be assessed.

The main problem in Newlands Beck is the extent to which it dries up in low flows.

Recommended Site List - Newlands Beck:

Archive Number	Site	NGR
1566	U/s Low Snab	NY 229 181
1567	At Low Snab	NY 130 184
1567.5	At Little Town	NY 232 194
1568	At Ghyll Bank	NY 236 205
1569	At Stair	NY 237 213
1570	At Little Braithwaite	NY 238 229
1571	D/s A66	NY 241 237
-	Within worked section	
-	Within worked section	
1572	NY 236254	NY 236 254

7.4 Mosedale Beck

Only one survey site was established on this stream due to access difficulties.

Recommendation

That an additional 3 or 4 sites are established and fished using backpack gear and a quad bike as part of the next strategic survey of the Upper Derwent.

Recommended Site List - Mosedale Beck

Site	NGR
U/s Carol Beck	NY 355 235
U/s Lobbs Farm	NY 357 245
U/s Highgate Close	NY 357 252

7.5 River Greta

The River Greta is not particularly suitable for electrofishing. However more sites are necessary to gain reasonable data on the river.

Site 1547 at Brundholme is not suitable for electrofishing and so should be deleted.

Recommendations

During a field visit a total of 5 or 6 sites should be established on the River Greta approximately one site per kilometre. These should be electrofished as part of the next strategic survey of the Upper Derwent.

7.6 Coledale Beck

In the upper reaches of Coledale beck there is a disused Barytes mine. Passive leachate from the slag heaps and the mine are the likely cause of the low fish numbers in this stream. A narrow stream of this nature is most likely to be more suitable for trout rather than salmon. If the leachate ameliorates the fish population will only recover extemely slowly because it would be starting form such a low level. Experiments with caged fish have been conducted in the past but the fish did not survive.

Recommendation

If there is evidence that the water quality improves in the future then a trial trout fry stocking experiment may be worthwhile to see if trout can survive.

7.7 River Marron

The Marron is an excellent salmon and trout nursery upstream of Ullock but the poor population from Branthwaite downstream is of concern. Between the surveys in 1991 and 1992 there was a decline in the older trout population, the reasons for this are not known.

Marron Catchment Survey 1994

In 1994, thirty four sites were electrofished throughout the catchment. On the main river three new sites were included in addition to those fished in 1992. The results for the main river are summarised below. The full survey will be the subject of a separate report. The main points are :

1. Older trout (>0+) densities were still low and had not recovered to 1991 levels.

2. Trout fry densities were similar to those found in 1991.

3. Salmon parr densities had improved marginally at Calva Hall from Class D to C. The site at Ullock had a low parr density in 1994 but the new site downstream yielded Class B.

4. Salmon fry densities were very similar to those recorded in 1991 and 1992. The new site (1702.2) established downstream of Ullock yielded Class C for salmon fry, this together with the high parr densities demonstrates that water quality is good downstream of Ullock.

5. Overall there was a slight increase in Total Salmonid Density at Calva Hall.

Water Quality
Macroinvertebrate data

Routine surveys reveal no water quality problems; the inferred water quality has always been high. This is also true of Ullock sewage works which is also monitored biologically.

Chemical Data

The data indicates that water quality is generally high. There have been a small number of minor incidents involving tributary streams but these had little impact on the Main River Marron and occurred in the vicinity of Bridgefoot. These could not possibly explain the decline from Branthwaite downstream.

Recommendations

1. Broodstock should not be collected from the River Marron catchment unless the progeny are to be returned to it.

2. The decline in fish population may be due to pollution which could be an historic pollution, from which the population has not recovered, or to an ongoing pollution. A macroinvertebrate water quality survey should be conducted on the whole River Marron but should concentrate especially on the area between Ullock and Calva Hall.

3. If the macroinvertebrate survey does not identify a problem, a detailed electrofishing survey should be conducted in the area between Ullock and Calva Hall to pinpoint where the fish population decline occurs. This should include sites with pools suitable for older trout.

4. The habitat downstream of Ullock should be assessed for suitability for older fish, juvenile fish and for the abundance of spawning gravels.

Information from these investigations will need to be collated before appropriate action can be recommended.

8. GLOSSARY

Salmonid — A salmonid is a member of the family salmonidae which includes salmon, trout and charr. For the purposes of this survey it includes salmon (*Salmo salar*) and trout (*Salmo trutta*).

Fry — Fry are fish which have hatched out in the current year, normally in May for salmon and trout. They normally range in size from 4 - 7.5cm at the time of year of these surveys.

0+ — 0+ fish are those which are less than one year old (but older than 0 years!). For the purposes of this survey, 0+ and fry are interchangeable but later in the year or early the following spring such fish would be large enough to be called parr. In warmer, more productive waters, 0+ fish may reach parr size by the end of the first summer.

Parr — Parr are salmon or trout which are normally 8 - 12cm long and have parr marks on the sides of the body (i.e. dark vertical bars).

>0+ — >0+ (greater than 0+) fish are those which are one year old or older. For salmon these fish are all parr i.e. the freshwater stage prior to becoming a smolt.

For trout the >0+ group includes all ages other than 0+ (i.e. parr and adult fish) and therefore can include several year classes. These year classes can be denoted >1+, >2+ etc.

Smolt — Smolts are the silvery stage of salmon or sea trout at which they migrate to sea. Smolts are typically 12 - 16 cms long.

Grilse — Grilse are salmon which have spent only one winter at sea before returning to freshwater.

Multi-seawinter Fish — As the name implies this refers to fish which have spent two or more winters at sea before returning to freshwater.

Redd — A redd is the "nest" which female salmon and trout cut to lay their ova in. Redds have a characteristic shape and in low, clear waters can be counted and mapped.

Year Class — All the fish which hatch in one particular year belong to the same year class. The success or "strength" of a year class depends upon a number of factors and it can vary greatly from year to year.

9. REFERENCES

Barnard S and Wyatt R J

A guide to HABSCORE field survey methods and the completion of standard forms.
WRC report for the National Rivers Authority R & D note 401

Farooqi M and Aprahamian M W 1993

The calibration of a semi Quantitative approach to Fish Stock Assessment in the North West Region of the N.R.A. NRA/NW/FTR/93/4

Farooqi M and Aprahamian M W 1995

An Evaluation of the survival of Atlantic salmon (*Salmo salar L*) stocked into eight streams in the North West of England.
National Rivers Authority, NW region internal report NRA/NW/FTR/95/8

Shearer 1984a

The natural mortality at sea for North Esk salmon. International Council for the Exploitation of the Sea C.M. 1984/M:23

Solomon 1993

Determining the role of restocking in Fisheries Management, Welsh Rivers - Stocking and Taking Stock; Proceeding of the Joint N.R.A. Welsh Region/WSTAA Seminars 1993. N.R.A. Welsh Region Technical Fisheries Report No.4.

Zippin 1958

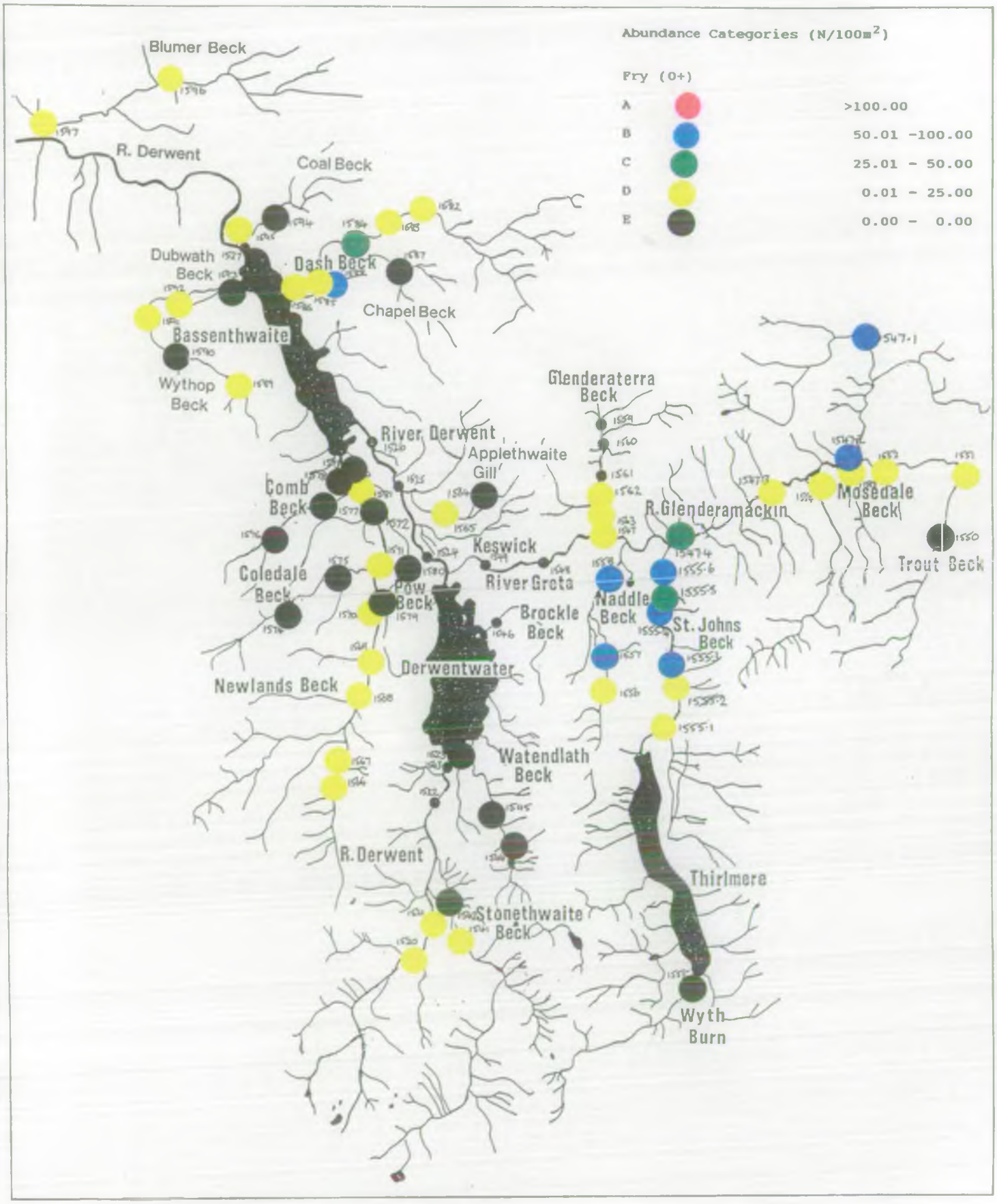
The Removal Method of Population Estimation
Journal of Wildlife Management Vol 22.

