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Studies of the eel *Anguilla anguilla* in Ireland

1. In the lakes of the Corrib System.

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ABSTRACT.

A total of 1,722 immature eels of lengths 25 to 95 cm and ages 5 to 33 years were collected in summer by fyke netting. It was shown that migration upstream was very slow, few eels of less than 9 years old being found upstream of Lough Corrib. Eels of less than 50 cm fed mainly on invertebrates, larger individuals becoming piscivorous. Differences in the diets in the various lakes were observed and some evidence of selective feeding was found.

INTRODUCTION.

A programme for the study of eels in Irish lakes was begun in 1967. The main object of the study was to discover why eel production in the Republic of Ireland was exceptionally low by the standards both of Northern Ireland and a number of continental countries at similar latitudes. The method of working was to collect samples of immature or "yellow" eels by using summer fyke nets.

The programme began with a preliminary study of the eels of Lough Corrib, in the region around Oughterard, Co. Galway which lasted from June to August 1967. In 1968 sampling was continued in Lough Corrib over a longer season, from May to early September. In 1969 the survey of Lough Corrib was concluded and samples from Lough Carra and Lough Mask were taken. A number of other waters have been studied in the course of the investigation and the results will be presented in future publications.

In 1965 a series of experiments using the "summer fyke nets" was begun. These nets were first operated in Ireland by a Danish fisherman, Mr. Norgaard, who, in 1963 made excellent catches in Lady's Island Lake, Co. Wexford. A preliminary report on work in 1965 and 1966 has already been published (Moriarty, 1971). Experience in the use of these nets showed that they served as a highly efficient sampling instrument for eels of more than 40 cm in length.

A considerable volume of information has been available on the annual "runs" of silver eels for some years. The situation with regard to the yellow eel population was quite different. Apart from some casual observations made in conversation by long-line fishermen, no information whatever was available on the eels in lakes in Ireland which formed the basis of all the fishing —silvers and yellows alike. The first question to be asked was whether the lakes were really densely populated with eels. The answer to this would lead to a choice of problems. If the stocks proved to be dense more efficient methods of catching the eels must be sought. If the eels proved to be less abundant than popularly believed a means of increasing the stocks would be required.

The approach made to the first question was to fish for eels using a standardised effort so that density of population could be compared from lake to lake. The low catches which resulted removed any possibility of estimating an absolute figure for any of the populations—tag and recapture data would have been inadequate. Length and age frequencies in the lakes could also be determined and should reveal in particular whether there was any shortage of eels due to inadequate supplies of elvers or, on the other hand, whether a population might be stunted on account of overcrowding. The stomach contents of the eels sampled could also be analysed in the hopes of establishing the degree of competition with other fish species and of determining whether some waters might be better than others as feeding grounds.

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A number of studies have been made of the size and age compositions of silver eel runs and of small yellow eels. In Ireland Marcus (1919) determined the ages of eels from the River Clare; Frost (1949) determined age and length frequencies for silver eels leaving Lough Neagh. Champ (1968) studied the eels of the River Boyne system, including fyke-net samples in Lough Ramor.

Sinha and Jones (1967) reviewed previous studies on age determination in eels. They state that otoliths were not used until Ehrenbaum and Marukara (1913) and they list subsequent investigations using this technique: Marcus (1919) on eels from the River Severn in Great Britain and the River Clare, Hornyold (1922) on a small Worcestershire pond, Tesch (1928) on the River Waal, Holland, Frost (1945) on the English Lake District, Rassmussen (1952) in Lake Esrum, Denmark and Deelder (1957) on the IJsselmeer.

Deelder (1970) summarised biological data on the eel and the scarcity of information on age and growth is remarkable. Although the species has received a great deal of attention work has been directed much more towards migratory habits and physiology than towards studies of the immature populations. There is also remarkably little said of the eel in standard text-books on fish population studies. Beverton and Holt (1957) mention in a footnote that a minimum size must be attained before migration while Nikolsky (1969) and Ricker (1953) make no reference to *Anguilla.*

Information on the food of eels is very scarce. Frost (1946) gave details of stomach analyses of Windermere eels, Sinha and Jones (1967) studied populations in Welsh rivers. Deelder (1970) stated that "eels are fully catholic with regard to animal food, provided it is alive or extremely fresh". This statement is doubtless true but it takes no account of the eel's preferences or of the availability of types of food. Comparison of the stomach contents of eels of different sizes and from different waters in this study shows very interesting variations in the food organisms which the eel apparently selects. Continental references to food appear to be limited to general statements such as those of Hornyold (1926) which list food types under broad headings.

An important feature of the present study is that it is confined to eels in Ireland. Besides the three papers listed above no investigations of Irish eels have been published. For a number of reasons it is impossible to relate Continental findings closely to local conditions. In the first place temperatures are different. In summer water on the Continent is usually warmer and in winter (in the northern latitudes) colder than in Ireland. In the larger Irish lakes temperatures above 18°C are seldom attained (Fitzmaurice 1971) and it appears from the work of Boëtius and Boëtius (1967) that maximum activity in eels might be found at temperatures of 25° to 26°C when respiratory rate and heart rate are at their highest. Deelder (1970) showed that eels become highly active at a temperature of 20° and higher. So it seems that the majority of Irish eels may never live at an optimum temperature.

The other great difference between Continental and even British waters and those of Ireland is the poverty of the Irish fauna. There are fewer species of fish in freshwater—18 as against 46 for Western Europe (Wheeler 1969). This could mean less competition for food but might also have a profound effect in reducing the number of fodder species available to a piscivorous eel. The shortage of invertebrate species could reduce the choice of food available to the eel. For example *Gammarus pulex* is an important constituent of the Windermere eels' diet (Frost 1946) but is absent from Ireland. It is not known whether *Gammarus duebeni* completely fills the niche of *G. pulex* in Ireland or whether its habits might make it more or less available to eels.

Besides any differences which exist between Irish lakes and Continental waters it became apparent that even within Ireland and within the rather narrow range of types of water selected there were great variations in food, growth and size of the eel populations. It is therefore essential that projects for increasing eel catches be based on local information.

One of the greatest difficulties in a study of eels is the degree of variation between individuals. This can be observed even in the uniform conditions of an aquarium where the rate of growth may vary from 1 g to 124 g in a single summer (Meske 1968). In the wild populations although, as expected, length is positively correlated with age and weight, great variations are observed in both age and weight in eels of any given length. It was found, however, that the samples collected were large enough to demonstrate marked variations between the populations and to permit significant conclusions to be drawn.

2. MATERIAL AND METHODS

CAPTURE

The usual method of sampling the eels was the use of the summer fyke net. A fyke net essentially consists of one or more conical traps of mesh supported on rigid hoops, each trap fitted with two or more valves of netting. The traps may be used on their own or with one or more "leaders" which form curtains of netting, in contact with the bed of the lake or river. The "summer fyke", so called because it is used in the warmer months of the year to capture eels in the course of their wandering in search of food, consists of a pair of traps joined mouth to mouth by a single leader. The diameter of the mouth is equal to the height of the leader and of the order of 50 cm. Details of the nets used in the study are given on page 15. The nets were set in trains from two to twenty, paid out from the stern of a moving boat. A train can be managed by one person and much of the work was done single-handed but a second operator was highly desirable and teams of two were employed wherever possible. The efficiency of the nets as a sampling tool is discussed on page 28.

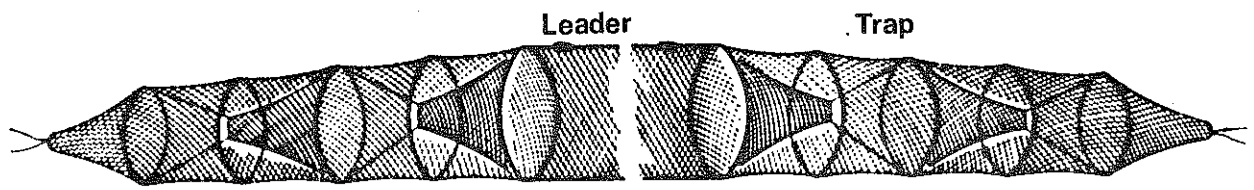

Fig. 1. Fyke-net unit.

The standard procedure in the field was to set a train of nets and lift them the following morning. Yellow eels are nocturnal animals, with peaks of activity after dusk and before dawn (Mohr 1971). The equivalent of a full day's fishing was therefore achieved even if the nets were not left in a fishing position throughout the day. The unit of effort used in the study is a "net day", representing a single net (consisting of two traps and one leader) set overnight. A train of eight nets set in the evening and raised the following morning therefore represented an effort of eight net days. The same train, set for longer periods up to four days was considered to represent a greater effort. Eight nets left in a fishing position for four nights gave an effort figure of 32. Nets which had been left down for longer periods were not taken into the account of total effort. The purpose of fishing daily on all possible occasions was to ensure the capture of eels with food in their stomachs. The average catch per net per day (total catch/total net days) was called the "unit catch".

Experience showed that in most of the main lakes a train of eight nets would yield a catch of between ten and twenty eels and this number was sufficient for examination in the course of the day. The train of eight nets, therefore, became established as a standard set. With this return it was usually possible to examine the entire catch. When sub-sampling was necessary the procedure was to measure the lengths of all specimens and to set aside the contents of one or more nets for detailed examination. The nets were left in the water for single nights except at weekends and when rough weather made fishing impossible.

EXAMINATION OF EELS

On return to base the eels were anaesthetised by immersion in a strong solution of Chlorbutol (1, 1, 1-trichloro-2-methylpropan-2-ol). This was made by dissolving one or two grams of the solid in about two litres of water. Such a solution would relax about ten eels. The two litres could not be used for a second batch; possibly a reaction between the mucus of the eels and the Chlorbutol rendered it ineffective. From time to time large specimens failed to react to the first immersion and these had to be treated with a fresh solution. Anaesthesia is essential in eel studies on account of the difficulty of holding a living or abruptly killed individual. The anaesthetised eels were measured and weighed and otoliths and stomach contents were preserved.

A rough assessment of the fullness of the stomach was made before preservation, using a slight adaptation of the "points" system devised by Hynes (1950). 0 indicates an empty stomach; 16 a full stomach (Hynes added 32 for "distended" but the distinction between "full" and "distended" was difficult to make); 8 points indicate a half-full stomach; 4 points quarter full and 1 point a stomach which contains a trace of food. Intermediate numbers of points are not allotted. After the fullness had been assessed the stomach was taken out and opened and the contents preserved in 70% alcohol.

Otoliths were treated by Christensen's burning technique (Christensen 1964) which reveals growth rings in contrasting black and white. Techniques for extracting and mounting the otoliths are described in a separate article (Moriarty, in press). When the eel's growth is rapid the pattern of rings on the otolith is frequently beautifully clear, fine black lines which indicate a winter check, alternating with broad white bands of summer growth. Unfortunately such patterns were found in fewer than half the specimens examined. Multiple rings in the form of one or more ill-defined black lines between better marked ones were frequent. There were many cases where the black lines were not concentric but two or more converged into single ones. Apparently growth of the otolith in these cases was localised, no growth taking place in two or more directions on some occasions.

Mr. Zoltan Thuransky, of the Hungarian National Fisheries Inspectorate, kindly supplied the writer with a sample of otoliths from eels which had been planted as elvers in a virgin lake and were known to be six years old or less. These otoliths showed numerous fine, dark rings and a small number of pronounced ones, the latter clearly being annual. This establishes beyond any doubt that a number of dark rings may be laid down in any one growing season.

The "clear" otoliths, those with well defined winter lines and few or no uncertain ones, could be read with confidence with a possible error of one year in either direction. There was far less certainty in dealing with the more complex patterns. However, omission of all the difficult specimens would lead to a strong bias in favour of individuals which had shown a steady, and probably faster than average, growth rate. The results are, therefore, based on reading all otoliths on the assumption that experience with the clear specimens would lead to a reasonable estimate of the ages of the complex ones. The percentage of "clear" to "poor" otoliths was recorded and showed some interesting variations. Reading of all of the otoliths used in this study took place between September 17 and December 1 1971. It is believed that confining the examination to this short period reduced the possibility of errors which might have appeard if the otoliths from various waters had been read at times separated by months or even years.

Comparisons of the results of otolith reading from burned specimens with those from the more widely used ground specimens were made by Champ (1968), using the different techniques on pairs of otoliths. He found a close correlation between results from the two methods in specimens up to nine or ten years old but subsequently the burning technique tended to reveal more rings. Continental workers have been concerned mainly with relatively small and young eels. For example Deelder's (1957) study of IJsselmeer eels dealt mainly with males of less than 40 cm which migrated at 9 years old and Tesch (1928) worked on eels of less than 42 cm, this being the maximum length for males in Holland. Ages in the present study are given as the number of winter rings outside the nucleus formed by leptocephalus growth. So a 10 year old eel will be one which has ten complete summer bands and one incomplete.

The information on water chemistry was kindly provided by the Inland Fisheries Trust. The "alkalinity" is given as milli-equivalents of bicarbonate per litre, electrical conductivity is expresses in reciprocal megohms per cm.

3 RESULTS

LOUGH CORRIB CENTRAL June—August 1967.

Lough Corrib, 166,000 ha, is divided into two district regions. The north basin (boundary at AA in Fig. 2) is a deep lake by Irish standards, reaching a maximum of 46 m. A large proportion of the lake is deeper than 3 m and there are many islands, formed from a drowned drumlin topography. The western shore and catchment are underlain by acid metamorphic rock. The eastern catchment is largely Carboniferous limestone, covered in many places by lime-rich glacial gravels. The water is relatively rich, alkalinity varies from 1.5 to 1.8, conductivity from 213 to 218 (see above).

The sampling season extended from June 17 to August 25, based at Oughterard (X 1967 on map, Fig. 2). Field work from June 26 to August 25 was by a university student Mr. Paul Curry. The highest temperatures recorded were 19.5°C in June, 15.5°C in July and 18°C in August.

