No. 2

I.C.E.S. NO. 2

SALMON AND TROUT COMMITTEE

SOME PRELIMINARY RESULTS OF FEEDING THYROID MATERIAL TO SALMON PARR

DR. D. J. PIGGINS

During the past two years, two thyroid feeding experiments have been carried out at the Furnace salmon rearing installations of the Salmon Research Trust of Ireland, Newport, Co. Mayo.

In all cases, two comparable batches of fish have been used, of similar size and at the same population density, serving as control and experimental groups. The fish were maintained in circular concrete rearing ponds and were fed with raw minced beef liver, together with the experimental additives, on a pair-feeding basis. Again, all experimental work has been carried out during the period February-May, when this period was chosen as being that at which salmonid fish could be expected to show maximum response to thyroid stimulation. (1).

In 1961 the effect of feeding fresh thyroid was investigated; this experiment has been described fully elsewhere (2) and is only briefly reported upon here.

Two groups of large-grade yearling salmon parr were used; (Controls: 3,568, Experimentals: 3,838). The experimental fish received 20% of their diet as fresh minced beef thyroid, which was fed three times daily from February 20th to May 1st. All 1+ smolts were graded out of the ponds from May 3rd - 6th when it was found that the thyroid-fed group had produced 913 smolts, against 510 in the controls.

Controls : 510 smolts : 2,993 parr = 14.7%

Thyroid-fed : 913 " : 2,853 " = 24.2%

It is apparent therefore, that thyroid feeding has resulted in an overall increase of 80% in the production of 1+ smolts. These smolts were also slightly larger, averaging 134 mm. as against 130 mm. for the controls. This increased smolt length can be taken as indicative of increased growth of the experimental batch, as a whole, this being confirmed by earlier sample measurements of both groups. This effect of thyroid treatment has been noted for rainbow trout (1).

The thyroid-fed smolts were in excellent condition and were markedly more silver than those in the control groups, where this increased deposition of guanine on the scales is another well-known feature of an hyperthyroid condition in salmonid fish.

The survival and speed of migration of these smolts was found to be exactly the same as for normal, hatchery-reared 1+ smolts when tested by releasing over 700 in fresh water, some two miles above a smolt trap. At the time of writing, one of these smolts has returned as a grilse. (August, 1962).

In 1962, it was decided to test the effects of dried thyroid powder (B.D.H.Thyroid, B.P.) since it was felt that the fresh gland was -

1) rather expensive (Approx. 15/- per week, per 1000 smolts).
2) supplied whole and required mincing.
3) irregular in supply, depending upon the work programme of the local meat processing factory. (Sufficient material could conceivably be fresh frozen over the winter.).

In an experiment involving yearling parr (comparable with those used in 1961) the two ponds each contained between 2,300 and 2,400 fish, but the mean length of one group was rather less than that of the other, at the beginning of the experiment. (67 mm. c.f. 76 mm. on 12.2.62). Dried thyroid powder was fed to the smaller group from February 8th until May 9th (90 days), mixed with liver in the proportion of 5% by weight, whilst the control group received the same weight of liver alone.

Overall growth in length was stimulated in the experimental group and their total increase in length was some 15% greater than that of the controls. Although the thyroid-fed smolts were smaller as a whole (having originated from a relatively stunted population) the percentage smolt transformation was approximately that of the controls (32% c.f. 35%) where untreated fish of their size might have been expected to have produced only half this number of smolts.

The treated smolts were again much more silvery than the controls and it was noticed also, that during the catching and handling of the fish whilst fin-clipping (May 9th and 10th) the thyroid-fed group were virtually free from fin- and tail-rot and none died as a result of handling. In the control group, most fish showed traces of dorsal fin-rot and 37 died from shock as a result of handling at this delicate stage. It has been suggested that the thyroid of salmonid fish exhibits hyperfunction at times of "stress" (3) and it seems possible that artificial hyperthyroidism may protect reared smolts against both mechanical and osmotic stress during migration.

Similar effects to the foregoing were noted in a population of 2-year-old parr which received an iodine supplement in their food. These fish were slightly larger and considerably more healthy in appearance than the control group, when it would appear that both food and water are iodine deficient in this locality.

Whilst the size and condition of reared smolts can be improved by iodine supplements, the improvement is limited by the degree to which the fish thyroid becomes active in the spring. It is suggested that induced hyperthyroidism will bring about growth in length, increased percentage smolt transformation and protection against mechanical and osmotic stress at a considerably higher level than that which results merely from full utilisation of the smolt's intrinsic thyroid activity. It should be borne in mind however, that symptoms

of thyrotoxicosis may develop at dosage rates of more than 20% for fresh gland and 5% for the dried powder.

