

**FISH POPULATIONS
IN THE EVAN WATER:
AUGUST, 1994**

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SUMMARY

Proposals to upgrade the A74 to motorway status will mean significant diversions of the Evan Water, a major tributary of the River Annan. These diversions have been designed with ecological principles in mind, especially those factors which are known to be important for salmonid fish. The present study reports a baseline survey carried out in late August 1994 to establish the status of fish populations at 14 key points on the network of the Evan Water, thus allowing comparisons to be made in the future with the situation before development, in August, 1994.

Most of the sites studied were found to have reasonable populations of both Salmon and Trout and in two places the numbers were high (more than 120 juvenile Salmon and Trout per 100 m²). Quantitative estimates of Trout at one site, using two different methods, gave very similar results (means of 59 and 58 fish per 100 m²). Two sites were found to be fishless and four others had no Salmon - the reasons for this are believed to be due to obstacles further downstream, all of them (with one exception) having been created by human activity in the past, related to the construction of either the roadway (A74) or the railway. It is expected that such sites can be returned to normal by removing these obstacles during the motorway construction process, thus enhancing the spawning and nursery habitat at present available to Atlantic Salmon and Sea Trout.

INTRODUCTION

This study is part of continuing ecological assessments of the Evan Water, a salmonid river which is going to be affected by the proposed M74 motorway developments (Scottish Office 1994). Previous studies have been concerned with the upper parts of the River Clyde at Elvanfoot (Maitland 1989), the upper stretches of the Evan Water (Maitland 1990) and the ecological characteristics of the Evan Water as a whole (Maitland 1993). Most recently, two studies have focused particularly on the invertebrate communities (Maitland 1994) and the fish populations (this report).

The M74 roadworks development will have an impact on several stretches of the Evan Water between Harthope and Beattock. Altogether, 12 sections of the river will be directly affected by new diversions or culverts amounting to a total of some 2,707 m of river channel between Harthope and Coatgate. In order to assess the impact of these roadworks and provide suggestions for amelioration, the river was surveyed in 1993 along this whole length (Maitland 1993). In addition, the nature of the tributaries where they join the main river and those areas adjacent to the river where pools may be created after gravel has been extracted were also examined.

The Evan Water has been described in a previous report (Maitland 1993). It rises in the hills east of Beattock Summit and flows west to the Clyde-Evan gap through which the present A74 road runs (Figure 1). The watershed between the two catchments at this point lies in a moss just east of the road. The Evan Water then starts its generally south-east course towards the village of Beattock collecting various tributaries (notably the Harthope Burn, Cloffin Burn and Garpol Water, all entering from the west) en route. The northern and western parts of the catchment largely drain over poor bedrock, and forestry is now an important land use here.

The Evan Water is small in its upper reaches, being only about 2-3 m across where it first crosses over the railway line (via an aqueduct) and under the A74 at March. Below this the river

meanders through young sitka plantations and alongside old quarry spoil until it flows east under the A74 and the railway line. The bed of the river here is mainly unstable stone and quarry spoil. Just before it passes under the road, bedrock appears and the next stretch of the river is gorge-like with much bedrock and occasional shingle, waterfalls alternating with pools. Downstream, approaching Tinnybank, the river broadens out to a width of some 5 m with alternating pools and riffle and a varying substrate of bedrock, boulders and gravel. It continues very much in this character, enlarging steadily as it gathers tributaries, passing under several further rail and road bridges to Harthope after which it flows between the A74 (to the east) and railway line (to the west) until it reaches Beattock. Along these middle and lower reaches the river is varied in character with many substantial pools alternating with long stretches of riffle. The river ranges in width from 10 to 20 m in this area and the substrate varies from coarse gravels, stones and boulders to waterworn bedrock. Some of these reaches form an ideal nursery habitat (Milner et al. 1985) for young Atlantic Salmon *Salmo salar* and Trout *Salmo trutta*.

The Evan Water is a significant part of the River Annan network and is important in terms of spawning and nursery grounds for both Salmon and Trout. For this and other reasons it was felt important that baseline data on the invertebrate and fish communities should be gathered before any work started on the motorway. Apart from intrinsic interest and its relevance to the current fishery, the data gathered would: (a) allow an objective assessment if it was ever claimed that the motorway works had damaged fish stocks, and (b) permit a future analysis of the success or otherwise of the new diversions and culverts which have been planned with ecological principles and fishery enhancement in mind.

OBJECTIVE

The main objective of the study was to survey the fish populations of selected sites of importance (Maitland 1985) on the Evan Water so that data may be available to compare with

the situation during or after the construction of the M74. Parallel work was carried out on the invertebrate communities at the same time (Maitland 1994).

METHODS

Site selection

Ten stretches within the river network (Figure 1) were selected for study of the fish populations (Table 1). Five of these were on the main river, starting near the source (Clydes Burn) then two sites (March and Shiel) further downstream sampled during a previous study (Maitland 1990), followed by two sites in the lower part of the river - Longbedholm and Valenciennes (just above Beattock). Five of the largest tributary burns entering below Harthope - Redshaw, Mellingshaw, Blacklaw, Cloffin and Garpol were sampled; on the last four of these two distinct sites (upper and lower) were examined.

Fish sampling

Sampling was carried out from 22-24 and 29-31 August, 1994.

All sampling of fish was carried out by electro-fishing. The strategies employed for the electro-fishing surveys differed between the main river sites and those on tributaries, but site-specific variations occurred throughout the programme. All fish sampling was carried out using a Marine Electrics Model 330C backpack electro-fisher which delivers a pulsed direct current with a peak of 400 volts. The variable pulse frequency control (30 to 150 pps) was kept about mid-range throughout the survey. Two people worked each site, one operating the electro-fisher with a netted electrode, the other collecting stunned fish by hand net. For each site, or sub-site, the period of electro-fishing was noted and the length/area of river or stream bed fished was measured. Fish collected were subsequently identified and counted. The fork length of all Salmon and Trout was measured. Between sub-surveys in any one stretch of river, fish caught were held

in suitable containers until their area had been fished; they were then returned to the river.

