IRISH FISHERIES INVESTIGATIONS

SERIES A (Freshwater)

No. 19 (1980)

An Roinn Iascaigh agus Foraoiseachta
(Department of Fisheries and Forestry)

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EDWARD FAHY.

SEA TROUT FROM THE CURRANE FISHERY IN 1973 AND 1974.

Sea trout from the Currane fishery in 1973 and 1974

by

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ABSTRACT

Collections of 1,163 sets of scales from rod-caught sea trout *Salmo trutta* L., made in 1973 and 1974, are described and the results compared with data from previous collections. The mean weight of 821 g was higher than usual in Irish fisheries and smolts were large, ranging from 22.8 to 24.5 cm at two years. Previous indications of a long lived-stock were confirmed by the identification of 37 age categories. The amount of B type growth was considerably less than that observed in samples from rivers with longer estuaries. Marine growth was relatively poor so that the length attained at the end of each sea winter was similar to that of sea trout in other Irish populations. The large size of specimens in the Waterville fishery may therefore be ascribed to longevity rather than to rapid growth at sea. Circuli on parr scales were more numerous than on scales from an east coast sample. Changes observed since the 1944 sampling included an increase in the proportion of older fish indicating that the drift net fishery has not had an adverse effect on the stocks.

INTRODUCTION

Sea-trout of the Currane fishery in Waterville, Co. Kerry, have been studied over a longer period than any other Irish stock. Nall's material (1931), collected between March and July, was taken by net and rod. Another account of the fishery by Went and Barker (1943) is of fish also taken early in the year by both net and trap. The average size of their sea-trout was relatively large. Went's later account (1944) is based on rod caught fish taken during the summer months. More recently, scales were collected from rod caught sea-trout during the 1973 and 1974 seasons in Waterville and these form the basis of the following account.

The thirty years which have intervened since the previous stock assessment was published make a re-examination of the biology of these fish desirable in an effort to identify any changes which have occurred since the earlier evaluations.

MATERIALS, METHODS AND TERMINOLOGY

Scales, fork length and weight data were collected from rod caught sea-trout taken between the first week of July and mid-September of 1973 and '74. The catch was sampled daily; when it consisted of few fish all were examined, otherwise a proportion, representative of the size range, was considered. Some 26% of the 1973 and 15% of the 1974 catch were thus surveyed. Back calculations on three scales from each set from pre-spawned fish were averaged. Back calculations were made for length achieved at the end of each freshwater year by each of the better represented age groups. Thus the calculations which were made on the scales of fish of different sea age could be compared to discover whether differential rates of development in freshwater and the sea influenced length at age measurements. In addition to the usual examination and description of scale formation, numbers of circuli on scales from the two year smolt class were counted. Additional data were collected on anglers' catch weights from local fishing registers.

The scale formula convention for sea trout begins with a figure for the number of riverine winters. This figure is followed by a full stop, the number of marine winters and the number of spawning marks (S.M.). A plus sign signifies growth which did not culminate in a winter band.

Fish in their year of first migration to sea are known as post-smolt. "Adult sea trout" have completed their first post migration winter.

A-type smolts migrate to sea at the end of the last parr winter before any growth has taken place in the year of migration. B-type fish grow in freshwater either prior to their migration or while moving downriver.

Mean smolt age (M.S.A.) is calculated as:

$$\frac{(\%\ S1) + (\%\ S2 \times 2) + (\%\ S3 \times 3) \ldots\ldots}{100}$$

where S_1, S_2 etc. are the smolt classes.

The mean age at first maturation is calculated as:

$$\frac{(\%\ Y1) + (\%\ Y2 \times 2) + (\%\ Y3 \times 3) \ldots\ldots}{100}$$

Where Y1, Y2 etc. are sea trout maturing at the second, third etc. post-migration winter, Y0 represents the first post-migration winter, not included in the figures.

RESULTS

In addition to the sea trout examined, scales from a number of other fish were included in the collections: one possibly brown trout, two salmon and 39 possibly pre-migratory sea trout, although their scales might have belonged to brown trout. Of the remaining collections 1,163 sets of scales (769 from 1973 and 394 from 1974) were deciphered. The age composition of these collections is shown in Table 1 from which it will be seen that two year smolt sea trout predominated. Collections in the two sampling years were quite different: the average weight of the 1973 fish was 624 g (1.37 lb) and 8.1% of the sample had spawned at least once. Of the latter collection the average weight was 779 g (1.72 lb) and 32% were previous spawners. Details of the weight of anglers' catches from local fishing registers are given (Table 2) and their similarity with the average weight of the 1974 collection contrasts with the figure for 1973. Length frequency of the sea run fish is given in Figure 1 in which the later size intervals are occupied by progressively more post spawning fish. The age composition of the collections differed in the two years and pre spawned fish were scarce in the 1973 collection.