LIST OF FIGURES

UPPER DERWENT CATCHMENT

Figure 1

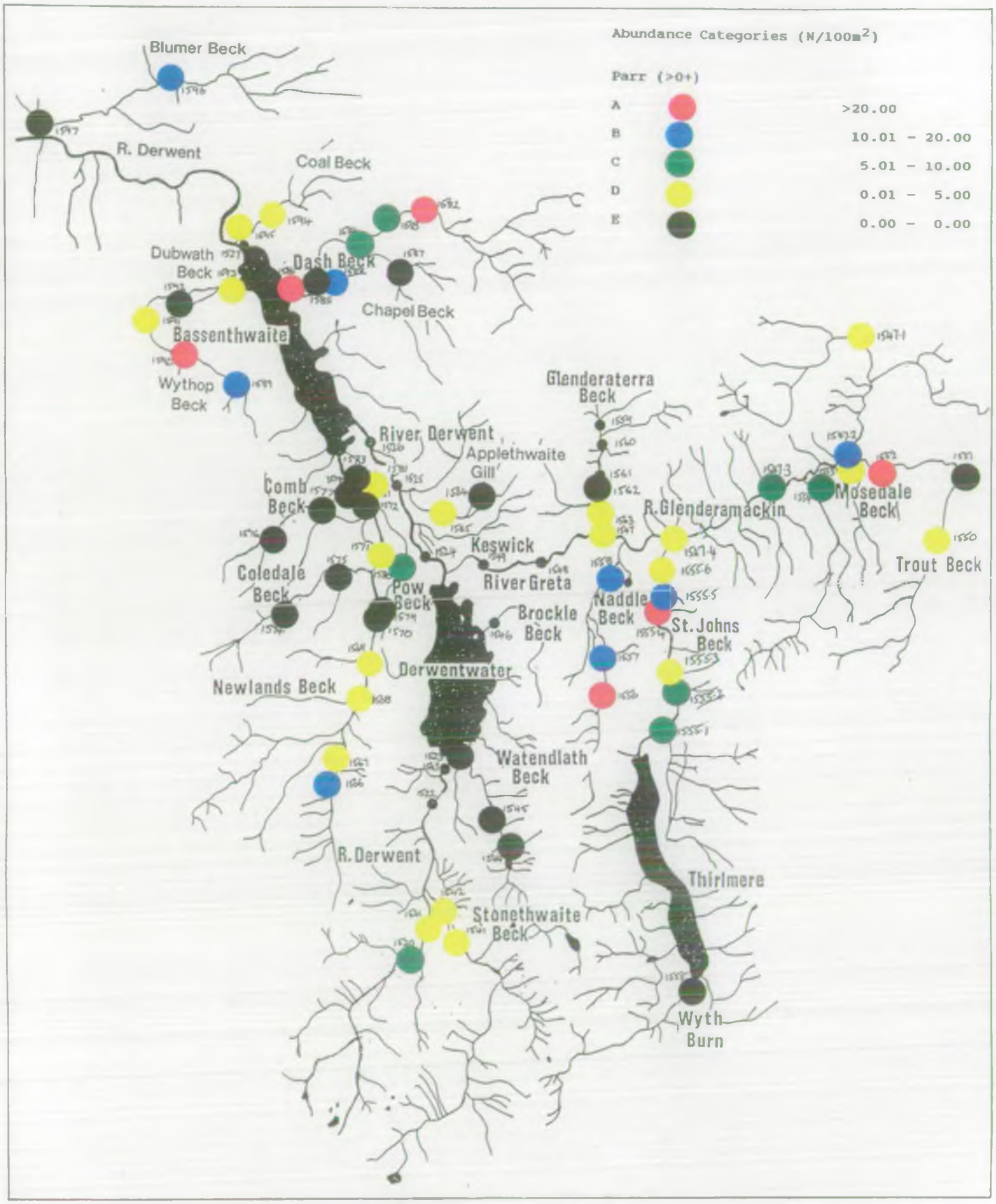
Salmon Fry (0+) Densities In 1992



UPPER DERWENT CATCHMENT

Figure 2

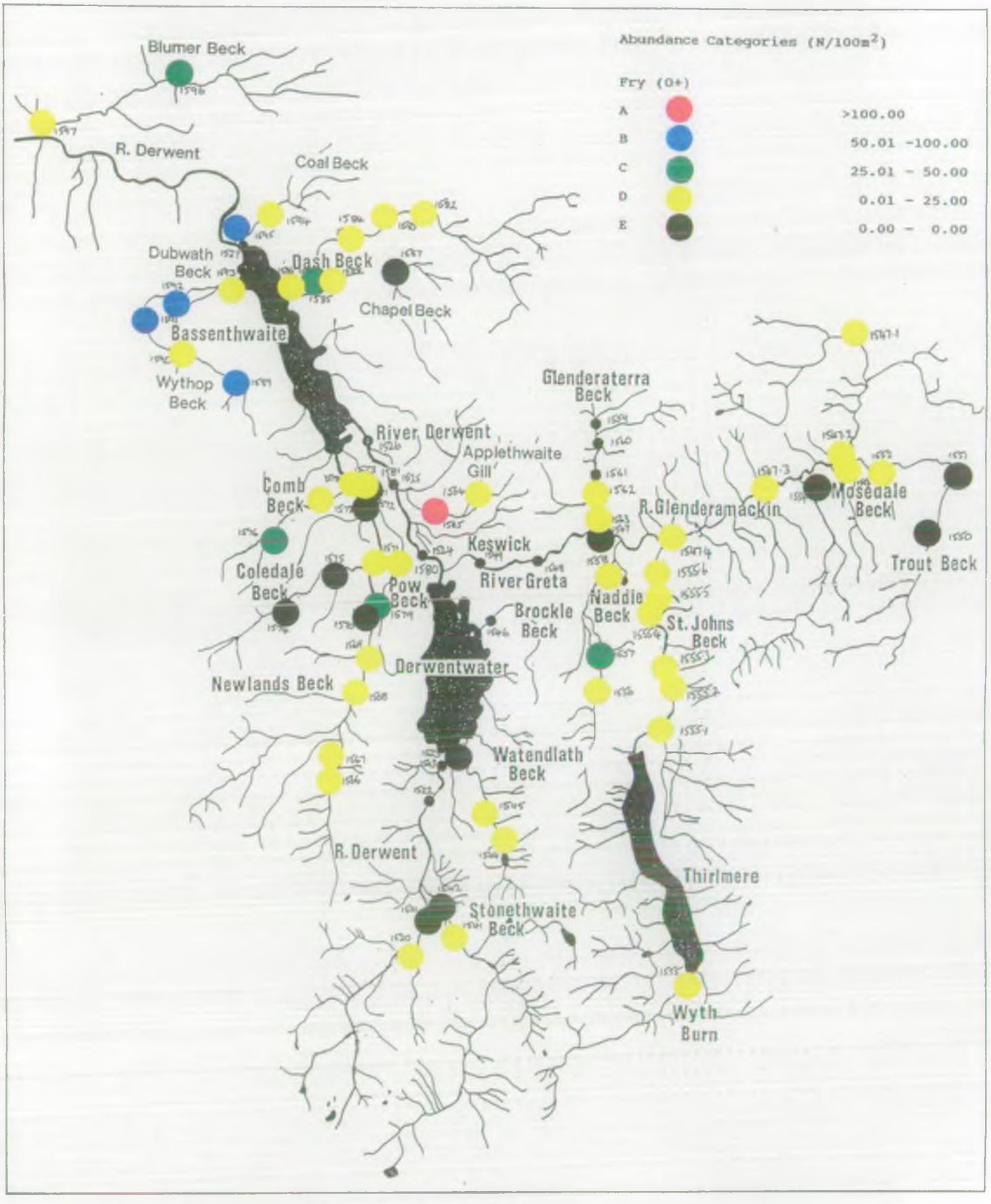
Salmon Parr (>0+) Densities In 1992



UPPER DERWENT CATCHMENT

Figure 3

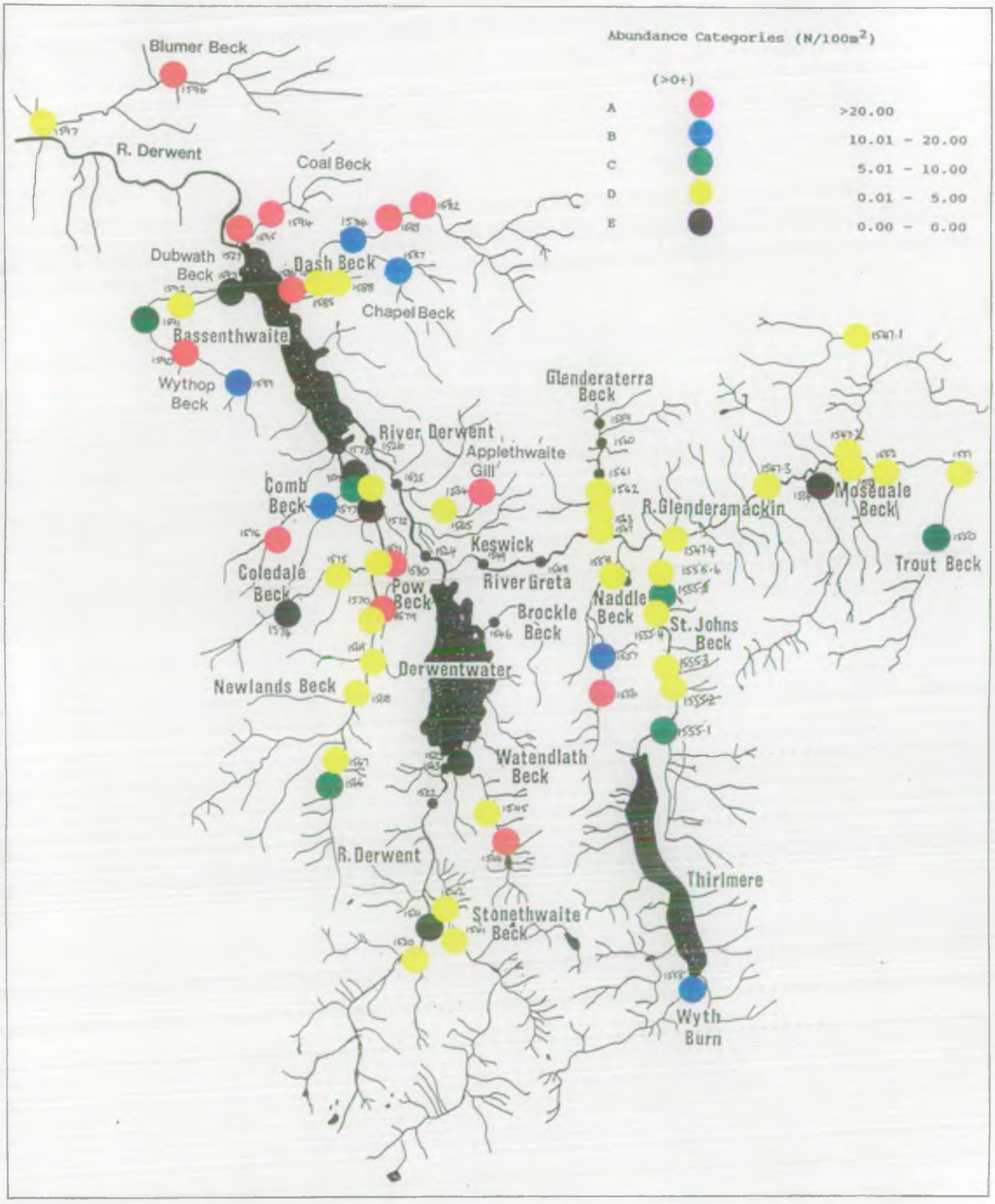
Trout Fry (0+) Densities In 1992



UPPER DERWENT CATCHMENT

Figure 4

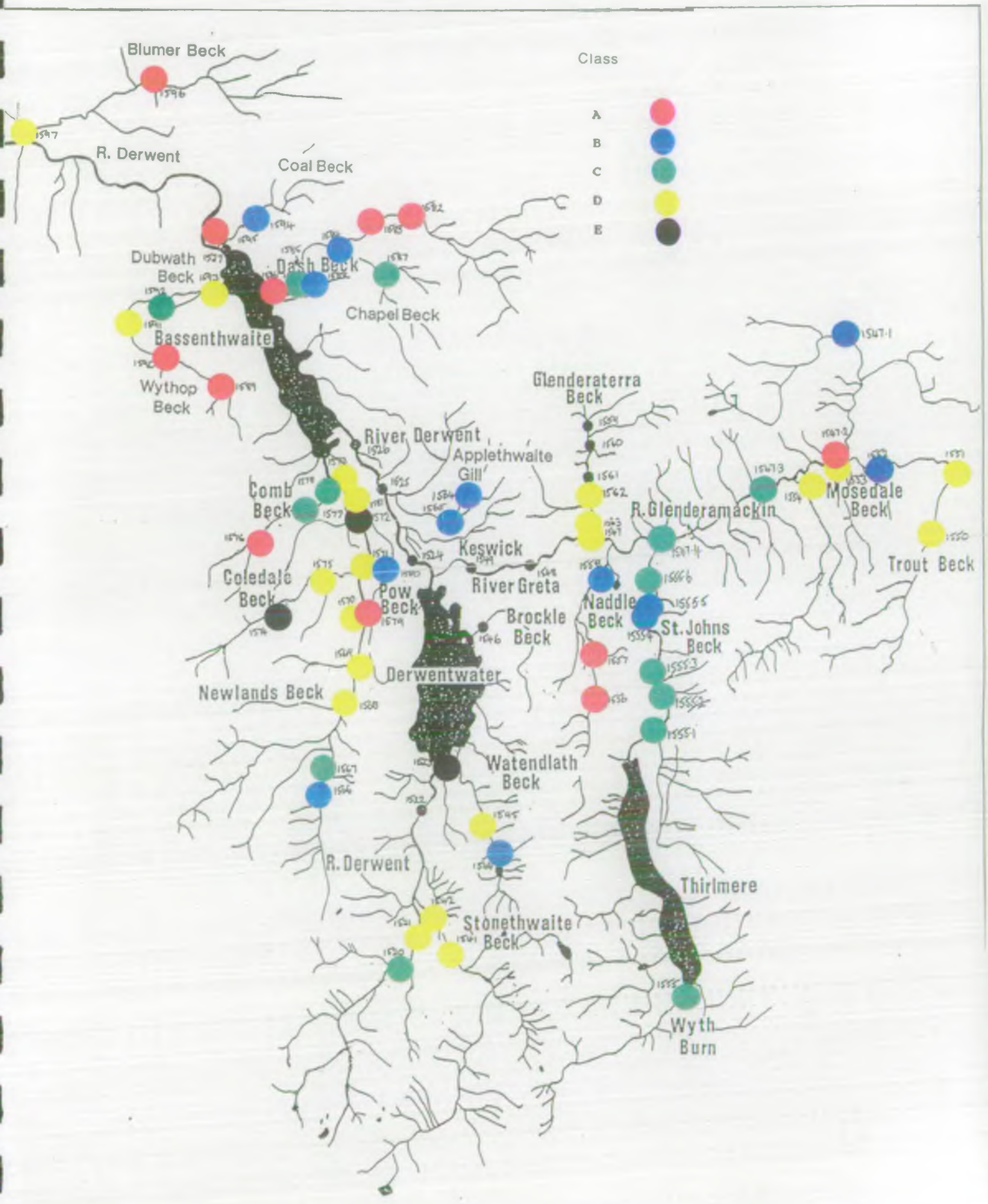
Trout (>0+) Densities In 1992



UPPER DERWENT CATCHMENT

Figure 5

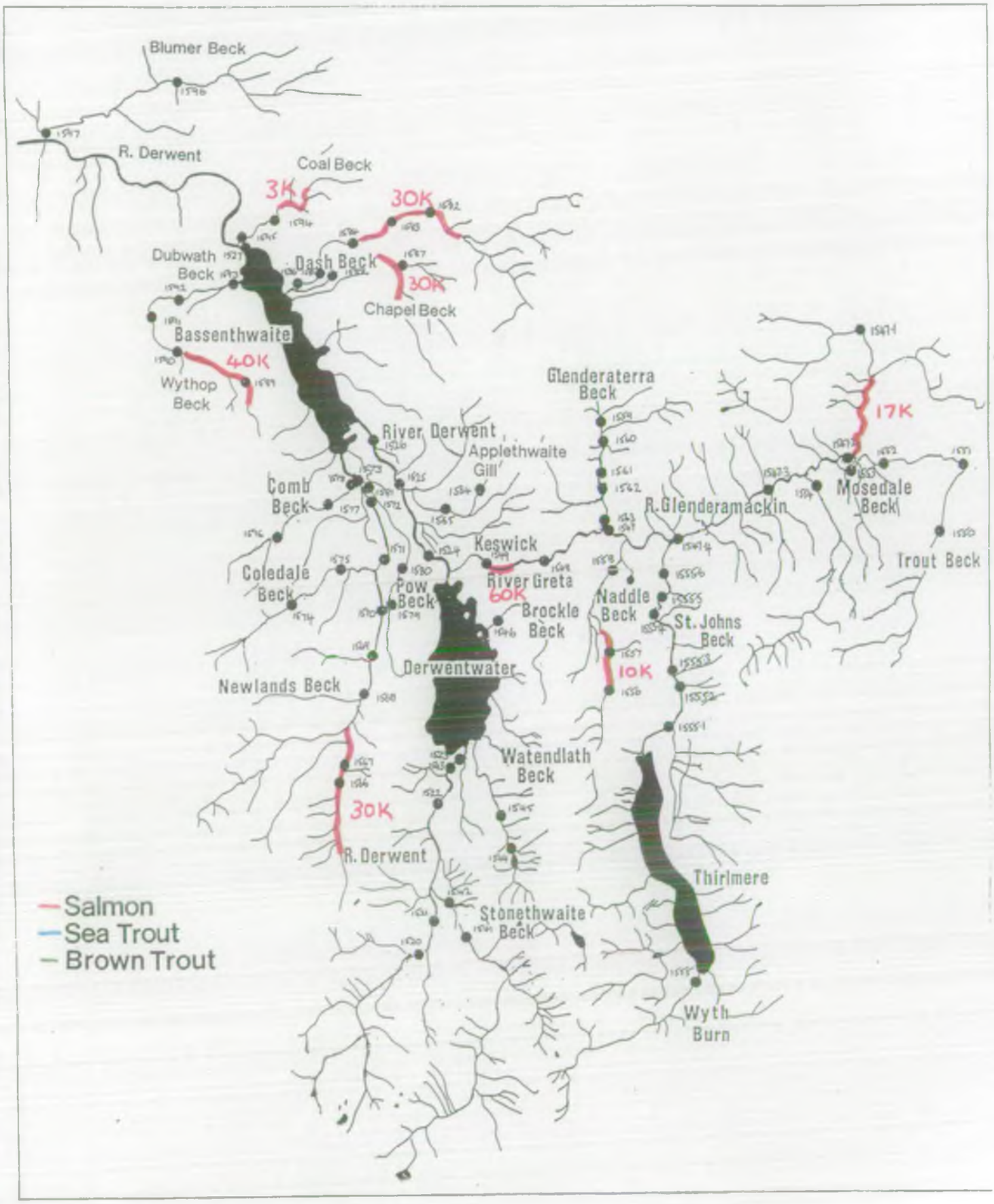
Total Salmonid Density Class 1992