At each of the wider main river sites (Shiel, Longbedholm and Valenciennes) six separate areas were sampled for 10 (or 15) minute periods. These stretches included both riffles and pools. At March (Site 2) a more intensive survey was conducted, again comprising six separate lengths of river. In this narrower part of the river, stop-nets were placed at the top and bottom ends of each section and three, separately recorded, electro-fishing sweeps were made covering the full bed area within each section. This intensive method enabled a fish population assessment to be made for that site, and the results are also of interest for comparative purposes with the results from the remaining sites where single sweeps only were made.

At Clydes Burn (Site 1) and the sites on tributaries (Sites 6-10), single sections were sampled for predetermined periods. On four of these tributaries, samples were taken at two distinct locations to determine any differences in fish species composition. In the Mellingshaw Burn (Site 7) and the Blacklaw Burn (Site 9) electro-fishing was carried out above and below culverts near the tributary junctions with the Evan Water. At the Cloffin Burn (Site 8) and the Garpol Water (Site 10) samples were taken both at the lower ends of these tributaries and further upstream nearer the head waters.

Sampling efficiency varied considerably among sites due to variations in water depth, water clarity, current speed, river width, problems of access (usually due to overhanging trees) and so on. For each site, a Fishing Efficiency Rating was assessed subjectively on a scale of 1-5: 1 = excellent conditions with a high probability of catching shocked fish; 5 = poor visibility, fast current, difficult access, significant numbers of shocked fish probably not caught (see Appendices 1-10). Site dimensions and electro-fishing periods are given in Table 2.

RESULTS

General

The raw results from the survey are given in Appendices 1-10. They will thus be available for direct comparison and analysis with any future study which may be carried out. A summary of the main results is given in Table 2, the most notable features of which are the complete absence of fish from two sites, the absence of Salmon from four others and the relative paucity of species other than Salmon and Trout.

More comparable data on numbers are given in Table 3. It must be stressed that these are all *minimum* values and the variation in fishing efficiency at each site (indicated in Table 3) must be borne in mind (see below). The division into 0+ and 1+ and older fish (Table 4) is based on length-frequency data, examples of which are shown in Figure 2.

At March (Site 2) the repeated sampling using identical fishing effort allowed an estimate of the total population (Table 5). Two methods were used in calculating this estimate - (1) the graphical technique of De Lury (1947) and Zippin (1956) (N.B.: because it produced extremely anomalous results, the modification of this technique, proposed by Cross & Stott (1975) was not used), and (2) the double catch method of Seber & Le Cren (1967). The density estimates produced by these two techniques were very similar (Table 5) and the means for Site 2 as a whole were almost identical - 59 Trout per 100m² (De Lury) and 58 Trout per 100m² (Seber & Le Cren).

This estimate of density (59 Trout per 100m²) is substantially greater than the minimum density estimate of 33 Trout per 100m² given in Table 3 which was the result of the first sweep (as at all other sites). It implies that the minimum density estimates are substantially below the real densities (in this case, only 56 per cent of the population was taken at the first sweep) and that, taking into account the varying fishing efficiencies at each site, the actual fish populations may be significantly greater than those given in Table 3.

Atlantic Salmon

Atlantic Salmon were absent from six sites. Two of these were the fishless sites (Mellingshaw and Blacklaw) discussed below. The other sites were Clydes Burn, Cloffin (Upper and Lower) and Garpol (Upper). Numbers were very low at March and Blacklaw (Lower). The species was most abundant in the main Evan Water below Harthope (at Shiel, Longbedholm and Valenciennes) and in the Redshaw, Mellingshaw (Lower) and Garpol (Lower) Burns.

The absence of Atlantic Salmon from parts of the river is very unlikely to be due to unsuitable habitat there and is almost certainly due to the access difficulties discussed below.

The abundance of Salmon was greatest in the main river at Shiel which was one of the sites examined in an earlier study (Maitland 1990). This is also the site on which many of the key habitat features proposed for the river diversions caused by the M74 have been based.

Growth of young fish was apparently similar in most parts of the River (Table 4). The largest 0+ fish were at Blacklaw (Lower) where density was low and food abundance, due to the fishless stretches upstream (see below) was high. The mean length of both 0+ and 1+ fish increased downstream from Shiel to Longbedholm to Valenciennes - in inverse ratio to the numbers of young Salmon there (Table 3). Only a few 2+ fish were found and it seems likely that most young Salmon in the Evan Water migrate downstream at the end of their second year.

Trout

Trout were much more widespread than Salmon and occurred at all sites except Mellingshaw (Upper) and Blacklaw (Upper). These sites are discussed below.

Elsewhere, Trout were reasonably abundant, both in the main river and in most tributaries. At a few sites, only 0+ fish were present - this is probably due to the nature of the

stretches which were fished, which tended to be relatively shallow. At such places, most older Trout occurred, and could be seen, in the deeper pools which were not sampled during this study.

Trout were not only more widespread and abundant than Salmon (Table 3) but almost everywhere their growth was better (Table 4). With the exception of the Garpol (Lower), both 0+ and 1+ Trout were larger than the equivalent Salmon living at the same site. In contrast to Salmon also, at several sites 2+ and older fish were quite common (e.g. Clydes, Redshaw, Cloffin (Upper and Lower) and Garpol (Upper)).

Other species

Only two other species of fish were encountered during the survey (see Appendices) - Minnow *Phoxinus phoxinus* and Eel *Anguilla anguilla* (Table 2). Minnows were abundant (74) at Clydes Burn and occurred in small numbers at Valenciennes (2) and Garpol Upper (5). Eels were found in small numbers at March (3), Cloffin (Lower) (2) and Blacklaw (Lower) (1).

DISCUSSION

Sites with no fish

The two sites which were found to be fishless (Mellingshaw (Upper) and Blacklaw (Upper)) were the smallest of those surveyed. Apart from the absence of fish, the other striking feature of these stretches was the enormous number of invertebrates which were present and which accumulated in substantial quantities on the nets being used. Although the reason for fish being absent was uncertain, it was clearly not due to present water quality, for good populations of fish were found downstream - in both cases below a significant obstruction to upstream migration.

