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FISHERIES BULLETIN No. 7 (1983)

A POPULATION STUDY OF THE EEL *ANGUILLA ANGUILLA* IN MEELICK BAY, LOUGH DERG

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Dublin: Published by the Stationery Office.

To be purchased through any Bookseller, or directly from the
GOVERNMENT PUBLICATIONS SALE OFFICE, SUN ALLIANCE HOUSE,
MOLESWORTH STREET, DUBLIN 2.

Price: 40p.

Fisheries Bulletin
(Dublin) ISSN 0332-4338

A population study of the eel *Anguilla anguilla* in Meelick Bay, Lough Derg

by

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ABSTRACT

Monthly samples totalling 1,945 yellow eels were caught by fyke net in a small bay, area 100 hectares, of a large lake in 1981 and 1982. Catch per unit effort figures showed that population density varied between months and between specific areas of the bay. Most of the eels sampled (80%) measured between 34 cm and 54 cm. Ages of a sample of 168 specimens taken in 1979 ranged from 7 to 17 years, 80% from 8 to 13 years. Length frequencies were constant throughout the bay within months but showed changes between months. Recapture rate of 1,660 eels tagged was extremely low at 1.14%.

The results showed that (1) when eel population density is being compared between years, it is necessary to define exactly the positions where sampling takes place and (2) the eel population in this bay was not resident but appeared to be undergoing constant change throughout the warm months of the year.

INTRODUCTION

An extensive study of the eels in the lakes of the Shannon river system was made in 1969 and 1970. This was followed by periodic sampling which is still in progress (Moriarty 1974, 1982). Lough Derg is the largest and most downstream of a number of lakes through which the Shannon and its tributaries flow. This river system yields the greatest catch of eels in Ireland (Republic) and is the only eel fishery in the State in which stock enhancement by the overland transport of elvers has been in progress for a sustained period. Continuing study of the eel stocks is being made so that the development of the fishery may be effectively controlled in the future.

Considerable variation in the eel population structure within the lake had been observed: between months, between years and between sampling locations. It was therefore decided to concentrate the major effort over a period of years in a small area of the lake over an extended period in each year. This work began in July 1981 and ran for a full season in 1982.

Although a number of studies of eels in lakes have been made (Tesch 1977), very few have been concerned with behaviour patterns of the lake populations of yellow eels. In the case of *A. anguilla* it appears that no reports on tagging have been published nor have any detailed studies been made of eel populations within a restricted area. Lake studies of *A. rostrata* have been made by Hurley (1972) and Labar (1982) and of *A. australis* and *A. reinhardtii* by Beumer (1979). These dealt with exploited eel populations while the present work is based on an unexploited population in which all the fishing was conducted by the author. Population changes and tag recoveries therefore reflected natural behaviour patterns and were not influenced by fishing mortality. The first two seasons' observations have led to conclusions on the migration of eels in lakes and are given in this paper.

MATERIALS AND METHODS

Lough Derg has an area of 11,635 ha., pH range 7.7 to 8.2 and conductivity 420 uS/cm (Flanagan and Toner 1975). It is the largest and most downstream lake of the River Shannon, 20 km from tidal water. Meelick Bay (Figure 1) lies on the northern side of Scarriff Bay and opens towards the south.

