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Salmonid carrying capacity of streams in the Connemara region, a resource appraisal

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ABSTRACT

Standing crops of salmonids in the Connemara region are described from 80 site fishings made between March 1982 and May of the following year. Trout were more widely distributed than salmon, being able to exploit isolated water bodies as resident populations. High salmonid densities were associated with salmon which during the dry summer months were caught in large numbers on riffles. The smallest streams in the region supported only trout presumably because there was insufficient depth of water to permit the entry of salmon. Trout biomass and density within the region were distributed within the lower range reported from a number of countries in which brown trout are endemic and naturalised.

Low salmonid densities at 16% of sites were in some cases associated with the rooting of angiosperms, and possibly oligotrophic conditions resulting from geological structure. Length at age of salmon and trout was similar to measurements recorded in Britain. The streams were important only for the first year of the trout life cycle.

Because trout move downstream as they grow, occupying lakes during the later parr phase, and the entire streambed area in Connemara is one fortieth of the lake area, space is unlikely to be a critical constraint on the later parr phase. The condition of the stream substratum may be a factor in the production of sea trout; where loose gravels do not occur in shallow nursery streams, the catchments tend towards producing "brown" or "resident" rather than sea trout.

INTRODUCTION

The Connemara region has traditionally been regarded as a producer of sea trout rather than salmon although both species occur there. Occasional descriptions of the characteristics of the trout have been published (Nall, 1931; Went, 1949, 1956; Fahy, 1979). The angling catch from the eastern part of the Connemara Fishery District has been described (Fahy, 1978, 1979); catches from the Connemara District have been regarded as an important indicator of the performance of sea trout fisheries in Ireland (Fahy, 1981). Details of spawning sea trout in the Connemara Fishery District have been given (Fahy and Nixon 1982) and some observations have been made on the feeding of trout fry there (Fahy, 1980).

Otherwise the juvenile salmonids of the Connemara Region have not been investigated although some observations are available on the summer algal flora of nursery streams (Keyes McDonnell and Fahy, 1978).

The purpose of the appraisal is to provide baseline data on the juvenile salmonid carrying capacity of streams in the Connemara Region; the recognition of habitat favoured by salmon or trout and the identification of any adverse environmental influence.

MATERIALS AND METHODS

Study Area

The Connemara region extends across the Ballinakill and Connemara and into the western part of the Galway Fishery Districts. It is a terrain of low hills dominated to the north by the Twelve Pins, the Maamturk mountains and, to the east, by the high ground of Iar Connaught. Surface drainage is through a large number of small coastal catchments. Bedrock consists of granites and migmatites; blanket bog or acidic grassland are ubiquitous. Drainage patterns branch irregularly in all directions and so can be described as dendritic in the classification of Zernitz (1932). Dendritic drainage develops over massive crystalline rocks or flat lying sedimentary ones where there is a lack of structural control and valley development. At the western end of the Connemara Fishery District the flatter topography makes for difficulty in distinguishing catchment boundaries.

To describe the region 24 trout producing catchments were studied. (Tables 1, 2; Fig. 1).

METHODS

Sites were described from a series of transect measurements, at intervals of 3m. At each the width of the stream, its average depth (usually at a point one third of the stream width from its margin) and whether the stream was a riffle or pool section was noted. On each sampling date as large a stream as possible was electrofished. The largest (greater than order 36) were not accessible with the equipment at any time during the course of the work; however streams of larger than order 31 accounted for 10.2% of streambed area within the region (Table 3).

Within the region surface runoff of rainwater is rapid and order 1 streams can discharge the greater volume of a shower within an hour. During persistently wet weather fishing was confined to lower order streams although the actual depth of water fished on any occasion varied little (Fig 2). Streams were fished on eight occasions between March 1982 and May 1983. The locations of sites are shown in Fig 3.

A site was stop-netted at each end prior to the commencement of electrofishing. The enclosed areas ranged between 33 and 412m^2 and the majority were approximately 200m^2. As far as possible a site was selected to include pool and riffle areas.

At least three and as many as nine fishings were made at each location, an estimate of the standing crop being obtained by regressing the catch at each fishing on the sum of previous catches and extrapolating to the horizontal axis the line best fitting the points (Seber and le Cren 1967). After the third fishing the significance of the correlation was tested and, if not significant, further fishings were undertaken.

For fifteen sites significant correlations seemed unlikely after six fishings; further fishings were not attempted and these sites are not considered.

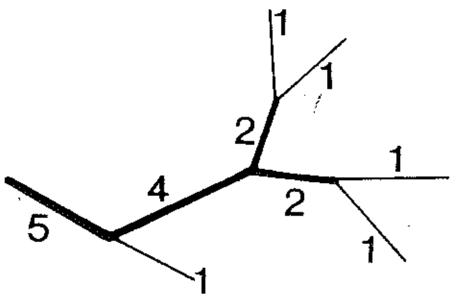
In view of the mesh size of the stop and catcher nets the method was efficient only for the removal of salmonids greater than 4cm fork length. Each salmonid was measured to the nearest mm fork length, identified to species and a sub-sample was retained for ageing and weighing.

RESULTS

Hydrological features

Physical characteristics of the catchments were measured from 1:63360 Ordnance Survey maps and are summarised in Table 1. Drainage density ratio of stream length (km) to land area (km$_2$) is regarded as an important statistic and a value of 1.2 is said to be typical of "steep impervious areas in regions of high precipitation" (Gregory and Walling 1973). Ten of the 24 catchments show this high ratio.

Further analysis of the stream network in the region is undertaken using the terminology of R. L. Shreve (in Gregory and Walling 1973). According to Shreve's system stream order is described as follows:



In the present work each tributary labelled above is referred to as a "segment". The distribution of stream segments among orders in the 24 Connemara catchments is set out in Table 2; segment lengths are given in Table 3.

Values in the regression y = bx + a of stream width (m) on stream order for 80 sites were:

b = 0.1874	a = 2.4051
r = 0.6896	$P < 0.001$

Streambed area was estimated using the above regression and multiplying the width for each order by the segment length (Table 3).

Order 1 streams are most numerous (Table 4) as might be expected in small catchments with dendritic drainage patterns. They provide 50% of streambed area. Total streambed area is 2.5 km^2, forty times less than the lake area of 92 km^2 within the 24 catchments. Stream area and depth (Table 5) did not correlate significantly ($P > 0.05$). The percentage area of streambed occupied by riffle correlated negatively with depth (cm):

b = -1.2751	a = 82.7251
r = -0.3523	$P < 0.01$

This result accords with the prevailing belief that falling water levels increase the area of riffle and decrease the area of the streambed occupied by pools.