It seems possible that thyroid feeding can be used in salmon and sea trout rearing to secure better survival of smolts as a result of their increased size and to effect a more complete smolt transformation of any one year-class, thus reducing subsequent rearing costs. From these preliminary experiments it appears that feeding fresh thyroid gland is about 50% more expensive than feeding the dried powder, but that both techniques are fully justified, in that it would be more costly to feed the non-transformed fish for a further year.

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(2) Salmon Research Trust of Ireland Inc. Ann. Rep. 1961, p. 6.

(3) Baggerman, B., 1960. "The diadromous migrations of fish" Symp. Zool. Soc. London. (1), 33-60.

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(THE SALMON RESEARCH TRUST OF IRELAND INCORPORATED)

APPENDIX I

SALMON AND SEA TROUT KELTS

by Dr. D. J. PIGGINS

Extract from Annual Report 1961

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SALMON AND SEA TROUT KELTS

General

Kelts of both salmon and sea trout have been tagged in the Burrishoole Fishery from 1951 ; salmon kelts have been tagged every year, but sea trout kelt tagging began in 1953, and has continued without break since 1955, although none were tagged in 1954. Until 1960, this tagging was carried out exclusively by the crew of a salmon draft net working on Lough Furnace, but in 1960 and 1961, the majority of the kelts were tagged from a trap which has been established on the Mill Race for all downstream migrants. Similarly, most of the recaptures are now made in the upstream trap, whereas previously, recaptures were almost entirely dependent upon the Furnace draft net.

We cannot yet check all the returning tagged fish, since a number of them reach Lough Feeagh via the Salmon Leap, which affords an uncontrolled passage in high flood. These falls are impassable in all but high floods, although there are grounds for believing that fish are attracted to the Salmon Leap in high water, rather than to the Mill Race.

In mid-July of this year, following 5" of rain in two days, we experienced the highest flood for forty years, when numbers of tagged salmon and sea trout were seen in the pool below the falls of the Salmon Leap.

We can, and do obtain recaptures of some of these fish as kelts, returning to sea via the Mill Race ; for example, of the 1960 taggings, 3/16 of the salmon and 7/45 of the sea trout recaptures were as kelts of fish which had gone up through the Salmon Leap to spawn in fresh water.

From 1951 to 1958, recaptures of tagged fish in the salmon draft net were deficient in that this net does not usually operate after June 30th. Most of the short-absence previously-spawned salmon return after this date, as do many of the sea trout. Again, sea trout kelts tagged from the draft net are not a representative sample, since only the larger specimens are retained by the minimum mesh size of $3\frac{3}{4}$" (stretched).

Only two types of tags have been used on kelts, these are :—

(i) The Lea hydrostatic tag.

(ii) Swivelled tag made of card impregnated with celluloid.

The latter was found to be ineffective and its use has been discontinued.

SALMON

Numbers Tagged and Recaptured

The numbers of salmon kelts tagged every year from 1951, together with the recaptures, are given in Table 1. From this it can be seen that the numbers of recaptures have increased from 1958, as would be expected, with the establishment of traps. Until 1958, there were only fourteen recaptures for 238 tagged kelts (approximately 6%) whilst from 1958 to 1960 there have been 26 recaptures from 143 kelts (18%).

Table 2 gives details of all salmon recaptures to date, including those of the 1961 taggings where it will be appreciated that records are incomplete, since recaptures as kelts and fresh fish in 1962 or later, have still to come.

Sea-absence habits :

From Table 2 the tagged kelts may be divided into three groups :—

(1) Grilse kelts which return within six months of tagging.

(2) Grilse kelts which return after more than a year's absence.

(3) Spring and summer fish kelts.

Of these groups (1) and (3) are typical, but group (2) is aberrant and seems to have attracted but little attention in the literature. Group (1) is composed of fish measuring from 21 to 26.5 inches at tagging, having a mean absence period of 133 days and showing a mean length increment of 2.4 inches on return. Group (2) is composed of fish measuring from 23 to 25.5 inches at tagging, but have a mean absence period of 470 days and increase