UPPER DERWENT CATCHMENT

Figure 6

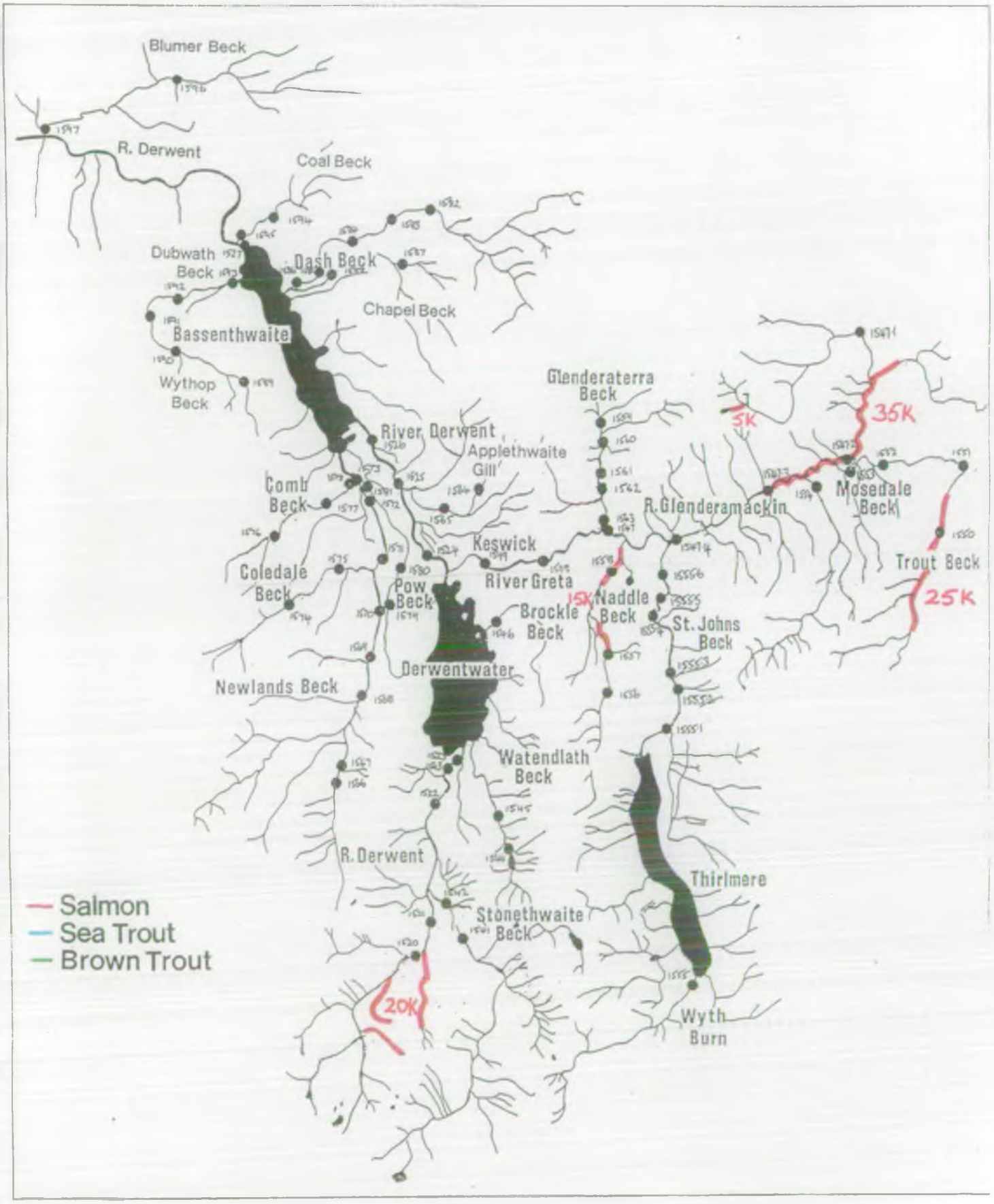
Stocking Data 1991



UPPER DERWENT CATCHMENT

Figure 7

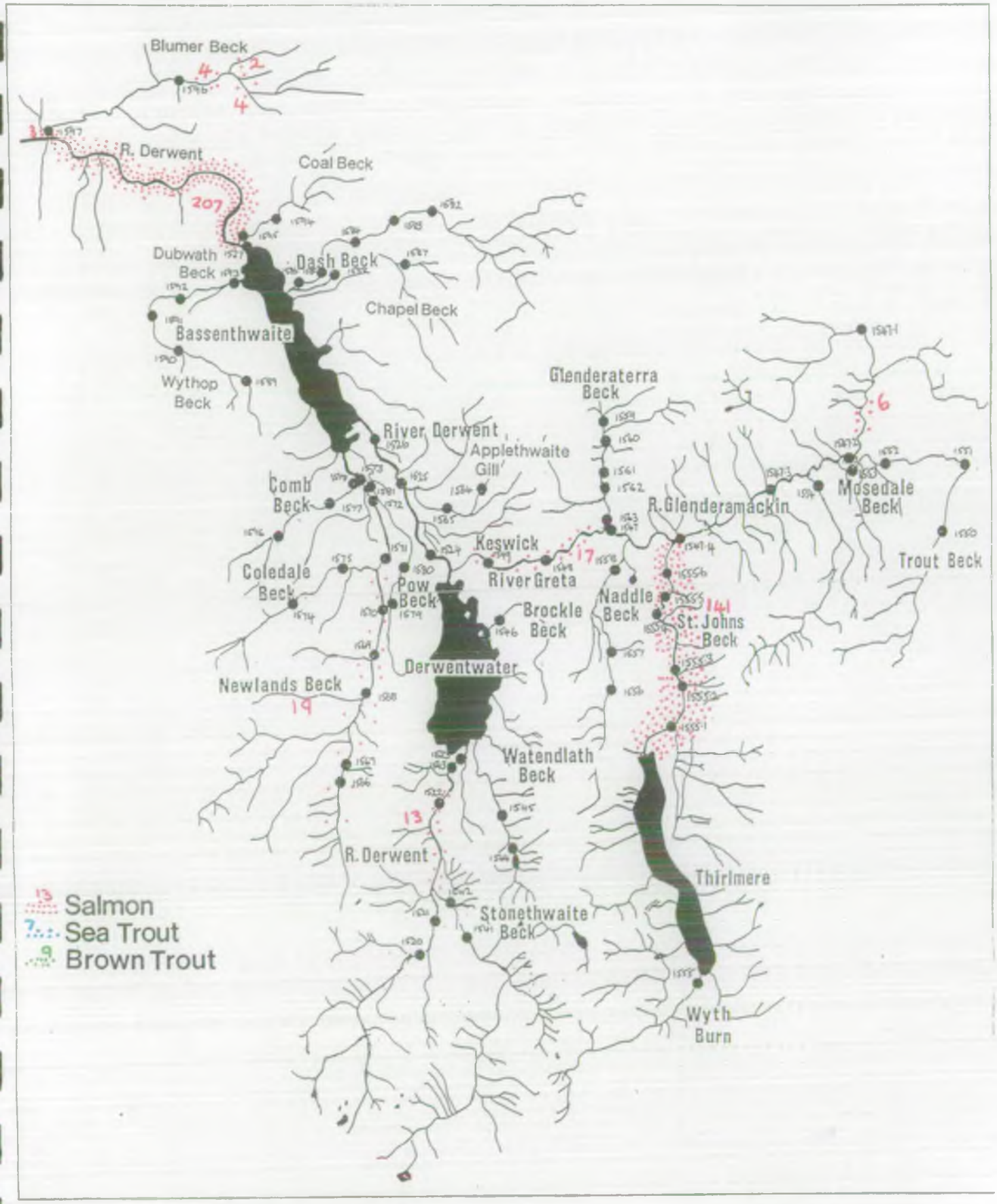
Stocking Data 1992



UPPER DERWENT CATCHMENT

Figure 8

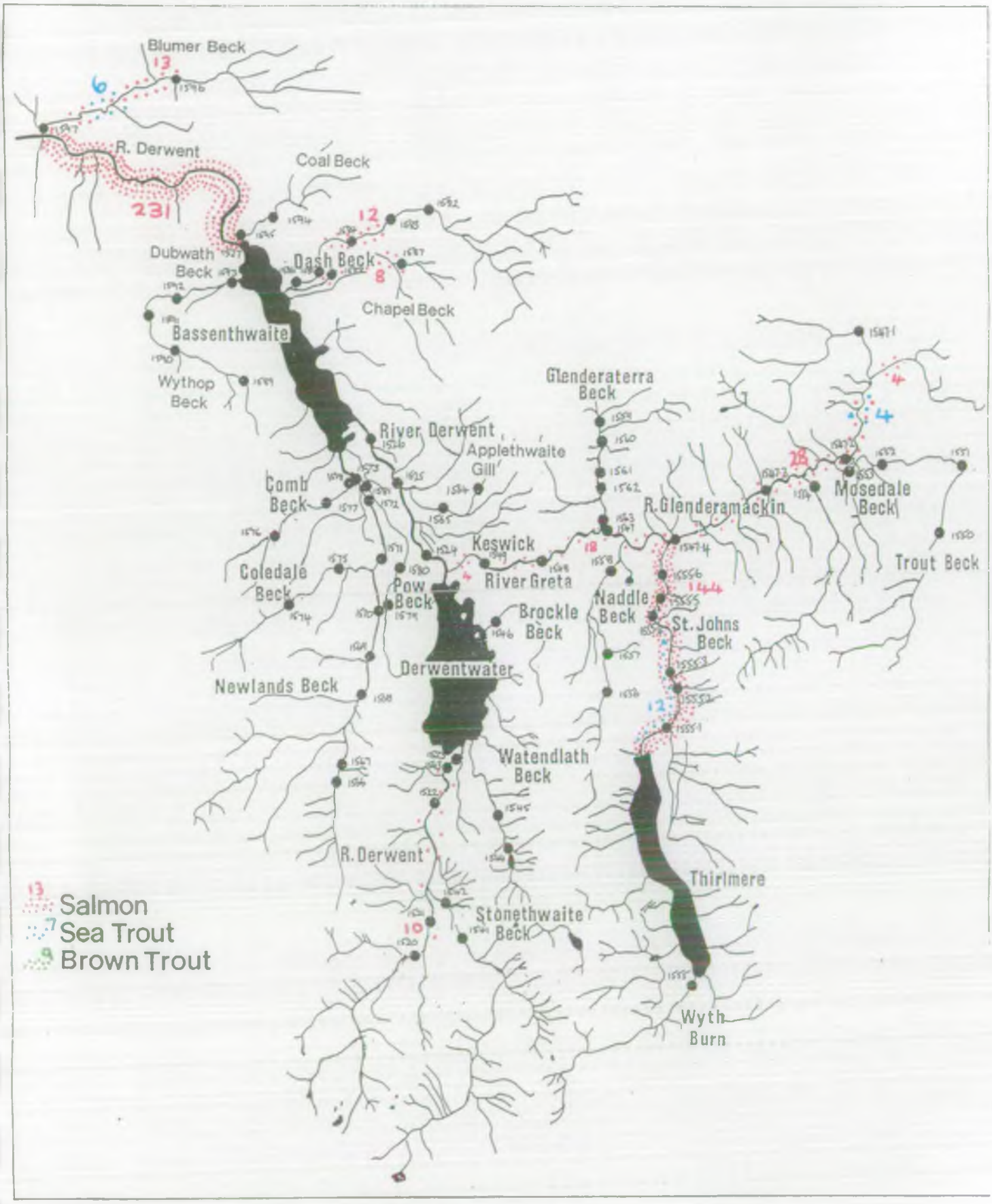
Redd Counts 1990



UPPER DERWENT CATCHMENT

Figure 9

Redd Counts 1991



UPPER DERWENT CATCHMENT

Figure 10

Known Obstacles To Migratory Fish - 1992

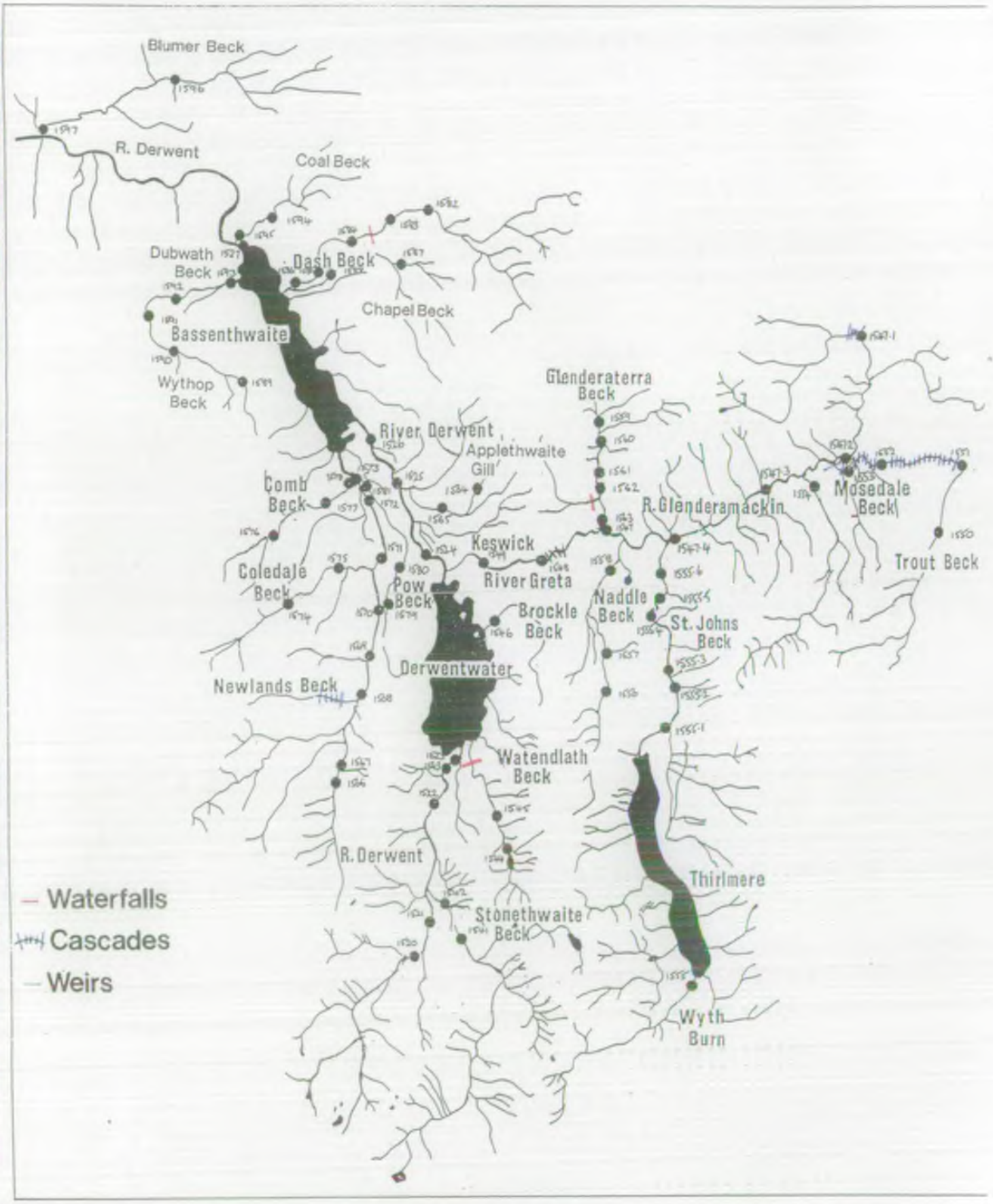


Figure 11

MARRON CATCHMENT

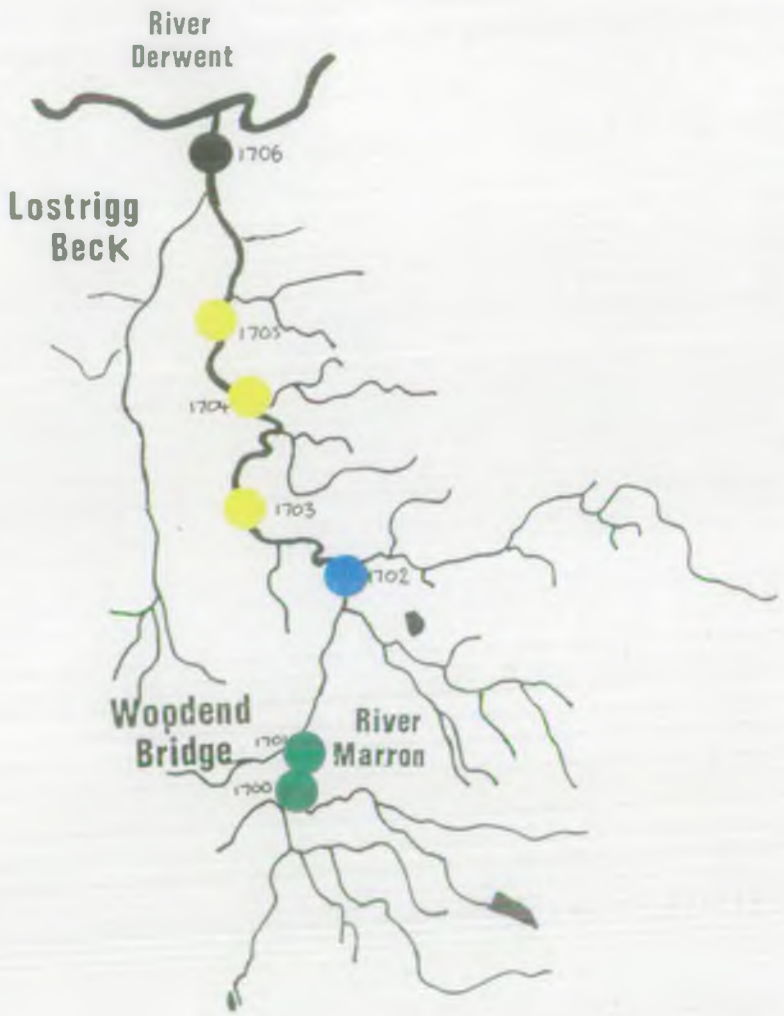
Salmon Fry (0+) Densities In 1992