Condition of fish

Weight: length relationships calculated as geometric mean functional regressions (Ricker, 1973) for samples taken in five months are shown in Table 6. The slope of the line b in the formula $w = al^b$ varied between 3.00 in February to 3.19 in December for trout. Throughout the sampling period trout of 10cm fork length varied in weight by less than 7%. The value of b for salmon in February was 3.44.

The weight of each fish measured was calculated from the regression, using the value for the month nearest to the date of sampling for trout and the February value for salmon. From these weights the biomass for each site was calculated on the assumption that the length frequency of the population was identical with that of the sample.

Length frequency distribution

The length frequency of aged samples of trout in seven of the eight sampling months is shown in Fig. 4; salmon in Fig. 5. The majority of trout were 0+ although there were some 1+ and a very few older fish. Salmon were represented by 0+ 1+ and 2+ age groups.

Back calculation of length at age in May 1982 gave the following:

		at 1 year	at 2 years
Trout	Number	75	10
	Mean fork length	6.1	13.7
	Standard deviation	1.84	2.16
Salmon	Number	39	8
	Mean fork length	4.4	8.7
	Standard deviation	1.19	1.42

Salmonid density and biomass

Salmonid characteristics of the 80 sites fished are set out in Table 7. The occurrence of salmonids was expressed in terms of biomass (gm^{-2}) and density (numbers m^{-2}). In Fig. 6 the frequency distribution of salmonid biomass values is shown. The range was from 0.02 to 5 fish m^{-2} with more than half the sites giving values between 0.2 and 0.6.

The streams

Different stretches of one stream in the Screebe system were fished on six occasions to provide a basis for comparison (Site numbers 1, 21, 33, 44, 52, 53, 55 and 71) but the outcome was very variable. Trout densities ranged from 0.11 to 0.71 m^{-2} and trout biomass from 0.27 to 1.89 g m^{-2}. Salmon numbers fluctuated between extremes of 0.08 and 0.91 and salmon biomass from 0.98 to 6.24 g m^{-2}. Trout comprised between 22 and 65% of the salmonid population. Sites 52 and 53 which were both fished on the same day were separated by 0.4 km.; site 53 showed the signs of a population depleted by the downstream autumn migration of juveniles some of which remained in the deeper stream water of the lower site.

Low salmonid densities

The range of trout densities at most sites was within the lower range described for *Salmo trutta* over a wide geographical area (Table 8). In 13 of the 80 sites however, densities of less than 0.1 salmonids m^{-2} were recorded. These are considered "low" and characteristics of the sites are described below.

Low numbers of salmonids were associated in six sites with streams in which the substratum had been compacted and rooted angiosperms like *Potamogeton* had become established. Systems in which these conditions occurred on a wide scale were known locally as producers of "brown" or "resident" rather than sea run trout. The following sites had a carpet of vegetation covering at least 40% of the streambed.

System	Site no.	% site area more than 20 cm deep	width, m	% riffle
Ballinaboy	60; 62	87; 17	2.4; 1.5	87; 50
Claddaghduff	74	50	1.5	50
Aughrusbeg	75	0	1.8	100
Camus Eighter	42	73	1.0	70
Gowla	73	40	3.4	60

One station (site 47) on the Owengarve River (an order 4 stream) was situated just above the tide and flounder *Pleuronectes flesus* were electrofished there with trout. Although the water at this point was fresh rather than brackish the proximity of salt water may have made the site more acceptable to trout. It is also possible that salmon did not spawn in the river in question. At three further sites low parr densities could not be readily explained or associated with particular environmental conditions.

Two stations on the west side of Lough Inagh (Ballinahinch system) had a substratum of quartzite stones which was unusual in the catchments surveyed. Both streams (sites 59 and 78, an order 3 and an order 1 stream respectively) were poor producers of trout. Apparently in the case of one site in the Inverbeg system (site 18, an order 10 stream) with an abundance of spawning gravels, the very low density of trout may be explained as autumn descent of juveniles at the time of spawning immigration.

High densities of salmonids

Densities of more than 1 salmonid m^{-2} occurred at only five sites (6.3% of the total). One of these (site 6) was examined in March 1982 and with 1.01 salmonids m2 was just above the lower limit. The other four were fished in July 1982 at a time of low water. Their physical chatacteristics were:

	Sites					
	33	34	35	37	average	standard deviation
Stream order	5	18	18	13	13.5	5.32
width (m)	3.0	5.0	4.4	4.9	4.3	0.80
Depth (cm)	16	13	7	11	11.8	0.29
Percentage riffle	37	10	81	100	57	35.5

To generalise, the stream order values were high, hence the streams tended to be among the widest sampled and they were shallow. The proportion of riffle varied.

Biological characteristics of the stations were:

	Sites					
	33	34	35	37	average	standard deviation
Salmonid density	1.62	2.61	3.32	1.04	2.15	0.88
Trout density	0.71	0.56	0.41	0.27	0.49	0.16
Salmon density	0.91	2.05	2.91	0.77	1.66	0.88
Salmonid biomass	5.26	16.45	7.58	12.03	10.33	4.29
Trout biomass	1.89	2.50	1.84	3.17	2.35	0.54
Salmon biomass	3.37	13.95	5.73	8.85	7.98	3.96
Percentage Trout	44	21	12	26	26	11.51

At all four sites trout densities were within a moderate range and the high numbers of salmonids were a result of salmon rather than trout.

Trout only streams

In general, trout densities in the Connemara region approximated to those recently reported for the neighbouring Corrib catchment (Browne and Gallagher, 1980).

Trout only occurred at moderate densities at 20 sites (25% of the total). In the cases of Traheen and Owennabaunnoge Rivers (sites 67 and 68; stream orders 3 and 5) steep falls are believed to have obstructed access by sea run trout in which case these sites could be described as supporting "resident" trout populations.

Other trout only streams with apparently free access to the sea occurred in:

Ballinahinch	:	sites 7, 40, 49, 54, 56, 58, 69, 79
Doohulla	:	63
Gorumna	:	77
Nafurnace	:	80
Invermore	:	43, 46
Gowla	:	45
Lough Fee	:	48
Lettermuckoo	:	50, 51
Screebe	:	1

Some of the physical characteristics of the above streams are compared with those of all streams sampled (standard deviation):

	Trout only; free access N = 18		All streams samples N = 80		*P*
Stream order	2.94	(3.54)	5.2	(5.94)	<0.05
Average depth cm	23.3	(6.42)	22.1	(6.82)	>0.05
Percentage riffle	58.7	(16.29)	54.6	(24.7)	>0.05

Trout only streams are of significantly lower order than those which contain mixed populations of trout and salmon probably because salmon are physically unable to enter the smaller water bodies.