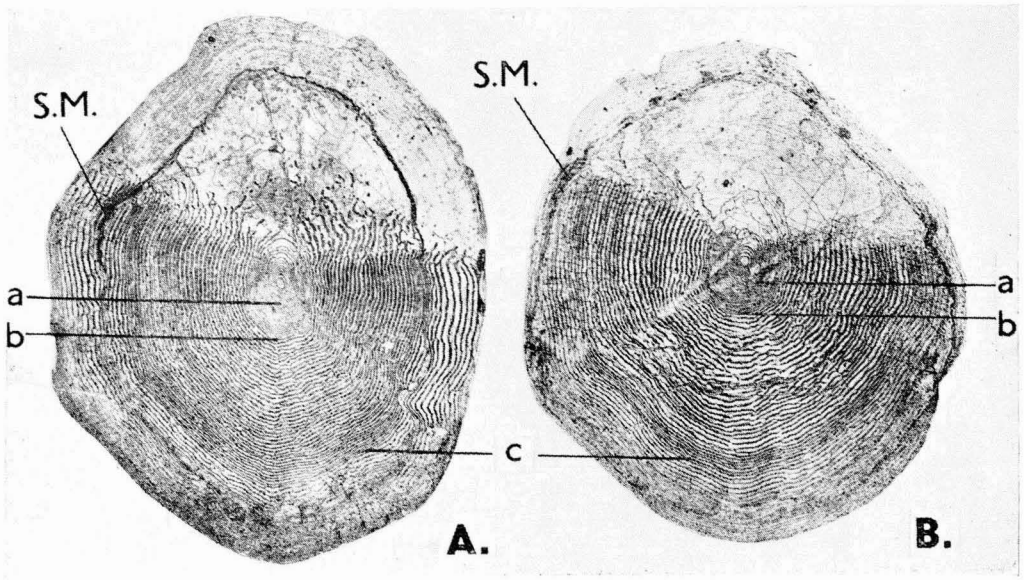

FIG. 1. Photomicrographs of salmon scales showing—
A. Spawning mark followed by full year's growth, and
B. Spawning mark followed by less than a full year's growth.
(a=first year in river ; b=second year in river, and c=first year in sea ; SM=spawning mark). Magnification ca. X9

in length by 6.7 inches (mean). The initial grilse status of group (2) is confirmed by scale-reading, as is the long absence-period, where the scales show a full year's growth outside the spawning mark. We have records and scales of nine such specimens ; a photograph of a scale of No. 67 is shown in Fig. 1, together with a scale of No. 66. These fish were tagged on the same day, and differed in length by only 0.6 cm. : one fish returned after 182 days, some 2.0″ longer whilst the other returned after 478 days, and was 6.75″ longer. Lindsay and Thompson (1932) figure a scale of a previously-spawned grilse which also spent a full year at sea after spawning. (Photograph reproduced in " Physiology of Fish " Vol. 1. p. 237). Table 3 gives details of these short and long absence groups.

From the point of view of fishery economics, these previously spawned grilse which spend some 15 months at sea before returning for a second spawning, are quite important fish. They may (at best) return as 32″ fish, weighing 12-13 lbs. from being grilse of 5 lbs. weight, when their egg potential to the fishery may be trebled, or if caught and sold, their value may be quadrupled.

This problem of " divided return " from grilse kelt stocks obviously merits further attention, since a proportion of the stock do not conform to the general belief that the longer a fish spends fasting in the river, the longer it needs to recuperate afterwards in the sea.

Fish returning to spawn for a third time appear to be uncommon in the Burrishoole Fishery ; none were noted in a study of some 800 sets of scales, and only one has been detected with any certainty, from the tagging programme.

Timing and Composition of Kelt Runs

Salmon kelts leave Lough Feeagh from the end of December when these first kelts are almost all males in poor condition, the run finishing in early February. A second run begins in mid-March, when these kelts are almost all females, with the peak of the run in late March or early April. The timing and composition of these runs in 1961 are shown in a distribution diagram (Fig. 2).

The run of female fish is rather later than is usual for a river fishery since they seem to spend a considerable time " mending " in Lough Feeagh. There have been no recaptures from the early running kelts and all the returns have been from well-mended female fish, leaving at the peak of the run.

Factors Affecting the Descent of Salmon Kelts

We have noticed no special significance of floods in initiating the runs of salmon

kelts, although this awaits confirmation from flow-records later. Salmon kelts mending in a large lake are not likely to be influenced by flood conditions to the same extent as kelts in rivers. Almost all the kelts descend during the hours of darkness, but a few may travel by day, at the peak of the run. There was no marked change in the water temperature just prior to the main run of 1961, but again, the effect, if any, of water temperature will be confirmed in subsequent years.