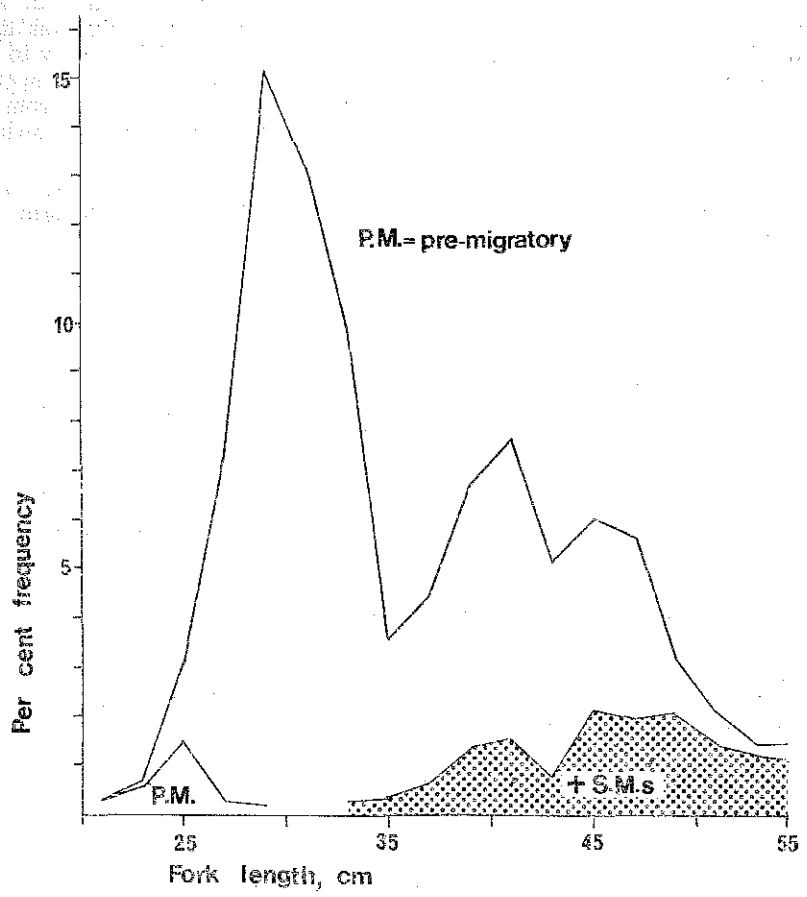

Figure 1. Length frequency distribution of sea trout taken at Waterville in 1973 and 1974. Previous spawners (+S.M.s) and pre-migratory fish (P.M.) are identified.

A description of growth of the premigratory freshwater phase, based on all two and three year old smolts (bulked), the largest smolt classes, is shown in Figure 2 in which the modal points of the two and three year old smolts at one year are separated by less than 1 cm. The same information expressed as length at age in different years is shown in Table 3. Mean lengths for one year old parr ranged from 7.29 to 8.80 cm; for 2 year olds from 16.30 to 22.11 cm and for 3 year olds 22.88 to 24.49 cm.

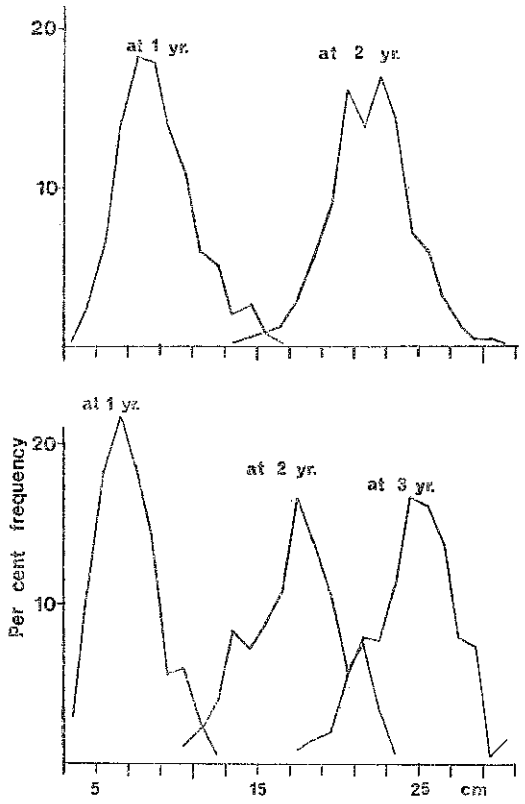

Figure 2. Length frequency distribution of the two largest smolt classes of Waterville sea trout at the end of the first, second and third year in fresh water. Two year smolts above, three year below.