DISCUSSION

Salmonid growth

The dimensions given for length at age are in good agreement with what is generally reported for juvenile salmonids (Mills, 1968, Egglishaw, 1970, Allen, 1938). Compared with the lengths of trout parr back-calculated from the scales of sea run fish the latest findings tend to be lower (usually by 1cm at 1 year) than usually recorded (Went, 1949, 1956; Fahy, 1979). These back-calculations derive from two and three smolt year trout. Nall (1931) gave parr lengths of trout as averages of a number of smolt classes and these, 5.9 cm at 1 year and 14.2 cm at 2 years, agree closely with the back calculations in the present investigation. A growth sequence can be discerned in the length frequency histograms (Figs. 4 and 5).

The weight:length regressions (Table 6), while considered adequate for present purposes, are likely to conceal some variation in the correlations due to age. Mann (1971) found that the slope b of the weight:length curve for 0+ trout was slightly though significantly greater than 3 although in 1+ and 2+ fish it did not differ significantly from 3.

Biomass and population density

Site selection was largely dictated by water level as a result of which the average stream order fished in a particular month varied considerably (Fig. 2). Stream dwelling salmonids move downstream as they grow (Jones, 1975; Milner, Gee and Hemsworth, 1978; Symons and Heland, 1978) so that a different kind of population might have been expected on each occasion. Superimposed on this is the downstream migration of juvenile salmonids which occurs in the autumn coinciding with the upstream movements of spawning fish, which has been interpreted as a survival mechanism for the juveniles (Buck and Youngson, 1982). Although the autumn descent has been described by various workers there is doubt as to whether the juveniles again move upstream the following spring after the departure of the spent adults (Thorpe, 1974; Stuart, 1957). The method of site selection adopted in this work did not permit an appraisal of whether this happened or not.

Maritime brown trout systems

Sea trout producing systems occupy a narrow coastal band of mainly small river and lake catchments in Ireland (Fahy, 1977). Systems further inland contain trout which, though migratory (in that they move between spawning and feeding areas within these catchments) do not venture out to sea. An occasional and intriguing anomaly is a brown trout system which occurs on the coast and within 5 km of the sea and to which access by sea run trout is readily available. It is not feasible to say that these systems are occupied exclusively by "resident" brown trout—no more than it is correct to state that sea trout stocks do not include some resident fish. It is possible to state that the majority of their yield consists ot trout in resident brown livery and that the systems in question are fished for these.

Within the Connemara sea trout catchments brown trout are frequently taken in association with sea run fish. These brown trout are small, about 70-100g in weight, and the majority are probably the precursors of sea run trout. In the maritime brown trout systems, the average weight of catch (from such occasional accounts as have been received) would seem to be approximately 400g but occasional fish of 1 kg occur. These weights are crudely comparable with those of sea trout.

Three small systems within the Connemara and Ballinakill districts are exploited only for brown trout of this kind (Aughrusbeg, Gorumna and Camus Eighter). Their geology is similar to that of the neighbouring sea trout fisheries but in an important respect the two groups differ. A measurement used to characterise the systems is the lake surface (km^2) to channel length (km) ratio which, for the three systems given, is 3.0, 0.26 and 0.28. A second group of catchments (Nagravin, Ballinaboy and Lough Fee) are reported to yield good numbers of both brown and sea trout and these have lake surface to channel length ratios of 0.15, 0.6 and 0.13. The remaining sea trout producing systems average at 0.20.

The lake surface to channel length ratio suggests—though far from conclusively—that some brown rather than sea trout producing systems have relatively less spawning and nursery area. Where the brown trout systems listed here have been examined and electrofished they have been found to contain mainly dead standing water often supporting profuse growths of *Potamogeton* and other aquatic vegetation and to have a peaty substratum. In such conditions parr densities are very low—so low at times that the source of brown trout occupying their lakes must be surmised; beach spawning might contribute some of these fish. The circumstances suggest that low rates of recruitment and high survival are the rule. Conversely, in fast flowing streams, plentiful opportunities for spawning produce many juveniles and intense competition for food and space may play a part in conditioning these trout to go to sea at a later stage.

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Table 2 Percentage distribution of stream segment numbers among order categories in 24 Connemara catchments

Catchment	1	2	3	4	5	6-10	11-15	16-20	21-25	26-30	31-50	51-70	71-90	91-110	›111	Totals
Aughrusbeg	1															
Ballinaboy	17	5	2	1		3	3									
Ballinahinch	131	31	14	5	6	11	7	3	4		3			1	2	
Camus Eighter	5	2	1													
Claddaghduff	1															
Costelloe	42	8	4	3	4	5	3	1	1	2	4	4				
Crumlin	18	2	1	1		7		2								
Derrychorraun	5	1	1	1	1											
Doohulla	10	1		1	1	2	1									
Gowla	17	4	1		1	3	2	2								
Gorumna	4	1	1													
Inverbeg	12	2	1		1	4	1									
Invermore	23	6	4		2	2	1		1							
Kylemore	52	5	3	3	3	8	4	2			5					
Lettermuckoo	7	3	1			2										
Lough Fee	19	5	1	1		1		2								
Nafurnace	14	3	3	2	1	1	1	1								
Nagravin	4	1	1	1												
Owengarve	4	1	1													
Owenglin	37	9	4	1	1	2	4	3	3	3	4					
Owennabunnoge	5	1	1	1	1											
Screebe	47	8	5	2	3	2		2	1	2	2					
Skannive	7	2	1	1		1										
Traheen	4	1	1	1												
TOTALS	486	102	52	25	25	54	27	18	10	7	18	4	0	1	2	831
Percentage	58.5	12.3	6.3	3.0	3.0	6.5	3.2	2.2	1.2	0.8	2.2	0.5	0	0.1	0.2	