Recaptures by Outside Nets

Thirteen tagged fish have been caught outside the home fishery since 1951, against a total of fourteen caught in the Furnace draft net and a total of thirty-four caught in the home fishery by net and traps combined. Most of the outside recaptures come from the drift nets of North Donegal and North Mayo, when the fish are returning home from the north. (Went, 1951 ; Went & Gibson, 1953). This is substantiated by the fact that no recaptures have been recorded south of our estuary and none from the fresh water reaches of any other river (Fig. 3). Two fish have been caught in the lower brackish portion of Newport River, (which has a common estuary with the Burrishoole River) when this was due probably to their wandering astray in low water conditions.

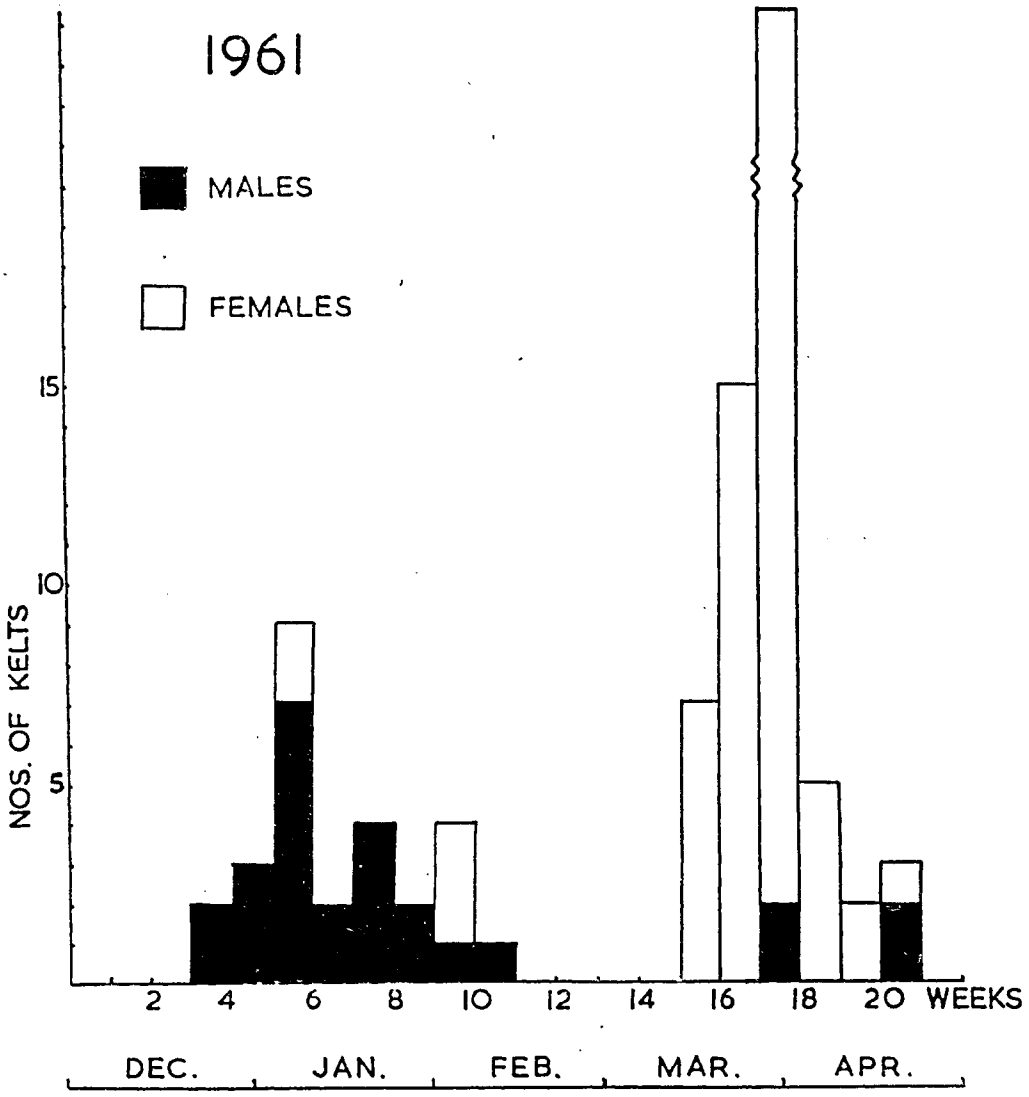

FIG. 2 Timing and composition of the kelt run in 1961 based on 27 males and 101 females.