Mean lengths (cm) at migration were:

Age group	A type	B type
2 year olds	22.8	24.5
3 „ „	25.1	26.5
4 „ „	26.7	26.4

It will be seen from the above measurements that the Waterville smolts were large. There was a low incidence of B type growth in all age classes (Table 4). The amount of B type growth which did occur was also low (Tables 5 and 6), less than 20% in most cases. Mean lengths of the few one year smolts, 16.5-16.8 cm, were greater than the means for one year old parr of the older smolt classes.

The numbers of circuli in the parr centres of 64 sets of scales from the Waterville fish were counted as were 139 sets from the east coast (Co. Wicklow) rivers and 64 sets from the Crumlin fishery in Co. Galway. The mean numbers of circuli formed were 18.9 and 23.7 in the first and second years respectively of Waterville fish (Table 7) and these were significantly greater ($P<0.01$) than the numbers in the Wicklow specimens.

Sea age frequencies of the Waterville fish are set out in Table 8 whose results again underscore the relatively long-lived nature of the stock. In view of the large size of the smolts however growth of the fish at sea is very poor:

Smolt class	Length (cm) at end of first sea winter	Number	S.D.
One year	28.6	10	5.70
Two „	33.1	298	5.96
Three „	32.5	41	8.13
Four „	32.5	3	9.80

At the end of the second post migration winter all pre spawned fish averaged 40.9 cm, fork length (N = 40; S.D. = 3.96).

DISCUSSION

The smolts of Waterville sea trout are known to be very large and part of the motivation for Went's (1944) investigation was to discover whether they are taken on rod and line. His conclusion that this occasionally happened is supported by the occurrence of premigratory fish in the present collection. As a percentage of the total sample Went's fish which did not display signs of marine growth amounted to 4.4% a figure which agrees well with 3.2% in 1973 and '74. In Figure 1 the length frequency distribution in both collections is set out and premigratory stages are included. The first peak in Figure 1 represents mainly post smolt and the second adult fish; the larger size intervals are occupied by progressively more previous spawners.

Collections made in the two years are quite different. The average weight of the 1973 fish was 624 g (1.37 lb) and 8.1% of its members had spawned at least once. Of the later collection the average weight was 779 g (1.72 lb) and 32% of its members were previous spawners. These two variables correlate well and the 1974 sample agrees closely with the previously observed relationships (Fahy 1978 a, b); the 1973 sample does not and it seems likely that the larger specimens in that year were omitted from the collection.

A search for documentation was undertaken in an effort to locate further corroborative details of anglers' catches. Apparently only one local hotel kept a current log and the management kindly allowed access to the figures (Table 2). From these the overall average weight of specimens in the summer catch in recent years is 821 g (1.81 lb). It has already been mentioned that there is a close relationship between the percentage of previous spawners in a sample and its average weight. According to this correlation an average weight of 820 g would represent approximately 36% previous spawners. Thus, the 1974 sample with 32% previously spawned fish and an average weight of 770 g is close to the observed relationship. The 1974 sample is therefore considered more suitable for comparison with Went's (1944) results.

The fish are divided into age categories in Table 1. In all 26 age categories are recorded from the 1973 sample in Waterville and 32 the following year. Expressed in terms of Williams' (1947) index of diversity these figures result in values for α of 5.0 and 8.0 or, on the bulked material from both years, a value of 6.5. Nall (1931) recorded 33 categories among 130 fish, a value for α of 12.0. For Went and Barker (1943) and Went (1944) it is not possible to specify the number of age categories although there may have been as many as 38, giving, if so, values for α as high as 10.0 and 7.6 respectively.

Freshwater growth

In Table 3 details of the freshwater phase of the Waterville sea-trout (both collections) are given and in Fig. 2 the back-calculated lengths of the two most important smolt classes at the end of each parr year are set out. Some features of Fig. 2 are general for distributions of this kind. The first year lengths cluster round a relatively narrow base which expands in subsequent growing seasons. There is little overlap between one and two year parr in the two year smolt class, a reflection of a rapid growth rate, but modes of the two and three year length distributions in the three year smolt class are quite close indicating a slowing down in the rate of extension of these fish.