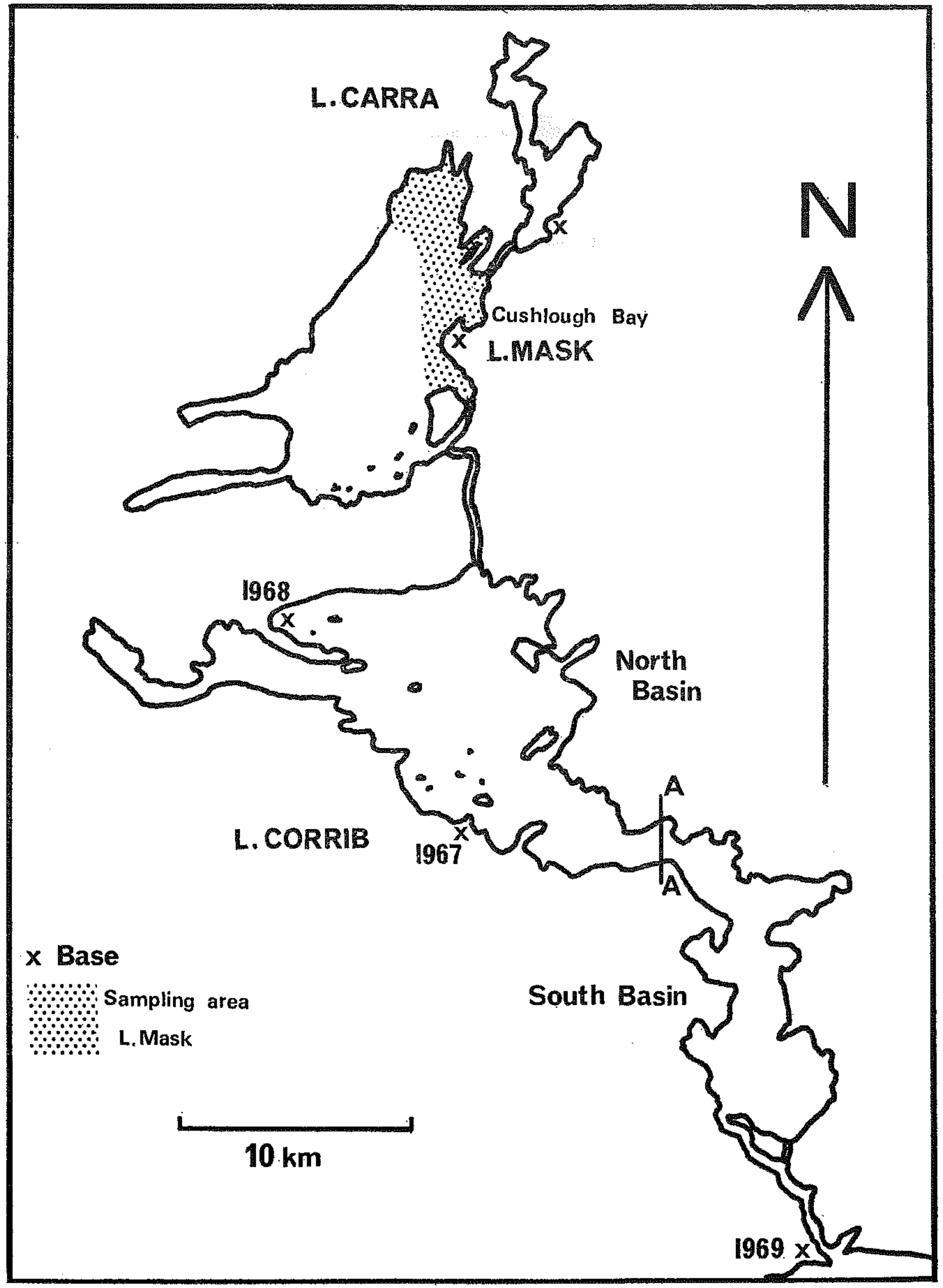

Fig. 2. The Corrib System, showing (AA) the boundary between north and south basins and (X) bases for sampling. (Based on the Ordnance Survey by permission of the Government (Permit No. 1833).

Catch and Effort

White nets (see page 15) were used throughout the season. As a rule two trains were fished every day; the numbers of nets in each train and the number of times such trains were fished are shown below:

Number of nets	...	2	3	4	5	6	Total
Times of fishing	...	23	36	8	0	17	84

The nets were set at random in eight areas, shown in Fig. 7. The areas, depth, effort and catch are shown in Table 1.

Table 1. Catch and Effort, North Corrib 1967

Position		Depth (m)	Effort (net days)	Unit Catch Min	Unit Catch Mean	Unit Catch Max	Total Catch
Barrusheen N.	...	2—5	108	0	1.2	2.6	129
Barrusheen S.	...	1—2	61	0	1.7	5.0	104
Illaunnacreeva	...	1—2	74	0	2.1	4.3	154
Inishshanboe E.	...	5—7	72	0.3	1.7	2.8	122
Inishshanboe S.	...	4—6	80	0.1	4.1	6.1	328
Roeillaun N.	...	6—10	52	0	0.9	2.5	46
Foorannagh	...	5	3	—	0.3	—	1
Derreenmeel	...	7—8	12	0	0.3	0.5	3
Total	...		462				887

Length and Weight

The length distributions of the total catches were set out on a month to month basis to determine whether there was any evidence of movement of large or small eels into the area as a whole in the course of the summer.

Table 2 shows the percentages of eels in each length group in each of the three months.

Table 2. Length distribution on date basis (% of n)

Length (cm)	June	July	August
20—30	9	6	8
30—40	30	32	52
40—50	34	45	28
50—60	19	12	9
60—90	8	5	3
n	64	534	243
Mean	43.9	47.3	42.1
SE	1.3	1.0	1.1

A fall in the proportion of larger eels (over 50 cm) from June to August was apparent. The modal length group was 40-50 cm in June and July but it fell to 30-40 cm in August. A possible explanation was that eels of different sizes had different habitat preferences and so the length distributions in the three areas where most fishing was done in July were compared. The unit catch figures had already indicated that these three areas had different densities of population. The figures are given in Table 3. (See Fig. 3).

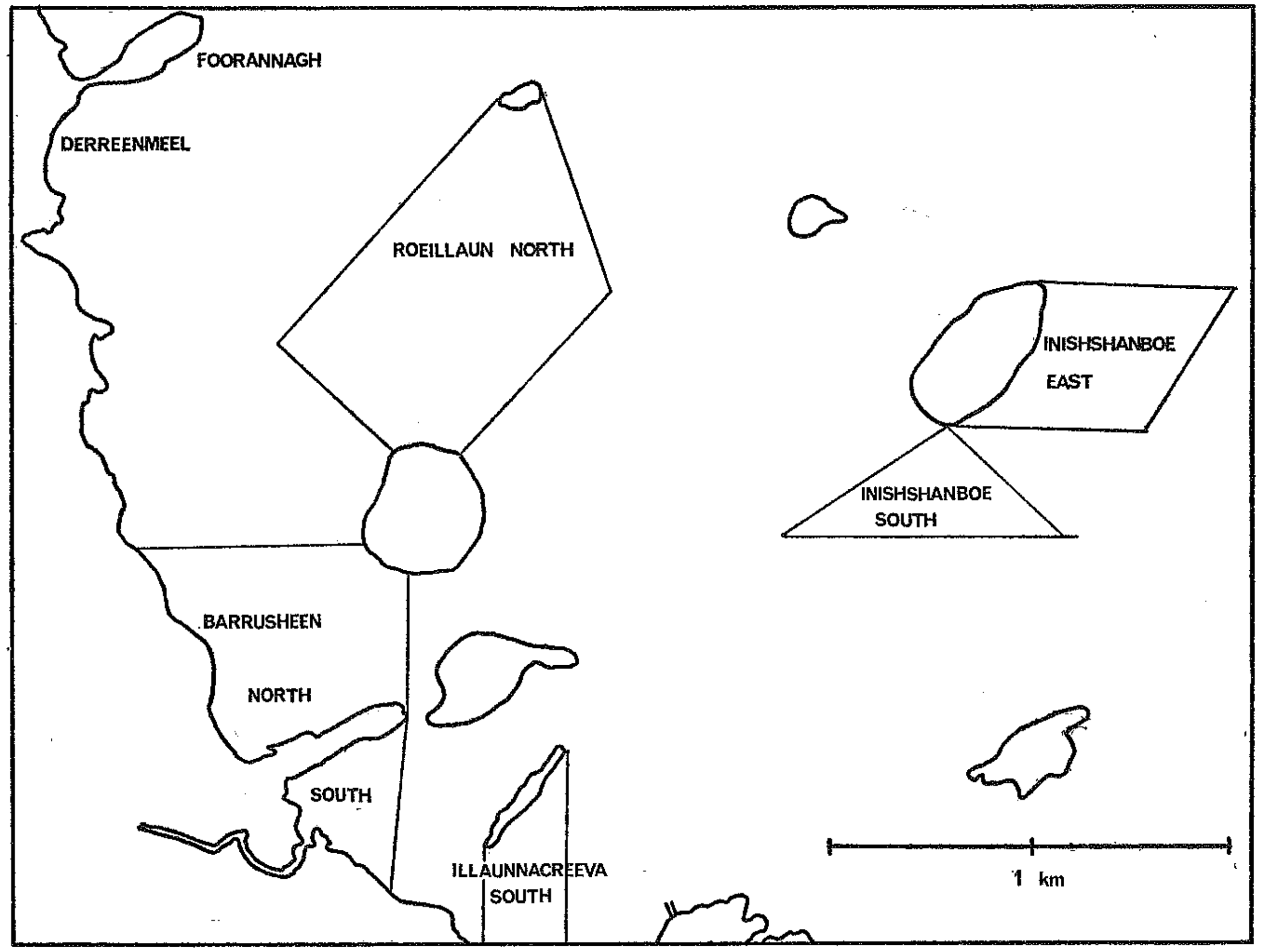

Fig. 3. Mid-Corrib region sampled in 1967. Based on the Ordnance Survey by permission of the Government (Permit No. 1833).

Table 3. Length distribution in July (% of n)

Length (cm)	Inishshanboe East	Inishshanboe South	Illaunnacreeva South
20—30	1	4	14
30—40	23	23	50
40—50	53	47	33
50—60	18	18	2
60—90	5	8	1
n	75	168	141
Mean	47.0	46.6	39.4
SE	1.01	0.88	0.57

These figures suggested a distinct choice of habitat between large and small eels. Small specimens were relatively plentiful in the shallow water to the south of Illaunnacreeva but scarce off Inishshanboe (4-7 m). Individuals of more than 50 cm were very scarce in the shallows but plentiful in the deeper, offshore waters where they made up nearly 25% of the catch in both positions. There was insufficient data in June to allow useful comparisons to be made. In August it was possible to compare the deep water area of Roeillaun North with the shallow one of Barrusheen South. The figures are shown in Table 4 (columns 2 and 3).

Table 4. Length distribution in June and August (% of n)

Length (cm)	August Roeillaun	August Barrusheen South	June Barrusheen North	August Barrusheen North
20—30	0	12	8	2
30—40	35	59	25	54
40—50	33	24	38	39
50—60	20	4	21	5
60—90	12	1	8	0
n	27	131	52	44
Mean	48.1	36.0	44.6	38.8
SE	2.01	0.57	1.54	1.02

This comparison supported the theory of difference in choice of habitat. The fact that in August a large proportion of the fishing took place in shallow water could therefore explain the apparent scarcity of large eels from the area as a whole in that month. It is possible to compare two more sets of figures, those taken from relatively shallow (2-5 m) inshore water at Barrusheen North in June and August. These distributions appear to confirm the suggestion that large eels are scarcer in the shallows in August than earlier in the season.

A regression line for comparing length and weight was computed, plotting $\log_{10}$ length against $\log_{10}$ weight and using the method of least squares to determine values of a and b in the equation $w = al^b$ (Ricker 1958). When all of the length and weight values were entered anomalous results were obtained—a negative slope on one occasion and figures well below the expected minimum of 2 on others. These were caused by the fact that below a certain size the mesh selected only the heaviest members of the length groups. The length distributions suggested that eels of over 40 cm were being fully sampled and regression lines were therefore based on the weights of eels of longer than 40 cm. The following monthly values for a and b were computed:

	a x 10^{-4}	b	s	n
June ...	5.4	3.30	0.07	33
July ...	2.2	3.53	0.07	65
August ...	3.3	3.41	0.06	43

The standard deviation(s) gives the variation in log weight for a given log length. The July line with 95% confidence limits is shown in Fig. 7 (page 30).

Age Composition

This section treats together the ages of eels from all parts of the area. The presence of eels of different sizes in different depths and the extent of migration (discussed below, page 29) makes it unlikely that a group of eels would settle in one small territory throughout their lives. It is assumed therefore that the eels are randomly distributed with regard to age and growth rate within the lake.

The otoliths in general proved difficult to read. Only 11% were clear (see page 6). It will be seen from Table 5 that eels from 6 to 20 years were collected, those of more than 20 being scarce. One exceptional specimen showed 33 clear and evenly spaced rings and apparently was a slow-growing individual of that age. The lengths of eels within each year class proved to be very variable, though showing a normal distribution. On account of the relatively small samples taken and this great variability it was found that treating the samples in 2-year classes was more satisfactory than considering 14 single classes. This treatment had the added advantage of reducing the influence of the uncertainty of age determinations.