It is believed that the fish populations of both these streams have been eradicated in the past by some local catastrophe, probably severe drought, but alternatively pollution resulting

from agricultural or forestry activities (the catchments of both streams are substantially afforested). After any such events, even though the habitat returned to normal, fish were unable to migrate back upstream into these stretches because of obstacles downstream, as follows:

LOCATION	OBSTACLE	NGR
Mellingshaw: between Sites 7A and 7B	culvert & fall under railway	36 037086
Blacklaw: between Sites 9A and 9B	fall to culvert under A74	36 052066

Sites with no Salmon

Several sites were found to have adequate populations of Trout but no Salmon. Again, this absence can be explained by downstream obstacles to fish trying to migrate upstream.

LOCATION	OBSTACLE	NGR
Clydes: below Site 1	aqueduct over railway	26 999144
Cloffin: below Site 8B	culvert & fall under railway	36 047066
Garpol, between Sites 10A and 10B	natural waterfall	36 065029

All the stretches concerned are regarded as having suitable nursery areas for young Salmon.

Relevance to M74 roadworks

It is believed that this survey has fulfilled the stated objective in relation to possible changes in the Evan Water fish populations related to the proposed upgrading of the A74

to motorway status (M74) and the associated river diversions. The most important points to note are as follows:

1. Baseline data for the fish populations in late summer are now available to compare with any subsequent surveys which may be required in the future.
2. The Evan Water is an important spawning and nursery habitat for young Salmon and Trout within the Annan system.
3. Several difficulties of access for both Salmon and Sea Trout, created by past human activities, have been identified. There is now the possibility of rectifying these problems by providing suitable access to adult fish migrating upstream - thus both restoring the fish populations back to their natural structure and substantially increasing the spawning and nursery habitat at present available to both species.

Future research

A range of options for relevant future research includes the following.

1. To repeat the present survey during or immediately after the motorway works to verify or otherwise any postulated damage to the fish populations.
2. To repeat the present survey at the same sites and at some of the diverted stretches of the river some 1-2 years after the motorway construction to assess the success of the design of the new stretches as good spawning and nursery habitat for salmonids.
3. To establish a catchment management plan for the Evan Water which would look into all aspects affecting the fish populations there and propose the best ways of integrating land and fishery management in a sustainable way for the benefit of all users.

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Table 1. Physical details of sites sampled in the Evan Water.

SITE	NGR	CATCHMENT (HA)	WIDTH (M)
<u>Main river</u>			
1. Clydes	26 995158	380	2.0
2. March	36 004139	830	4.1
3. Shiel	36 042096	3990	7.3
4. Longbedholm	36 058060	6240	13.6
5. Valenciennes	36 071036	7990	14.2
<u>Tributaries</u>			
6. Redshaw	36 032126	630	3.0
7. Mellingshaw			
A. Upper	36 038086	170	1.8
B. Lower	36 040086	171	2.3
8. Cloffin			
A. Upper	36 022069	470	2.5
B. Lower	36 045066	1150	6.4
9. Blacklaw			
A. Upper	36 052066	220	2.5
B. Lower	36 051065	221	2.5
10. Garpol			
A. Upper	36 037051	370	3.0
B. Lower	36 070035	1380	7.0

Table 2. Summary details of site dimensions, sampling periods and fish catch at sites sampled in the Evan Water.

SITES	AREA SAMPLED (M ²)	SAMPLING PERIOD (MINUTES)	FISH CATCH		
			SALMON	TROUT	OTHERS
<u>Main river</u>					
Clydes	167	60	0	52	74
March	278	72	1	103	3
Shiel	725	90	201	174	0
Longbedholm	830	60	95	72	0
Valenciennes	324	60	33	54	2
<u>Tributaries</u>					
Redshaw	300	60	22	55	0
Mellingshaw					
Upper	161	20	0	0	0
Lower	61	20	6	69	0
Cloffin					
Upper	162	30	0	14	0
Lower	250	30	0	20	2
Blacklaw					
Upper	175	30	0	0	0
Lower	122	30	2	32	1
Garpol					
Upper	417	30	0	27	5
Lower	350	30	15	20	0

Table 3. Comparative minimum catches per unit effort and minimum densities of Salmon and Trout at sites sampled in the Evan Water. Note: 1++ includes 1+ fish and older.

SITES	C P U E (NOS/60 MIN)				DENSITY (NOS/100M ²)			
	SALMON		TROUT		SALMON		TROUT	
	0+	1++	0+	1++	0+	1++	0+	1++
<u>Main river</u>								
Clydes	0	0	24	28	0	0	14	17
March	0	1	59	27	0	<1	21	12
Shiel	121	13	116	0	25	3	24	0
Longbedholm	59	36	67	5	7	4	8	<1
Valenciennes	23	10	54	0	7	3	17	0
<u>Tributaries</u>								
Redshaw	5	17	45	10	2	6	15	3
Mellingshaw								
Upper	0	0	0	0	0	0	0	0
Lower	18	0	204	3	10	0	112	2
Cloffin								
Upper	0	0	0	28	0	0	0	9
Lower	0	0	4	36	0	0	<1	7
Blacklaw								
Upper	0	0	0	0	0	0	0	0
Lower	2	2	64	0	<1	<1	26	0
Garpol								
Upper	0	0	6	48	0	0	<1	6
Lower	20	10	36	4	3	1	5	<1

Table 4. Mean lengths (fork length in mm) of Salmon and Trout captured at sites sampled in the Evan Water. Note: 2++ includes 2+ fish and older.

SITES	SALMON			TROUT		
	0+	1+	2++	0+	1+	2++
<u>Main river</u>						
Clydes	-	-	-	59.3	102.3	123.0
March	-	-	126.0	63.1	118.9	133.5
Shiel	52.1	102.2	131.0	58.5	-	-
Longbedholm	55.8	104.1	-	67.5	112.0	132.0
Valenciennes	57.5	113.1	-	64.4	-	-
<u>Tributaries</u>						
Redshaw	59.4	107.7	-	64.7	110.8	133.0
Mellingshaw						
Upper	-	-	-	-	-	-
Lower	57.3	-	-	59.5	104.0	-
Cloffin						
Upper	-	-	-	-	105.3	121.9
Lower	-	-	-	71.0	106.0	119.4
Blacklaw						
Upper	-	-	-	-	-	-
Lower	62.0	108.0	-	73.9	-	-
Garpol						
Upper	-	-	-	67.6	104.7	152.7
Lower	57.4	111.0	140.0	56.3	101.0	128.0

Table 5. Quantitative estimate of Trout densities in the Evan Water at March. Note: A, using method of De Lury (1947) and Zippin (1956); B, using method of Seber & Le Cren (1967).