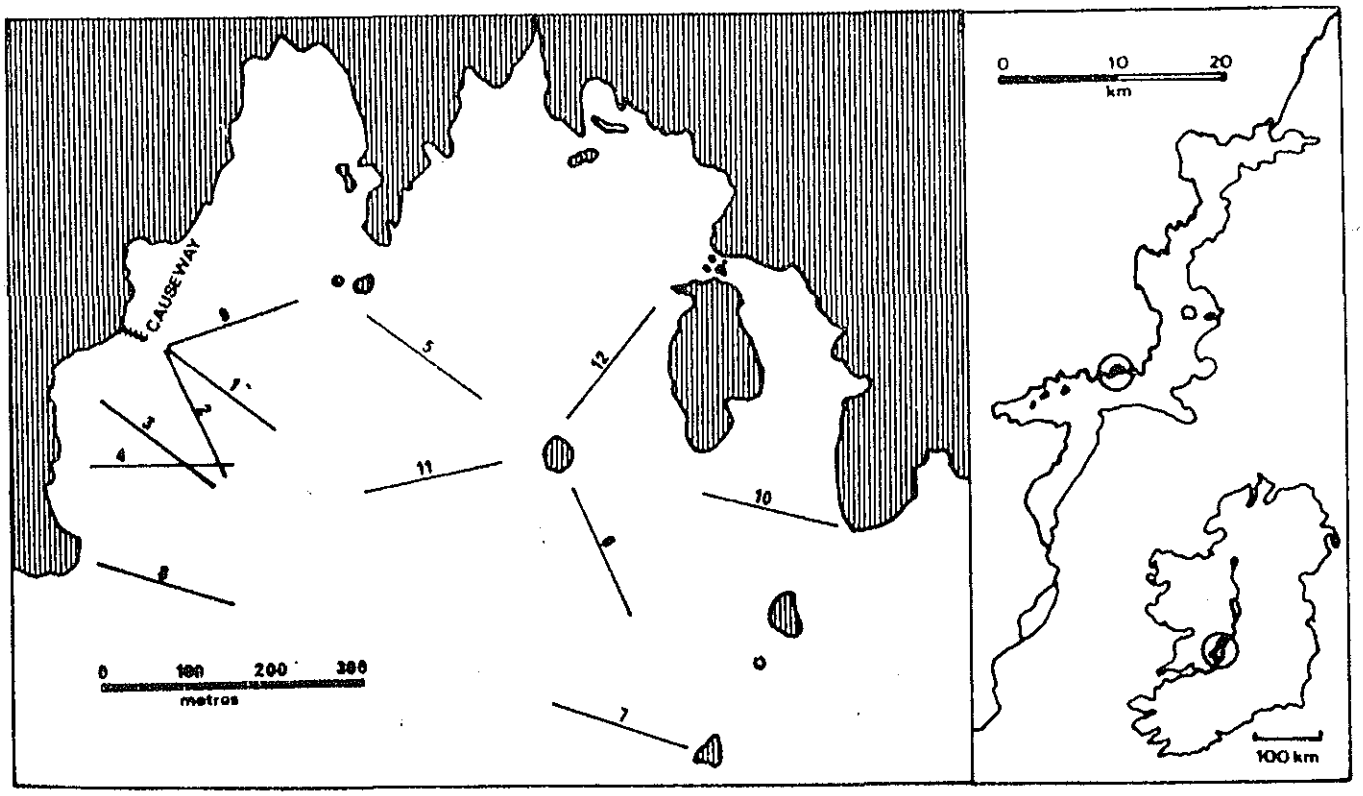

FIGURE 1. (left) Meelick Bay, showing positions of trains of ten nets. (right) Lough Derg with Meelick Bay encircled and shaded in black; Ireland showing main River Shannon with Lough Derg encircled.

Routine procedure was to set trains of ten summer fyke nets to fish overnight in two of the positions shown. The water in all positions was greater than one metre deep. The primary basis of selection otherwise was to ensure that the placing of the nets could be repeated accurately by reference to conspicuous landmarks. As far as possible each position was fished once a month.

All eels captured were anaesthetised with chlorbutol and measured to nearest mm. One or two specimens from each position were retained for age determination and stomach analysis. All the others were marked with Floy tags inserted just in front of the origin of the dorsal fin and allowed to recover in a bucket of fresh water. They were then released at the Causeway.

RESULTS

Catch per unit of effort

Samples were taken monthly from July to November 1981 and April to August 1982 with additional samples in February and October 1982. As a rule the effort in each position was ten nets in each month. Occasionally the nets were incorrectly counted at setting so that nine or eleven were used. In April 1982 the effort in each position was doubled: one sample being taken early in the month, the second sample in the last week. At position 1 in the last week of April ten nets were set nightly over three nights. No significant differences in the catch per net were observed within positions on these occasions. From April to September catches in most positions were greater than one eel per net and details of these are given in Table 1.

These figures show that five positions gave consistently high catches, never less than 2.3 while the remaining six were usually less than 2.3 and generally had substantially lower catches than the first five. The five good positions lay in the eastern half of the bay while the six poor lay in the western half.

Lengths

When the mean lengths of the eels in each sample were compared by F test within months between positions no significant differences were observed. All samples for each month were therefore pooled to compare lengths between months. Length frequencies and means are given in Table 2. No significant differences in mean lengths between the samples in the months of May, June and July 1982 were observed and the catches for these three months are therefore treated as a single sample.