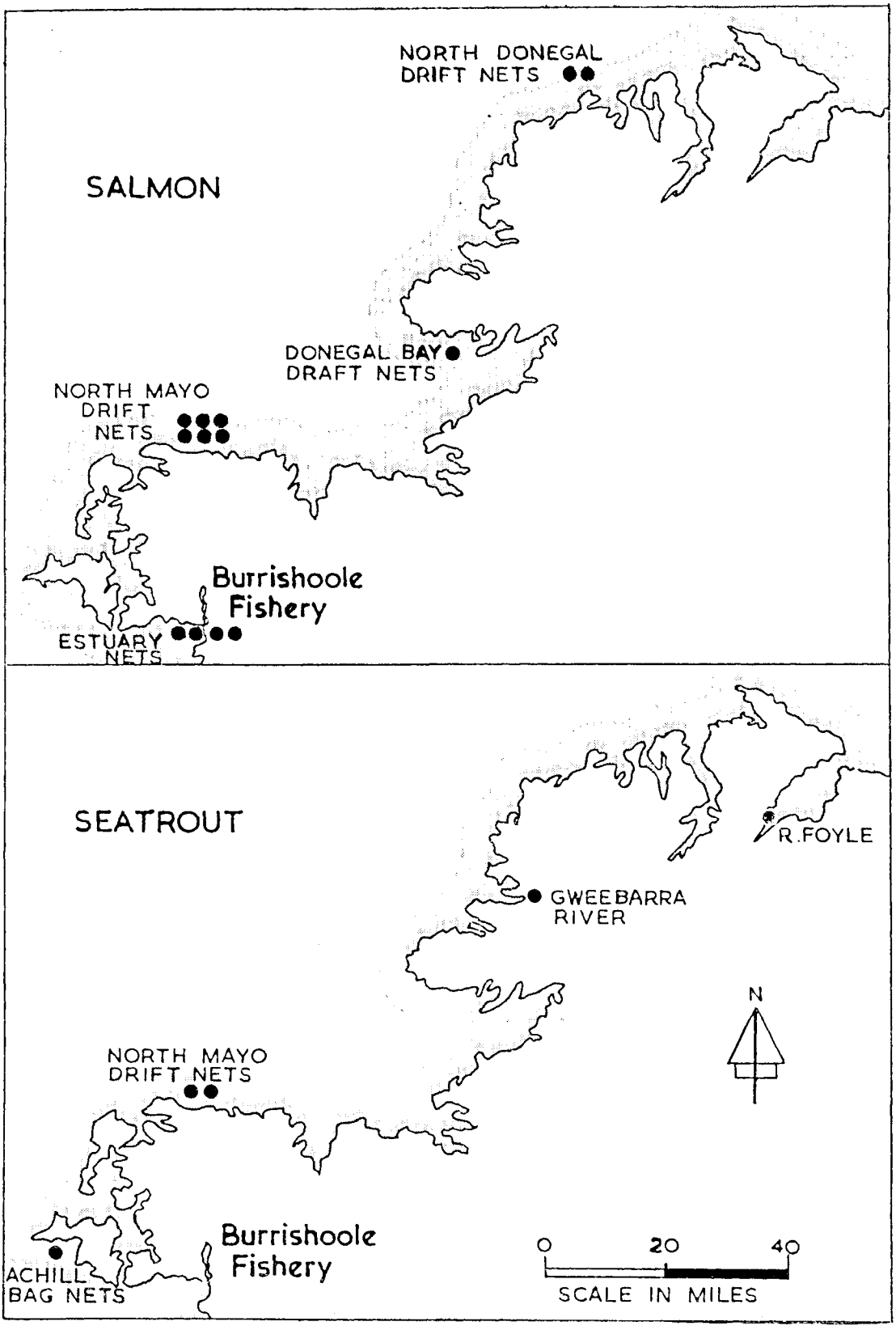

FIG. 3. Sketch maps showing recaptures of salmon and sea trout tagged as kelts in the Burrishoole Fishery.

Significance of Previously Spawned Fish

The percentage return of previously-spawned fish to this fishery is rather greater than the average for Irish rivers, where this would seem to be due to the well-mended condition of female kelts leaving the lake, by comparison with normal river kelts.

We are not yet in a position to assess accurately the proportion of previous spawners to fresh fish each year, although first indications are of the order of 10%. This would result in approximately one-fifth of the egg deposition of any one year being attributable to previously spawned fish. It remains to be seen whether the eggs and resulting fry of previous spawners are any less viable than those of maiden fish.