TABLE 1 Physical characteristics of 24 catchments in the Connemara region

	Catchment area (km^2)	Land area (km^2) (I)	Lake area (km^2)	Stream lengths (km) (II)	Drainage density (II/I)
Aughrusbeg	2.4	1.8	0.6	0.2	0.11
Ballinaboy	30.5	20.3	10.2	17.0	0.84
Ballinahinch	160.0	148.3	11.7	209.7	1.41
Camus Eighter	7.2	6.0	1.2	4.3	0.72
Claddaghduff	2.7	2.1	0.6	1.6	0.76
Costelloe	69.5	64.1	5.4	59.4	0.93
Crumlin	26.6	23.0	3.6	22.5	0.98
Derrychorraun	12.1	9.7	2.4	8.8	0.91
Doohulla	18.4	13.8	4.6	11.5	0.83
Gowla	38.1	28.6	9.5	32.3	1.13
Gorumna	8.5	7.4	1.1	4.3	0.58
Inverbeg	12.2	8.7	3.5	15.5	1.78
Invermore	74.1	64.3	9.8	37.6	0.58
Kylemore	48.1	45.8	2.3	63.2	1.38
Lettermuckoo	15.3	14.0	1.3	9.1	0.65
Lough Fee	22.9	19.3	3.6	28.0	1.45
Nafurnace	20.2	17.1	3.1	24.9	1.46
Nagravin	10.6	9.4	1.2	7.9	0.84
Owengarve	4.7	4.7	—	6.1	1.30
Owenglin	31.9	31.1	0.8	52.9	1.70
Owennabunnoge	5.4	5.4	—	10.0	1.85
Screebe	55.4	45.1	10.3	90.3	2.00
Skannive	16.7	12.5	4.2	6.8	0.54
Traheen	8.6	7.8	0.8	10.2	1.31
TOTALS	702.1	610.3	91.8	734.1	1.20

Table 4 Percentage frequency distribution of 80 samples and the percentage frequency distribution of stream segment numbers, lengths and areas among streams of orders 1-50.

	Stream Orders										
	1	2	3	4	5	6-10	11-15	16-20	21-25	26-30	31-50
Percentage distribution of 80 samples	31.3	10.0	16.3	7.5	11.3	7.5	11.3	2.5	1.3	0	1.3
Percentage distribution of stream segment numbers (N = 824)	59.0	12.4	6.3	3.0	3.0	6.6	3.3	2.2	1.2	0.8	2.2
Percentage distribution of stream segment lengths (N = 726.2km)	62.5	12.3	6.2	2.6	3.4	5.7	2.5	2.1	0.7	0.7	1.3
Percentage distribution of stream segment areas (N = 2.18km²)	53.8	12.6	6.1	2.8	3.8	7.4	4.0	4.0	1.7	1.7	2.2

Table 3 Percentage distribution of stream segment lengths (km) among order categories in 24 Connemara catchments with estimates of the area they represent.

	Stream Categories																
Catchment	1	2	3	4	5	6-10	11-15	16-20	21-25	26-30	31-50	51-70	71-90	91-110	>111	Totals	Percentage
Aughrusbeg	0.2															0.2	0
Ballinaboy	8.1	4.0	1.1	0.2		1.3	2.3									17.0	2.3
Ballinahinch	145.0	25.0	9.0	2.4	4.8	6.0	5.5	3.1	1.5		3.2			1.0	3.2	209.7	28.6
Camus Eighter	3.2	0.3	0.8													4.3	0.6
Claddaghduff	1.6															1.6	0.2
Costelloe	34.3	6.1	2.3	2.6	3.2	4.5	1.3	0.5	0.3	0.6		3.7				59.4	8.1
Crumlin	12.9	1.0	0.3	1.5		4.7		2.1								22.5	3.1
Derrychorraun	4.5	0.2	2.9	0.6	0.6											8.8	1.1
Doohulla	5.3	1.6		0.8	0.2	1.3	2.3									11.5	1.6
Gowla	18.2	4.8	1.0		1.5	1.8	1.9	3.1								32.3	4.4
Gorumna	3.9	0.2	0.2													4.3	0.6
Inverbeg	10.0	1.0	0.3		0.5	3.5	0.2									15.5	2.1
Invermore	21.2	7.2	3.4		1.8	2.7	0.3		1.0							37.6	5.1
Kylemore	42.7	6.0	1.6	1.6	0.8	7.1	2.6	0.8								63.2	8.6
Lettermuckoo	4.7	3.1	0.3			1.0										9.1	1.2
Lough Fee	17.4	5.8	0.5	0.8		0.8		2.7								28.0	3.8
Nafurnace	14.2	1.8	3.4	1.6	1.1	2.4	0.2	0.2								24.9	3.4
Nagravin	4.5	1.0	1.8	0.6												7.9	1.1
Owengarve	4.2	1.1		0.8												6.1	0.8
Owenglin	33.8	4.4	2.9	0.8	0.3	1.6	0.6		0.8	2.1	4.8					52.9	7.2
Owennabunnoge	4.0	1.3	0.2	2.4	2.1											10.0	1.4
Screebe	51.8	11.9	8.6	1.0	7.3	2.1		2.1	1.8	2.1	1.6					90.3	12.3
Skannive	3.5	0.2	0.6	0.6		1.9										6.8	0.9
Traheen	4.5	1.0	3.9	0.8												10.2	1.4
TOTALS	453.7	89.0	45.1	19.1	24.7	41.4	18.2	15.2	5.4	4.8	9.6	3.7		1.0	3.2	734.1	
Percentage	61.8	12.1	6.1	2.6	3.4	5.6	2.5	2.1	0.7	0.6	1.3	0.5		0.1	0.4		
Area represented (km²)	1.175	0.247	0.134	0.060	0.083	0.162	0.088	0.088	0.036	0.037	0.095	0.051		0.021	0.076	2.353	
Percentage Area	49.9	10.5	5.7	2.5	3.5	6.9	3.7	3.7	1.5	1.6	4.0	2.2		0.9	3.2		

Table 5 Physical Characteristics of 80 Stream sites from the Connemara Region

Site No	System	Stream order	Average width (m)	Average depth (cm)	Percentage riffle	Percentage of site with depth greater than 20cm	Site length (m)
22-23 March 1982							
1	Screebe	5	3.7	20	58	38.5	42
2	Ballinahinch	11	7.9	37	38	90.9	40
3	Ballinahinch	11	5.4	42	20	86.7	53
4	Inverbeg	10	4.9	38	13	100.0	28
5	Gowla	13	3.4	30	50	83.3	20
6	Gowla	13	2.2	18	88	41.7	39
7	Ballinahinch	2	2.2	27	47	81.3	55
8	Ballinahinch	3	6.1	19	80	40.0	34
9	Gowla	4	6.1	23	83	50.0	37
10	Gowla	1	2.2	25	42	63.2	61
11	Screebe	11	2.8	16	61	33.3	26
12	Ballinahinch	2	2.6	20	31	30.8	42
13	Ballinahinch	5	3.8	23	44	44.4	68
14	Ballinahinch	3	3.2	21	25	60.0	36
11-12 May							
15	Screebe	25	8.2	21	39	42.9	41
16	Screebe	36	7.9	21	47	56.3	52
17	Ballinahinch	13	5.8	25	59	58.8	57
18	Inverbeg	4	3.3	14	70	10.0	29
19	Invermore	3	3.9	24	20	60.0	48
20	Invermore	1	2.0	14	40	20.0	44
21	Screebe	5	3.4	18	43	33.3	45
22	Kylemore	6	6.0	12	68	27.3	36
23	Kylemore	13	4.4	20	75	33.3	43
24	Ballinahinch	3	2.9	14	38	23.1	44
25	Camus Eighter	1	4.4	13	19	62.5	55
26	Costelloe	1	3.8	18	55	40.0	36
27	Costelloe	3	1.8	36	22	66.6	24
26-28 July							
28	Skannive	1	3.0	24	40	50.0	28
29	Skannive	2	1.7	23	36	42.9	20
30	Invermore	10	5.0	22	19	53.8	36
31	Invermore	10	5.0	19	19	55.6	24
32	Costelloe	6	3.7	18	55	40.0	36
33	Screebe	5	3.0	16	37	36.8	52
34	Lough Fee	18	5.0	13	10	0	10
35	Lough Fee	18	4.4	7	81	0	16
36	Owenglin	13	5.9	30	0	100.0	12
37	Owenglin	13	4.9	11	100	0	22
38	Doohulla	4	2.8	17	36	30.0	28