It may be said that all of the figures in Table 5 point to the fact that the samples were very much too small to permit the making of a satisfactory statistical analysis. In spite of this reservation some general conclusions could be drawn. There was a fall in the proportion of eels above the 11-12 group through the period, from 51% in June to 39% in August. An increase in mean length from June to July was shown by all age groups, as might be expected. But in August the mean length per age group fell. The data for the 11-12 and 13-14 age groups are shown in Fig. 4. Whatever the significance of these observations they suggested that, in comparing populations, samples should be taken over comparatively short periods. Comparisons of a July population with an August one from a different water might give misleading results.

Table 5 shows that eels of over 19 years of age may be as small as 40 cm while a length of over 76 cm may be attained by an individual of 13-14 years. Exceptionally large specimens, those of over 80 cm were all more than 19 years old. The modal age group of 11-12 had a mean length of the order of 40 cm. The fall in numbers of eels above this age suggested that, in this little-exploited fishery, this was the age when migration began.

Table 5. Length and age data. Mid Corrib 1967

Age	%	Length (cm) Min	Max	Mean	SE
JUNE	n= 57				
7— 8	5	30	36	32.9	1.67
9—10	16	26	39	33.8	1.65
11—12	28	27	49	39.3	1.30
13—14	20	38	52	46.3	1.39
15—16	9	35	46	42.5	1.80
17—18	14	44	65	52.4	2.32
19+	8	46	76		
JULY	n=137				
7— 8	10	27	41	34.6	1.24
9—10	23	27	50	38.9	0.98
11—12	22	28	57	42.8	1.05
13—14	19	35	76	49.9	1.67
15—16	10	41	62	51.9	1.44
17—18	7	44	62	52.6	1.76
19+	9	49	86		
AUGUST	n= 75				
7— 8	9	29	36	33.8	1.70
9—10	24	26	40	33.2	0.82
11—12	28	33	48	40.6	0.88
13—14	12	37	50	45.2	1.56
15—16	11	44	65	50.6	3.02
17—18	7	49	56	52.6	1.12
19+	9	40	74		

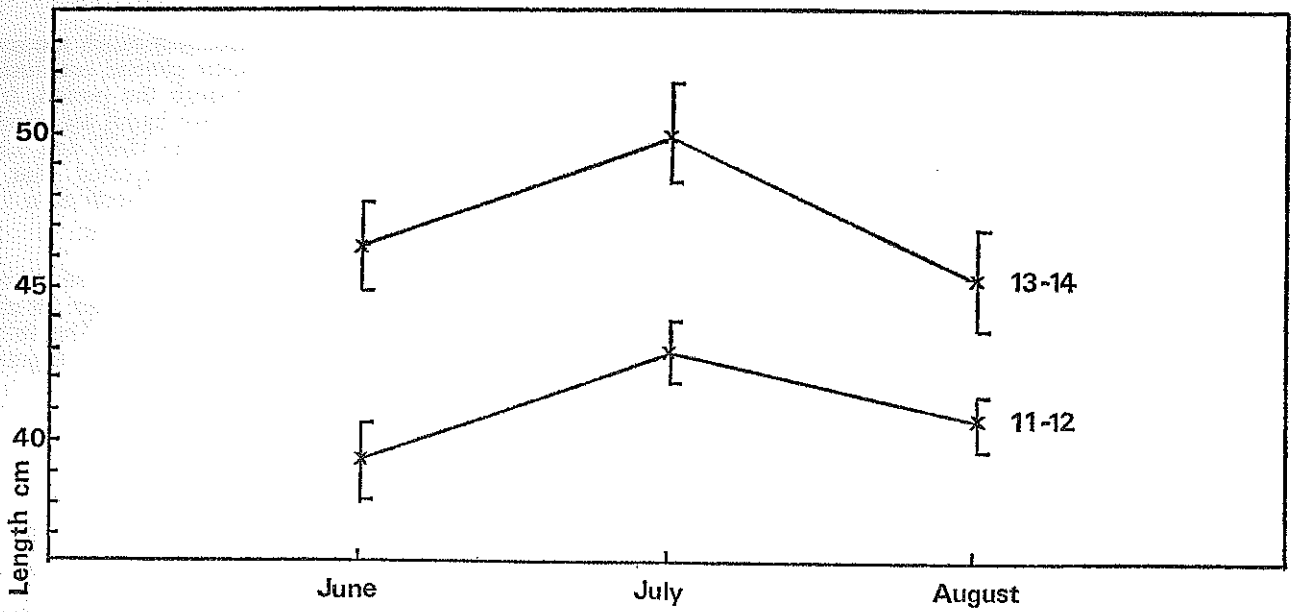

Fig. 4. Mean lengths for two age groups, Corrib 1968. Vertical lines equal 1 standard deviation.

The great range in lengths for each year class made it difficult to judge the age of an eel by its length. A regression line for age-length data was computed by the method of least squares. It was found that when all of the observations for a month were entered a negative slope for the regression line resulted. This was caused by the large number of specimens between 30 and 45 cm, many of which represented the faster growing eels in the lower age groups. To reduce the influence of these a sub-sample was taken, made up of the first five entries in each 5 cm length group. For example, the June sample on this basis consisted of the following:

Length (cm)	25—30	30—35	35—40	40—45	45—50	50—55	55—60	60—65	65—70	70—75	75—80
Numbers	5	5	5	5	5	5	5	0	3	0	1

The following lines were computed for the equation y=cx + d (see page 29) where x=age, y=length, r=regression coefficient and s=standard deviation of length.

	n	c	d	r	s(cm)	Length range of sample (cm)
June ...	39	2.7	8.2	0.8	6.4	26—76
July ...	50	2.6	15.4	0.8	10.6	27—86
August ...	35	2.5	12.1	0.8	6.3	26—74

Food

The stomachs of 275 of the eels were analysed. The fullness of the stomachs for three length groups over the three months is shown in Table 6. These figures are taken from 214 stomachs from the eels which were caught after a single night's fishing. The remaining 61 were rejected as it was not possible to tell how long the eels had been in captivity. The figures are percentages of stomachs in each 'fullness category' (see page 6) per length group per month.

Table 6. Fullness of stomachs (% of *n*)

Length (cm)	June				July				August			
	0	1—8	16	*n*	0	1—8	16	*n*	0	1—8	16	*n*
20—40	25	50	25	16	12	52	36	26	25	22	53	28
40—50	21	50	29	14	37	41	22	54	44	44	12	16
50—90	0	54	46	11	19	51	30	37	17	50	33	12

The eels of less than 40 cm appeared to feed better as the season advanced. In the 20-40 cm group the number of full stomachs increased from June to August. In the 50-90 cm group no empty stomachs were found in June but the percentage of fulls declined from June to August. The 40-50 cm group showed an increase in empties and a decrease in fulls through the season. The seasonal change shows that in comparing the feeding habits of populations of eels it could be desirable to work within a limited period and as far as possible to use specimens from within a narrow size range.

Observations on the food organisms are set out under three headings. The first compares the frequency with which one or more individuals of the most important groups of species were found. All of the groups except two were found in 1967 and frequencies with reference to the size of eels containing them are shown in Table 7. The other two groups are (a) Mysidacea and (h) *Anodonta* spp. The second heading is the dominant food items in full stomachs, as opposed to stomachs which were only partly filled. The third heading is the full list of organisms found, identified where possible to species level.

The figures in Table 7 represent the number of occasions when one or more specimens of organisms in the groups were found. They are expressed as percentages of n where n is the number of stomachs which contained identifiable food. The most striking feature of the table is its indication of the tendency for larger eels to feed on fish. Eels of less than 40 cm had a largely invertebrate diet, fish-eating began at that stage and had become an almost exclusive diet for individuals of over 60 cm. As size increased gastropods and *Asellus* remained relatively important until the 60 limit but the other Arthropoda declined more rapidly. Amongst the Arthropoda, crustaceans listed are adults and insects are nymphs or larvae unless otherwise indicated.

Table 7. Occurrences of major food items (% of *n*) where *n* = number of stomachs containing food)

Length (cm)	b	c	d	e	f	g	j	*n*
20—30	28	42	28	57	57	28	0	7
30—40	34	41	22	43	45	45	4	53
40—50	25	21	10	27	23	37	27	56
50—60	30	12	6	18	9	24	54	33
60—90	0	0	0	0	0	0	89	18

(b. *Asellus*, c. *Gammarus*, d. Ephemeroptera, e. Trichoptera, f. Chironomidae, g. Gastropoda, j. Fish).

In attempting to compare the nature of the available food in various areas it was decided to concentrate on the food organisms which dominated in the full stomachs. These, presumably, would represent the organisms which were most easily obtained by the eels. Table 8 shows the dominant food items in the full stomachs from the areas listed. The last column shows the number of stomachs examined in each length group. Columns 2 to 5 give the number of times each organism was dominant, though it could have been present in others as a subsidiary. The omitted length groups are those from which no full stomachs were found at the time and station indicated.

In June, when eels of over 50 cm were plentiful in the shallows, five with full stomachs were collected. All contained fish—one pike, one eel, two perch and one perch and eel. Two of nine smaller individuals with full stomachs also contained fish, the rest were feeding on invertebrates. The July and August figures in Table 8 show clearly the difference in feeding habits between eels in deep and shallow water. In the shallow areas, Illaunnacreeva and Barrusheen South, the food was almost exclusively invertebrate with gastropods predominating. These two areas were distinguished also by the absence of large eels. The deep areas were inhabited largely by fish-eating eels, with gastropods taking a second place and only two instances of other invertebrates of which one was the exceptional case of a large eel which had been feeding on Cladocera. One interesting point which was revealed by this comparison was the difference between the two areas to east and west of Inishshanboe. These were of roughly the same depths but the eastern part gave a unit catch of 1.7 and only 16% of full stomachs while the southern had unit catch 4.1 and 33% full stomachs. Char were plentiful in the by-catch off Inishshanboe South but relatively scarce to the east.

No strongly marked changes in food organisms were apparent from July to August. *Gammarus* and other invertebrates did play an important part in July but the difference could be explained as much by variations in the benthos as by the date.

Besides the gastropods and fish, species of *Gammarus* (*lacustris* and *duebeni*) were dominant food organisms in the full stomachs (from all areas) on seven occasions, *Asellus* (*aquaticus* and *meridianus*) on four, Trichoptera (one unidentified, one *Phryganea*) on two. There were single instances of Cladocera, Chironomid larvae, bivalve molluscs and fish ova. The fishes identified in the full stomachs were:

Unidentified	Salmonid	Brown Trout	Char	Pike	Eel	Perch	Stickleback
3	1	1	6	1	1	7	1

The gastropods included:

Unidentified	*Bithynia tentaculata*	*Limnaea pereger*	*Limnaea & Bithynia*
2	4	25	1

Of the four instances of *Bithynia* three were in stomachs of eels of over 50 cm.

On two occasions the proportion of full stomachs throughout the samples was exceptionally high. These were at Illaunnacreeva on July 26 and at Barrusheen South on August 4. On July 26 all eight were filled with *Limnaea pereger*. On August 4 there was more variety: of five specimens two contained *Limnaea* and one each *Asellus meridianus, Gammarus duebeni* and a Phryganeid pupa.

Table 8. Dominant food in full stomachs

	Gammarus	Gastropoda	Fish	Others	Number of Stomachs
JULY	Inishshanboe East (A)				
20—40	0	0	0	Trichoptera 1	2
40—50	0	0	0		15
50—60	0	1	2		10
60—90	0	0	0	Cladocera 1	3
	Inishshanboe South (B)				
20—40	0	0	0		6
40—50	0	0	1	Fish ova 1	7
50—60	0	2	3		8
60—90	0	0	4		12
	Illaunnacreeva South (C)				
20—40	1	6	0	Invertebrates 1	12
40—50	0	9	0		22
50—60	0	0	0		2
60—90	0	0	0		1
AUGUST	Roeillaun North (D)				
20—40	0	1	0		1
40—50	0	0	0	Not identified 1	9
50—60	0	2	1		6
60—90	0	0	1		3
	Barrusheen South (F)				
20—40	5	8	1	*Asellus* 1, Trichoptera 1, Chironomid 1, Bivalve 1	27
40—50	0	0	0		8
50—60	0	0	0		2

At least forty different organisms were recorded from the stomachs and are listed in Table 9 (see Appendix). The number of varieties of organisms found is likely to depend to some extent on the size of the sample of stomachs. The figures suggest that 20 stomachs are required to give a good indication of the feeding. Roeillaun North (F), with only 11 stomachs gave the low score of 11 varieties. This makes the case of Barrusheen North (A), sampled in June, an outstanding one—22 stomachs yielded only nine varieties of which no fewer than five were fish.

The following groups were not included in Table 9 since identification was not detailed enough for their classification by area headings to be meaningful:

Cyclops (1)	1 stomach
Adult Coleoptera (1)	1
Other Trichoptera lv. (1-4)	7
Trichoptera pp. (1)	8
Mollusc broken shell	11

In two cases it appeared that eels were attracted to particular feeding grounds. The first was Inishshanboe East (B) where 5 out of 23 contained the eggs of cyprinids, suggesting that this was a spawning ground for bream or rudd. An unusual incident on this ground was the occurrence of Cladocera in three cases. At Inishshanboe South (C) at least six and possibly 14 of the 23 stomachs contained char and it appeared that suitable invertebrates were scarce in the area and not sought. While it is possible that some of the char were taken by the eels after becoming enmeshed in the fyke net this does not explain the exceptionally dense population of eels in the region.