Abundance Categories (N/100m^2)

Fry (0+)	
A	>100.00
B	50.01 -100.00
C	25.01 - 50.00
D	0.01 - 25.00
E	0.00 - 0.00

MARRON CATCHMENT

Salmon Parr (>0+) Densities In 1992



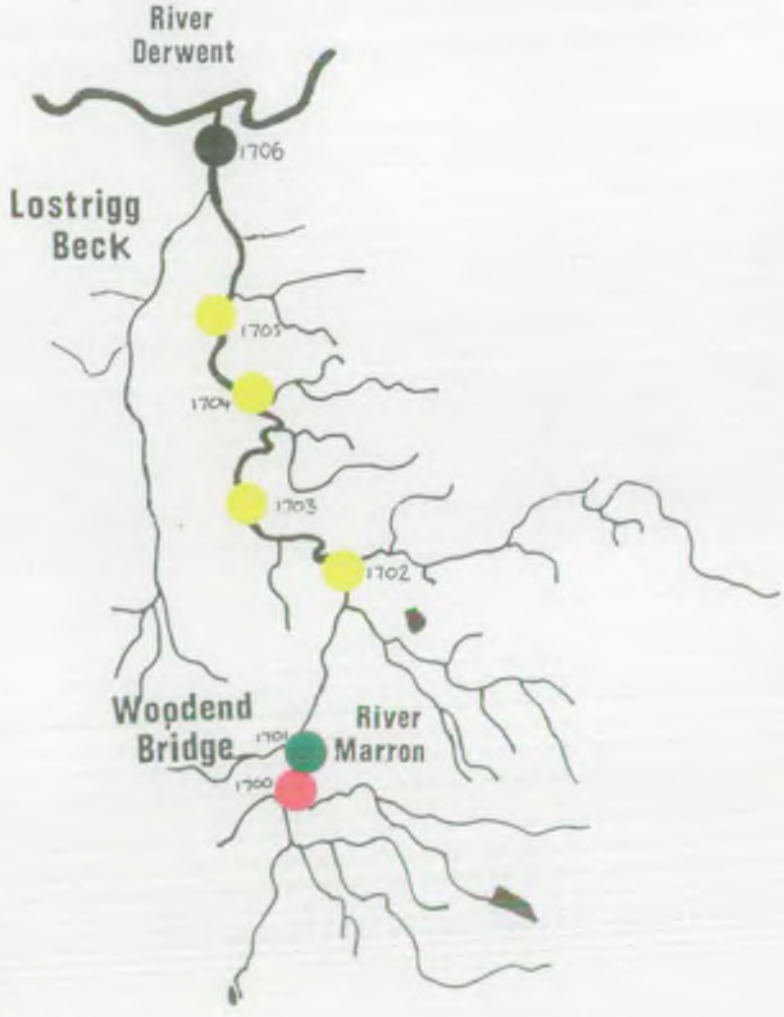
Abundance Categories (N/100m^2)

Parr (>0+)	
A	>20.00
B	10.01 - 20.00
C	5.01 - 10.00
D	0.01 - 5.00
E	0.00 - 0.00

Figure 13

MARRON CATCHMENT

Trout Fry (0+) Densities In 1992



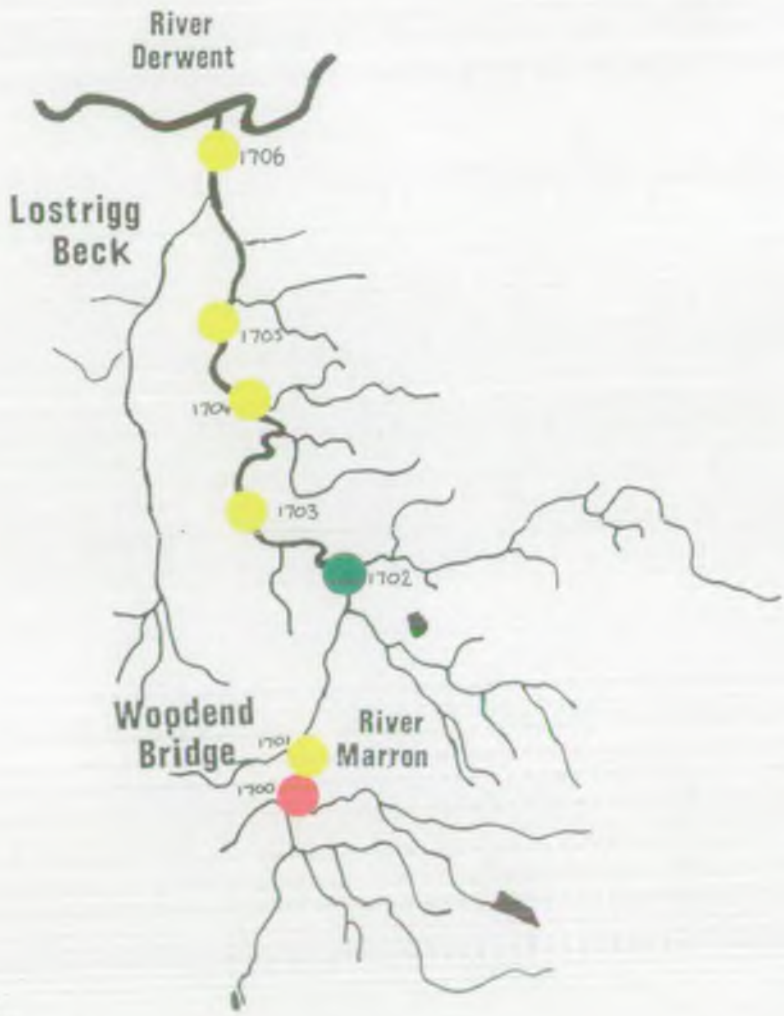
Abundance Categories (N/100m^2)

Fry (0+)	
A	>100.00
B	50.01 -100.00
C	25.01 - 50.00
D	0.01 - 25.00
E	0.00 - 0.00

Figure 14.