Back-calculations of length at age on successive collections of parr can differ significantly (Fahy, 1979b). Similar tests on the back-calculations in Table 3 were attempted for the Waterville fish. Length at age of two year smolts in successive collections were not significantly different. In 1973 three year smolt fish were significantly larger in their third year than in 1974 ($P<0.001$); otherwise significant differences were not detected.

The above exercise was extended to ascertain whether length at age determinations were influenced by the sea age of the fish from which scales were removed. Checks on the validity of method of ageing and back calculation are advisable (Sych, 1971) and it is conceivable, should scale formation take place at different rates in fresh and salt water, that back calculation from the scales of sea run fish would yield lengths at age which

were not true. Such distortion should however be identifiable by comparing the back-calculated lengths at age of fish in a particular freshwater year from scales of fish of different sea ages. Because the majority of Irish sea-trout survive briefly at sea there are few opportunities for tests of this kind in stock descriptions. In this case the tests did not reveal any significant differences in length at age as back-calculated from the scales of adult fish of one sea winter and post-smolts (Table 3).

Mean smolt age

The mean smolt age (M.S.A.) is calculated as 2.26 years (2.2% one year olds, 71.7% two, 24.5% three and 1.7% four year). The figure represents a further decrease on previous measurements (2.62, Nall, 1931; 2.62 Went and Barker, 1943 and 2.52, Went, 1944). Again this would appear to be in keeping with the general trend throughout the century. More recent stock assessments (though not always of the same river systems) have usually been lower than readings obtained in the course of earlier investigations (Fahy, 1978a; 1979b).

A and B type smolts

In Table 4 the relative numbers of A and B type smolts are given. The incidence of B type smolts in Waterville is very low. Indeed these figures are the lowest recorded in any Irish stock assessment to date. It has been remarked that the mean smolt age has been declining but the incidence of B type growth has remained constant during the period in which stock assessments have been carried out: in the Irish literature overall B type percentages of between 77.0 and 89.4 are recorded in assessments made between 1948 and 1958. There was a single low value of 65.2% (Piggins, 1961) but otherwise between 1962 and 1978 the B type percentage composition of various stocks fluctuated between 76.1% and 82.9%.

Interlinked with the incidence of B type growth is the amount which can occur. This variable can be greatly influenced by the physical features of the river system concerned, sea-trout migrating through long estuaries occasionally displaying considerable (and recognisably two phased) B type increments (Fahy, 1978c). The Waterville system debouches almost directly to the sea without the intervention of a sizeable estuary so that, unlike the Foyle and Moy systems, from which exceptionally large B type increments have been reported, the physical features of the catchment are not conducive to large B type increases in length. A comparison of B growth in the Moy, Foyle and Waterville catchments is provided in Table 5.

B type growth is interpreted as compensatory, enabling the fish to achieve a uniform length before migration (Allen, 1934). Smolts with a longer parr phase eventually achieve a slightly greater length than at a faster growth rate. Consequently these fish require a small B type increment to bring them to migrating dimensions. It has been previously reported that the Waterville smolts are very large and it is noteworthy that the additional pre-migratory growth increment is relatively small. Expressed as a percentage of the total parr length (to the end of the last freshwater winter) additional B type growth accounts for 20.7% in one year smolts, 12.4% in two, 14.5% in three and 9.1% in four year olds.

A reduction in the amount of B type growth results, at the extreme, in a classification of the scale as A type. Hence, the high incidence of this kind of scale in Waterville can be attributed to a combination of the physical nature of the system, the increasing strength of the two year smolt class (with the decline in M.S.A.) and a possible downward trend in B type increments in two year smolts. Table 6 summarises the lengths at age of A and B type fish which conform to generally observed characteristics. A type smolts are slightly larger at any winter than B type but the length at migration of B type slightly exceeds that of A type smolts.