The shallow water habitats of Illaunnacreeva and Barrusheen South were inhabited by small eels which were feeding on the widest range of invertebrates encountered and which rarely ate fish. At both sites *Limnaea pereger* was the dominant food organism, followed by Chironomid larvae. At Illaunnacreeva (D) the caddis larvae, *Athripsodes cinerea* came next, followed by *Asellus meridianus* and *Gammarus duebeni*. A total of seven caddis species were identified. The order at Barrusheen South (E) was slightly different: after Chironomid larvae came Chironomid pupae, *Gammarus, Asellus* and *Limnaea stagnalis*. Of the latter species only small individuals were eaten. Only four species of Trichoptera were found and none were of particular importance.

ii *LOUGH CORRIB NORTH May—September 1968.*

A second season on northern Lough Corrib was desirable to determine whether some of the observations made in 1967 could be repeated. The season extended from May 3 to September 12, based at Dooros (X 1968 in Fig. 2). Mr. Paul Curry, a University student, assisted with the field work from June 24 to August 30. The highest temperatures recorded were 11.5° up to May 25 and 20° in June.

Catch and Effort

It was not possible to obtain supplies of nets with the same dimensions as those used in 1967. The replacement nets were substantially smaller than those used before and had a greater mesh size at the cod end. The 1967 nets were white, those used in 1968 and subsequently, brown. Besides the two main kinds of net a third (green) one was incorporated until August 8, attached to the white train. In the hopes of capturing much smaller eels a fine-meshed net was tried but was soon abandoned having proved very inefficient and unlikely to provide a useful sample. All of the nets used permanently had nylon mesh and a mesh size in the leader of 36 mm (stretched). Green and white nets had hoops of cane; brown nets had hoops of stainless steel. The three nets are compared in Table 10. The marked variation in the catch of each net indicated that, when the unit catch is used to compare the densities of populations, nets of similar dimensions must be used. Detailed catch and effort figures are given in Table 11.

Table 10. Comparison of nets used in 1968.

	Net days	Leader Length m	Trap length m	Hoop diameter m	Cod-end mesh mm	Unit catch
Green ...	47	9.0	2.8	0.5	20	0.8
White ...	409	6.5	3.2	0.5	20	1.7
Brown ...	426	4.7	1.8	0.4	22	0.4

The sampling positions have been grouped into twelve areas. Dooros Bay, a large area with many islands, which appeared to have an uniform population, was divided into two on a basis of depth. The other areas were considerably smaller. The positions are shown in Fig. 5 and depth, catch and effort figures are given in Table 11.

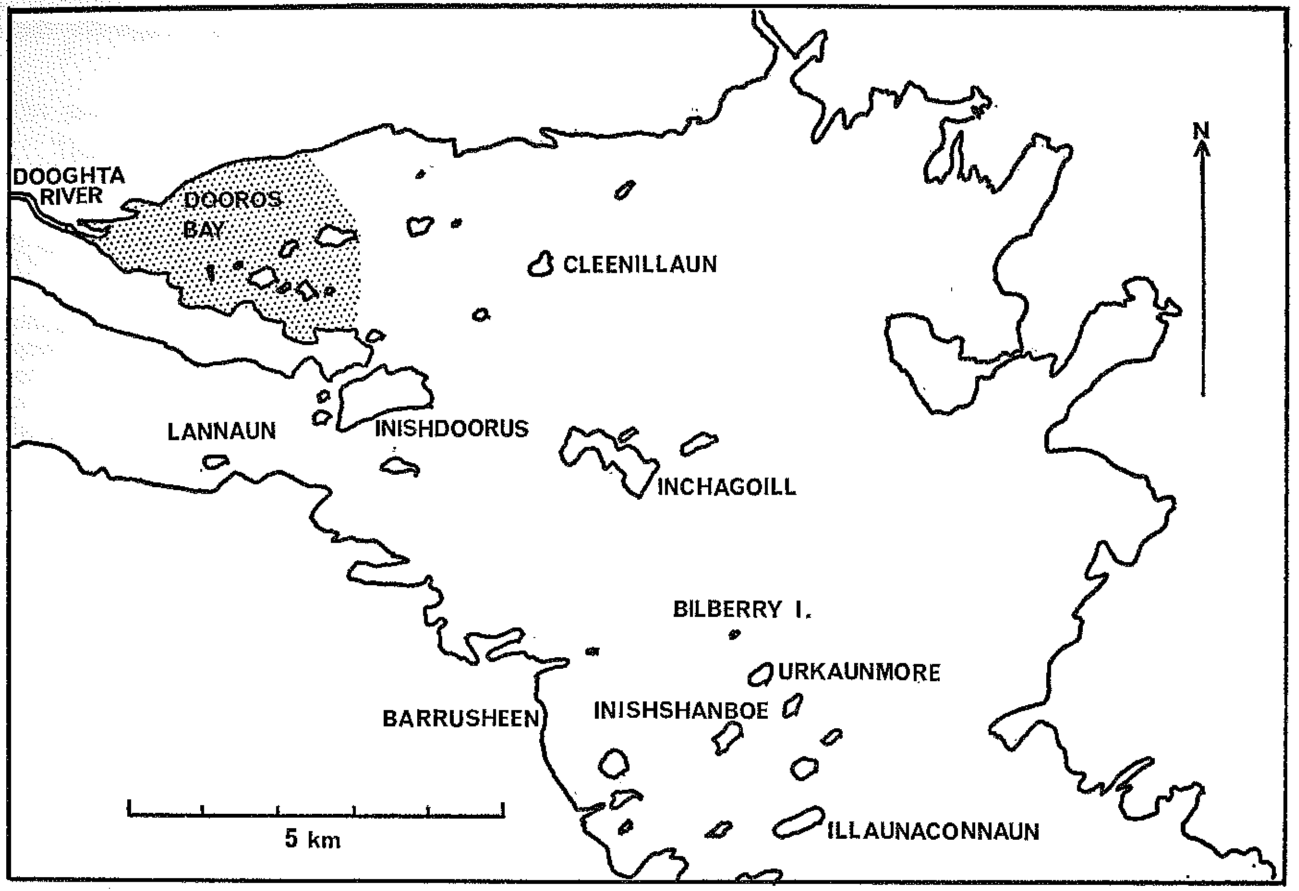

Fig. 5. North Corrib region sampled in 1968, shaded area indicates extent of Dooros Bay. Based on the Ordnance Survey by permission of the Government (Permit No. 1833).

Comparison of the catches in May, mostly made in Dooros Bay, with those in the same area and elsewhere in subsequent months showed that the May catches were very much smaller than the others. Mean May catches are shown in Table 11 to be only one-third of the mean for the other months .The increase occurred in June and may have been associated with a rise in temperature (measured at lake surface) of approximately 10° to 15°C. In comparing the catches with other waters the June—August figure has been used since no sampling took place in the main lakes in May.

In most cases the white nets caught about four times as many eels as the brown. The exceptions were in shallow water in Dooros Bay and at the Dooghta River Mouth. These were the only instances when both nets were used in shallow water and it seems likely that the long leaders of the white nets are liable to be twisted by wave action and thereby rendered less efficient. A comparison of the length distributions of brown and white net catches in Dooros Bay Deep showed no significant differences between the means at 95% level. The minimum length of eel caught by both nets was 28 cm. It was therefore concluded that the effect of the difference in mesh size of the two nets could be ignored for the Corrib population.

Length and Weight

The 1967 results having suggested that comparisons of length distribution over the whole season would be of little or no value, distributions on a monthly basis were compared. Figures are given in Table 12 and the distributions from Dooros Bay and Urkaunmore (H) are shown graphically in Fig. 11. The departure of large eels from shallow water in July, observed at Barrusheen in 1967, was again apparent: 20% of the June sample from Dooros Bay shallows (A) were longer than 50 cm and no eels of this size were taken in July.

Table 11. Position, Catch and Effort, North Corrib 1968.

			White net			Brown net		
		Depth m	Net-days	Unit catch	Total	Net-days	Unit catch	Total
A. Dooros Bay	...	0—3	115	0.7	68	78	0.2	16
B. Dooros Bay	...	4—10	93	1.4	132	140	0.3	35
C. Dooghta R.	...	3—5	15	2.0	30	24	2.5	63
D. Cleenillaun	...	10—13	18	0.5	99	40	0.2	8
E. Inchagoill	..	16	12	0.7	8	8	0.3	2
F. Illaunaconnaun	...	3	48	0.8	40	—	—	—
G. Inishshanboe N.	...	1	6	0.7	4	8	0.4	3
H. Urkaunmore	...	10—16	12	2.3	28	16	0.4	7
I. Bilberry I.	...	16	12	1.1	13	16	0.3	4
J. Inishdoorus	...	4—14	12	0.8	9	8	0.4	3
K. Barrusheen	...	4—16	66	1.4	95	80	0.6	46
L. Lannaun	...	30	—	—	—	8	0.9	7
TOTAL	...		409	1.0	417	426	0.4	190
May	...		123	0.4	43	140	0.2	21
June-August	...		286	1.3	374	286	0.6	169

Table 12. Length distributions on date and locality basis.
(Distribution as % of *n*, see Table 11 for key to positions).

Month Position	May B	July B	Aug. B	June A	July A	August F	H	C	J	K
Length (cm)										
20—30	4	9	2	0	4	7	0	8	0	4
30—40	39	43	36	29	60	42	20	35	60	39
40—50	50	39	56	51	36	40	16	38	32	49
50—60	7	7	0	10	0	7	32	14	4	7
60—100	0	2	6	10	0	4	32	5	4	1
n	46	44	48	31	25	77	35	77	25	141
$\bar{x}$	39.3	39.6	42.6	44.0	37.8	40.3	54.9	43.6	40.1	40.6
SE	0.96	1.22	1.37	2.31	1.18	1.14	2.76	1.44	1.63	0.58

A population of exceptionally large eels was found off Urkaunmore (H) in August, 64% of the catch being longer than 50 cm and the mean length of 54.9 cm being significantly greater than that of any of the other August samples. An interesting sample was that from water of 30 m deep to the north of Lannaun Island. The population density was relatively high, exceeded only by the Dooghta River figure for the brown nets. Of the seven eels taken six were less than 40 cm and the seventh measured only 45.8 cm. The mean length was 36.9 cm ± 2.03, a figure not significantly lower than that for the nearby, but shallower station of Inishdoorus but lower than the other means for August. Unfortunately unsettled weather prevented repetition of this experiment.

The following length/weight regression figures were calculated for each month for specimens of over 40 cm (see page 10).

	a (x 10—4)	b	s	n
May ...	11	3.14	0.05	25
June ...	7.9	3.20	0.05	32
July ...	5.4	3.31	0.07	58
August ...	1.0	3.15	0.07	32

Age Composition

Twenty-five per cent of the otoliths were clear (see page 6). Details of age determinations on a monthly basis are given in Table 13 and the mean of groups 11-12 and 13-14 are shown in Fig. 6. The increase in mean length per age group extended back to May and a statistically significant difference in the means was observed in the 11-12 group from May to June but not elsewhere. A steady increase in the proportion of eels of over 12 years old was observed, in contrast to the fall recorded in the previous season. The range of growth rates was extended by the observation of an 11-12 year eel of 78 cm. From May to July the modal age was 11-12 and this had a mean length of the order of 40 cm.

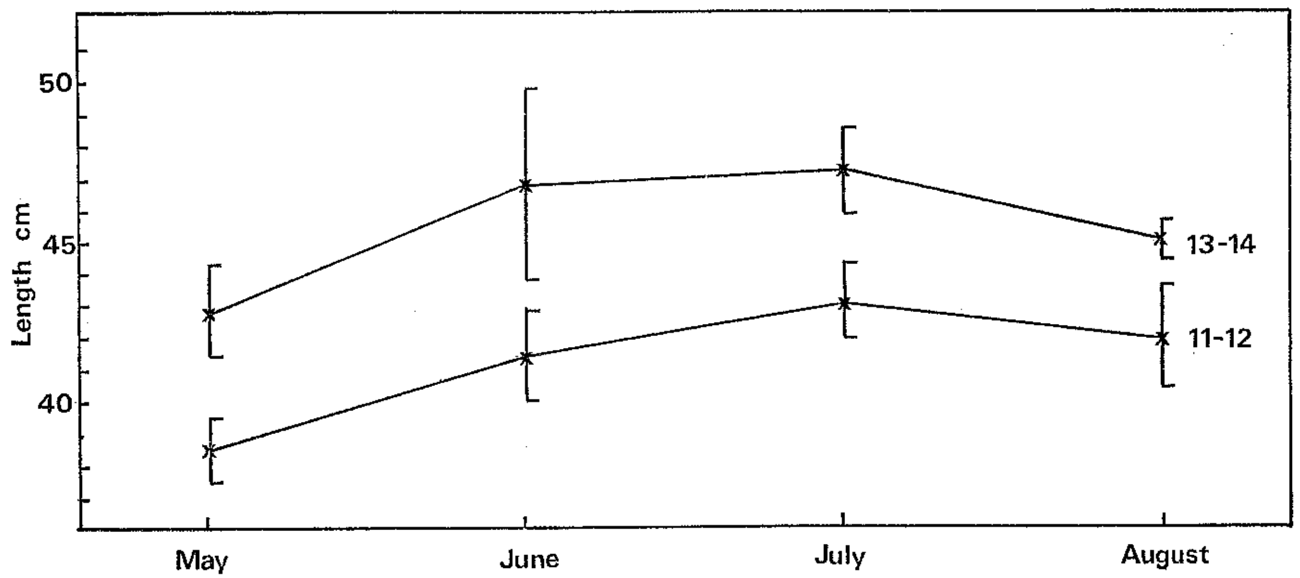

Fig. 6. Mean lengths for two age groups, Corrib 1967. Vertical lines equal 1 standard deviation.