MARRON CATCHMENT

Trout (>0+) Densities In 1992



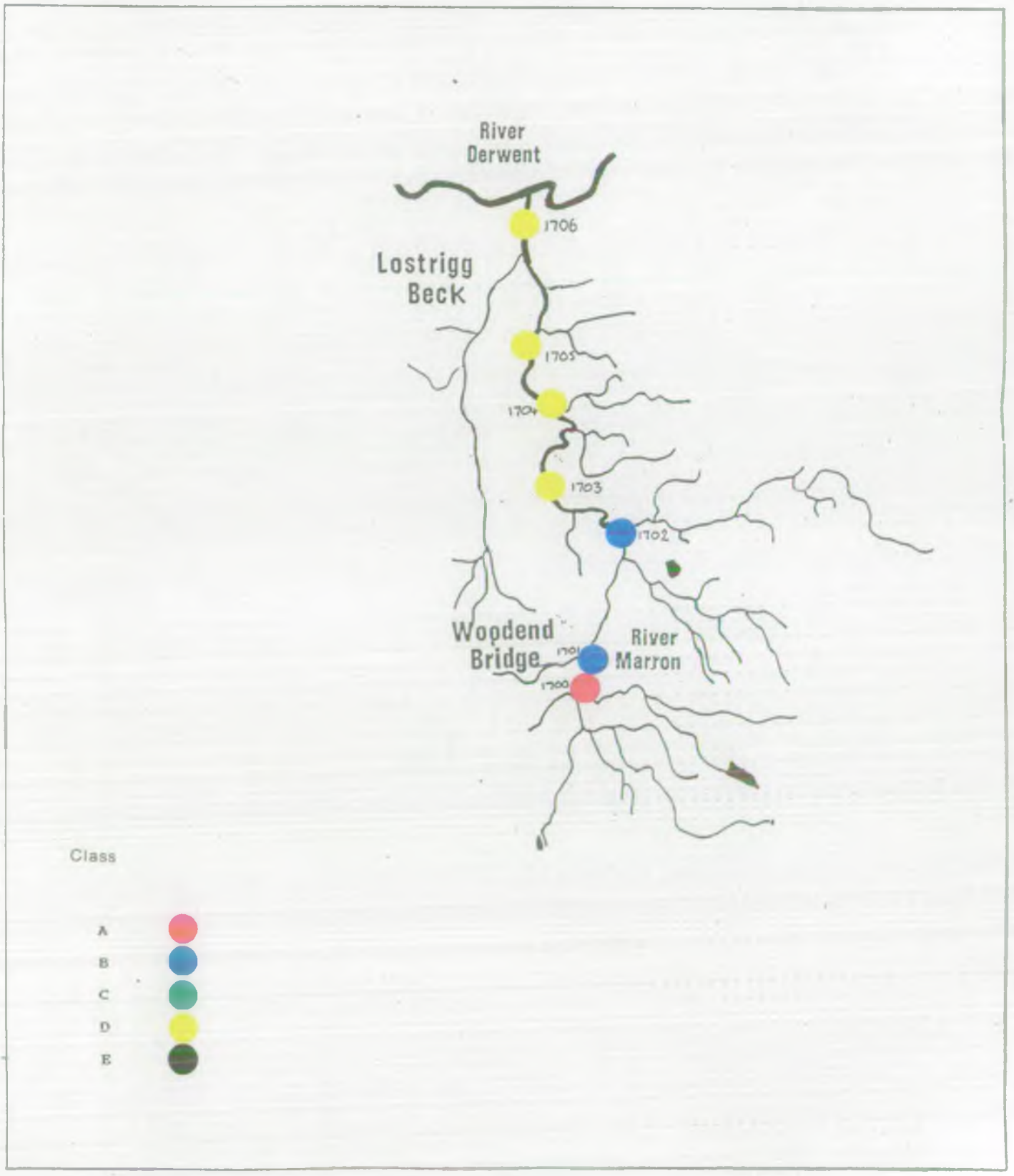
Abundance Categories (N/100m^2)

	(>0+)	
A		>20.00
B		10.01 - 20.00
C		5.01 - 10.00
D		0.01 - 5.00
E		0.00 - 0.00

Figure 15

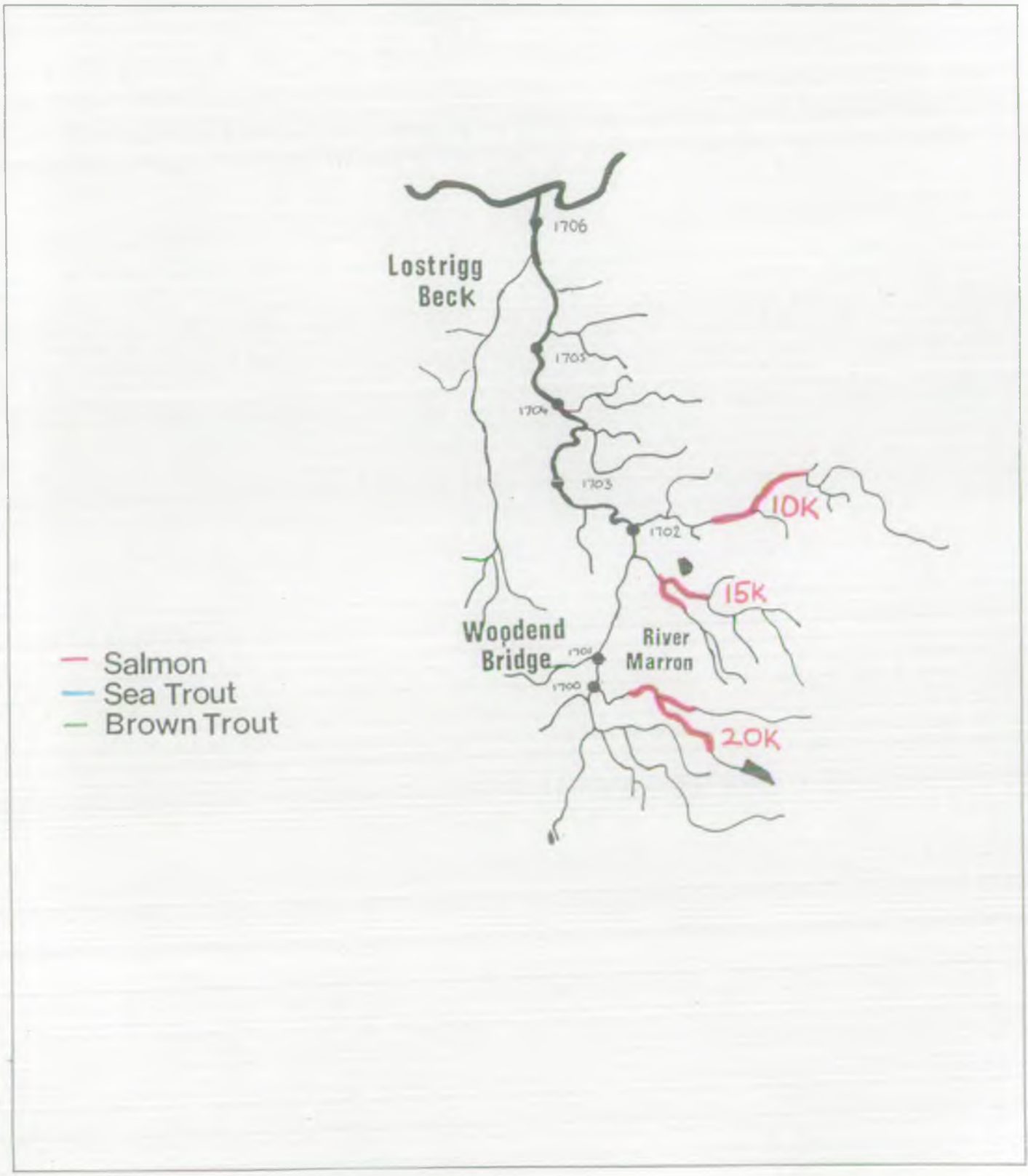
MARRON CATCHMENT

Total Salmonid Density Class 1992



MARRON CATCHMENT

Stocking Data 1992



MARRON CATCHMENT

Redd Counts 1990

13 Salmon
? Sea Trout
9 Brown Trout

MARRON CATCHMENT

Redd Counts 1991

13 Salmon
7 Sea Trout
9 Brown Trout

LIST OF APPENDICES

APPENDIX 1

Calculation of Estimated Population Densities

The relationship between densities obtained from single fishings (S.Q.) and multiple fishings (Q) was the subject of an N.R.A. Regional study - it is reported in:-

Farooqi, M. and Aprahamian M. W. 1993.

> The calibration of a semi-quantitive Approach to Fish Stock Assessment in the N.W. Region of the N.R.A.
>
> N.R.A. Internal Report: NRA/NW/FTR/93/4

A strong correlation between both methods of sampling was achieved (>80%) in all age classes for salmonids. The appropriate multipliers are shown below.

Age and Species

0+ Salmon	$Q = 2.16 \times SQ$
>0+ Salmon	$Q = 2.36 \times SQ$
0+ Trout	$Q = 1.94 \times SQ$
>0+ Trout	$Q = 1.86 \times SQ$

Where Q = the quantitive result from multiple fishings and SQ = the semi quantitive result from a single fishing.

These multipliers were used in this survey to produce an estimated population density ($N/100m^2$).

APPENDIX 2

Derivation of Total Salmonid Density Class

In order to create a class which related to Total Salmonid Density (ie. all salmon plus all trout) it was necessary to rationalise the abundance categories for the two different age classes, ie. fry and parr (Table 1).

The classes are based on the assumption that 1 in 5, or 20%, of fry survive to become parr (Table 1). Thus, by dividing the total fry density by 5, all densities could be related to the Abundance Class for parr.

An index for Total Salmonid Density was calculated using densities as follows;

Index = $^1/_5$ (Salmon 0+ + Trout 0+) + (Salmon >0+ + Trout 0+)

As this index was derived from both salmon and trout the parr abundance categories have been doubled (Table 3).

Table 3 Classification for Total Salmonid Density Index (N/100m^2)

Class	
A	>40.00
B	20.01 - 40.00
C	10.01 - 20.00
D	0.01 - 10.00
E	0.00

Thus a site scoring Class B would have a minimum of 20.01 parr per 100m^2 and a maximum of 40 parr per 100m^2 or the equivalent fry densities, or a mixture of both.

APPENDIX 3

ESTIMATION OF PRODUCTION BY REACH

Method

Each site was assigned a stream length which extended from a point midway to the next site upstream to a point midway to the next site downstream.

For the most upstream site on a reach the assigned length started 0.5km upstream of the site unless there was a waterfall or other obstruction.

The length was measured down to the confluence or another significant feature for the most downstream site on a reach.

The assigned length was then multiplied by the site width to obtain an area. This area was then multiplied by the densities of each age class to obtain numbers of fish. These numbers were then added together to give production figures for whole streams or reaches.

Assumptions

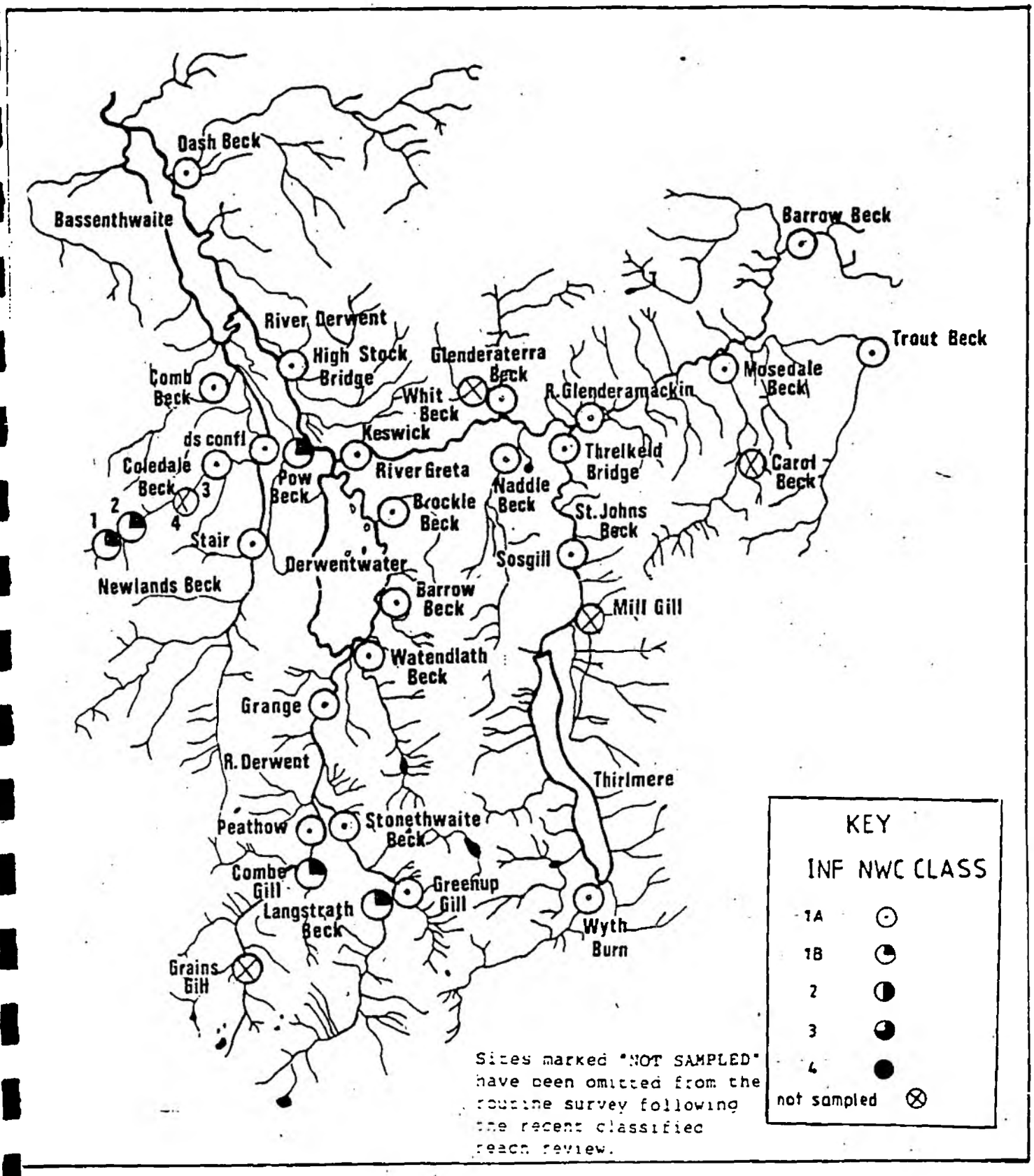
1. That there is no production above the 0.5km upstream of the top site of a reach (not true in most cases).