Site No	System	Stream order	Average width (m)	Average depth (cm)	Percentage riffle	Percentage of site with depth greater than 20cm	Site length (m)
18-22 October							
39	Screebe	1	2.4	22	100	85.7	23
40	Ballinahinch	1	1.8	21	67	55.6	29
41	Ballinahinch	2	2.9	16	91	18.2	37
42	Camus Eighter	1	1.0	28	70	73.3	53
43	Invermore	1	2.0	42	20	90.0	33
44	Screebe	4	4.2	27	43	85.7	26
45	Gowla	1	2.3	30	36	71.4	23
46	Invermore	1	1.0	28	55	90.0	35
47	Owengarve	4	5.3	25	38	75.0	24
48	Lough Fee	1	1.6	23	79	75.0	40
49	Ballinahinch	2	1.6	21	67	44.4	31
50	Lettermuckoo	1	1.5	25	55	80.0	33
51	Lettermuckoo	2	3.0	27	83	66.6	29
16-17 December							
52	Screebe	3	3.8	23	83	66.7	25
53	Screebe	5	4.1	38	17	100.0	25
54	Ballinahinch	1	1.5	19	62	46.2	41
8-11 February 1983							
55	Screebe	5	3.2	21	67	44.4	23
56	Ballinahinch	1	1.4	15	50	30.8	37
57	Ballinahinch	1	4.3	28	14	63.6	39
58	Ballinahinch	1	2.4	14	62	15.4	38
59	Ballinahinch	3	1.5	20	63	25.0	24
60	Ballinaboy	3	2.4	24	87	86.7	45
61	Ballinahinch	3	2.8	19	42	46.2	40
62	Ballinaboy	1	1.5	16	50	16.7	38
63	Doohulla	1	3.0	20	40	50.0	35
64	Ballinahinch	5	3.2	14	65	20.0	33
65	Kylemore	7	3.7	23	44	66.6	31
21-25 March							
66	Ballinahinch	3	5.0	18	100	28.0	21
67	Traheen	3	2.7	33	64	72.7	35
68	Owennabunnoge	5	3.8	20	63	33.3	37
69	Ballinahinch	4	3.1	20	57	60.0	52
70	Ballinahinch	2	2.7	20	100	58.3	42
71	Ballinahinch	5	3.0	22	77	36.4	33
72	Screebe	3	1.9	20	41	54.5	35
73	Gowla	2	3.4	24	60	40.0	31
74	Claddaghduff	1	1.5	21	50	50.3	34
75	Aughrusbeg	1	1.8	13	100	0	29
9-11 May							
76	Ballinahinch	3	2.9	22	81	46.2	40
77	Gorumna	1	1.7	19	59	36.4	34
78	Ballinahinch	1	4.2	25	100	75.0	44
79	Ballinahinch	1	1.4	25	89	57.1	39
80	Nafurnace	1	1.3	27	68	78.6	49

Table 6 Log weight (g): log length (cm) regressions for trout in four sampling months and salmon in one and weight at three fork lengths from the regressions.

	Regressions				Weight at fork length		
	Slope (b)	Intercept (a)	N	r	5 cm	10 cm	15 cm
Trout							
July 1982	3.0544	-1.9661	126	0.9969	1.48	12.25	42.28
October	3.0681	-1.9795	98	0.9985	1.46	12.26	42.55
December	3.1895	-2.1011	111	0.9965	1.34	12.26	44.67
February 1983	2.9977	-1.8814	84	0.8740	1.64	13.07	44.07
May	3.1804	-2.0710	101	0.9809	1.42	12.86	46.71
Salmon							
February 1983	3.4457	-2.3398	79	0.9984	1.17	12.76	51.60

Table 7 Details of Salmonids from 80 stream sites in the Connemara Region

Site Number	No. Salmonids /m²	No. Trout /m²	No. Salmon /m²	Wt. Salmonids g/m²	Wt. Trout g/m²	Wt. Salmon g/m²	Mean length Trout (cm)
March 1982							
1	0.30						
2	0.42						
3	0.44						
4	0.06						
5	0.31						
6	1.01	0.07	0.93	1.96	0.09	1.87	7.00
7	0.13	0.13	0	1.91	1.91	0	8.27
8	0.57	0.41	0.17	5.04	2.27	2.77	7.40
9	0.18	0.03	0.15	0.76	0.09	0.68	6.39
10	0.20	0.17	0.02	1.05	0.41	0.65	5.82
11	0.40	0.40	0	1.58	1.58	0	7.50
12	0.16	0.07	0.09	0.52	0.38	0.13	7.50
13	0.44	0.04	0.39	3.41	0.75	2.67	9.38
14	0.46	0.04	0.42	1.75	0.11	1.65	6.00
May							
15	0.16	0.11	0.05	1.26	0.73	0.53	9.56
16	0.44	0.15	0.28	2.71	0.77	1.94	8.36
17	0.45	0.08	0.38	2.59	0.83	1.76	11.23
18	0.23	0.15	0.07	1.85	0.82	0.80	9.35
19	0.01	0.01	0	0.15	0.15	0	13.50
20	0.02	0.02	0	0.14	0.14	0	9.00
21	0.54	0.19	0.35	2.74	0.89	1.85	7.69
22	0.29	0.13	0.16	1.25	0.68	0.56	8.82
23	0.66	0.15	0.51	3.41	1.30	2.12	10.64
24	0.49	0.07	0.42	1.58	0.38	1.20	8.61
25	0.43	0.03	0.41	1.67	0.13	1.54	8.00
26	0.37	0.15	0.22	3.03	1.81	1.22	11.70
27	0.53	0.51	0.02	6.02	5.79	0.23	12.10
July							
28	0.79	0.49	0.30	5.68	3.02	2.65	6.89
29	0.83	0.69	0.14	1.77	1.49	0.28	5.30
30	0.20	0.18	0.01	0.68	0.64	0.04	6.50
31	0.06	0.06	0	0.63	0.63	0	8.50
32	0.74	0.30	0.44	4.86	1.31	3.55	6.19
33	1.62	0.71	0.91	5.26	1.89	3.37	5.29
34	2.61	0.56	2.05	16.45	2.50	13.95	6.17
35	3.32	0.41	2.91	7.58	1.84	5.73	6.17
36	0.45	0.11	0.34	7.75	1.32	6.43	8.67
37	1.04	0.27	0.77	12.03	3.17	8.85	8.25
38	0.22	0.12	0.10	3.49	1.46	2.03	8.61