SEA TROUT

Numbers Tagged and Recaptured

From 1953 to 1961, excluding 1954, 830 sea trout kelts have been tagged in the Burrishoole Fishery ; details for each year are given in Table 4. Results from this tagging have been variable, ranging from 5 to 40% recaptures before trapping began, although, as mentioned in the introduction to this Appendix, the selective effect of the net mesh on the size of kelts tagged must have contributed to the high proportion of recaptures. In 1960, only the larger trap-caught kelts (over 12 inches) were tagged and 32% have been recaptured. In 1961, the lower size limit for tagging was reduced to 10 inches, and so far, only 15% have been recaptured. This effect of size at tagging on subsequent survival is illustrated diagrammatically in Fig. 4.

Factors Affecting Survival

In the 10 to 12 inches group, two factors may be operative ; firstly perhaps, the relatively large, conspicuous tag decreases the chances of survival of a small, tagged fish and secondly, finnock (whitling) which have spawned may have a poor survival rate, whether tagged or not. The small tags we are to use on fish of less than 12 inches in the coming season will test the validity of the first factor. In 1961, no fish of 19 inches and over at tagging, survived for a further spawning ; these fish are approaching, or have reached the end of their life-span. Some fish of over 19 inches (tagged by the net-crew) have been recaptured in earlier years.

Length Increments

The large fish (over 19 inches) which return make little or no growth whilst away at sea, and it is generally, although not invariably found that the smaller fish make the

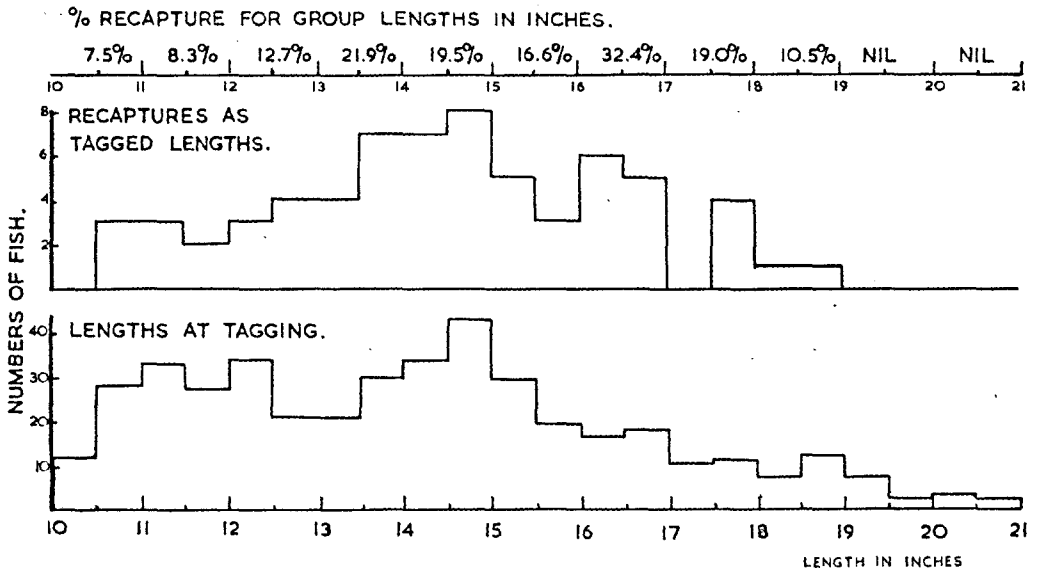

FIG. 4. Effect of size of sea trout at tagging on subsequent recaptures.

best growth between tagging and recapture. Of 42 records of increments made during the summer following tagging, values ranged from 0.4 to 2.9 inches with a mean of 1.6 inches. Fish measuring from 10 to 15 inches at tagging had a mean increment of 2.0 inches, whilst that of fish measuring 15.1 to 20.0 inches was 1.2 inches.

Absence Periods

The majority of recaptures of tagged sea trout are made during the six months following taggings, with occasional fish returning up to nine months later. The mean absence period of 118 fish (over 8 years) was 105 days, ranging from 43 to 263 days. We have noticed annual variations in this mean value ; for example, in 1960, it was 93 days, whilst in 1961, it was 111 days. There is no evidence either from taggings or from scale-reading, that sea trout in this fishery spend a full year or more at sea after spawning.