2. That the whole stream length has the same productivity as the survey sites (this is probably less true for wider streams where riffle habitats are often scarcer than on narrow streams).

3. That there is no production on unsurveyed streams. Such streams are small but could produce significant numbers in total.

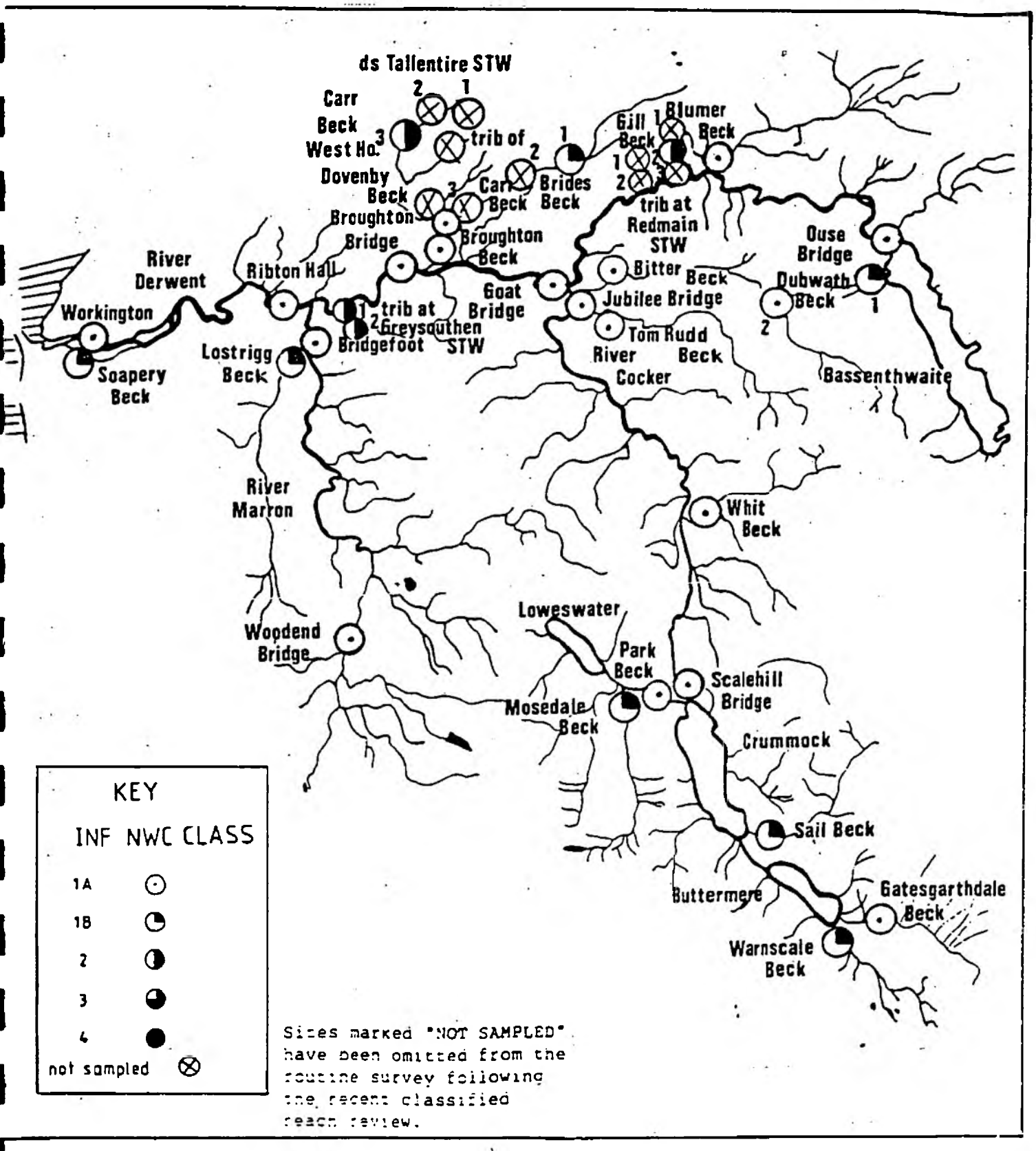
Bass Lake to Borrowdale with St.Johns, Wyth Burn & Mungrisdale

Sampling date June – August 1992



Workington to Bass Lake with Rivers Marron & Cocker

Sampling date June — August 1992



Sites marked "NOT SAMPLED" have been omitted from the routine survey following the recent classified reach review.

SITE DETAILS: UPPER DERWENT CATCHMENT 1992

SITE NUMBERS	STREAM NAME	SITE	DATE	NGR	WIDTH (m)	LENGTH (m)	AREA (m2)
1,520.00	RIVER DERWENT	AT THORNEYTHWAITE	23/07/92	NY 250135	8.10	52	421
1,521.00	RIVER DERWENT	AT LONGTHWAITE	23/07/92	NY 255142	10.30	50	515
1,523.00	RIVER DERWENT	AT LODORE	20/07/92	NY 261187	21.90	56	1,226
1,541.00	STONETHWAITE BECK	IN STONETHWAITE	24/07/92	NY 263138	11.60	54	626
1,542.00	STONETHWAITE BECK	AT ROSTHWAITE	24/07/92	NY 259148	12.70	51	648
1,544.00	WATENDLATH BECK	AT WATENDLATH	05/10/92	NY 275163	5.70	57	325
1,545.00	WATENDLATH BECK	AT NY 275163	20/07/92	NY 275172	7.40	52	385
1,547.00	RIVER GRETA	AT BRUNDHOLM	24/07/92	NY 300247	18.40	51	938
1,550.00	TROUT BECK	AT ROUKIN HOUSE	25/06/92	NY 382253	3.20	51	163
1,551.00	TROUT BECK	NR TROUTBECK HOTEL	05/10/92	NY 389270	3.90	50	195
1,552.00	TROUT BECK	AT NY 370269	25/06/92	NY 370269	4.00	52	208
1,553.00	TROUT BECK	U/S GLENDERAMACKIN	29/06/92	NY 358267	5.00	60	300
1,554.00	MOSEDALE BECK	AT WALLTHWAITE	29/06/92	NY 354264	4.30	54	232
1,555.00	WYTH BURN	AT STEEL END	24/07/92	NY 321128	4.60	52	239
1,556.00	NADDLE BECK	AT SHOULTHWAITE	29/06/92	NY 300206	1.70	54	92
1,557.00	NADDLE BECK	AT DALEBOTTOM	30/06/92	NY 298216	1.90	52	99
1,558.00	NADDLE BECK	AT NY 300239	17/07/92	NY 300239	4.40	68	299
1,562.00	GLENDERATERRA BECK	AT DERWENTFOLDS	20/08/92	NY 296256	5.80	52	302
1,563.00	GLENDERATERRA BECK	AT BRUNDHOLME	20/08/92	NY 299249	6.30	52	328
1,564.00	APPLETHWAITE GILL	IN APPLETHWAITE	06/08/92	NY 265257	1.30	53	69
1,565.00	APPLETHWAITE GILL	U/S A591	06/08/92	NY 259251	1.70	54	92
1,566.00	NEWLANDS BECK	AT LOW SNAB	28/07/92	NY 229181	4.00	51	204
1,567.00	NEWLANDS BECK	AT LITTLE TOWN	28/07/92	NY 231184	5.70	52	296
1,568.00	NEWLANDS BECK	AT GHYLL BANK	28/07/92	NY 236205	6.90	53	366
1,569.00	NEWLANDS BECK	AT STAIR	28/07/92	NY 237213	9.60	53	509
1,570.00	NEWLANDS BECK	LITTLE BRAITHWAITE	28/07/92	NY 238229	6.70	52	348
1,571.00	NEWLANDS BECK	D/S A66	29/07/92	NY 241237	5.30	51	270
1,572.00	NEWLANDS BECK	AT NY 236254	29/07/92	NY 236254	7.10	52	369
1,573.00	NEWLANDS BECK	AT COMB BECK CONFL	29/07/92	NY 233259	5.30	54	286
1,574.00	COLEDALE BECK	AT NY 220228	06/09/92	NY 220228	3.40	51	173
1,575.00	COLEDALE BECK	AT BRAITHWAITE	06/09/92	NY 229235	3.00	52	156
1,576.00	COMB BECK	AT VISITOR CENTRE	29/07/92	NY 210245	1.70	52	88
1,577.00	COMB BECK	AT THORNTHWAITE	05/08/92	NY 220251	3.40	50	170
1,578.00	COMB BECK	U/S NEWLANDS BECK	29/07/92	NY 233259	3.00	51	153
1,579.00	POW BECK	LITTLE BRAITHWAITE	29/07/92	NY 239229	1.70	52	88
1,580.00	POW BECK	NEAR HOW	29/07/92	NY 245243	2.70	52	140
1,581.00	POW BECK	AT NY 233259	29/07/92	NY 233259	3.40	51	173
1,582.00	DASH BECK	AT NY 247331	17/07/92	NY 247331	2.80	46	129
1,583.00	DASH BECK	NEAR HIGH CLOSE	07/08/92	NY 239327	3.50	50	175
1,584.00	DASH BECK	BASSENTHWAITE VILLAGE	07/08/92	NY 231324	5.10	52	265
1,585.00	DASH BECK	AT NY 222315	07/08/92	NY 222315	2.30	52	120
1,586.00	DASH BECK	U/S CHAPEL BECK	07/08/92	NY 221312	2.70	53	143
1,587.00	CHAPEL BECK	MELBECKS BRIDGE	17/07/92	NY 241318	2.40	56	134
1,588.00	CHAPEL BECK	IN CHAPEL	06/08/92	NY 228316	2.10	51	107
1,589.00	WYTHOP BECK	AT NY 196288	04/08/92	NY 196288	1.10	52	57
1,590.00	WYTHOP BECK	NEAR ESKIN	04/08/92	NY 185292	1.90	52	99
1,591.00	WYTHOP BECK	NEAR NETHERSCALE	04/08/92	NY 177301	2.40	51	122
1,592.00	WYTHOP BECK	NEAR THE CLOSE	04/08/92	NY 181306	3.30	53	175
1,593.00	DUBWATH BECK	AT DUBWATH	18/08/92	NY 197311	6.30	51	321
1,594.00	COAL BECK	U/S CARAVAN SITE	18/08/92	NY 204325	2.86	52	149
1,595.00	COAL BECK	U/S CONFLUENCE DERWENT	18/08/92	NY 201321	3.35	52	174
1,596.00	BLUMER BECK	AT NY 177349	18/08/92	NY 177349	3.21	54	173
1,597.00	BLUMER BECK	AT ISEL HALL	19/08/92	NY 156337	7.62	52	396

APPENDIX 5b SITE DETAILS: ST JOHN'S BECK AND THE RIVER GLENDERAMACKIN 1992

SITE NUMBER	STREAM NAME	SITE	DATE	NGR	WIDTH (m)	LENGTH (m)	AREA (m2)
1,547.10	RIVER GLENDERAMACKIN	MUNGRISEDALE	24/09/92	NY 365300	4.96	79	392
1,547.20	RIVER GLENDERAMACKIN	U/S TROUTBECK	29/09/92	NY 359269	5.80	53	307
1,547.30	RIVER GLENDERAMACKIN	GUARDHOUSE	12/10/92	NY 340260	8.90	50	445
1,547.40	RIVER GLENDERAMACKIN	TOWNFIELD BRIDGE	29/09/92	NY 319248	8.48	47	399
1,555.10	ST JOHN'S BECK	LEGBURTHWAITE	18/09/92	NY 319199	8.99	70	629
1,555.20	ST JOHN'S BECK	LOW BRIDGE END	18/09/92	NY 317206	7.45	70	522
1,555.30	ST JOHN'S BECK	SOSGILL BRIDGE	17/09/92	NY 316211	7.17	53	380
1,555.40	ST JOHN'S BECK	BRIDGE HOUSE	21/09/92	NY 311227	7.89	60	473
1,555.50	ST JOHN'S BECK	WANTHWAITE BRIDGE	21/09/92	NY 313231	5.87	64	376
1,555.60	ST JOHN'S BECK	MIREHOUSE	22/09/92	NY 314239	6.43	58	373

APPENDIX 5c SITE DETAILS: MARRON CATCHMENT 1992

SITE NUMBERS	STREAM NAME	SITE	DATE	NGR	WIDTH (m)	LENGTH (m)	AREA (m2)
1,700.00	RIVER MARRON	ASBY	21/07/92	NY 065207	2.70	50	135
1,701.00	RIVER MARRON	NEAR WRIGHT GREEN	22/07/92	NY 067217	4.20	54	227
1,702.00	RIVER MARRON	ULLOCK	22/07/92	NY 074239	5.20	54	281
1,703.00	RIVER MARRON	BRANTHWAITE	22/07/92	NY 059249	8.50	50	425
1,704.00	RIVER MARRON	CALVA HALL	22/07/92	NY 058264	11.20	50	560
1,705.00	RIVER MARRON	OLDFIELD	22/07/92	NY 057272	6.70	52	348
1,706.00	RIVER MARRON	D/S A66	23/07/92	NY 057298	9.50	50	475