STATION	AREA (M ²)	FISH COLLECTED			ESTIMATED		NUMBERS	
		CATCH	CATCH	CATCH	TOTAL		PER 100M ²	
		1	2	3	A	B	A	B
1.	48	11	4	4	21	17	44	35
2.	54	21	10	4	35	40	65	74
3.	43	25	6	3	34	33	79	77
4.	45	15	8	4	32	32	71	71
5.	39	15	3	2	20	19	51	49
6.	49	16	3	2	21	20	43	41

Figure 1. The Evan Water and its main tributaries. The stations sampled were as follows: 1. Clydes Burn. 2. March. 3. Shiel. 4. Longbedholm. 5. Valenciennes. 6. Redshaw Burn. 7. Mellingshaw Burn (A: Upper, B: Lower). 8. Cloffin Burn (A: Upper, B: Lower). 9. Blacklaw Burn (A: Upper, B: Lower). 10. Garpol Burn (A: Upper, B: Lower). See also Table 1. Note: the dotted stretches are those river lengths to be diverted.

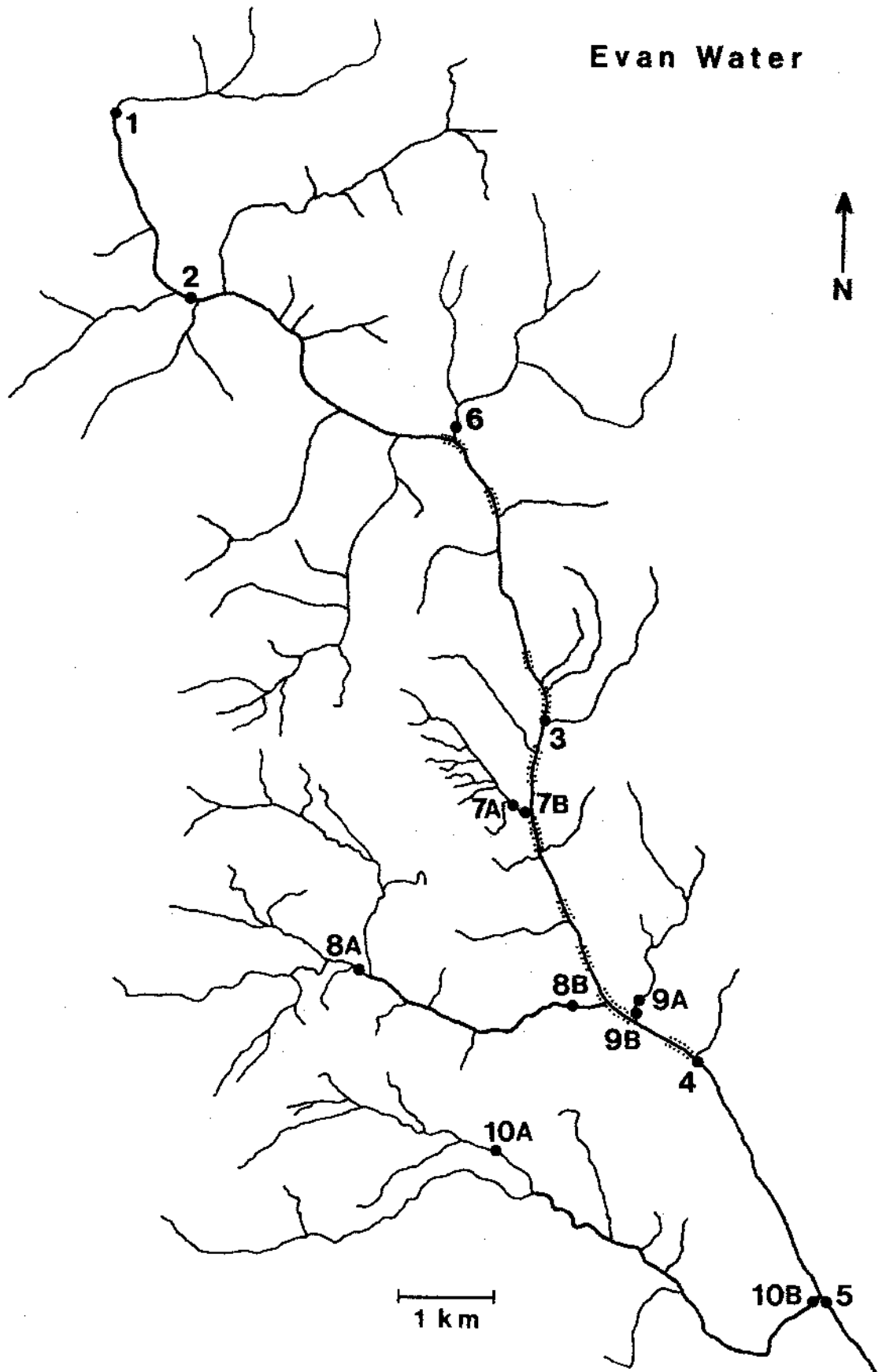


Figure 2a. Length frequency distribution of Salmon from Sites 3 (Shiel), 4 (Longbedholm) and 5 (Valenciennes).