The following values were computed for the age/length regression equation (see page 12).

	n	c	d	r	s	l (cm)
May ...	29	1.9	18.16	0.5	7.4	26—63
June ...	34	3.2	5.92	0.8	8.6	26—82
July ...	48	3.6	4.34	0.9	7.1	28—97
August ...	43	2.8	9.88	0.8	9.4	28—80

Table 13. Length and age data on date basis (% of n)

		Length (cm)			
Age	%	Min	Max	Mean	SE
MAY	n= 72				
7— 8	7	31	53	38.3	4.05
9—10	26	26	46	36.5	1.30
11—12	40	29	49	38.4	1.02
13—14	15	34	51	42.7	1.41
15—16	8	42	54	47.6	2.10
17—18	3	47	63	55.9	
19—20	1	48			
JUNE	n= 57				
7— 8	7	29	47	36.7	3.73
9—10	19	26	46	39.1	1.86
11—12	33	31	54	41.4	1.43
13—14	16	38	68	46.8	3.12
15—16	16	40	82	56.2	4.20
17—18	4	44	49	46.7	
19—21	5	63	76		
JULY	n=149				
5— 6	1	29			
7— 8	8	29	47	35.9	1.41
9—10	21	28	53	36.9	0.95
11—12	25	30	78	43.0	1.32
13—14	20	33	64	47.2	1.33
15—16	10	41	69	53.5	2.08
17—18	9	45	73	56.5	2.01
19—23	6	68			
AUGUST	n=121				
5— 6	1	33			
7— 8	5	28	45	34.4	2.60
9—10	20	28	47	36.0	0.92
11—12	23	31	83	41.8	1.79
13—14	25	38	51	45.1	0.64
15—16	13	37	68	48.3	1.95
17—18	7	41	63	52.6	2.95
19—21	6	49	80		

Food

An analysis of the fullness of the stomachs of 362 eels which had been in captivity for less than 24 hours is given in Table 14.

Tabe 14. Fullness of stomachs on basis of date and size (% of *n*)

Length (cm)	May				June				July				August			
	0	1—8	16	*n*	0	1—8	16	*n*	0	1—8	16	*n*	0	1—8	16	*n*
20—40	17	62	21	37	36	53	11	19	45	41	14	47	31	42	27	43
40—50	8	46	46	31	30	52	18	27	49	28	23	38	43	44	13	63
60—100	20	80	0	5	25	50	25	12	45	42	13	23	28	44	28	17

These figures confirm to some extent the observations made in 1967. In particular, June was again a poor month for small eels and good for large, while August was good for small. However, the steady rise in numbers of small eels with full stomachs and fall in numbers for large, full specimens from June to August was not repeated. July appeared to be a poor month for all sizes, with over 40% of stomachs empty in all cases. An interesting addition to the observations of 1967 was that May was a good feeding month for all sizes, fewer empty stomachs being found then than in the later months while nearly half the 40-50 cm eels were full. Except in May the large eels were found to have the lowest frequency of empty stomachs.

An analysis of the fullness of stomachs based on date and position showed that, in all areas from May to July and in three out of five in August, when the large eels were feeding well, the small were not feeding to the same degree and vice versa. No full stomachs were found in large eels anywhere in May, in Dooros Bay shallows in June, at Illaunaconnaun in July and at Inishdoorus in August. Small eels with all stomachs less than full were found in Dooros Bay deeps in June, July and August and at Inishdoorus in August.

Food preferences on the basis of size, taking the region as a whole, are given in Table 15.

Table 15. Occurrences of major food items (% of *n* where *n*=number of stomachs containing food).

Length (cm)	b	c	d	e	f	g	j	*n*
20—30	13	62	50	50	62	13	13	8
30—40	16	36	19	49	60	47	8	97
40—50	14	21	7	32	38	50	20	107
50—60	4	17	0	13	13	39	35	23
60—100	0	4	0	0	0	21	52	28

(b : *Asellus*, c : *Gammarus*, d : Ephemeroptera, e : Trichoptera, f : Chironomidae, g : Gastropoda, j : Fish).

As in 1967 there was a tendency for the larger eels to feed on fish but some individuals in all of the size groups were found to do so. There was more evidence than observed previously of an invertebrate diet on the part of the largest eels, notably the presence of gastropods which were eaten by 21% of the group. The smallest eels appeared to have a much more varied diet than the larger ones.

There were three occasions when, with a catch of seven or more eels, more than half had full stomachs and one occasion when all eels caught (total 3) were full. The first such 'good' day was June 26 at Dooros Bay shallows. All four full stomachs contained a variety of organisms with cyprinid eggs dominant in two, larvae of the small trichopteran, *Oxyethira*, in one and nymphs of the small ephemeropteran *Caenis* in one. This situation compares with the observation in 1967 that eels gathering for the cyprinid eggs appeared to be ready to take other forms of exceptionally small organisms. On July 3 at Illaunaconnaun when all three eels had full stomachs, each contained a different dominant organism: large bivalve, *Limnaea pereger* and *Asellus aquaticus*. On August 27 at Dooghta River Mouth all five full stomachs contained fish—four perch and one pike. Three days later in the same area the more usual diversity was found amongst five full stomachs: eel in two, one *Limnaea pereger*, one *Valvata piscinalis* and one with roughly equal quantities of *Asellus meridianus* and *Gammarus duebeni*.

Two stations, Dooros Bay (4-10 m) in May and Illaunnaconnaun in July provided eleven and twelve full stomachs respectively and are entered separately in Table 16 which shows the dominant food in all full stomachs (see page 13). Dooros Bay provided a wide range of invertebrates whereas Illaunnaconnaun was notable as a rich shellfish ground with *Bithynia, Limnaea pereger* and *L. stagnalis*. All three instances of *Mysis* came from 4 to 14 m off Inishdoorus.

Table 16. Dominant food in full stomachs.

	Gammarus	Gastropoda	Fish	Others	Number of stomachs
MAY	Dooros Bay 4-10 m				
20—30	0	0	0	*Phryganea* & Stickleback 1	2
30—40	0	1	0	Cyprinid egg 1 *Phryganea* 1	17
40—50	3	2	1	Invertebrates 1	23
MAY	Other stations (A, D)				
30—40	1	0	2	*Mystacides* & Chironomid 1	14
40—50	0	2	0		
JUNE	Stations A, B, J				
30—40	0	0	0	*Oxyethira* & Chironomid 1 *Ephemera* 1	17
40—50	0	2	1	Cyprinid egg 2	27
60—85	0	0	3		6
JULY	Illaunaconnaun 3 m				
20—30				Chironomid 2	3
30—40				Invertebrates 2	9
40—50	0	6	1		15
50—60	0	0	1		3
JULY	Other stations (B, E, G, H, J)				
30—40	0	3	1	*Phryganea* 1 Chironomid 1	38
40—50	0	0	1		28
50—60	0	0	2	*Mysis* 1	16
60—100	0	0	1		11
AUGUST	Stations A, B, C, E, J, K				
20—30	0	0	0	Invertebrates 1	3
30—40	0	1	1	*Asellus* 1, *Mysis* 1 *Asellus* & *Gammarus* 1 Chironomid 1 Invertebrates 1	37
40—50	0	5	5	*Mysis* 1	63
50—60	0	1	2		11
60—85	0	0	3		7

The full list of food organisms identified is given in Table 17 (Appendix) and amounted to 44 types. Other organisms, which could not be satisfactorily identified, included:

Ephemeroptera	... 1	Other insect larvae	... 3
Trichoptera larvae	... 4	Invertebrate egg mass	... 2
Trichoptera pupae	... 5		

There were also three occasions when species of *Asellus* and five when *Gammarus* could not be determined.

Nineteen or more varieties of food organisms were found in five out of the twelve areas. The greatest numbers, 33 and 31, came from Dooros Bay shallows and deeps respectively—which were also the most intensively sampled regions. The shallow areas, Dooghta River Mouth and Illaunnaconnaun, also showed a considerable variety of organisms. The deeper areas Cleenillaun (D), Urkaunmore (H) and Lannaun (L) apparently had poorer faunas. All of the organisms found in the Lannaun sample, at 30 m depth, were benthic forms indicating that the eels were feeding at this depth.

Molluscs again appeared in the greatest number of stomachs, *Limnaea pereger* was found in 80 out of the 255. *Bithynia* occurred in 47 and was the only organism found in all twelve areas. Chironomid larvae came next to *L. pereger* in frequency and were found in all areas except Urkaunmore (H). *Gammarus lacustris* and the two species of *Asellus* were also plentiful. Other invertebrates found on 20 or more occasions were *Mysis, Cyrnus flavidus, Ocetis ochracea,* Chironomid pupae, *Valvata* and cyprinid eggs. Fish were recorded from 48 stomachs, stickleback and eel being the most frequent.

iii *LOUGH CORRIB SOUTH July 1969*

The south basin of Lough Corrib (Fig. 2) is a shallow lake, rarely exceeding a depth of 4 m. The clear water allows the maximum penetration of light and weed growth, where it occurs, is dense. Besides the weed beds there are areas of marl and of mud, the latter usually rich in shells of gastropods. Alkalinity is 1.8 and conductivity 218.

The sampling season extended from July 9 to 28. In addition to work in the lake, samples were collected from the River Corrib in Galway City from May 7 to 9 and in the river channel for about 500 m upstream of the southern end of the navigation channel known as 'The Cut'. Field work in July was by two university students, Messrs T. Hayden and M. O'Grady. The highest temperatures recorded were 13°C in May and 18° in July.

Catch and effort

In July one or two trains of eight brown nets were fished daily except at weekends and two periods of stormy weather. Catches were good on every occasion, only two falling below a unit catch of one and the highest being 13.1. Catches were somewhat lower in the River. Figures are given below.

River Corrib, May	32 net days	1.0 unit catch	33 total
River Corrib, July	24 net days	1.4 unit catch	33 total
Lough Corrib, July	88 net days	4.4 unit catch	390 total

Length and weight

The eels in all of the samples were relatively small, nearly half being less than 40 cm. Length distributions shown below suggested that lake and river eels belonged to a uniform population.

	20—30	30—40	40—50	50—60	60—100 cm	*n*	$\bar{x}$	SE
River, May	4	48	26	11	11	27	43.4	2.35
River, July	0	52	41	7	0	33	40.2	0.88
Lake, July	2	43	38	11	6	349	41.3	0.87

Length/weight regression computed for 59 lake specimens of over 40 cm gave a=0.00059, b=3.29, s=0.07.

Age composition

No significant difference between length for age of River and Lake eels was observed. Forty-four per cent of the otoliths were clear. The modal age was 9-10 and large specimens (up to 69 cm) were found in this class. Details of age determinations of 331 eels from the lake are given in Table 18.

Table 18. Length and age data, Lough Corrib South.

Age	% (n=331)	Min 1.	Max 1.	Mean 1. (cm)	SE
5— 6	2	32	37	35.6	0.76
7— 8	13	31	43	35.6	0.53
9—10	32	27	69	40.1	0.63
11—12	25	30	57	43.2	0.62
13—14	16	40	83	49.0	1.13
15—16	8	41	78	54.0	1.93
17—18	3	44	86	64.9	5.08
19+	1	51	81		

Values in the age/length regression were:

n	c	d	r	s	length range
47	3.13	12.7	0.7	11.3	27—86 cm

Food

An analysis of the fullness of the stomachs of eels caught after a single night's fishing is given below:

Length	River, May				River, July				Lake, July			
	0	1—8	16	*n*	0	1—8	16	*n*	0	1—8	16	*n*
20—40	27	66	7	14	39	44	17	18	39	43	18	86
40—50	29	56	15	7	27	73	0	15	44	50	6	96
50—100	33	33	33	6					50	34	16	44

Full stomachs in the river numbered seven. In May one of these contained *Asellus aquaticus*, one *Limnaea pereger* and one perch. In July three contained perch and one had no dominant type but a mixture comprising *Asellus,* Zygopterous nymphs, Chironomid larvae and *Bithynia.* In the lake in July *Asellus* and *Gammarus* played a major part in full eels of 30-40 cm: out of 17 full stomachs seven contained *Asellus* and eight *Gammarus* with one Chironomid and one perch. The dominant food items in the 14 full stomachs of eels of over 40 cm were: one each *Asellus, Gammarus,* Chironomid larvae and *Anodonta,* three Gastropods and seven fish (perch and eel).

The food preferences of the eels, as judged by the presence or absence of groups of organisms, are shown in Table 19.

Table 19. Occurrences of major food items (% of *n* where *n* = number of stomachs containing food).

	b	c	d	e	f	g	j	*n*
River, May 30—40	54	0	0	18	54	54	9	11
40—50	20	20	0	20	20	40	0	5
50—100	0	0	20	20	0	40	0	5
River, July 30—40	40	0	30	20	60	40	20	10
40—50	25	0	12	25	62	50	25	8
Lake, July 30—40	40	45	16	22	44	22	6	68
40—50	22	28	5	25	37	30	17	64
50—60	12	24	0	6	17	12	65	17
60—100	8	0	0	8	8	8	75	12

(b *Asellus,* c *Gammarus,* d Ephemeroptera, e Trichoptera, f Chironomidae, g Gastropoda, j Fish).

The diet of small eels in the river consisted largely of *Asellus,* Chironomids and gastropods in May and July. The larger eels also had a mixed invertebrate diet in both months and it was noted in May that none of the ten eels of over 40 cm contained fish.

The small lake eels in July fed largely on arthropods: *Gammarus, Asellus* and Chironomids being taken by more than 40% Chironomids and gastropods were of greater importance than the crustaceans amongst the 40-50 cm eels and fish predominated in the longer specimens. The large eels did, however, feed on invertebrates to a considerable degree.