ESTIMATED SALMONID POPULATION DENSITIES N/100m2 (1992 CALIB)
FOR STREAM SITES ON UPPER DERWENT CATCHMENT 1992

Site No	Stream	Site	Salmon		Trout	
			0+	>0+	0+	>0+
1,520.00	RIVER DERWENT	AT THORNEYTHWAITE	4.10	8.96	0.47	0.45
1,521.00	RIVER DERWENT	AT LONGTHWAITE	1.25	1.37	0.00	0.00
1,523.00	RIVER DERWENT	AT LODORE	0.00	0.00	0.00	0.00
1,541.00	STONETHWAITE BECK	IN STONETHWAITE	0.69	1.13	0.62	1.48
1,542.00	STONETHWAITE BECK	AT ROSTHWAITE	0.00	1.46	0.00	0.58
1,544.00	WATENDLATH BECK	AT WATENDLATH	0.00	0.00	0.60	30.26
1,545.00	WATENDLATH BECK	AT NY 275163	0.00	0.00	1.01	1.93
1,547.00	RIVER GRETA	AT BRUNDHOLM	0.93	2.00	0.00	0.20
1,550.00	TROUT BECK	AT ROUKIN HOUSE	0.00	1.44	0.00	7.96
1,551.00	TROUT BECK	NR TROUTBECK HOTEL	1.10	0.00	0.00	3.80
1,552.00	TROUT BECK	AT NY 370269	1.04	22.69	0.93	3.56
1,553.00	TROUT BECK	U/S GLENDERAMACKIN	12.96	2.36	1.94	4.32
1,554.00	MOSEDALE BECK	AT WALLTHWAITE	12.10	6.11	0.00	0.00
1,555.00	WYTH BURN	AT STEEL END	0.00	0.00	6.50	10.09
1,556.00	NADDLE BECK	AT SHOULTHWAITE	16.44	61.53	14.78	66.55
1,557.00	NADDLE BECK	AT DALEBOTTOM	58.90	14.29	41.18	13.12
1,558.00	NADDLE BECK	AT NY 300239	72.96	12.62	2.60	0.61
1,562.00	GLENDERATERRA BECK	AT DERWENTFOLDS	2.85	0.00	7.07	4.92
1,563.00	GLENDERATERRA BECK	AT BRUNDHOLME	5.27	2.88	7.11	0.56
1,564.00	APPLETHWAITE GILL	IN APPLETHWAITE	0.00	0.00	2.82	24.19
1,565.00	APPLETHWAITE GILL	U/S A591	7.04	2.57	101.30	4.03
1,566.00	NEWLANDS BECK	AT LOW SNAB	13.76	15.02	5.71	5.45
1,567.00	NEWLANDS BECK	AT LITTLE TOWN	18.25	2.38	5.90	3.14
1,568.00	NEWLANDS BECK	AT GHYLL BANK	4.73	1.30	1.59	2.54
1,569.00	NEWLANDS BECK	AT STAIR	4.23	2.78	1.90	1.82
1,570.00	NEWLANDS BECK	LITTLE BRAITHWAITE	1.86	0.00	0.00	0.54
1,571.00	NEWLANDS BECK	D/S A66	11.21	3.49	12.23	0.69
1,572.00	NEWLANDS BECK	AT NY 236254	0.00	0.00	0.00	0.00
1,573.00	NEWLANDS BECK	AT COMB BECK CONFL	0.00	0.00	0.68	0.00
1,574.00	COLEDALE BECK	AT NY 220228	0.00	0.00	0.00	0.00
1,575.00	COLEDALE BECK	AT BRAITHWAITE	0.00	0.00	0.00	4.75
1,576.00	COMB BECK	AT VISITOR CENTRE	0.00	0.00	26.49	54.82
1,577.00	COMB BECK	AT THORNTHWAITE	0.00	0.00	2.29	12.00
1,578.00	COMB BECK	U/S NEWLANDS BECK	0.00	0.00	2.54	9.70
1,579.00	POW BECK	LITTLE BRAITHWAITE	0.00	0.00	37.51	35.84
1,580.00	POW BECK	NEAR HOW	0.00	5.05	4.16	22.52
1,581.00	POW BECK	AT NY 233259	3.74	1.37	0.00	1.08
1,582.00	DASH BECK	AT NY 247331	18.42	36.56	19.57	47.46
1,583.00	DASH BECK	NEAR HIGH CLOSE	11.10	6.75	14.43	36.05
1,584.00	DASH BECK	BASSENTHWAITE VILLAGE	30.97	9.79	22.72	12.60
1,585.00	DASH BECK	AT NY 222315	5.40	0.00	27.51	4.64
1,586.00	DASH BECK	U/S CHAPEL BECK	3.02	23.09	2.72	25.96
1,587.00	CHAPEL BECK	MELBECKS BRIDGE	0.00	0.00	0.00	15.23
1,588.00	CHAPEL BECK	IN CHAPEL	64.60	13.23	9.07	3.47
1,589.00	WYTHOP BECK	AT NY 196288	3.78	16.56	71.53	19.54
1,590.00	WYTHOP BECK	NEAR ESKIN	0.00	26.20	9.81	22.49
1,591.00	WYTHOP BECK	NEAR NETHERSCALE	10.63	3.87	74.80	6.09
1,592.00	WYTHOP BECK	NEAR THE CLOSE	30.86	0.00	54.37	1.06
1,593.00	DUBWATH BECK	AT DUBWATH	0.00	1.46	0.60	0.00
1,594.00	COAL BECK	U/S CARAVAN SITE	0.00	3.16	14.33	24.90
1,595.00	COAL BECK	U/S CONFLUENCE DERWENT	1.23	2.71	93.75	66.10
1,596.00	BLUMER BECK	AT NY 177349	2.51	10.90	32.54	30.02
1,597.00	BLUMER BECK	AT ISEL HALL	1.64	0.00	12.25	1.41

APPENDIX 6b

ESTIMATED SALMONID POPULATION DENSITIES (N/100m2)
FOR SITES ON ST JOHN'S BECK AND THE RIVER GLENDERAMACKIN 1992

Site No	Stream	Site	Salmon		Trout	
			0+	>0+	0+	>0+
1,547.10	RIVER GLENDERAMACKIN	MUNGRISEDALE	84.00	4.10	1.30	0.80
1,547.20	RIVER GLENDERAMACKIN	U/S TROUTBECK	52.70	10.10	3.30	1.60
1,547.30	RIVER GLENDERAMACKIN	GUARDHOUSE	18.70	7.00	1.30	1.30
1,547.40	RIVER GLENDERAMACKIN	TOWNFIELD BRIDGE	33.90	1.80	4.80	1.50
1,555.10	ST JOHN'S BECK	LEGBURTHWAITE	8.40	8.70	7.20	5.90
1,555.20	ST JOHN'S BECK	LOW BRIDGE END	22.60	7.30	15.70	1.30
1,555.30	ST JOHN'S BECK	SOSGILL BRIDGE	59.70	3.20	6.30	2.60
1,555.40	ST JOHN'S BECK	BRIDGE HOUSE	52.00	21.30	10.10	2.50
1,555.50	ST JOHN'S BECK	WANTHWAITE BRIDGE	26.10	12.00	4.80	6.70
1,555.60	ST JOHN'S BECK	MIREHOUSE	66.50	3.50	3.80	0.50

APPENDIX 6c

ESTIMATED SALMONID POPULATION DENSITIES N/100m2 (1992 CALIB)
FOR STREAM SITES ON THE RIVER MARRON 1991

Site No	Stream	Site	Salmon		Trout	
			0+	>0+	0+	>0+
1,700.00	RIVER MARRON	ASBY	6.48	7.08	31.07	18.55
1,701.00	RIVER MARRON	NEAR WRIGHT GREEN	107.99	21.23	43.69	8.35
1,702.00	RIVER MARRON	ULLOCK	14.58	12.97	2.43	18.09
1,703.00	RIVER MARRON	BRANTHWAITE	4.32	9.91	3.50	12.62
1,704.00	RIVER MARRON	CALVA HALL	5.77	4.32	3.24	6.49
1,705.00	RIVER MARRON	OLDFIELD	3.02	1.89	1.94	11.50
1,706.00	RIVER MARRON	D/S A66	5.18	0.47	2.72	1.48

APPENDIX 6d

ESTIMATED SALMONID POPULATION DENSITIES N/100m2 (1992 CALIB)
FOR STREAM SITES ON THE RIVER MARRON 1992

Site No	Stream	Site	Salmon		Trout	
			0+	>0+	0+	>0+
1,700.00	RIVER MARRON	ASBY	12.81	8.73	178.35	24.73
1,701.00	RIVER MARRON	NEAR WRIGHT GREEN	58.03	9.34	41.07	2.45
1,702.00	RIVER MARRON	ULLOCK	28.44	13.42	5.53	5.29
1,703.00	RIVER MARRON	BRANTHWAITE	0.52	2.22	0.91	3.06
1,704.00	RIVER MARRON	CALVA HALL	13.50	2.10	3.13	1.00
1,705.00	RIVER MARRON	OLDFIELD	3.71	1.34	2.80	3.19
1,706.00	RIVER MARRON	D/S A66	9.55	0.00	0.00	1.95

MINIMUM DENSITIES (n/100m2) OF MAJOR COARSE FISH SPECIES
FOR SITES ON THE UPPER DERWENT 1992

Site No	Stream	Site	Eels	Pike	Dace	Perch
1,520.00	RIVER DERWENT	AT THORNEYTHWAITE	1.90	0.00	0.00	0.00
1,521.00	RIVER DERWENT	AT LONGTHWAITE	2.33	0.00	0.00	0.00
1,523.00	RIVER DERWENT	AT LODORE	4.08	0.00	0.00	0.00
1,541.00	STONETHWAITE BECK	IN STONETHWAITE	0.80	0.00	0.00	0.00
1,542.00	STONETHWAITE BECK	AT ROSTHWAITE	1.39	0.00	0.00	0.00
1,544.00	WATENDLATH BECK	AT WATENDLATH	0.00	0.00	0.00	0.00
1,545.00	WATENDLATH BECK	AT NY 275163	0.00	0.00	0.00	0.00
1,547.00	RIVER GRETA	AT BRUNDHOLM	0.43	0.00	0.00	0.00
1,550.00	TROUT BECK	AT ROUKIN HOUSE	3.68	0.00	0.00	0.00
1,551.00	TROUT BECK	NR TROUTBECK HOTEL	0.51	0.00	0.00	0.00
1,552.00	TROUT BECK	AT NY 370269	0.00	0.00	0.00	0.00
1,553.00	TROUT BECK	U/S GLENDERAMACKIN	0.00	0.00	0.00	0.00
1,554.00	MOSEDALE BECK	AT WALLTHWAITE	0.86	0.00	0.00	0.00
1,555.00	WYTH BURN	AT STEEL END	0.00	0.00	0.00	0.00
1,556.00	NADDLE BECK	AT SHOULTHWAITE	5.43	0.00	0.00	0.00
1,557.00	NADDLE BECK	AT DALEBOTTOM	1.01	0.00	0.00	0.00
1,558.00	NADDLE BECK	AT NY 300239	2.01	0.00	0.00	0.00
1,562.00	GLENDERATERRA BECK	AT DERWENTFOLDS	0.66	0.00	0.00	0.00
1,563.00	GLENDERATERRA BECK	AT BRUNDHOLME	0.00	0.00	0.00	0.00
1,564.00	APPLETHWAITE GILL	IN APPLETHWAITE	0.00	0.00	0.00	0.00
1,565.00	APPLETHWAITE GILL	U/S A591	1.09	0.00	0.00	0.00
1,566.00	NEWLANDS BECK	AT LOW SNAB	1.96	0.00	0.00	0.00
1,567.00	NEWLANDS BECK	AT LITTLE TOWN	0.00	0.00	0.00	0.00
1,568.00	NEWLANDS BECK	AT GHYLL BANK	0.00	0.00	0.00	0.00
1,569.00	NEWLANDS BECK	AT STAIR	1.57	0.00	0.00	0.00
1,570.00	NEWLANDS BECK	LITTLE BRAITHWAITE	3.45	0.00	0.00	0.00
1,571.00	NEWLANDS BECK	D/S A66	2.22	0.00	0.00	0.00
1,572.00	NEWLANDS BECK	AT NY 236254	0.54	0.00	0.00	0.00
1,573.00	NEWLANDS BECK	AT COMB BECK CONFL	1.40	0.00	0.00	0.00
1,574.00	COLEDALE BECK	AT NY 220228	0.00	0.00	0.00	0.00
1,575.00	COLEDALE BECK	AT BRAITHWAITE	0.00	0.00	0.00	0.00
1,576.00	COMB BECK	AT VISITOR CENTRE	0.00	0.00	0.00	0.00
1,577.00	COMB BECK	AT THORNTHWAITE	0.00	0.00	0.00	0.00
1,578.00	COMB BECK	U/S NEWLANDS BECK	8.50	0.00	0.00	0.00
1,579.00	POW BECK	LITTLE BRAITHWAITE	9.09	0.00	0.00	0.00
1,580.00	POW BECK	NEAR HOW	2.14	0.00	0.00	0.00
1,581.00	POW BECK	AT NY 233259	8.67	0.00	0.00	0.00
1,582.00	DASH BECK	AT NY 247331	2.33	0.00	0.00	0.00
1,583.00	DASH BECK	NEAR HIGH CLOSE	1.14	0.00	0.00	0.00
1,584.00	DASH BECK	BASSENTHWAITE VILLAG	0.38	0.00	0.00	0.00
1,585.00	DASH BECK	AT NY 222315	2.50	0.00	0.00	0.00
1,586.00	DASH BECK	U/S CHAPEL BECK	2.10	0.00	0.00	0.00
1,587.00	CHAPEL BECK	MELBECKS BRIDGE	2.24	0.00	0.00	0.00
1,588.00	CHAPEL BECK	IN CHAPEL	0.93	0.00	0.00	0.00
1,589.00	WYTHOP BECK	AT NY 196288	3.51	0.00	0.00	0.00
1,590.00	WYTHOP BECK	NEAR ESKIN	1.01	0.00	0.00	0.00
1,591.00	WYTHOP BECK	NEAR NETHERSCALE	3.28	0.00	0.00	0.00
1,592.00	WYTHOP BECK	NEAR THE CLOSE	4.00	0.00	0.00	0.00
1,593.00	DUBWATH BECK	AT DUBWATH	0.62	0.00	0.00	0.00
1,594.00	COAL BECK	U/S CARAVAN SITE	9.40	0.00	0.00	0.00
1,595.00	COAL BECK	U/S CONFLUENCE DERWE	3.45	0.00	0.00	0.00
1,596.00	BLUMER BECK	AT NY 177349	1.16	0.00	0.00	0.00
1,597.00	BLUMER BECK	AT ISEL HALL	1.77	0.00	0.00	0.00