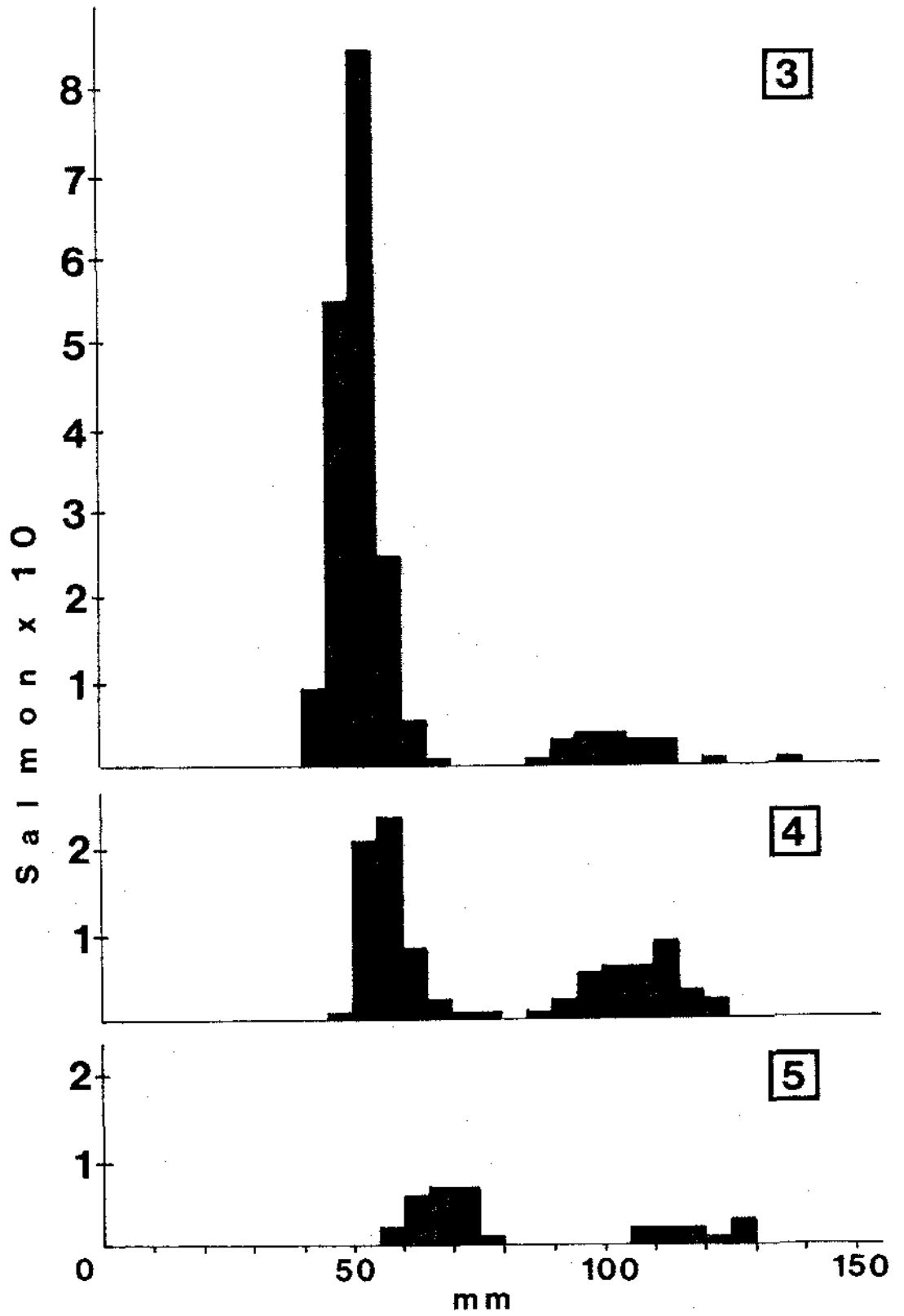
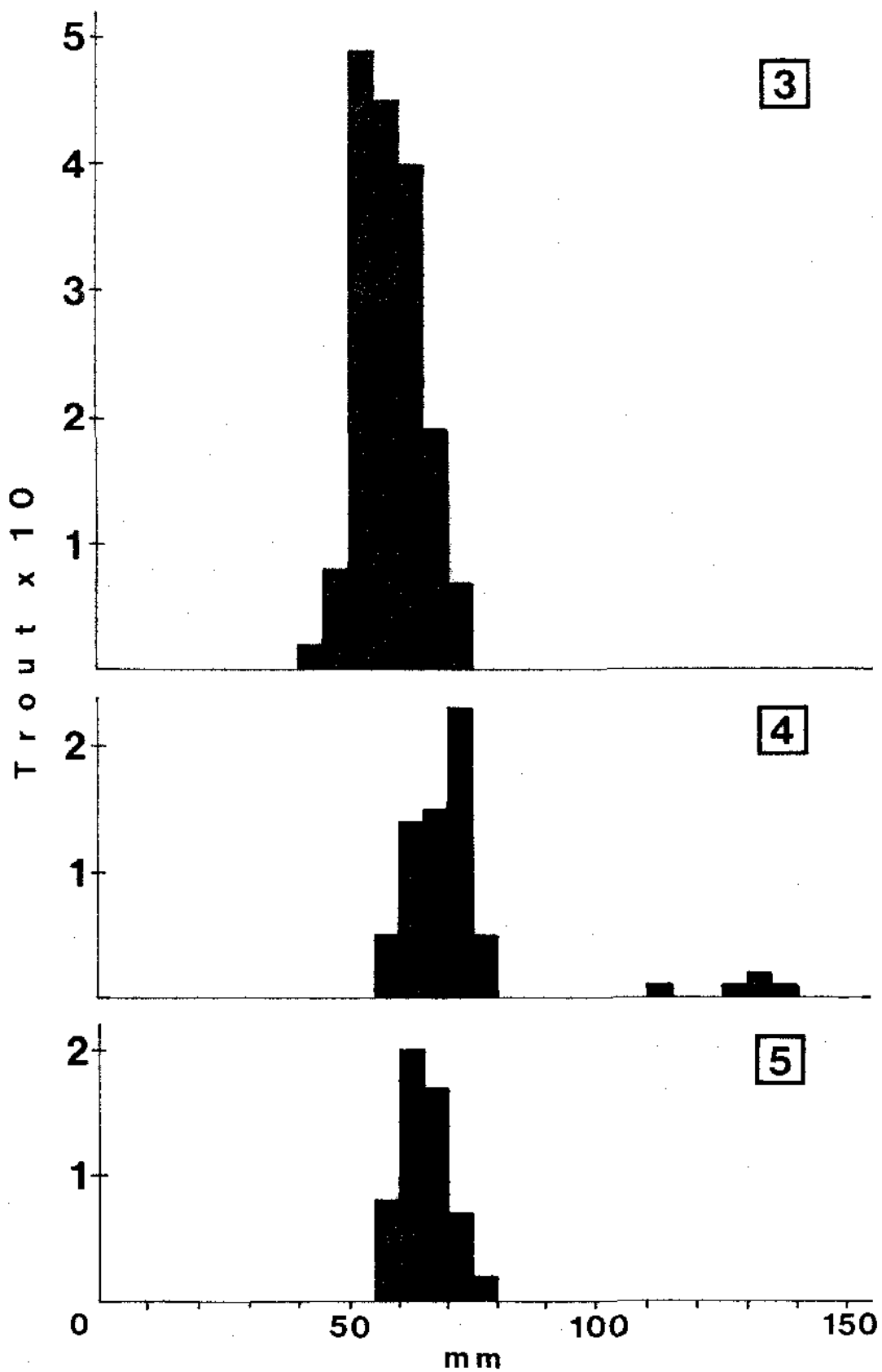


Figure 2b. Length frequency distribution of Trout from Sites 3 (Shiel), 4 (Longbedholm) and 5 (Valenciennes).