The full lists of identified food organisms are given in Table 20 (See Appendix). Thirty-six varieties were identified from the lake, 16 from the river in May and 14 in July. Five species of Corixid, one *Notonecta* and one *Chaoborus* were found usually as single individuals and therefore of little importance as food but interesting in showing the eel's readiness to eat actively swimming or planktonic types of organisms. One oligochaete worm was found, the only one in the investigation to date. Eleven species of Trichoptera were identified: six Polycentropids, four Leptocerids and one Lepidostomatid—no Limnephilids. Remains of *Anodonta* were found in two lake eels. Ephemeroptera were frequent in the stomachs but could seldom be identified except in the case of *E. danica.* The genus *Caenis* was not recorded, and was not amongst the unidentified Ephemeroptera. Where specimens of *Gammarus* occurred the bodies were usually too much damaged to make certain identifications but, where the distinction could be made, *G. duebeni* was found to outnumber *G. lacustris.*

Organisms not fully identified included:

Asellus sp.	2	Corixid	9	Insects	2
Ephemeroptera ny	11	Trichoptera lv.	6	Fish	2
Coleoptera lv.	1	Trichoptera pp.	3		

iv *LOUGH CARRA August 1969*

Lough Carra (fig 2) lies in limestone surroundings, some 50 km from the sea which it reaches through Lough Mask and Lough Corrib. A large proportion of the lake is less than 5 m in depth and the bed is covered by a marl deposit, generally poor in invertebrate life. There are extensive beds of *Scirpus lacustris.* The water is exceptionally clear and rich in lime, the alkalinity being 3.85 and conductivity 385. The sampling season extended from July 29 to August 13. Field work was by two university students, Messrs T. Hayden and M. O'Grady. The highest temperature recorded was 18°C.

Catch and effort

One train of ten brown nets, which included one torn trap, was fished daily except at two weekends and two days of stormy weather. Catches were low, ranging from 0.1 to 1.5. The best catch was made in a *Scirpus* patch on a rocky bed and the lowest was made over marl but intermediate numbers were taken over both types and no preference for a particular type of ground was apparent. For an effort of 142.5 net days the unit catch was 0.5, total 71.

Length, weight and age

Nearly half the sample belonged to the 40-50 cm group, 17% were smaller and 36% larger. Eels of more than 60 cm were scarce. Length data are given below:

30—40	40—50	50—60	60—100 cm	*n*	$\bar{x}$	SE
17	47	30	6	71	47.6	0.98

Length weight regression computed for 45 specimens of over 40 cm gave a=0.00076, b=3.24, s=0.04.

Seventy-seven per cent of the otoliths were clear. The modal age was 11-12 and relatively large specimens (up to 55 cm) were found down to the 9-10 year class. Details of age determinations of 68 eels are given in Table 21.

Table 21. Length and age data, Lough Carra.

Age	% (*n*=68)	Length (cm) Min	Max	Mean	SE
7—8	7	31	47	40.3	3.40
9—10	27	33	55	41.4	1.12
11—12	32	36	65	47.2	1.70
13—14	25	38	68	50.8	2.10
15—16	7	47	65	54.4	3.25
17—18	1	47			
19—20	1	59			

Values in the age/length regression were

n	c	d	r	s	length range
31	2.7	17.3	0.5	8.6	31—68

Food

It had been noticed that in a number of cases in previous work while the stomach might be empty the hind gut could still contain food. The presence of food in the gut, distal to the stomach, was recorded subsequently. The fullness of stomachs of eels caught after a single night's fishing is shown in Table 22.

Table 22. Fullness of stomachs on size basis (% of *n*).

Length (cm)	Empty Hind-gut void	Empty Hind-gut full	1—8	16	*n*
30—40	38	25	37	0	8
40—50	25	35	40	0	20
50—70	31	31	38	0	13

No full stomachs were found in the one-day catches, though one was recorded from a two-day sample. The numbers of empties with void and full hind guts were approximately equal and all sizes showed the same proportion (about 40%) of stomachs containing food. The one full stomach contained 80 *Gammarus duebeni,* two *Ephemera danica,* one *Limnaea pereger* and an unidentified fish.

Food preferences on the basis of presence or absence of the major groups are shown in Table 23.

Table 23. Occurrences of major food items (% of *n* where *n*=number of stomachs containing food).

	b	c	d	e	f	g	j	*n*
30—40	0	50	75	0	25	25	50	4
40—50	25	25	25	0	37	50	0	8
50—70	0	43	14	28	14	71	14	7

(b. *Asellus,* c *Gammarus,* d Ephemeroptera, e Trichoptera, f Chironomidae, g Gastropoda, j Fish).

The larger eels had a well mixed invertebrate diet and only one of the sample was found to contain fish. *Ephemera danica,* the only Ephemeropteran nymph found, was of considerable importance though exceeded both in quantity and in number of occurrences by *Gammarus duebeni.* Chironomid larvae, *Limnaea pereger* and cyprinid eggs also played a major part. Only two Trichopterous larvae, both Polycentropids, were found. Table 24 (Appendix) giving the complete list of food organisms, includes 15 varieties, from the 19 stomachs containing food.

v *LOUGH MASK August—September 1969*

Lough Mask (Fig. 2) lies between Lough Corrib and Lough Carra, on Carboniferous limestone except on the western side which is underlain by acid metamorphic rock. It is a comparatively deep lake, reaching a maximum depth of 59 m. The alkalinity of the water is 1.85, conductivity 218. It is 40 km from the sea, most of this distance being occupied by Lough Corrib. The sampling season extended from August 14 to September 5. Field work was by Messrs. T. Hayden and M. O'Grady.

Catch and effort

A train of eight standard brown nets and a train of eight nets with same cod-end mesh but rather larger mouth and longer leader were used. The latter were torn in places and their catches were not considered in the catch and effort figures. Owing to persistent stormy weather the nets could not be recovered from August 16 to 30 and no fishing took place. Otherwise the usual procedure of daily fishing, except at one weekend was followed. During the stormy weather some faunal samples were taken in Cushlough Bay and eight netting samples were taken there when the weather moderated in September. Low catchs (0.2 and 0.4) were made on the two occasions when the nets were set over mud, the respective depths being 10 m and 1 m. Otherwise the catches were good, from 1.1 to 2.7, the best being made on a rocky bed at a depth of 3 m. For an effort of 56 net days the unit catch was 1.2, total 78.

Length, weight and age

A little more than half the sample belonged to the 40-50 cm length group, 23% were larger and 21% smaller. Length data are given below:

20—30	30—40	40—50	50—60	60—100 cm	*n*	Mean	SE
1	20	56	15	8	127	46.5	0.79

Length/weight regression computed for 48 specimens of over 40 cm gave a=0.00038, b=3.39, s=0.05.

Forty-five per cent of the otoliths were clear. The modal age was 9-10 and specimens of up to 52 cm were found in this class. Details of age determinations of 116 eels are given in Table 25.

Table 25. Length and age data. Lough Mask.

Age	% (*n*=116)	Length (cm) Min	Max	Mean	SE
7— 8	5	31	44	38.0	1.98
9—10	31	37	52	41.6	0.79
11—12	29	33	79	44.6	1.41
13—14	18	39	75	47.3	1.67
15—16	7	43	56	50.4	1.58
17—18	7	50	67	60.6	2.03
19+	3	55	75		

Values in the age/length regression were:

n	c	d	r	s	Length range
38	2.5	17.1	0.7	9.0	29—75 cm

Food

The fullness of stomachs of eels caught after a single night's fishing is shown in Table 26.

Table 26. Fullness of stomachs on size basis (% of *n*).

Length	Empty Hind-gut void	Hind-gut full	1—8	16	*n*
20—40	24	12	60	4	25
40—50	19	16	63	2	43
50—80	27	0	67	6	15

Approximately 70% of stomachs of all sizes contained food, though fewer than 6% had full stomachs. Amongst the empties there were substantially more void hind guts than full ones.

Only three full stomachs were collected. The first, from a 37 cm eel, contained 81 small Ephemeroptera, 44 *Gammarus duebeni*, a small Coleopteran, a haliplid larva, a *Potamopyrgus* and four fish eggs. The second, length 42 cm, contained one perch weighing 3.1 g and the third, 64 cm, contained two 10-cm perch.

Food preferences on the basis of presence or absence of the major groups are shown in Table 27.

Table 27. Occurrences of major food items (% of *n* where *n*=number of stomachs containing food).

	b	c	d	e	f	g	j	*n*
20—40	83	33	39	22	28	66	0	18
40—50	72	19	44	16	28	50	6	32
50—80	0	0	0	0	7	14	71	14

(b *Asellus*, c *Gammarus*, d Ephemeroptera, e Trichoptera, f Chironomidae, g Gastropoda, j Fish).

Asellus was the most important constituent of the food of eels of less than 50 cm while the larger ones had a largely fish diet, with some gastropods. Gastropods and small Ephemeroptera, probably Baetids, were important items for all but the larger eels.

The full list of organisms (Table 28 Appendix) totalling 37 varieties from only 64 stomachs, showed a wide range of choice. Planktonic crustacea were found in nine cases: eight Cladocera and one Copepoda. Other swimming invertebrates included at least three species of Corixid and one mite. Trichoptera were seldom taken and included two Polycentropids, two Leptocerids and one Sericostomatid. One stomach contained 31 pupae of a case-building species, probably a Leptocerid. *Asellus* and *Bithynia* were the most frequent constituents and were usually eaten in substantial numbers. Ephemeropterans were frequent but only one specimen of *Ephemera danica* was found and none of *Caenis*. In addition to the food items listed in Table 28 the following were recorded:

Coleoptera ad.	...	2	Other Trichoptera lv.	...	1
Corixid	...	8	Trichoptera pp.	...	1

Cushlough Bay survey

From August 16 to 30 when stormy weather prevented fishing, a study was made of the sheltered Cushlough Bay. As soon as fishing could begin again samples were taken from this area.

The depth of water was less than 2 m over most of the bay. There was extensive weed growth on the bottom, in particular beds of *Chara aspersa* in the shallows and *Potamogeton lucens* with *Myriophyllum spicatum* in the deeper parts. The largest catches of eels were made over the *Chara* beds. Pond-net samples of the fauna were taken and the organisms counted and roughly classified. In Table 44 counts of the benthic invertebrates and of the stomach contents of the eels over two *Chara* beds are compared. Groups represented by five individuals or fewer have been omitted.

Two plentiful genera *Notonecta* and *Limnaea* were found to be scarce or unrecorded from the stomachs. Chironmid larvae and pupae and *Bithynia* were frequent constituents of both pond net and stomach contents. *Asellus* was notably scarce in the pond nets samples but the most abundant form in the stomachs.

Table 29. Cushlough Bay, bottom fauna and stomach contents.

	Position A		Position B	
	Numbers in:		Numbers in:	
	Pond net	Stomachs (11)	Pond net	Stomachs (13)
Asellus ...	4	80	5	156
Gammarus ...	2	0	4	14
Notonecta ...	9	0	3	0
Corixid ...	10	6	4	10
Ephemeroptera ...	10	6	4	32
Chironomid ...	61	39	5	6
Bithynia ...	26	37	12	8
Limnaea ...	41	0	3	2
Bivalve large ...	8	0	2	4

4. DISCUSSION

LOUGH CORRIB, NORTH BASIN

The results of the North Corrib survey were used to establish a method of working for subsequent studies in the other waters. From the positively skewed length distributions it was safe to assume that the fyke nets took a random sample of all sizes of eels above the minimum retained by the mesh. The modal length group varied from 30-40 to 40-50 cm and the smallest eels taken were 28 cm. Computations of log length/log weight regression lines for eels of all lengths sampled showed that those in the 30-40 cm group and below were not being adequately sampled—only those of larger girths being retained. Forty centimetres was therefore taken as the minimum length to be considered in length/weight observations.

Comparison of different fyke nets showed markedly different catching powers (see Table 10, page 15). The most efficient was the white net, with leader of 6.5 m, next was the green, 9 m and least efficient the brown, 4.7 m. Apparently an eel on meeting the 9 m leader and turning away from a trap would give up following the leader before it had reached the trap at the other end. The 6.5 m leader was short enough for a majority of eels meeting it to reach the trap no matter at which point they met the leader. The 4.7 m leader was too short to be fully effective, too large a proportion of the train being taken up by traps which the eels could swim beneath. The efficiency of the nets may be compared by considering a train of ten brown nets which has a total leader length of 47 m and would catch on average 4 eels. The same catch would be made by five greens with leader length 45 m. Seven white nets, however, with the same length of leader, would catch 11.9 eels. Assuming that the length of the trap is immaterial the 6.5 m leader is seen to be some three times as efficient as the 4.7 or the 9 m. It was not possible to obtain further supplies of white nets and the brown were used for subsequent work.

The eels caught in a train of nets were usually unevenly distributed with respect to the traps, several being found together in some and single specimens or none in others. Small eels and large were found together in traps and all of the observations made pointed to an absence of territorial or schooling behaviour. Schooling of eels, according to Deelder (1970) is virtually unknown.

It became clear that certain regions were favoured by eels of different sizes at different times. Large individuals (over 50 cm) were very scarce in the shallows (1-3 m) in July and August but plentiful in June. In late July and early August large individuals were especially abundant at Urkaunmore where they formed 64% of the catch of 35 at 10-16 m but they were absent from the catch of seven at Lannaun in 30 m. These results suggested that misleading length distributions might be determined from sampling confined to shallow water —in June too many large eels would be taken and too few in July and August. Isolated samples in deep (10 m upwards) water would also be unreliable. Samples from intermediate depths in July and August, however, could be expected to give a reasonable picture of the population.

The scarcity of eels in May was surprising. It had been expected that the water temperature (10°C) prevailing then would have been high enough to bring the eels to normal summer activity. Possibly the rise in temperature to 15° in June was required. A second possibility is that there had been emigration to winter quarters elsewhere in the lake from the Dooros Bay area where most of the sampling in May took place. Such seasonal migrations of yellow eels are well known, (Deelder 1970), although it is very difficult to measure their extent in lakes. Mann (1963) found that small (17-22 cm) eels in the Elbe started their summer migration at a temperature of 8° to 9°.