The longest record we have of a tagged sea trout was of a fish tagged as an 18.4" kelt in March 1955, recaptured as an 18.5" kelt in March 1956, and was further recaptured, still bearing the original Lea tag, as a 20" kelt in March 1958. It is quite common for a fish to be recaptured for the first time, in the year following that of tagging, since a proportion of the fish take the Salmon Leap route to Lough Feeagh. Of the 1960 tagged kelts, 37 out of 145 were recaptured as fresh fish during the following summer and autumn, a further 7 were passed through the downstream trap as kelts, having gone up the Salmon Leap and two were recaptured for the first time in the summer of 1961, having gone up and down the Salmon Leap. We have been interested to note that contrary to local tradition, neither salmon nor sea trout select one of the two routes to Lough Feeagh and maintain their choice. Both inward and outward migration routes are governed only by expediency.

From our records to date the duration of the sea absence has no bearing on the increase in length made during this period. Twenty-seven fish with an absence period of under 100 days had exactly the same mean length increment (1.6 ins.) as seventeen fish whose absence period ranged from 100 to 263 days. This may be due to the latter group having spent the later part of their sea-absence in the estuary or in Lough Furnace, with but little active feeding.

Timing and Composition of the Kelt Run

The first sea trout kelts leave Lough Feeagh in mid-November and there is then a steady run of kelts throughout the winter months. The run builds up gradually to a peak in late March and early April, but occasional kelts appear as late as early June. Unlike salmon, there is no division of sexes in the composition of the run, males and females migrating in similar proportions throughout.

Whilst some salmon kelts will move downstream by day at the height of the run, it is only very rarely that sea trout appear in the trap other than at night. Again, the incidence of floods has but little effect on the timing of the run, where the kelts are free to leave the lake at anytime irrespective of the height of water.

Recaptures by Outside Nets

Five tagged sea trout have been reported captured other than in the home fishery since 1953, where this small number is due probably to most of the trout being able to escape from the mesh of the nets in common use along the seaboard of North-West Ireland. (See Fig. 3). One fish became meshed in a bag-net at Achill, two were caught in drift-nets along the North Mayo coast, one was caught on rod and line in the Gweebarra River (Co. Donegal) and one was meshed in a stake-net at Rosses Bay in the River Foyle. The two last recaptures are particularly interesting in that they represent the longest distances (150 miles and 230 miles respectively) so far recorded for Irish sea trout migrations.

The sites of recaptures suggest that, as for salmon, the returning sea trout follow a southerly direction.

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TABLE 1

Salmon—Numbers Tagged and Recaptured

		Recaptures		
Year	No. Tagged	Home Fishery	Outside Nets	% Recapture
1951	50	2	2	8.0
1952	14	Nil	Nil	Nil
1953	24	2	1	12.5
1954	37	3	Nil	8.1
1955	51	2	Nil	3.9
1956	15	Nil	Nil	Nil
1957	47	Nil	2	4.3
1958	41	4	2	14.6
1959	19	4	Nil	21.1
1960	83	12	3	18.1
1961	146	7	3	7.0 to date
Totals	527	36	13	

TABLE 2

Details of All Salmon Recaptures to Date

TAGGING					RECAPTURE		
No.	Date	Length Inches	Length Inches	Incr.	Date	Absce. Period	Place of Recapture
266	23/1/51	24.5	27.25	2.75	23/7/51	181	Furnace draft net
268	23/1/51	28.8	—	—	3/7/51	161	2 miles N. of Horn Head.
281	23/1/51	22.2	—	—	29/6/51	157	1½ miles off Portacloy
282	23/1/51	24.6	26.5	1.9	2/7/51	160	Furnace draft net
834	12/1/53	24.25	—	—	1/7/53	170	Portacloy Bay
837	12/1/53	23.5	27.7	4.2	25/5/54	499	Furnace, net
843	27/3/53	24.5	27.0	2.5	22/7/53	117	Feeagh, rod
3917	8/1/54	24.2	31.5	7.3	4/5/55	481	Furnace, net
3920	8/1/54	25.0	33.0	8.0	27/4/55	474	Furnace, net
3921	9/1/54	23.4	30.2	6.8	27/5/55	503	Furnace, net