Table 2 also contains length frequencies of samples from Meelick Bay taken in July 1974 and 1975. The means for the July samples showed a significant decrease between the years 1975 and 1981 but no significant differences between successive years. In 1981 the mean length increased from July to August but decreased in the same period in 1982. The 1981 increase resulted from the presence of higher numbers of eels greater than

44 cm while the 1982 decrease followed an influx of eels less than 41 cm. The mean length in April 1982 was greater than that of any of the samples from 1975 onwards and was caused by the presence of substantial numbers of eels of 51 cm and over.

Tagging

In 1981 and 1982 a total of 1,660 eels were tagged from all parts of the bay and released at the Causeway. Fifteen were recovered. The numbers of days between release and recapture for each position are given in Table 3B.

Only one eel of the 353 tagged in 1981 was recaptured the following year. Unfortunately the final digits of the number of the tag could not be read and it was thus not possible to assess the growth of the specimen between taggings. Eleven of the recaptures were made in less than 48 hours after tagging. One of these was recaptured at Position 8, apparently arrested in the course of a rapid departure from the bay. One of the recaptures at Position 9 had made the journey in daylight and in less than three hours.

Table 3 gives the numbers of eels caught in each month and the numbers of recaptures. The figures in the first column of the table are the numbers tagged on the dates shown. Those tagged on the last day of each sampling visit are added to the numbers tagged in the following period. This takes account of the fact that those tagged on the last day had very little chance of being recaptured within the period. A figure for monthly percentage of recapture is calculated from this giving a mean monthly recapture rate of 1.14%.

As each season progressed the numbers of eels tagged increased but the rate of recapture after the first month showed no distinct change. Values for "expected recaptures" were calculated on the assumption that the tagged eels remained in the bay and the recovery rate remained constant at 1.14%. The chi square test indicated that the recovery rate was significantly lower than expected ($p<0.01$).

Age

The age composition of a sample of 168 eels taken in the bay in August 1979 is shown in Table 4. The most frequent age groups were 9 to 12 inclusive accounting for 62.5% of the total. In the previous month nine of the biggest eels caught, ranging in length from 55 to 77 cm had been selected for ageing giving readings from 14 to 23 years.

DISCUSSION

The validity of fyke net samples of eels in stock assessment exercises has been discussed by Moriarty (1975). He showed that the net is capable of catching eels of all sizes above the minima which are able to escape through the meshes. The scarcity of eels of greater than 45 cm in the samples from Meelick Bay is thus an indication of a scarcity of such eels in the population as a whole. The age determinations showed that the population was

composed of relatively young specimens, the few large ones examined being between two and twelve years older than the majority.

The catch per unit effort figures for both years showed clearly the existence of some areas within the bay which are more favoured by the eels than others. These lie on the eastern side of the bay, but it is not yet clear whether this is a chance distribution or reflects the existence of some preferred type of substrate.

The small size of the eels in the bay, compared with the sizes observed in other parts of the Shannon system (Moriarty 1974) suggests that the population must be subject to regular emigration of immature individuals. The maintenance of the very low recapture rate of tagged eels throughout the season shows that the population is changing from month to month. In a more sedentary population a steady increase in recaptures would be expected as the numbers of tagged eels in the area increased.

Changes in the population are also shown by the different length frequencies observed at different times: many large eels present in April and many small specimens in August. The increase in numbers of small eels observed in August 1982, however, had not been apparent in August 1981.

The rate of recapture, at little more than 1%, is extremely low when compared with other work on the eel. LaBar (1982), for example, in Lake Champlain, Vermont, U.S.A. observed recaptures of 32 out of 373 *Anguilla rostrata* tagged in 1980, over 8%. In Australia, Beumer (1979) recorded a recapture rate of 18.5% of eels in Macleods Morass, a shallow water body of 423 hectares. Relatively high rates of recapture were also recorded by Hurley (1972) in Lake Ontario: 5.5% in an experiment in which eels were displaced from the point of capture. However, when eels were replaced at the points of tagging in the tortuous Bay of Quinte, 8.9% were recaptured from a point near its upstream end while only 0.9% were recovered from a tagging location nearer the downstream end. This observation may be comparable to the results of the present work which show rapid emigration from a relatively downstream position. In the absence of details on the nature of the fishing effort to which the eels were exposed after release, it is not possible to make close comparisons with the other studies. However, it seems reasonable to conclude that a rate of recapture of between 5% and 18% could have been expected in Meelick Bay.