The length/weight regression equation, $w=al^b$ was used by Sinha and Jones (1967) who plotted length and age on double logarithmic paper, showing straight lines for various waters. Values of b for 1967 were higher than those for 1968 (pages 10 and 18) and each year showed an increase to a maximum value in July. The July to August drop could be attributed to the departure of the heavier individuals while the rise earlier in the year could be expected to result from a build-up of fat reserves following hibernation. Unfortunately variation in weight for a given length is enormous in eels and no statistically significant differences between the regression lines were observed. The extreme values of b, 3.14 for May 1968 and 3.52 for July 1967 have been plotted in Fig. 7 together with 95% confidence limits. It will be seen, for example, that the weight of a 50 cm individual may vary from 160 to 270 g.

The rise and fall of mean lengths in the two largest age groups (Fig. 4 & 6), recorded in both seasons might be ascribed to chance variation, the differences in means not being statistically significant. However, the fact that the observations were repeated does suggest that changes in the population were in progress. If the larger eels in these age groups were feeding actively in July but changing their behaviour in August in preparation for migration so that they did not enter the fyke nets, the observed length per age groups could be expected to fall.

An interesting behavioural change from yellow eel to silver eel is well known to the fishermen, who use different gear for each. When they meet an obstruction on the bottom, such as a net, yellow eels turn and follow it. This means that the low leader (about 50 cm high) used in the summer fykes is sufficient to direct the eels to the trap. The silver eels on the other hand swim upwards and attempt to surmount the obstacle, even breaking the surface of the water to do so. The leaders of fyke nets used for silver eel capture have therefore to extend for 50 cm or so above the surface. This change would explain why maturing eels might avoid the summer fykes. Small numbers of maturing eels were captured in most of the lakes studied.

Some increase in length from May or June to July is to be expected due to growth but there must also be immigration to replace the mature eels. Upstream migration of yellow eels can be observed on the River Shannon in the summer and presumably takes place in other systems at the same time.

On account of great differences in behaviour between individuals eels vary in length for a given age as they do weight for length. Bertin (1956) remarked that to judge an eel's age by its length would involve a risk of error of five years in either direction. These variations make it impossible to construct with any accuracy a growth curve, such as von Bortolannfy's, of the kind used in studies of shoaling fish where growth rates are much more even. Other investigations (for example Deelder 1970, Champ 1968) have simply referred to an average annual increment. It was therefore considered reasonable to suppose that the growth curve was a straight line and a regression equation was computed as described on page 12. In view of the changes of habitat shown to take place eels from all stations were taken together in age/length calculations.

The disappearance of the larger individuals in August could be expected to bring about a fall in the slope of the age/length regression lines and this was observed in both years (pages 12 and 18). However, while a May-June-July rise was observed in 1968 a slight fall from June to July was recorded for 1967. Furthermore the July slopes ranged from 2.6 in 1967 to 3.6 in 1968—divergence which could scarcely be expected to be caused by anything other than sampling error. Apart from the very low figure of 1.9 for May 1968 none of the variations observed were in fact statistically significant. The May sample was clearly an incomplete one, the length range being only 26 to 63 cm. The two regression lines for July are shown in Fig. 8 with dotted lines to indicate 95% confidence limits. The results indicated that the variation between growth rates calculated for July and August could be ignored and all of the samples from other lakes could be treated together regardless of the date of sampling.

Observations on feeding activity as shown by fullness of stomachs were inconclusive—apart from the very striking fact that at all times substantial numbers of eels with empty stomachs were caught. In 1967 more eels with food were found in July than in August but in 1968 this trend was reversed. It was assumed therefore that these variations were of no significance.

The North Corrib studies revealed no pronounced changes in food from month to month with the minor exceptions of such items as cyprinid eggs which were not available throughout the summer. The nature of the

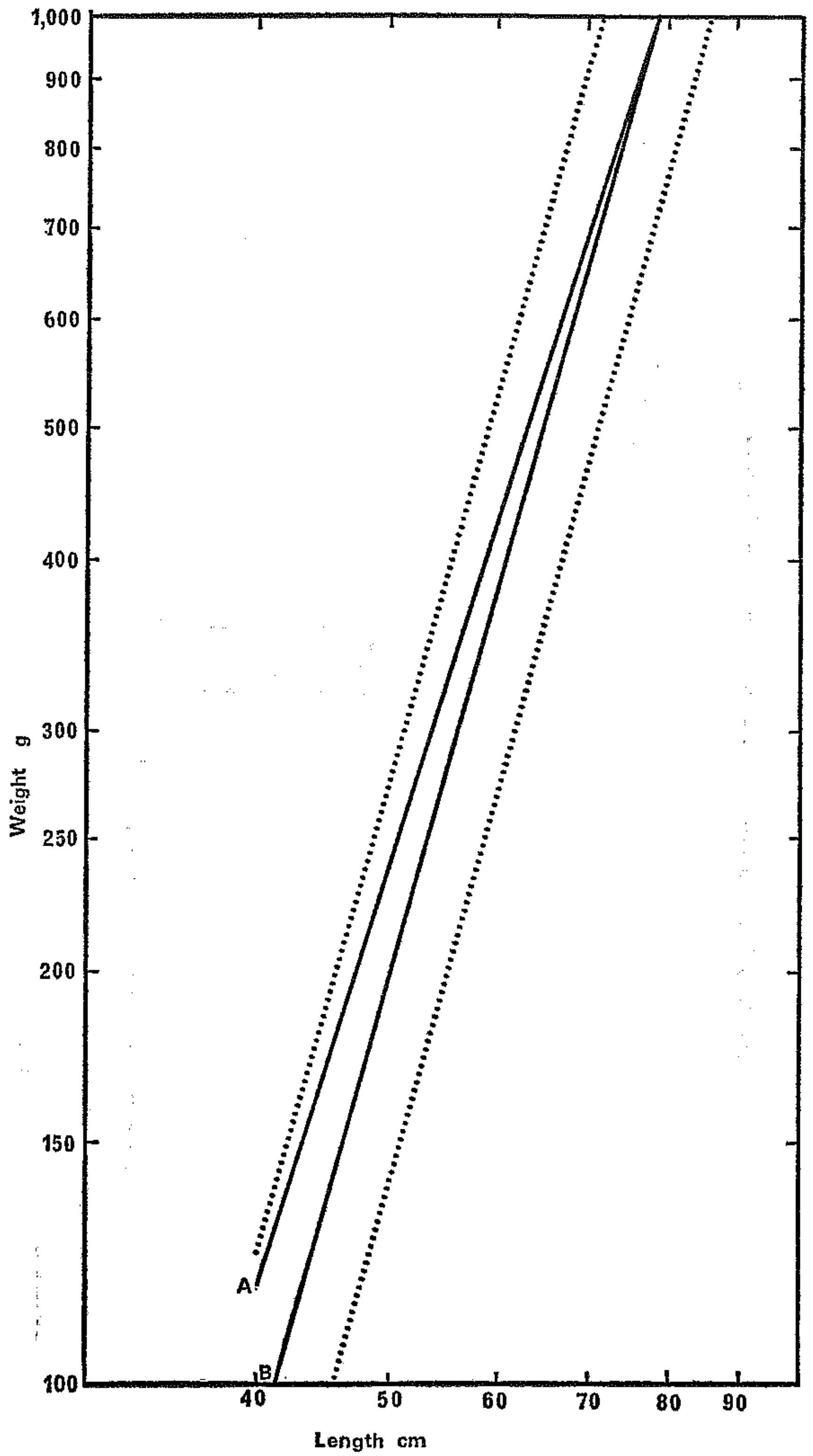

Fig. 7. Length/weight regression on logarithmic scale, A : May 1968, B : July 1967. Dotted lines indicate 95% confidence limits for B.

food did vary with the size of the eels (Tables 7 & 15). Individuals longer than 60 cm were largely piscivorous though in 1968 gastropods were present in 20% of the stomachs. Crustaceans and insect larvae, which were usually small species, not exceeding 3 mm in diameter, were most frequent in the smallest eels and declined steadily in frequency until they virtually disappeared at the 60 cm limit. Gastropods, mostly *Bithynia tentaculata* and *Limnaea pereger* were relatively scarce in eels of less than 40 cm, with *Gammarus* next (see Table 8). Eleven full stomachs were found in the 40-50 cm eels in July and August 1967 of which nine contained dominant gastropods, one fish and one fish ova. Larger individuals fed mainly on fish with gastropods next.

In 1968 (Table 15) gastropods were the most important single group for the eels of less than 40 cm but twice as many full stomachs in this class contained other invertebrates; *Phryganea* and Chironomids being the most frequent with *Gammarus* taking only a minor place. The stomachs of 40-50 cm eels were clearly dominated by gastropods and fish appeared with increasing frequency in the larger individuals. Taking all the observations together gastropods and fish appeared to be the most important groups with a variety of small arthropods next. This order was reflected in the detailed food item frequency lists (Tables 9 and 17) where gastropods (82 and 165) came first and fish (44 and 50) second.

It was considered that the four headings under which feeding was examined—fullness of stomachs, frequency of major food items (as groups rather than species), the dominant food in full stomachs and the detailed list of food items—would be useful in comparing the nutrition of eels in the various waters.

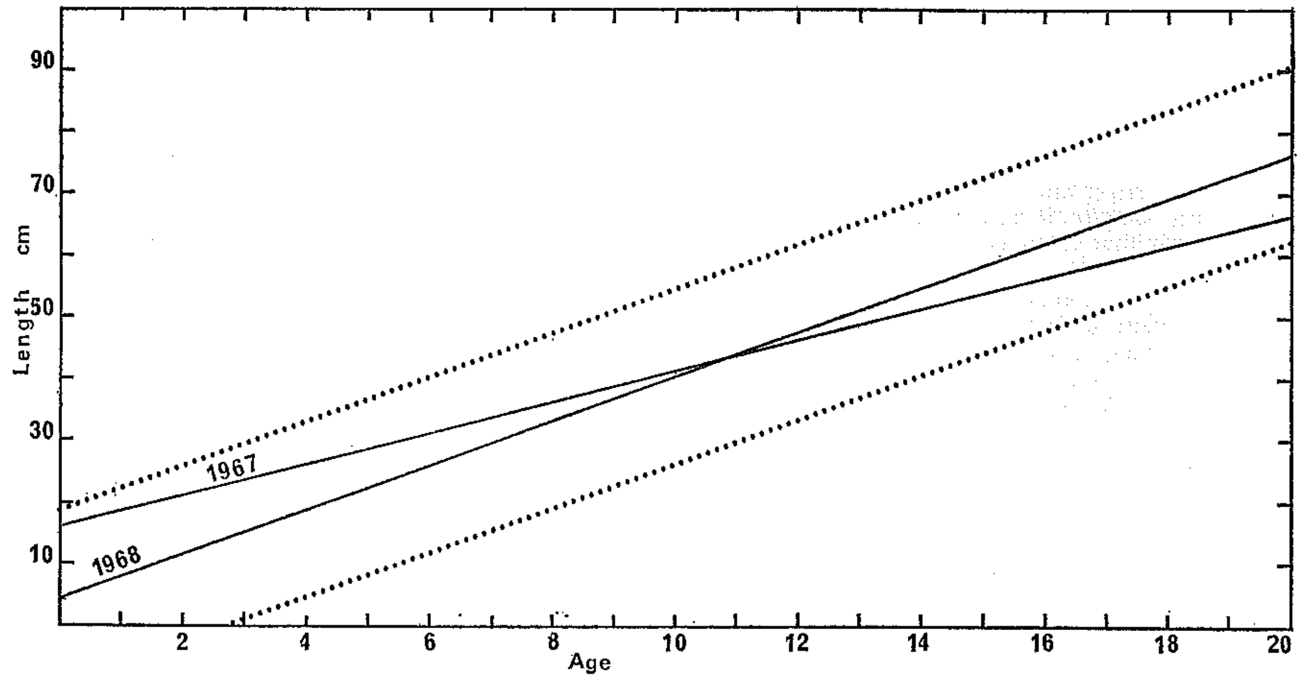

Fig. 8. Age/length regression for July Corrib eels. Dotted lines indicate 95% confidence limits for 1968.

CORRIB SYSTEM

In 1969, with surveys of South Corrib, Mask and Carra, the study of the lakes of the system was concluded. A summary of the statistics collected is given in Table 30.

Table 30. Vital statistics of Corrib System eels.

		Lough Corrib			Lough	Lough
		South	Mid	North	Mask	Carra
Unit catch	...	4.4	1.9	1.3	1.2	0.5
Number measured	...	349	797	378	127	71
% less than 40 cm	...	45	45	37	21	17
% 40—50 cm	...	38	39	42	56	47
% over 50 cm	...	17	16	21	23	36
Number aged*	...	331	137	149	116	68
% 5—8 years	...	15	10	9	5	7
% 9—10 years	...	32	23	21	31	27
% 11 years and over	...	53	67	70	64	66
% clear otoliths	...	44	11	25	45	77
Length at 10 years	...	44	41	40	42	44
Length at 15 years	...	59	54	58	53	58

*July figures only for Mid and North Corrib.

These figures show, as the distance from the mouth of the river increases, that the unit catch falls and the proportions of larger and of older eels rise. The growth rates do not differ significantly from the mean for North Corrib. This being so, it may be concluded that the migration of eels upstream through the river system takes place so slowly that virtually no young eels reach the upper lakes.

The proportion of eels of 11 years and older was relatively low in South Corrib, the figures for North Corrib and the upstream lakes being higher and showing little variation. This leads to the conclusion that the South Basin is something of a nursery ground which many eels leave to migrate upstream. North Corrib, on the other hand, contains a more sedentary population where the majority of eels stay until they reach maturity, the same being true of Mask and Carra.