Appendix 1. Site 1: description and basic field data. Note: individual fish fork lengths given in mm.

Evan Water at Clydes Burn: NGR: 26 995158. Just above stone wall. Sampled: 29.08.94. River level: moderate. Substrate: mainly stony with some gravel. Current moderate. Mainly riffle/pool sequences. Open, with no trees. Weather fine apart from two light showers. Fishing Efficiency Rating: 2.

Time = 60 minutes; Area = 167 m². SALMON: Nil. TROUT: 51, 52, 54, 55, 55, 55, 56, 57, 58, 58, 59, 59, 59, 60, 60, 62, 62, 63, 63, 63, 64, 64, 65, 69, 94, 96, 98, 102, 103, 105, 106, 107, 107, 107, 107, 108, 108, 108, 108, 108, 109, 111, 111, 112, 112, 114, 121, 124, 158, 158, 173, 204. OTHERS: Minnows (Seventy four).

Appendix 2. Site 2: description and basic field data. Note: individual fish fork lengths given in mm.

Evan Water at March: NGR: 36 004139. Just above track to Bidhouse. Sampled: 24.08.94. River level: moderate, but rising during sampling. Substrate: Stony with occasional gravel. Current: moderate to fast. Mainly shallow riffle with some pooling. Open at both banks (not trees). Weather poor - sampling done between heavy showers. Fishing Efficiency Rating: 3.

Station 1: Time = 10+8+7 minutes; Area = 48 m². SALMON: Nil. TROUT: 52, 53, 57, 63, 65, 65, 67, 67, 72, 75, 74 + 52, 56, 65, 74 + 59, 64, 65, 72. OTHERS: Nil.

Station 2: Time = 15+12+11 minutes; Area = 54 m². SALMON: Nil. TROUT: 55, 55, 56, 56, 58, 58, 58, 58, 60, 63, 63, 63, 65, 65, 67, 68, 69, 69, 72, 72, 145 + 51, 52, 52, 55, 55, 57, 58, 65, 75, 98 + 62, 65, 69, 114. OTHERS: Nil.

Station 3: Time = 11+10+8 minutes; Area = 43 m². SALMON: Nil. TROUT: 46, 54, 57, 60, 62, 62, 63, 63, 66, 68, 68, 69, 69, 71, 73, 113, 122, 123, 125, 128, 130, 146, 167, 168, 185 + 54, 60, 60, 112, 124, 158 + 61, 62, 120. OTHERS: Eel (0+One+0).

Station 4: Time = 11+10+8 minutes; Area = 45 m². SALMON: Nil. TROUT: 53, 56, 58, 58, 61, 63, 65, 67, 68, 70, 110, 118, 121, 124, 129 + 56, 73, 74, 113, 114, 117, 125, 174 + 58, 116, 119, 140. OTHERS: Eel (One+0+0).

Station 5: Time = 13+9+8 minutes; Area = 39 m². SALMON: Nil. TROUT: 63, 67, 68, 108, 109, 110, 113, 122, 125, 129, 137, 143, 157, 165, 203 + 127, 134, 162 + two lost. OTHERS: Nil.

Station 6: Time = 12+9+7 minutes; Area = 49 m². SALMON: 126+0+0. TROUT: 56, 59, 63, 64, 65, 65, 65, 67, 68, 69, 70, 75, 100, 130, 135, 145 + 62, 65, 70 + 68, 122. OTHERS: Eel (One+0+0).

Appendix 3. Site 3: description and basic field data. Note: individual fish fork lengths given in mm.

Evan Water at Shiel: NGR: 36 042096. Island at Dead Burn entry. Sampled: 22.08.94. River level: low. Substrate: stony with some boulders. Current: moderate. Mainly shallow riffle. RH stations (1-4) in main channel between island and RHB - this section open. LH stations (5-6) in narrow channel between island and LHB - this section overhung in places by bushes (some sections missed). Weather fine. Fishing Efficiency Rating: 1.

Station 1: Time = 15 minutes; Area = 144 m². SALMON: 50, 51, 52, 53, 53, 53, 53, 53, 53, 54, 54, 55, 55, 57, 57, 58, 58, 59, 59, 61, 69, 93, 99, 102, 104, 106, 113. TROUT: 48, 48, 50, 51, 52, 53, 54, 55, 55, 55, 56, 57, 57, 58, 58, 59, 60, 62, 62, 63, 63, 64, 64, 66, 67, 68, 71. OTHERS: Nil.

Station 2: Time = 15 minutes; Area = 206 m². SALMON: 48, 49, 50, 50, 50, 51, 51, 52, 52, 52, 53, 53, 54, 54, 55, 61, 94, 100, 100, 100, 106, 109, 125, 137. TROUT: 46, 49, 50, 51, 51, 52, 52, 52, 53, 53, 53, 53, 53, 54, 55, 55, 55, 55, 56, 56, 59, 59, 59, 59, 60, 60, 61, 62, 62, 62, 63, 64, 64, 68, 69, 70, 71. OTHERS: Nil.

Station 3: Time = 15 minutes; Area = 119 m². SALMON: 48, 48, 49, 51, 52, 52, 52, 53, 53, 53, 54, 55, 57, 58, 61, 63, 115. TROUT: 44, 48, 51, 53, 53, 53, 54, 54, 54, 55, 55, 56, 56, 57, 57, 57, 58, 58, 60, 61, 63, 63, 64, 64, 66, 68, 70, 70. OTHERS: Nil.