Recaptures in Meelick Bay were nearly all made within a few days of release. Application of the chi-square test to compare the results between months showed that there was no evidence ($p<0.01$) that the tagged eels were remaining within the bay. During the study no fishing for yellow eels took place outside the bay. The tagging therefore indicates that migration through the bay is rapid and suggests that most of the population may move out of it several times in the course of the season, to be replaced by immigrants from elsewhere in the lake.

CONCLUSIONS

The results of the first two seasons of work in Meelick Bay have shown clearly that substantial differences in population density of eels may be observed not only between months but also between areas of a small water body which appeared superficially to be uniform. It is therefore essential in stock assessment exercises to make exact definitions of sampling areas.

Migrations of large and small eels into and out of the bay are shown by changes in length frequencies between months. However, these changes were not constant between years and interpretation of this observation will depend on repetition of the sampling over a number of years.

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Table 1. Mean monthly catch per unit effort.

Position	1981 July	Aug.	Sept.	1982 April	May	June	July	Aug.	Mean	SE
1	4.4	1.4		2	2.2	0.8	1.5	2.0	2.0	.25
2	5.1	0.8		0.6				2.3	1.5	.72
3	1.4	1.5								
4	1.4						2.4	1.9	1.9	.46
5	2.9	11.7	2.7	5.2	4.8	4.0	3.0	2.8	4.6	.46
6	5.1	3.4			4.8	4.5	4.7	6.8	4.9	.53
7	2.9			6.9	3.5	2.7	2.3	7.5	4.3	.56
8	3.7	1.8	1.7	2.1	3.4	1.2	1.6	5.3	2.6	.63
9	1.9				1.8	1.0	2.9	4.1	2.3	.86
10							4.2	6.2	5.2	
11							2.9	4.0	3.5	
1, 2, 3, 4, 8, 9										
Mean	3.0	1.4	1.7	1.6	2.5	1.0	2.1	3.1		
SE	.36	.69		.77	.58	1.0	.54	.38		
5, 6, 7, 10, 11										
Mean	3.6	7.5	2.7	6.0	4.4	3.7	3.4	5.5		
SE	.33	.27		.31	.29	.32	.26	.20		

Table 2. Length frequencies (cm, rounded downwards, percentage of n).

	July 1974	July 1975	July 1981	August 1981	April 1982	May-July 1982	August 1982
25-30			1		1	1	2
31-33	4	1	4	2	1	4	5
34-36	12	11	15	14	6	14	18
37-39	13	16	26	20	16	23	26
40-42	9	14	21	17	23	18	21
43-45	14	17	17	18	17	15	14
46-48	6	19	8	12	15	12	8
49-51	13	7	7	11	9	7	3
52-54	12	8	1	4	6	2	1
55-57	6	3	1	1	1	1	1
58-60	5	1		1	2	1	
61-69	1	2	1		1	1	1
70-99	5		1		2	1	1
n	107	214	223	222	292	583	448
Mean	46.7	44.1	40.8	42.3	44.3	41.6	40.1
SE	0.99	0.45	0.38	0.36	0.42	0.25	0.27

Table 3. Tag recapture data. The number of eels tagged on the last day of each monthly sampling period is added to the total for the next month and not included in the month when tagging took place.

A	Numbers tagged		Total monthly catch	Recoveries			
	Monthly	Cumulative		Number	%	Observed	Expected
July 1981	148	148	223	0	0		
August	205	353	222	3	1.5	3	4
April 1982	175	175	292	1	—		
May	171	346	190	4	2.3	4	4
June	99	445	142	0	0	0	5
July	290	735	275	4	1.4	4	8
August	572	1307	601	3	0.5	3	15

B	Recapture position	Days between tagging and recapture				
		<1	1	2	22—30	365
	1	1	1	1		
	2	1	1		1	
	4		1			
	5	1	1			
	6				1	1
	8		1			
	1	1	1		1	

Table 4. Length at age data for 168 Meelick Bay eels caught on 21.8.79.

Age	Number	Length (cm)	
		Mean	SE
7	6	35.6	1.50
8	15	37.7	0.95
9	27	38.4	0.70
10	31	40.8	0.84
11	28	41.5	0.86
12	19	41.5	1.24
13	16	44.2	1.07
14	10	43.4	1.52
15	6	44.2	1.82
16	7	47.4	3.00
17	3	51.6	4.01

(9395)143257. 550. 5-84. F.P.—G3.