Site Number	No. Salmonids /m²	No. Trout /m²	No. Salmon /m²	Wt. Salmonids g/m²	Wt. Trout g/m²	Wt. Salmon g/m²	Mean length Trout (cm)
October							
39	0.32	0.25	0.07	1.16	0.69	0.47	5.64
40	0.72	0.72	0	3.16	3.16	0	6.71
41	0.45	0.38	0.07	2.13	1.77	0.36	7.40
42	0	0	0	0	0	0	0
43	0.49	0.49	0	5.32	5.32	0	8.30
44	0.24	0.16	0.08	1.40	0.34	1.06	5.38
45	0.13	0.13	0	1.23	1.23	0	7.79
46	0.40	0.40	0	4.77	4.77	0	8.50
47	0.04	0.04	0	1.54	1.54	0	11.83
48	0.23	0.23	0	1.21	1.21	0	6.87
49	0.39	0.39	0	7.25	7.25	0	9.55
50	0.14	0.14	0	0.55	0.55	0	6.79
51	0.27	0.27	0	?	?	?	?
December							
52	0.30	0.19	0.10	1.27	0.29	0.98	5.06
53	0.93	0.21	0.72	7.00	0.76	6.24	4.94
54	0.25	0.25	0	0.89	0.89	0	6.17
February 1983							
55	0.41	0.11	0.30	3.22	0.27	2.95	5.75
56	0.21	0.21	0	1.91	0	0	7.95
57	0.10	0.07	0.02	0.95	0.76	0.19	8.40
58	0.37	0.37	0	5.45	5.45	0	8.37
59	0.09	0.09	0	0.25	0.25	0	6.17
60	0.04	0.04	0	0.22	0.22	0	8.50
61	0.52	0.07	0.46	3.62	0.31	3.31	7.00
62	0	0	0	0	0	0	0
63	0.14	0.14	0	1.31	1.31	0	8.07
64	0.52	0.30	0.23	3.03	1.74	1.29	6.71
65	0.41	0.40	0.01	3.65	3.52	0.13	8.28
March							
66	0.83	0.16	0.67	6.26	1.07	5.19	7.28
67	0.34	0.34	0	8.90	8.90	0	11.65
68	0.24	0.24	0	5.36	5.36	0	11.31
69	0.42	0.42	0.01	2.65	2.63	0.02	7.21
70	0.58	0.23	0.35	2.70	0.67	2.03	6.07
71	0.64	0.19	0.45	2.65	0.41	2.24	5.50
72	0.25	0.23	0.03	1.71	1.39	0.31	7.83
73	0.09	0.09	0	2.02	2.02	0	9.90
74	0.06	0.06	0	0.30	0.30	0	7.50
75	0	0	0	0	0	0	0
May							
76	0.62	0.40	0.21	1.86	0.98	0.88	4.60
77	0.18	0.18	0	1.05	1.05	0	5.00
78	0.05	0.05	0	0.31	0.31	0	7.30
79	0.92	0.92	0	0.62	0.62	0	3.50
80	0.34	0.34	0	4.27	4.27	0	10.00

Table 8 Reported values for brown trout *Salmon trutta* standing stocks (g per m²).

Location	g/m²	Authors	Date
Pennsylvania	1.3 - 13.7	McFadden and Cooper	1962
United Kingdom	0.5 - 12.9	Le Cren	1969
United Kingdom	0.3 - 16.6	Crisp, Mann and McCormack	1974
United Kingdom	6.6 - 12.4	Crisp and Cubby	1978
Tasmania	0.1 - 18.2	Nicholls	1958
Michigan	*C* 12.0	Ellis and Gowing	1957
United Kingdom	0.5 - 2.0	Horton	1961
United Kingdom	2.6 - 19.7	Milner, Gee and Hemsworth	1978
Ireland	0.6 - 13.9	McCarthy	1972
Ireland	0.1 - 8.9	Present work	