Station 4: Time = 15 minutes; Area = 170 m². SALMON: 46, 48, 48, 49, 49, 50, 50, 50, 52, 52, 52, 52, 53, 53, 54, 55, 55, 55, 55, 56, 56, 59. TROUT: 50, 51, 52, 52, 52, 53, 53, 54, 54, 54, 54, 55, 55, 56, 56, 56, 56, 56, 57, 57, 57, 57, 57, 58, 59, 59, 60, 61, 61, 62, 62, 62, 63, 64, 65, 65, 65, 72. OTHERS: Nil.

Station 5: Time = 15 minutes; Area = 35 m². SALMON: 42, 43, 43, 44, 44, 44, 46, 46, 46, 46, 46, 47, 47, 47, 47, 48, 48, 48, 48, 49, 49, 49, 49, 49, 49, 49, 49, 50, 50, 50, 50, 50, 50, 50, 50, 50, 51, 51, 51, 51, 51, 51, 52, 52, 52, 52, 52, 52, 53, 53, 53, 53, 54, 54, 54, 54, 55, 55, 55, 55, 55, 55, 56, 56, 56, 56, 56, 57, 58, 59, 60, 101, 105, 112. TROUT: 45, 52, 53, 54, 59, 60, 60, 60, 61, 62, 62, 63, 63, 64, 66, 68, 68, 72, 73, 73. OTHERS: Nil.

Station 6: Time = 15 minutes; Area = 51 m². SALMON: 44, 44, 45, 46, 46, 47, 47, 48, 49, 49, 49, 50, 51, 51, 51, 51, 52, 52, 52, 53, 53, 53, 54, 54, 54, 54, 55, 55, 55, 56, 57, 58, 58, 59, 65, 89, 91. TROUT: 53, 53, 54, 57, 58, 58, 58, 59, 59, 60, 60, 61, 63, 63, 64, 64, 64, 66, 66, 66, 67, 67, 70, 74. OTHERS: Nil.

Appendix 4. Site 4: description and basic field data. Note: individual fish fork lengths given in mm.

Evan Water at Longbedholm: NGR: 36 058060. At Fullshaw Linn entry. Sampled: 31.08.94. River level: moderate. Substrate: stones with some boulders. Current: generally strong. Mainly an area of smoothish riffle. Shallow to RHB (stations 1-3), overhung there by alder. Undercut and tree roots at LHB (stations 4-6). Weather fine. Fishing Efficiency Rating: 2.

Station 1: Time = 10 minutes; Area = 149 m². SALMON: 54, 55, 56, 56, 56, 58, 60, 60, 63, 98, 107, 113, 115, 120. TROUT: 59, 62, 62, 63, 63, 65, 71, 72, 72, 79. OTHERS: Nil.

Station 2: Time = 10 minutes; Area = 120 m². SALMON: 51, 53, 55, 55, 60, 60, 65, 66, 99, 104, 108, 108, 117. TROUT: 57, 60, 63, 66, 68, 69, 70, 70. OTHERS: Nil.

Station 3: Time = 10 minutes; Area = 146 m². SALMON: 51, 53, 54, 54, 55, 56, 57, 57, 58, 58, 59, 64, 64, 100, 101, 101, 103, 106, 106, 114, 116, 123. TROUT: 63, 67, 71, 72, 74, 74, 74, 75, 75, 76. OTHERS: Nil.

Station 4: Time = 10 minutes; Area = 149 m². SALMON: 52, 52, 53, 55, 55, 58, 58, 59, 60, 61, 94, 99, 103, 113, 122. TROUT: 62, 62, 64, 64, 68, 70, 72, 76, 126, 137. OTHERS: Nil.

Station 5: Time = 10 minutes; Area = 120 m². SALMON: 50, 51, 54, 54, 55, 57, 58, 59, 61, 76, 90, 93, 98, 103, 104, 107, 113, 113. TROUT: 57, 60, 63, 63, 64, 64, 67, 69, 69, 70, 71, 72, 73, 74, 77, 112. OTHERS: Nil.

Station 6: Time = 10 minutes; Area = 146 m². SALMON: 52, 56, 57, 58, 58, 62, 63, 68, 72, 106, 113, 113, 114. TROUT: 62, 62, 63, 65, 68, 69, 69, 71, 71, 71, 72, 73, 73, 75, 75, 77, 131, 134. OTHERS: Nil.

Appendix 5. Site 5: description and basic field data. Note: individual fish fork lengths given in mm.

Evan Water at Valenciennes: NGR: 36 071036. At Garpol Water entry. Sampled: 31.08.94. River level: moderate. Lower stations (1-4) -Substrate: stones and boulders. Current: strong. An area of strong, broken riffle. Trees overhanging on both banks, but access all right. Upper stations (5-6) - Substrate: mainly bedrock. Current poor (in areas sampled). Mainly pools in bedrock on RHB. Weather fine. Fishing Efficiency Rating: 4.

Station 1: Time = 10 minutes; Area = 55 m². SALMON: 55, 58, 66, 67, 103, 122. TROUT: 62, 65, 67, 67, 68, 74, 75, 76, 78. OTHERS: Nil.

Station 2: Time = 10 minutes; Area = 53 m². SALMON: 61, 63, 68, 116. TROUT: 58, 61, 62, 63, 63, 63, 64, 65, 66, 67, 70, 71, 73. OTHERS: Minnows (two).

Station 3: Time = 10 minutes; Area = 67 m². SALMON: 56, 59, 64, 69, 102, 108, 121. TROUT: 56, 56, 57, 60, 61, 63, 63, 64, 65. OTHERS: Nil.

Station 4: Time = 10 minutes; Area = 60 m². SALMON: 54, 56, 59, 60, 61, 63, 64, 64, 66, 68, 70, 73, 110, 112, 115, 122. TROUT: Nil. OTHERS: Nil.

Station 5: Time = 10 minutes; Area = 43 m². SALMON: Nil. TROUT: 56, 58, 58, 63, 65, 69, 72, 74. OTHERS: Nil.

Station 6: Time = 10 minutes; Area = 46 m². SALMON: Nil. TROUT: 63, 65, 65, 65, 66, 66, 66, 67, 67, 67, 68, 69, 69, 69, 74. OTHERS: Nil.

Appendix 6. Site 6: description and basic field data. Note: individual fish fork lengths given in mm.