TABLE 2—continued

TAGGING					RECAPTURE		
No.	Date	Length Inches	Length Inches	Incr.	Date	Absce. Period	Place of Recapture
A501	21/12/54	23.5	28.5	5.0	9/4/56	474	Furnace, net
A529	29/12/54	23.3	31.5	8.2	3/4/56	460	Furnace, net
3	10/1/57	23.5	—	—	27/6/57	168	Portacloy
39	10/1/57	24.5	27.0	2.5	19/7/57	190	Portacloy, drift net
58	27/1/58	23.0	30.0	7.0	1/5/59	459	Furnace, net
62	27/1/58	24.0	—	—	16/8/59	566	Trap
66	27/1/58	24.0	26.0	2.0	28/7/58	182	Newport River draft net
67	27/1/58	23.75	30.5	6.75	20/5/59	478	Newport River, draft net
114	20/3/58	29.25	—	—	29/7/59	496	Trap
127	25/3/58	25.0	26.0	1.0	12/4/59	Kelt	Furnace, net
202	2/4/59	21.25	—	—	24/9/59	154	Trap
229	2/4/59	25.25	32.0	6.75	9/5/60	403	Furnace, net
250	3/4/59	28.1	—	—	2/6/60	425	Trap
257	28/3/59	25.0	29.4	4.4	2/4/61	Kelt	Downstream trap
417	25/3/60	—	28.0	—	12/7/60	109	Newport R. Est. draft net
424	30/3/60	—	—	—	6/7/60	98	Trap
306	3/4/60	—	—	—	16/7/60	105	Off Pig Island, Porturlin.
439	5/4/60	—	—	—	22/8/60	139	Trap
332	7/4/60	—	—	—	25/8/60	140	Trap
335	7/4/60	—	31.5	—	28/3/61	356	Furnace net
346	8/4/60	—	29.7	—	30/3/61	Kelt	Downstream trap
352	9/4/60	—	—	—	21/11/60	226	Trap
353	9/4/60	—	—	—	3/4/61	Kelt	Downstream trap
357	9/4/60	—	—	—	30/8/60	143	Trap
369	10/4/60	—	28.9	—	12/7/61	—	Trap
372	10/4/60	—	33.8	—	31/3/61	355	Furnace, net
376	10/4/60	—	—	—	18/9/60	161	Trap
	10/4/60	—	25.1	—	2/4/61	Kelt	Downstream trap
458	11/4/60	—	28.2	—	8/7/60	88	Horn Head
467	29/4/60	—	—	—	23/8/61	116	Trap
938	30/3/61	24.7	28.0	3.3	3/7/61	95	Dunkineely, drift net
989	31/3/61	26.6	28.5	1.9	27/6/61	90	Furnace, net
996	31/3/61	23.3	26.0	2.7	27/6/61	90	Furnace, net
53	1/4/61	23.2	—	—	29/6/61	89	Trap
84	2/4/61	24.1	26.5	2.4	30/6/61	89	Newport R. Est. draft net
729	20/3/61	21.4	—	—	26/8/61	159	Trap
2	31/3/61	24.1	—	—	/8/61		N. Mayo drift net
6	31/3/61	26.6	—	—	16/9/61	169	Trap
887	27/3/61	22.0	—	—	18/10/61	201	Trap
863	26/3/61	23.8	—	—	9/10/61	193	Trap

TABLE 3

Details of the Short and Long-Absence Groups

SHORT-ABSENCE GROUP			LONG-ABSENCE GROUP		
Length at tagging	Absence Period	Increment	Length at tagging	Absence Period	Increment
24.5 inches	181 days	2.75 inches	23.5 inches	499 days	4.2 inches
24.6 ,,	160 ,,	1.9 ,,	24.2 ,,	481 ,,	7.3 ,,
24.5 ,,	117 ,,	2.5 ,,	25.0 ,,	474 ,,	8.0 ,,
24.5 ,,	190 ,,	2.5 ,,	23.4 ,,	503 ,,	6.8 ,,
24.0 ,,	182 ,,	2.0 ,,	23.5 ,,	474 ,,	5.9 ,,
24.7 ,,	95 ,,	3.3 ,,	23.3 ,,	460 ,,	8.2 ,,
26.6 ,,	90 ,,	1.9 ,,	22.6 ,,	459 ,,	7.0 ,,
23.3 ,,	90 ,,	2.7 ,,	23.7 ,,	478 ,,	6.75 ,,
24.1 ,,	89 ,,	2.4 ,,	25.3 ,,	403 ,,	6.75 ,,
MEAN 24.5 ,,	133 ,,	2.4 ,,	23.8 ,,	470 ,,	6.7 ,,

TABLE 4

Sea Trout Numbers Tagged and Recaptured

Year	No. Tagged	RECAPTURES		
		Home Fishery	Outside Nets	% Recapture
1951	Nil			
1952	Nil			
1953	46	4	1	10.9
1954	Nil			
1955	12	4	1	41.7
1956	53	3	Nil	5.7
1957	24	6	1	29.7
1958	95	5	Nil	5.3
1959	7	2	Nil	28.7
1960	146	45	1	31.5
1961	447	68	1	15.4 (to date)
Totals	830	137	5	