Marine growth

If the months preceding migration are occupied by an equalising of smolt sizes, the end of the first winter's marine growth sees a further reduction in out-standing differences. The mean back-calculated length for sea-trout of this age in Waterville is 32.9 cm derived from the following: all one year smolt sea-trout 28.6 cm; all two year olds 33.1; all three year olds 32.5 and all four year olds 32.5 cm. This size is very close to but slightly above, the value for this variable calculated as a mean of all stocks examined in Ireland to date (31.5 cm) (Fahy, 1978a) which indicates how little influence even exceptionally large smolt size has on the size of the returning fish. However these measurements also corroborate an observation which has been noted generally elsewhere: that a growth advantage in the smolt is maintained in the post smolt and adult stages so that sea run fish from older smolts are slightly longer than those from the same river systems with a shorter freshwater phase. At the end of the second sea winter all pre-spawned fish averaged 40.91 cm ($\pm$ 0.626) which is within the range of measurements given by Went and Barker (1943) for fish of this age (2 year smolt fish 38.6 and four year 44.5 cm). There were too few pre-spawned fish of 3 sea winters to pursue the calculations further.

Circulus formation

Circulus counts on scales from the two year smolt class are summarised in Table 7 and set alongside similar measurements from an east coast fishery (Wicklow) and a west coast system in which the smolts are considerably smaller than at Waterville (Crumlin in Connemara; Fahy 1979a). Bilton (1973) demonstrated

that environmental conditions could influence rate of circulus formation and that the length at age of various Pacific salmons correlated with circulus number. Table 7 shows a similarity in length of scale per circulus which in all three cases varies between 0.024 and 0.026 mm. Although Waterville smolts are longer than those from Crumlin the number of circuli formed in both are similar. The numbers of circuli formed per year at Waterville and Crumlin on the west coast were significantly higher than at Wicklow on the east coast.

Maturation

An indication of mean age at first maturation can be obtained by determining what proportion of a particular age category has spawned. Of the .1+ fish 9.9% of the 1974 collection bore spawning marks. Again this characteristic has shown considerable variation in past assessments. As few as 0.9% of fish in this group had spawned in Went and Barker's 1943 collection and as many as 14.3% in Nall's examination (1931). However Went's (1944) sample contained 10.3% 0.1+ fish with spawning marks, a figure which compares very well with the 1974 collection.

Change in sea age distribution

The sea age composition of the samples is set out (Table 8) and compared with the results of previous assessments. Nall's (1931) material he himself described as representative of the spring run of fish. Went and Barker (1943) did not give sufficient details to make comparison with their work possible; Went's (1944) assessment can be used for the purpose and his results display similarity with the 1974 collection from Waterville—though not with the 1973 collection. Went's (1944) material was made up of representative samples from the rod catch in 1942.

Compared by Chi square test the 1974 "sea" age distributions and those in Went's (1944) paper are significantly different ($P<0.05$). The mean age of Went's material was 1.34 and of the later collection 2.44 sea winters. Sea-trout are vulnerable to capture by drift net (Fahy, 1977) but there is no indication from these figures that there has been in recent times a major depletion of the older age categories, such as one might expect as a result of drift net exploitation at sea.

ACKNOWLEDGEMENTS

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Table 1. Ages of sea-trout taken in 1973 and 1974 from the Currane catchment, Waterville.

Age categories	1973	1974	Total	% composition
1. +	2	4	6	0.5
2. +	286	116	402	34.6
3. +	134	34	168	14.4
4. +	6	4	10	0.9
1.1 +	6	2	8	0.7
2.1 +	203	80	283	24.3
3.1 +	33	8	41	3.5
4.1 +	3	1	4	0.3
2. + SM +	—	4	4	0.3
3. + SM +	3	4	7	0.6
4. + SM +	2	1	3	0.3
1.2 +	—	3	3	0.3
2.2 +	26	17	43	3.7
3.2 +	—	4	4	0.3
4.2 +	1	—	1	0.1
1.1 + SM +	2	1	3	0.3
2.1 + SM +	12	50	62	5.3
3.1 + SM +	2	12	14	1.2
4.1 + SM +	1	—	1	0.1
1.2 SM +	1	1	2	0.2
2.2 SM +	28	8	36	3.1
3.2 SM +	3	1	4	0.3
4.2 SM +	1	—	1	0.1
2.3 +	2	—	2	0.2
2.3 SM +	2	1	3	0.3
2.2 + SM +	4	8	12	1.0
3.2 + SM +	—	2	2	0.2
1.1 + 2 SM +	3	2	5	0.4
2.1 + 2 SM +	—	13	13	1.1
4.1 + 2 SM +	2	—	2	0.2
2.1 + 3 SM +	1	6	7	0.6
2.2 + 2 SM +	—	1	1	0.1
2.3 + SM +	—	1	1	0.1
2.1 + 4 SM +	—	2	2	0.2
3.1 + 4 SM +	—	1	1	0.1
2.1 + 5 SM +	—	1	1	0.1
3.3 + 3 SM +	—	1	1	0.1
TOTALS	769	394	1,163	

Table 2. Mean weights in g (lb in brackets) of rod-caught Waterville sea trout.