APPENDIX 7b

ESTIMATED MAJOR COARSE FISH POPULATION DENSITIES (N/100m2)
FOR SITES ON ST JOHN'S BECK AND THE RIVER GLENDERAMACKIN 1992

Site No	Stream	Site	Eels	Pike	Dace	Perch
1,547.10	RIVER GLENDERAMACKIN	MUNGRISEDALE	0.50	0.00	0.00	0.00
1,547.20	RIVER GLENDERAMACKIN	U/S TROUTBECK	0.30	0.00	0.00	0.00
1,547.30	RIVER GLENDERAMACKIN	GUARDHOUSE	1.10	0.00	0.00	0.00
1,547.40	RIVER GLENDERAMACKIN	TOWNFIELD BRIDGE	0.00	0.00	0.00	0.00
1,555.10	ST JOHN'S BECK	LEGBURTHWAITE	6.00	0.00	0.00	0.00
1,555.20	ST JOHN'S BECK	LOW BRIDGE END	7.70	0.00	0.00	0.00
1,555.30	ST JOHN'S BECK	SOSGILL BRIDGE	5.50	0.00	0.00	0.00
1,555.40	ST JOHN'S BECK	BRIDGE HOUSE	5.30	0.00	0.00	0.00
1,555.50	ST JOHN'S BECK	WANTHWAITE BRIDGE	2.40	0.00	0.00	0.00
1,555.60	ST JOHN'S BECK	MIREHOUSE	3.80	0.00	0.00	0.00

APPENDIX 7c

MINIMUM DENSITIES (n/100m2) OF MAJOR COARSE FISH SPECIES
FOR STREAM SITES IN THE MARRON CATCHMENT 1991.

Site No	Stream	Site	Eels	Pike	Dace	Perch
1,700.00	RIVER MARRON	ASBY	1.00	0.00	0.00	0.00
1,701.00	RIVER MARRON	NEAR WRIGHT GREEN	7.00	0.00	0.00	0.00
1,702.00	RIVER MARRON	ULLOCK	5.75	0.00	0.00	0.00
1,703.00	RIVER MARRON	BRANTHWAITE	15.20	0.00	0.00	0.00
1,704.00	RIVER MARRON	CALVA HALL	3.83	0.00	0.00	0.00
1,705.00	RIVER MARRON	OLDFIELD	9.00	0.00	0.00	0.00
1,706.00	RIVER MARRON	D/S A66	8.80	0.00	0.00	0.00

APPENDIX 7d

MINIMUM DENSITIES (n/100m2) OF MAJOR COARSE FISH SPECIES
FOR STREAM SITES IN THE MARRON CATCHMENT 1992.

Site No	Stream	Site	Eels	Pike	Dace	Perch
1,700.00	RIVER MARRON	ASBY	3.70	0.00	0.00	0.00
1,701.00	RIVER MARRON	NEAR WRIGHT GREEN	1.32	0.00	0.00	0.00
1,702.00	RIVER MARRON	ULLOCK	3.91	0.00	0.00	0.00
1,703.00	RIVER MARRON	BRANTHWAITE	1.88	0.00	0.00	0.00
1,704.00	RIVER MARRON	CALVA HALL	5.18	0.00	0.00	0.00
1,705.00	RIVER MARRON	OLDFIELD	3.16	0.00	0.00	0.00
1,706.00	RIVER MARRON	D/S A66	4.21	0.00	0.00	0.00

MINOR COARSE FISH ABUNDANCES AT SITES IN THE UPPER DERWENT CATCHMENT 1992

Site No	Stream	Site	Stoneloach	Bullhead	Minnow	Stickleback	Lampr
1,520.00	RIVER DERWENT	AT THORNEYTHWAITE	0	0	101-1000	0	
1,521.00	RIVER DERWENT	AT LONGTHWAITE	0	0	1-10	0	
1,523.00	RIVER DERWENT	AT LODORE	0	0	101-1000	0	
1,541.00	STONETHWAITE BECK	IN STONETHWAITE	0	0	11-100	0	
1,542.00	STONETHWAITE BECK	AT ROSTHWAITE	0	0	101-1000	0	
1,544.00	WATENDLATH BECK	AT WATENDLATH	0	0	11-100	0	
1,545.00	WATENDLATH BECK	AT NY 275163	0	0	11-100	0	
1,547.00	RIVER GRETA	AT BRUNDHOLM	11-100	0	101-1000	0	
1,550.00	TROUT BECK	AT ROUKIN HOUSE	11-100	0	101-1000	0	
1,551.00	TROUT BECK	NR TROUTBECK HOTEL	101-1000	0	11-100	0	
1,552.00	TROUT BECK	AT NY 370269	11-100	0	0	0	
1,553.00	TROUT BECK	U/S GLENDERAMACKIN	11-100	0	11-100	0	1
1,554.00	MOSEDALE BECK	AT WALLTHWAITE	11-100	0	0	0	
1,555.00	WYTH BURN	AT STEEL END	0	0	11-100	0	
1,556.00	NADDLE BECK	AT SHOULTHWAITE	0	0	0	0	
1,557.00	NADDLE BECK	AT DALEBOTTOM	1-10	0	101-1000	0	
1,558.00	NADDLE BECK	AT NY 300239	1-10	0	1-10	0	
1,562.00	GLENDERATERRA BECK	AT DERWENTFOLDS	0	0	0	0	
1,563.00	GLENDERATERRA BECK	AT BRUNDHOLME	0	0	0	0	
1,564.00	APPLETHWAITE GILL	IN APPLETHWAITE	0	0	0	0	
1,565.00	APPLETHWAITE GILL	U/S A591	0	0	11-100	0	
1,566.00	NEWLANDS BECK	AT LOW SNAB	0	0	1-10	0	
1,567.00	NEWLANDS BECK	AT LITTLE TOWN	0	0	0	0	
1,568.00	NEWLANDS BECK	AT GHYLL BANK	0	0	0	0	
1,569.00	NEWLANDS BECK	AT STAIR	0	0	1-10	0	
1,570.00	NEWLANDS BECK	LITTLE BRAITHWAITE	0	0	11-100	0	
1,571.00	NEWLANDS BECK	D/S A66	0	0	11-100	0	
1,572.00	NEWLANDS BECK	AT NY 236254	0	0	0	0	
1,573.00	NEWLANDS BECK	AT COMB BECK CONFL	0	0	0	0	
1,574.00	COLEDALE BECK	AT NY 220228	0	0	0	0	
1,575.00	COLEDALE BECK	AT BRAITHWAITE	0	0	0	0	
1,576.00	COMB BECK	AT VISITOR CENTRE	0	0	0	0	
1,577.00	COMB BECK	AT THORNTHWAITE	0	0	0	0	
1,578.00	COMB BECK	U/S NEWLANDS BECK	0	0	1000+	0	2
1,579.00	POW BECK	LITTLE BRAITHWAITE	0	0	0	0	
1,580.00	POW BECK	NEAR HOW	1-10	0	101-1000	0	
1,581.00	POW BECK	AT NY 233259	11-100	0	11-100	0	2
1,582.00	DASH BECK	AT NY 247331	0	0	0	0	
1,583.00	DASH BECK	NEAR HIGH CLOSE	0	0	0	0	
1,584.00	DASH BECK	BASSENTHWAITE VILLAGE	1-10	0	1000+	0	
1,585.00	DASH BECK	AT NY 222315	1-10	0	11-100	0	4
1,586.00	DASH BECK	U/S CHAPEL BECK	1-10	0	11-100	0	2
1,587.00	CHAPEL BECK	MELBECKS BRIDGE	0	0	0	0	
1,588.00	CHAPEL BECK	IN CHAPEL	0	0	1-10	0	
1,589.00	WYTHOP BECK	AT NY 196288	0	0	0	0	
1,590.00	WYTHOP BECK	NEAR ESKIN	0	0	0	0	
1,591.00	WYTHOP BECK	NEAR NETHERSCALE	0	0	0	0	
1,592.00	WYTHOP BECK	NEAR THE CLOSE	0	0	11-100	0	
1,593.00	DUBWATH BECK	AT DUBWATH	11-100	0	101-1000	1-10	
1,594.00	COAL BECK	U/S CARAVAN SITE	101-1000	0	101-1000	0	
1,595.00	COAL BECK	U/S CONFLUENCE DERWENT	0	0	0	0	
1,596.00	BLUMER BECK	AT NY 177349	11-100	0	0	0	
1,597.00	BLUMER BECK	AT ISEL HALL	0	0	101-1000	101-1000	1

APPENDIX 8b

ESTIMATED MINOR COARSE FISH POPULATION DENSITIES (N/100m2)
FOR SITES ON ST JOHN'S BECK AND THE RIVER GLENDERAMACKIN 1993

Site No	Stream	Site	Loach	Minnow	Stickleback
1,547.10	RIVER GLENDERAMACKIN	MUNGRISEDALE	0.20	0.00	0.00
1,547.20	RIVER GLENDERAMACKIN	U/S TROUTBECK	22.80	0.00	0.00
1,547.30	RIVER GLENDERAMACKIN	GUARDHOUSE	6.50	2.50	0.00
1,547.40	RIVER GLENDERAMACKIN	TOWNFIELD BRIDGE	0.00	0.30	0.00
1,555.10	ST JOHN'S BECK	LEGBURTHWAITE	0.00	3.70	0.20
1,555.20	ST JOHN'S BECK	LOW BRIDGE END	0.20	1.90	0.20
1,555.30	ST JOHN'S BECK	SOSGILL BRIDGE	0.00	4.20	0.30
1,555.40	ST JOHN'S BECK	BRIDGE HOUSE	2.40	15.50	0.00
1,555.50	ST JOHN'S BECK	WANTHWAITE BRIDGE	0.00	12.10	0.40
1,555.60	ST JOHN'S BECK	MIREHOUSE	3.80	51.80	1.20

APPENDIX 8c

MINOR COARSE FISH ABUNDANCES
AT SITES IN THE MARRON CATCHMENT 1991

Site No	Stream	Site	Stoneloach	Bullhead	Minnow	Stickleback	Lamprey
1,700.00	RIVER MARRON	ASBY	-	-	-	-	
1,701.00	RIVER MARRON	NEAR WRIGHT GREEN	0	0	0	0	
1,702.00	RIVER MARRON	ULLOCK	0	0	0	0	
1,703.00	RIVER MARRON	BRANTHWAITE	0	0	101-1000	0	
1,704.00	RIVER MARRON	CALVA HALL	11-100	0	0	1-10	
1,705.00	RIVER MARRON	OLDFIELD	0	0	0	0	
1,706.00	RIVER MARRON	D/S A66	101-1000	0	0	0	

APPENDIX 8d

MINOR COARSE FISH ABUNDANCES
AT SITES IN THE MARRON CATCHMENT 1992

Site No	Stream	Site	Stoneloach	Bullhead	Minnow	Stickleback	Lamprey
1,700.00	RIVER MARRON	ASBY	0	0	0	0	3
1,701.00	RIVER MARRON	NEAR WRIGHT GREEN	0	0	1-10	0	
1,702.00	RIVER MARRON	ULLOCK	0	0	11-100	0	
1,703.00	RIVER MARRON	BRANTHWAITE	0	0	0	0	
1,704.00	RIVER MARRON	CALVA HALL	11-100	0	11-100	1-10	1
1,705.00	RIVER MARRON	OLDFIELD	0	0	0	0	
1,706.00	RIVER MARRON	D/S A66	11-100	0	101-1000	0	

APPENDIX 9

RIVER GLENDERATERRA SURVEY RESULTS

Estimated Densities Of Salmonid Fish, (N/100m^2) At Sites On The River Glenderaterra Surveyed 4/3/93
(Calculations according to Zippin (1958))

	1561	1562
Trout 0+	20.11	23.31
Trout >0+	7.61	7.88
Salmon 0+	2.74 min est	0.00
Salmon >0+	6.39 min est	1.63 min est

Table 3

Estimated densities of salmonid fish, (N/100m^2) at sites on the River Glenderaterra surveyed 20/8/92

	1562	1563
Trout 0+	7.07	7.11
Trout >0+	4.92	0.56
Salmon 0+	2.85	5.27
Salmon >0+	0.00	2.88

Site 1561 300m u/s landslip
1562 200m d/s landslip
1563 1000m d/s landslip