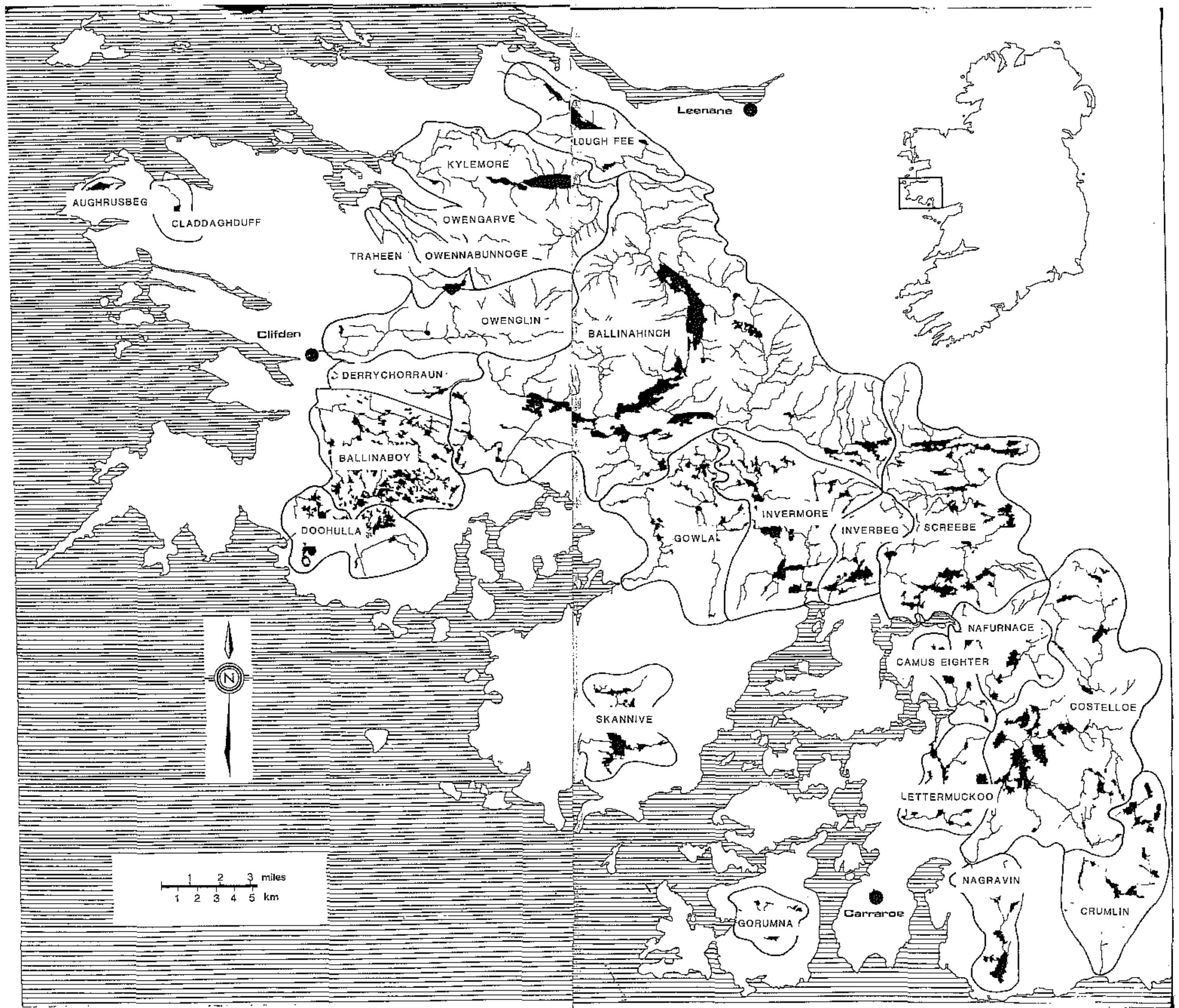

Figure 1. The Connemara Region showing the 24 catchments whose physical features were considered in characterising the area.

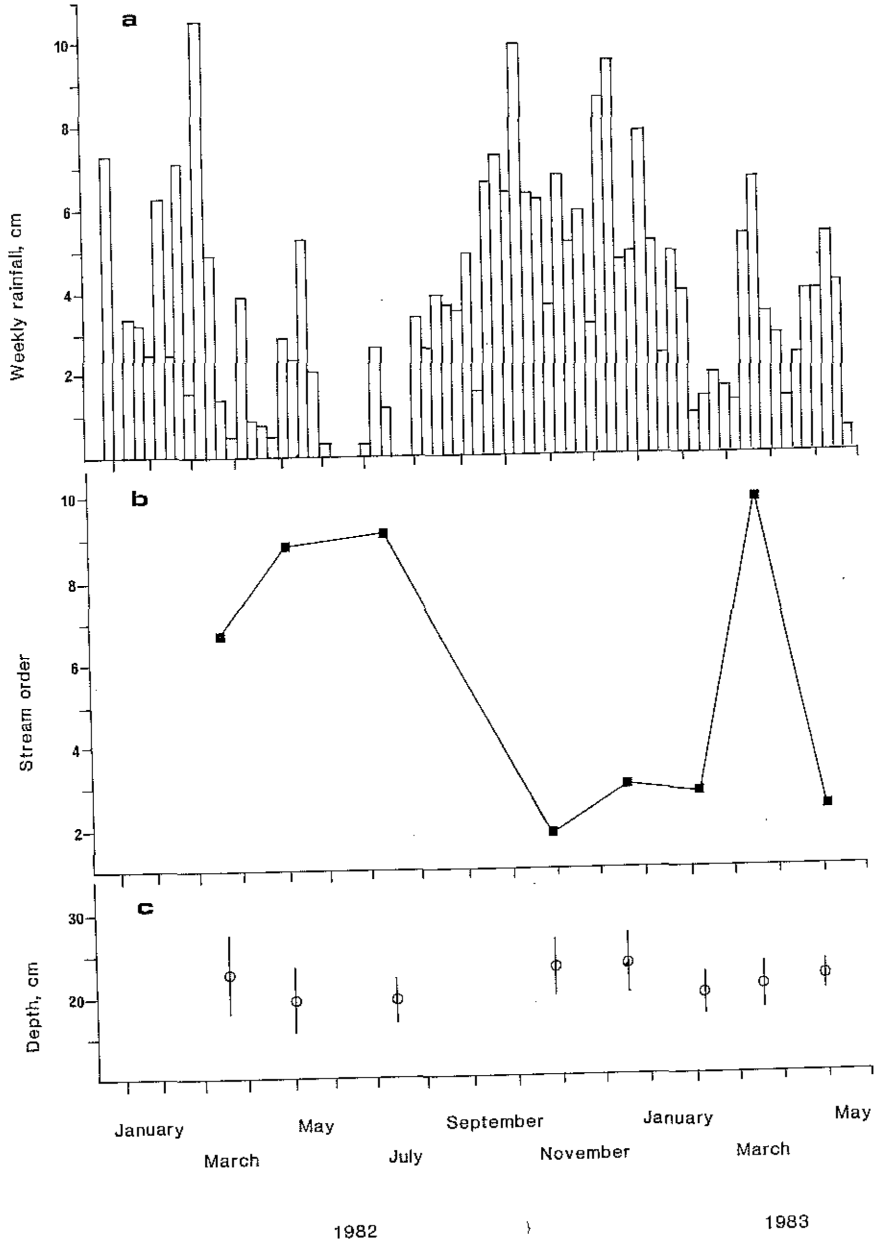

Figure 2. Details of the sampling programme from March 1982 to May 1983 a, Weekly rainfall at Ballinahinch b, Mean stream order fished and c, Mean depth of water fished (vertical line = ±1 standard deviation).

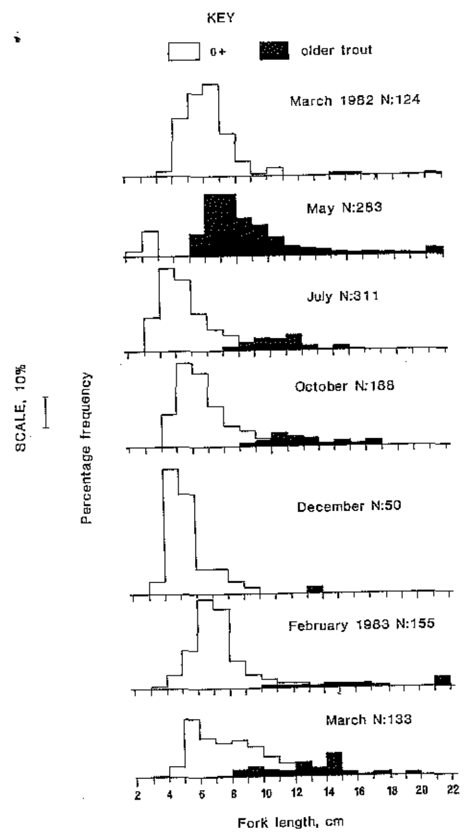

Figure 4. The length frequency distribution of trout parr.