There must, of course, be a certain amount of migration upstream through North Corrib and Mask. While the age determinations did not show any statistically significant differences in the growth rates the appearance of the otoliths may provide some information on this migration. In South Corrib the relatively high proportion of clear otoliths may be explained by the large numbers of young eels in the population, specimens of less than 9 years being frequently easy to read. In Mid and North Corrib the proportion of clear otoliths was much lower than in Mask and Carra. This suggests that the eels which reach the upper reaches are the more vigorous individuals of the population. The food of the eels varied to some degree in the different lakes. In South Corrib *Gammarus*, Chironomids, *Asellus* and fish were the main food items. In Mid and North Corrib gastropods, mainly *Limnaea*, took first place both in frequency in all stomachs and as the dominant items in the full ones. Fish and Chironomids came next with *Gammarus* third. In Mask only three stomachs were full, of which two held fish. In order of frequency *Asellus* came first, followed by *Bithynia* and Ephemeroptera. There were no full stomachs in the Carra sample and evidently little benthic food in the lake. *Gammarus, Ephemera,* and *Limnaea* were the most frequent food items. The eels in all of the lakes except Carra appeared to be well fed. In Carra not only were there no full stomachs but 61% of all the stomachs were empty.

5. SUMMARY

1. Eels from the three largest lakes on the Corrib System, Corrib, Mask and Carra, were sampled by fyke netting. Catch per unit effort decreased from 4.4 in Southern Lough Corrib through 1.2 in Mask to 0.5 in Carra. The use of fyke nets with different leaders showed that of lengths 9, 6.5 and 4 m, the 6.5 m leader was the most efficient in still water.

2. Observations of lengths and ages suggested that the eels belonged to a single population on the basis of growth rate but higher proportions of small and young eels were found in the lower reaches of the system than in the upper. Forty-five per cent of the South Corrib catch were less than 40 cm in contrast to 17% of Lough Carra eels. Fifteen per cent were younger than 9 years in South Corrib, 7% in Carra. This led to the conclusion that migration upstream was so slow that the waters upstream of South Corrib were underpopulated.

3. Eels of less than 50 cm fed largely on invertebrates; above this size fish-eating became apparent and was almost the exclusive diet of eels longer than 60 cm. There were some exceptions including that of a 67 cm eel with full stomach which contained only Cladocera. *Asellus, Gammarus* and Chironomids were the dominant invertebrates in South Corrib eels, *Limnaea* in North Corrib, *Asellus* and *Bithynia* in Mask; *Gammarus, Ephemera* and *Limnaea* in Carra. Food appeared to be scarce in Carra where 61% of the eels had empty stomachs and no full stomachs were recorded. In the other lakes food was adequate and 43% or fewer empty stomachs were found.

4. In the course of a study of bottom fauna and eel stomach contents in Cushlough Bay, Lough Mask, evidence was found of eels actively selecting *Asellus* and rejecting *Limnaea.*

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APPENDIX 1

Table 9. Food Organisms, Lough Corrib

Area	A	B	C	D	E	F	Others	Numbers	Total stomachs
Cladocera		3						25—00	3
Asellus sp.	2	1	1	3			2	1—11	7
A. aquaticus				1	2		1	1—55	4
A. meridianus			2	14	4	1	2	1—53	23
Gammarus sp.		2	3	8			2	1—20	15
G. lacustris			1					2	1
G. duebeni			1	11	6		4	1—33	22
Ephemera danica		2	3	9	1		1	1—57	16
Caenis sp.					1		4	1—10	5
Haliplid		1	1	13	3		1	1— 7	19
Polycentropus flavomaculatus				2			1	1— 3	3
Cyrnus flavidus		1			1	2		1	4
C. trimaculatus				2	1			1— 9	3
Athripsodes aterrimus		2		8			4	1— 4	14
A. cinerea		2		20	2	1	1	1—33	26
Mystacides azurea				4				1— 2	4
M. longicornis							1	1	1
Oecetis ochracea				5	2		3	1— 6	10
Phryganea sp.		1						1	1
Chironomid lv.		4	2	22	7	1	4	1—21	40
Chironomid pp.				3	7			1— 3	10
Bithynia tentaculata	4	5	1	5	3	2	2	1—34	22
Limnaea stagnalis				4				1— 5	4
L. pereger	1	2	3	26	13	1	3	1—41	49
Valvata piscinalis			1	2	1	1	1	1	6
Planorbis albus					1			3	1
Bivalve large			2	2	3	2		1—50	9
Bivalve small		2		7	2		3	1— 2	6
Fish (unidentified)	5	6	8	3		1		1— 2	23
Brown Trout		1						1	1
Char			6					1— 2	6
Pike	3							1	3
Eel	2		1				1	1	4
Perch	4		1			1		1	6
Stickleback			1					1	1
Cyprinid egg		5		2		1	1	1—585	9
Perch egg	4		1	1				1— 8	6
Total food items	8	16	18	23	17	11	18		35
Stomachs with food	22	23	22	44	33	11	15		170

A. Barrusheen North
B. Inishshanboe East
C. Inishshanboe South
D. Illaunnacreeva
E. Barrusheen South
F. Roeillaun North

APPENDIX 2

Table 17. Food organisms, Lough Corrib 1968.

	A	B	C	D	E	F	G	H	I	J	K	L	n	Range	Mean
Helobdella stagnalis ...		3	1							1			5	1— 2	1.2
Cladocera ...			4					1			1	2	8	1— 89	16.3
Asellus aquaticus ...	5	3	1			3	4	1			3		20	1— 59	5.2
A. meridianus ...	8	6	2			2	2	1			2		23	1— 67	10.7
Gammarus lacustris ...	7	30	2	2	4	1		1				2	49	1— 44	7.7
G. duebeni ...	4	1	5							1			11	1— 64	14.0
Mysis relicta ...	1	3		6						7		6	23	1— 57	10.4
Zygoptera ...	1												1	1	1
Ephemera danica ...	2	3		1	1								7	1— 2	1.4
Caenis sp. ...	2	2	1		1	5		2					13	1— 27	4.4
Heptagenia sulphurea ...		1											1	1	1
Centroptilum luteolum ...	2		4									1	7	1— 2	1.4
Cloeon simile ...	1												1	1	1
Baetis sp. ...			4										4	1— 4	2.0
Halipid sp. ...	2	5	3		4	1					2	1	18	1— 7	1.7
Gyrinus sp. lv. ...			3										3	1— 5	3.0
Corixid ny. ...	1												1	1	1
Oxyethira sp. ...	1		1		2								4	1—129	33.0
Cyrnus flavidus ...		8	2			7					2	1	20	1— 20	3.1
C. trimaculatus ...	2					1							3	1— 2	1.3
Phryganea sp. ...	2	5		1	1								9	1— 4	1.6
Limnephilus marmoratus ...	1												1	1	1
Athripsodes aterrimus ...					2								2	2— 3	2.5
A. cinerea ...	2				1	6	4				4		17	1— 15	3.1
Mystacides azurea ...	1	2									2		5	1— 2	1.2
M. longicornis ...	3	7		2		4					1		17	1— 14	2.6
Ocetis ochracea ...	8	8	1	3	1			1		1			23	1— 16	3.2
Chironomid lv. ...	9	23	7	1	1	12	1		1	2	15		72	1—101	12.5
Chironomid pp. ...	2	16	8	2		2	1	2	2	1	9		45	1— 19	2.7
Bithynia tentaculata ...	4	14	2	1	1	1	6	1	3	1	12	1	47	1— 23	5.0
Valvata piscinalis ...	4	4	2	1		1	2				8		22	1— 32	3.3
Limnaea stagnalis ...	1	1	2			1	1		2		2		10	1— 15	5.2
L. pereger ...	12	25	5		2	8	6	2	1	2	17		80	1— 53	7.4
Planorbis alba ...	2	2							1		1		6	1— 3	1.6
Bivalve large ...	2	4		1	5					3	3		18	1— 9	3.8
Bivalve small ...	1	6	2	1	1	4				1	3		19	1— 6	2.3
Brown Trout ...		1											1	1	1
Char ...									1				1	1	1
Pike ...	1		1								1		3	1	1
Eel ...	2	2			2	3				1		1	11	1	1
Perch ...	1	2	3			2							8	1— 4	1.7
Stickleback ...	1	6	1	1		1	1	1					12	1— 2	1.1
Cyprinid egg ...	4	2		2	3		3	1	2		4	1	22	1—513	77.2
Perch egg ...		1											1	20	20
Fish ...	2	4		1	4	1				2			14	1— 2	1.1
Total food items ...	33	31	23	13	14	20	12	11	8	11	19	10	46		
Stomachs with food ...	49	60	17	14	16	22	11	6	5	12	38	5	255		

APPENDIX 3

Table 20. Food organisms, South Corrib.

	River May	River July	Lake	Total	Range	Mean
Annelid			1	1	1	1.0
Asellus aquaticus ...	6	5	28	39	1—197	13.1
A. meridianus ...	1	1	22	24	1— 94	26.4
Gammarus sp. ...	3	0	50	53	1—174	28.9
Zygoptera ny. ...	0	0	2	2	1	1.0
Ephemera danica ...	0	0	6	6	1— 2	1.1
Cloeon simile ...	0	2	1	3	1— 3	1.6
Notonecta sp. ...	0	0	2	2	1	1.0
Cymatia bonsdorffi ...	0	0	1	1	1	1.0
Corixa affinis ...	0	0	1	1	1	1.0
Sigara dorsalis ...	0	0	1	1	1	1.0
S. distincta ...	0	0	1	1	1	1.0
Arcotocoriza germari ...	0	0	7	7	1— 3	1.7
Haliplid lv ...	0	2	5	7	1— 3	1.3
Neureclepsis bimaculata ...	0	0	1	1	2	2.0
Polycentropus flavomaculatus ...	0	1	24	25	1— 83	6.5
P. irroratus ...	0	0	2	2	1— 2	1.5
Cyrnus flavidus ...	1	0	3	4	1— 7	3.7
C. trimaculatus ...	0	0	1	1	2	2.0
Hydropscyche sp. ...	2	0	5	7	1— 5	3.3
Athripsodes cinerea ...	0	0	6	6	1— 4	1.8
Mystacides longicornis ...	1	0	0	1	1	1.0
Triaenodes bicolor ...	0	0	1	1	1	1.0
Ocetis ochracea ...	0	0	2	2	1— 2	1.5
Lepidostomum hirtum ...	0	0	1	1	7	7.0
Chironomid lv. ...	6	12	54	72	1—100	8.3
Chironomid pp. ...	1	1	10	12	1— 5	1.8
Chaoborus ...	0	0	1	1	3	3.0
Bithynia tentaculata ...	8	6	11	25	1— 25	6.0
Valvata piscinalis ...	1	2	1	4	1	1.0
Limnaea pereger ...	4	2	27	33	1— 54	4.6
Planorbis albus ...	1	1	0	2	1	1.0
Anodonta sp. ...	0	0	2	2	1	1.0
Bivalve large ...	8	2	6	16	1— 25	3.1
Bivalve small ...	2	2	1	5	1— 3	2.0
Eel ...	2	0	15	17	1	1.0
Perch ...	2	6	18	26	1— 2	1.0
Stickleback ...	0	0	2	2	1	1.0
Total food items ...	17	16	38	40		
Total stomachs with food ...	19	22	156	197		

APPENDIX 4

Table 29. Food organisms, Lough Carra.

	Number of stomachs	Individuals per stomach Range	Mean
Asselus sp. ...	2	1	1
Gammarus duebeni ...	7	1—80	25.1
Ephemera danica ...	6	1— 2	1.6
Corixid ...	2	1— 3	2.0
Haliplid lv ...	1	1	1
Polycentropus flavomaculatus ...	1	1	1
Holocentropus dubius ...	1	1	1
Chironomid lv ...	5	1—15	3.8
Chironomid pp ...	1	3	3.0
Bithynia tentaculata ...	4	1—13	4.0
Valvata piscinalis ...	1	12	12
Limnaea pereger ...	6	1— 2	1.3
Bivalve small ...	1	1	1
Cyprinid egg ...	6	1—95	21.8
Fish ...	3	1	1
Total food items ...	15	Total stomachs with food ...	19

APPENDIX 5

Table 28. Food organisms, Lough Mask.

	Number of stomachs	Individuals per stomach Range	Mean
Cladocera ...	8	1—99	15.5
Copepoda ...	1	100	100
Asselus aquaticus ...	38	1—75	14.7
Gammarus lacustris ...	1	1	1
Gammarus duebeni ...	11	1—44	9.1
Ephemera danica ...	1	1	1
Centroptilum luteolum ...	1	15	15
Baetis niger ...	1	1	1
Ephemeroptera ...	19	1—81	9.4
Cymatia bonsdorfii ...	3	1— 2	1.3
Sigara scotti ...	4	1— 8	3.0
Callicorixa praeusta ...	1	2	2
Gyrinus lv. ...	2	1	1.0
Haliplid ...	6	1— 3	1.5
Sisyra lv. ...	1	3	3.0
Lepidoptera lv. ...	1	1	1
Polycentropus flavomaculatus ...	2	1	1.0
Holocentropus dubius ...	3	1— 2	1.6
Athripsodes senilis ...	1	1	1
Mystacides longicornis ...	1	1	1
Sericostoma personatum ...	1	9	9
Chironomid lv. ...	15	1—18	3.3
Chironomid pp. ...	2	1	1.0
Hydracarina ...	1	1	1
Valvata piscinalis ...	4	1— 5	2.7
Bithynia tentaculata ...	24	1—23	4.8
Potamopyrgus jenkinsi ...	2	1	1.0
Physa fontinalis ...	2	1— 2	1.5
Limnaea pereger ...	7	1— 2	1.1
Planorbis albus ...	1	1	1.0
Bivalve large ...	3	6—25	12.3
Bivalve small ...	6	1— 3	2.0
Salmonid ...	1	1	1
Pike ...	1	1	1
Perch ...	8	1— 2	1.1
Fish ...	2	1	1.0
Fish eggs ...	1	4	4
Total food items ...	37		
Total stomachs with food ...	64		

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