Redshaw Burn: NGR: 36 032126. Just above A74 culvert. Sampled: 29.08.94. River level: medium to high. Substrate: bedrock and boulders with some stones. Current generally fast. Mainly pools and cascades. Overhung in some places by bushes (some sections missed). Weather fine. Fishing Efficiency Rating: 4.

Time = 60 minutes; Area = 300 m². SALMON: 55, 58, 59, 59, 66, 93, 95, 97, 104, 106, 107, 108, 108, 109, 110, 110, 110, 111, 113, 113, 118, 119. TROUT: 53, 56, 56, 57, 57, 58, 58, 58, 58, 59, 60, 61, 61, 62, 62, 62, 63, 63, 63, 63, 63, 63, 64, 64, 64, 66, 66, 66, 66, 66, 66, 67, 68, 68, 70, 70, 70, 71, 72, 73, 73, 75, 75, 76, 78, 100, 104, 110, 113, 119, 119, 133, 165, 170, 179. OTHERS: Nil.

Appendix 7. Site 7: description and basic field data. Note: individual fish fork lengths given in mm.

A: *Mellingshaw Burn Upper*: NGR: 36 038086. Just above track to pylon. Sampled: 30.08.94. River level: moderate. Substrate: stones with some gravel and occasional bedrock. Current moderate to fast. Mainly pool/riffle sequences. Open with a few bushes. Weather fine. Fishing Efficiency Rating: 1.

Time = 20 minutes; Area = 161 m². SALMON: Nil. TROUT: Nil. OTHERS: Nil.

B: *Mellingshaw Burn Lower*: NGR: 36 040086. Just above entry to Evan W. Sampled: 30.08.94. River level: moderate. Substrate: stones with some gravel. Current moderate. Mainly pool riffle sequences. Weather fine. Fishing Efficiency Rating: 1.

Time = 20 minutes; Area = 61 m². SALMON: 52, 57, 58, 59, 59, 59. TROUT: 38, 44, 45, 45, 46, 46, 46, 47, 47, 48, 48, 49, 50, 50, 50, 51, 52, 52, 53, 53, 53, 54, 55, 57, 57, 57, 57, 58, 58, 58, 58, 60, 60, 61, 61, 62, 62, 62, 62, 62, 62, 63, 64, 64, 64, 64, 65, 65, 65, 67, 67, 68, 68, 68, 69, 69, 69, 70, 70, 70, 71, 72, 73, 75, 77, 78, 104. OTHERS: Nil.

Appendix 8. Site 8: description and basic field data. Note: individual fish fork lengths given in mm.

A: Cloffin Burn Upper: NGR: 36 022069. Just above track to Mosshope. Sampled: 30.08.94. River level: moderate to high. Substrate: Bedrock and boulders with some stones and gravel. Current generally fast. A stretch of cascades, riffles and pools. Overhung by bushes in places (some sections missed). Weather fine. Fishing Efficiency Rating: 4.

Time = 30 minutes; Area = 162 m². SALMON: Nil. TROUT: 95, 105, 107, 107, 109, 109, 117, 118, 120, 123, 123, 125, 127, 134, OTHERS: Nil.

B: Cloffin Burn Lower: NGR: 36 045066. Just above bridge at cottages. Sampled: 30.08.94. River level moderate to high. Substrate: mainly stony with some boulders and gravel. Current fast. General pool/riffle sequence. Overhung by trees on RHB. Weather fine. Fishing Efficiency Rating: 3.

Time = 30 minutes; Area = 250 m². SALMON: Nil. TROUT: 70, 72, 106, 113, 113, 114, 115, 119, 120, 120, 123, 123, 124, 124, 125, 131, 134, 135, 145, 168. OTHERS: Eel (Two).

Appendix 9. Site 9: description and basic field data. Note: individual fish fork lengths given in mm.

A: *Blacklaw Burn Upper*: NGR: 36 052066. Just above forestry road. Sampled: 29.08.94. River level: moderate to high. Substrate: stony with some bedrock. Current: fast. A stretch of cascades, riffles and pools. Largely overhung by bushes (some sections missed). Weather fine. Fishing Efficiency Rating: 4.

Time = 30 minutes; Area = 175 m². SALMON: Nil. TROUT: Nil. OTHERS: Nil.

B: *Blacklaw Burn Lower*: NGR: 36 051065. Below A74 culvert. Sampled: 29.08.94. River level: moderate to high. Substrate: mainly stony with some boulders. Current: moderate to fast. Pool/riffle sequences. Mainly overhung by alders, but access reasonable. Weather fine. Fishing Efficiency Rating: 2.

Time = 30 minutes; Area = 122 m². SALMON: 62, 108. TROUT: 58, 62, 62, 63, 64, 64, 64, 67, 68, 68, 69, 69, 69, 71, 71, 72, 73, 73, 78, 79, 83, 85, 86, 87, 89, 90, 90, 94, 97, 97, 98, 102. OTHERS: Eel (One).

Appendix 10. Site 10: description and basic field data. Note: individual fish fork lengths given in mm.

A: *Garpol Water Upper*: NGR: 36 037051. Below S Upland Way footbridge. Sampled: 30.08.94. River level: moderate. Substrate: stones with some gravel. Current moderate to fast. A series of riffles and pools. Generally open (a few bushes). Weather fine. Fishing Efficiency Rating: 2.

Time = 30 minutes; Area = 417 m². SALMON: Nil. TROUT: 64, 65, 74, 86, 98, 100, 101, 104, 105, 109, 109, 110, 114, 116, 142, 144, 146, 147, 150, 154, 157, 161, 161, 165, 179, 185, 188. OTHERS: Minnow (Five).

B: *Garpol Water Lower*: NGR: 36 070035. Just above railway culvert. Sampled: 30.08.94. River level: moderate to high. Substrate: stones with some boulders. Current fast. A stretch of mainly riffle, overhung by large trees - access easy but dark from shading. Weather fine. Fishing Efficiency Rating: 5.

Time = 30 minutes; Area = 350 m². SALMON: 50, 54, 55, 55, 56, 57, 59, 60, 62, 66, 105, 110, 114, 115, 140. TROUT: 45, 50, 51, 56, 57, 58, 58, 58, 58, 59, 59, 60, 61, 62, 64, 65, 70, 80, 122, 128. OTHERS: Nil.