	1974	1975	1976	1974-1976	Number
July	—	912 (2.01)	966 (2.13)	925 (2.04)	413
August	640 (1.41)	835 (1.84)	—	717 (1.58)	189
September	564 (1.24)	1,030 (2.27)	—	789 (1.74)	677
Total				821 (1.81)	1,279

TABLE 3. Back calculations of length at age of parr.

Year of collection	Source of scales	Back-calculated length (cm) at age 1 year L	1 year S.D.	1 year N	2 years L	2 years S.D.	2 years N	3 years L	3 years S.D.	3 years N
1973	2. +	8.80	2.43	281	21.92	2.39	280			
1974	2. +	8.57	2.94	101	20.93	3.58	101			
1973	3. +	7.32	6.58	134	16.64	3.40	131	24.49	2.60	130
1974	3. +	6.79	1.65	58	16.30	3.22	58	22.88	3.00	59
1973	2.1 +	8.41	2.09	197	21.80	3.07	200			
1974	2.1 +	8.78	2.79	53	22.11	2.70	53			
1973	3.1 +	7.29	1.73	31	16.62	3.02	33	23.68	2.82	32
1974	3.1 +	7.36	2.77	8	17.19	4.16	8	24.36	4.64	8

Material from different sources compared in the same years

Table 4. Percentage frequency of A and B type smolts.

Smolt Class	Type B	Type A	Number
1	42.1	57.9	25
2	48.7	51.3	833
3	33.3	66.7	285
4	20.0	80.0	20
TOTALS	44.3	55.7	1,163

Table 5. Frequency distribution showing degree of B type increment (expressed as percentage of length at the end of the last parr winter).

Origin	% B type growth on scales										Number in Sample
	<10	20	30	40	50	60	70	80	90	100	
2 year smolts											
Waterville	6.4	76.4	13.9	1.9	0.8	0.5					373
Finn (Foyle)	4.0	33.5	38.5	15.0	5.5	1.2	1.5	0.8			133
Moy	4.0	32.6	34.0	18.6	7.0	1.5	0.3	0.8	1.0	0.8	658
3 year smolts											
Waterville	7.7	83.1	—	7.7	1.5						65
Finn (Foyle)	13.5	67.5	11.0	4.9	2.0	—	1.1				41
Moy	8.5	51.5	29.0	8.5	1.5	—	1.0				244

Table 6. Mean back-calculated lengths (cm) of smolt classes at the end of each freshwater year.

A type smolts

Smolt class	First	Second	Third	Fourth
1	16.46	—	—	—
2	8.84	22.84	—	—
3	7.41	17.72	25.10	—
4	5.83	14.45	21.42	26.69

B type smolts

Smolt class	First	Second	Third	Fourth	Length at migration
1	16.83	—	—	—	20.29
2	8.60	21.50	—	—	24.53
3	6.30	15.98	23.10	—	26.46
4	5.37	11.73	17.07	24.17	26.37

Table 7. Characteristics of circulus formation in two-year smolts.

		Number of circuli formed per year				scale length (mm) per circulus		Regression of number of circuli (y) on fork length (cm) (x)			
		1st year		2nd year							
Collection	Date	Mean	S.D.	Mean	S.D.	Mean	S.D.	Number	r	Slope	Intercept
Wicklow	1977	14.4	4.8	19.8	5.9	0.026	0.006	139	0.94	1.03	0.792
Waterville	1974	18.9	5.2	23.7	5.6	0.025	0.003	64	0.93	1.80	2.735
Crumlin	1978	21.0	4.0	24.8	5.3	0.024	0.003	64	0.92	2.06	4.350

Table 8. Percentage frequencies of sea age groups.

	Sea age								
Source	0	1	2	3	4	5	6	7	Number
Nall (1931)	0.8	15.4	18.5	26.2	23.9	13.8	0.8	0.8	130
Went (1944)	37.4	27.5	14.1	10.7	6.2	3.3	0.5	0.3	1,169
Present work									
1973 and 1974	50.4	30.1	15.0	3.4	0.8	0.3	0.2	—	1,163
1974 only	40.1	25.4	24.6	6.6	2.0	0.8	0.5	—	394

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