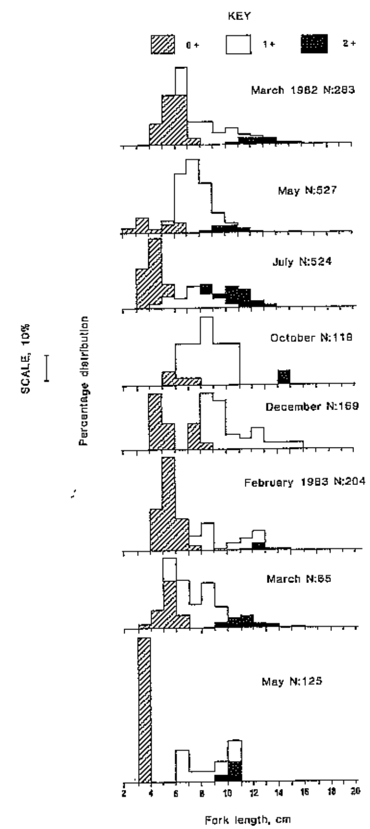

Figure 5. The length frequency distribution of salmon parr.

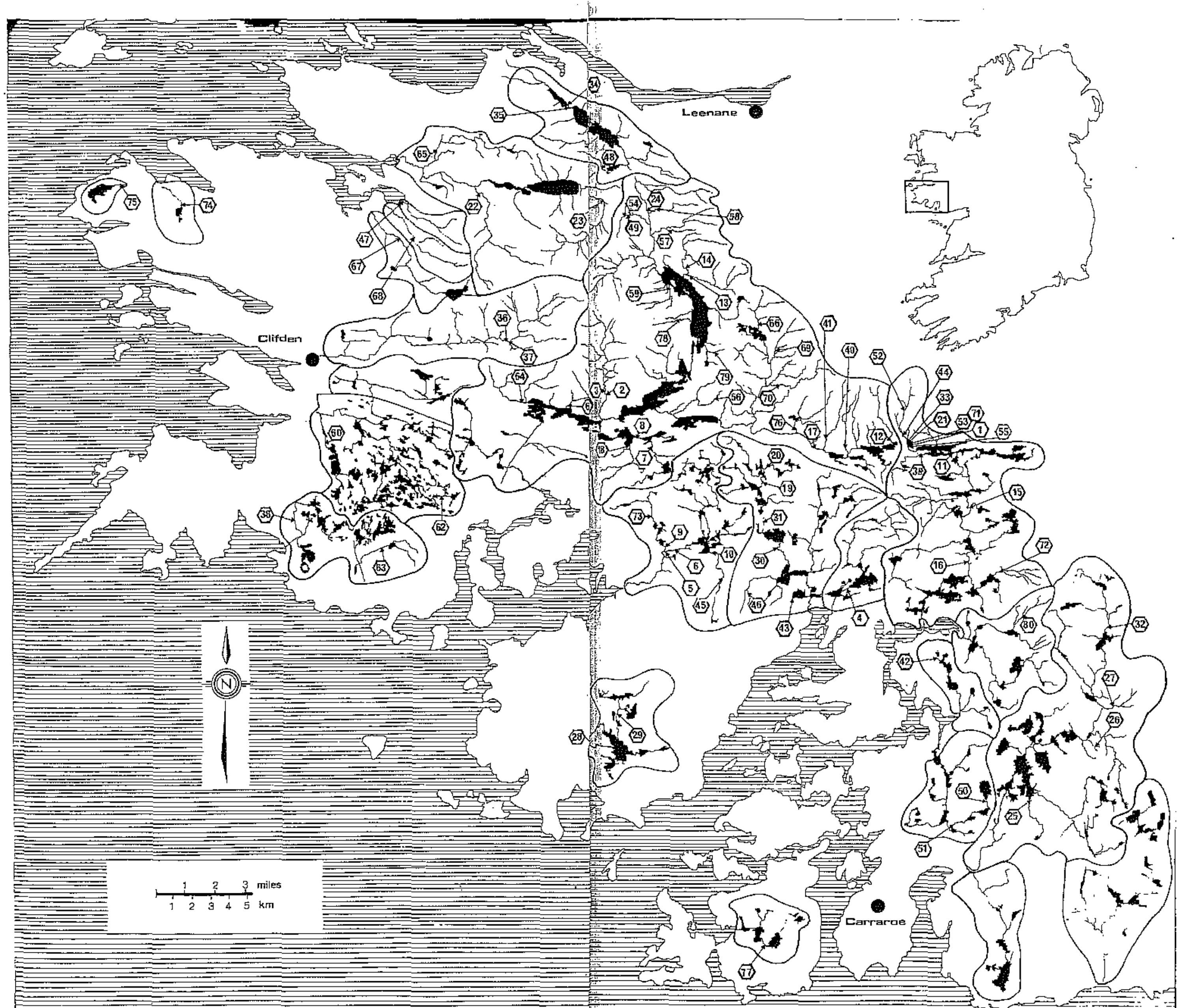

Figure 3. Location of 80 stream sites in the Connemara Region fished between March 1982 and May 1983.

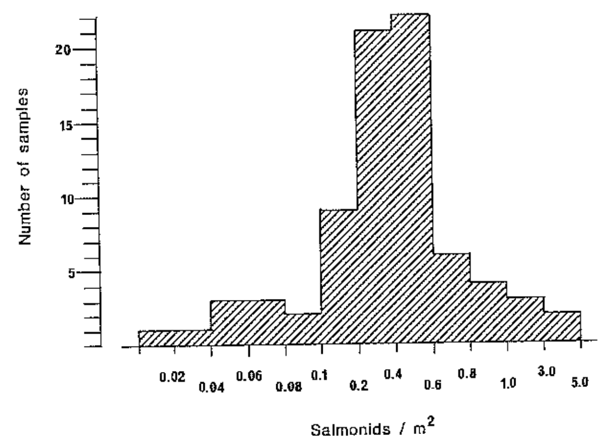

Figure 6. Frequency distribution of salmonid density (numbers per m^2) from 80 sites in the Connemara Region.

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