Results of English Cod Tagging in the Barents Sea

By

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Introduction

In 1951 and 1952 two tagging experiments were carried out by the "Ernest Holt" on the Spitsbergen Shelf. Their primary aim was to determine the annual movements of the immature cod of the Bear Island shoals, whilst a secondary aim of the earlier experiment was to test two types of tag: the Lea cod tag against the black Petersen opercular button. Numerical data are given and results of the tag comparisons are described in the present paper. Movements of the tagged populations have been described elsewhere and the annual migrations of the immatures derived (TROUT, 1957a).

No tagging was carried out in 1953 but during and after 1954 tagging has been undertaken on most cruises, incidental to the main projects, as part of the Anglo-Norwegian research programme. Some data of the first year's recaptures of the 1954 and 1955 releases are included herein.

The 1951 Experiment

Two main release areas were chosen and fished without encountering commercial fishing. At Hope Island 1995 cod were tagged between 23. and 28. August; 997 with Lea cod tags, attached in front of the first dorsal fin by means of stainless steel, single-ended bridles. The remaining 998 cod were tagged with the black Petersen opercular tag, attached to the left pre-operculum with silver wire in the orthodox manner.

The second release area was at Spitsbergen, on the Hornsund and Sörkapp grounds, from 7. to 12. September. There 658 Lea and 583 Petersen tags were used, bringing the total number of cod released during the cruise to 3,236, i. e., 1655 Lea and 1581 Petersen. (NB. Discrepancies in numbers, e. g., between total numbers released, and length/frequency tables, are due to some lengths of cod not being recorded during the tagging).

Table 1

Total 1951 returns for 6 complete years

Area	Tag	Year of recapture 1	2	3	4	5	6
Hope Island releases	Lea	161	55	26	12	6	3
	Petersen	51	16	4	3	–	–
Spitsbergen releases	Lea	24	22	13	5	5	4
	Petersen	18	4	–	–	–	–

Recaptures made during the six complete years since release are given in Table 1 for each type of tag and for each area. Direct comparisons of these returns cannot, however, be made either between tag types or between areas. Experience at Hope Island showed that the Petersen was too brutal a method to be used for really small cod, whilst the Lea was entirely suitable for cod of 40 cm. and even below. Hence, a certain selection took place during tagging and the tag type was suited to the size of cod. Furthermore, the size composition of the tagged populations in the two areas was markedly different. At Hope Island only few cod of the 40/44 cm. length group were tagged, whereas at Spitsbergen they were the predominant length group on the Hornsund ground. Only Lea tags were used on these small cod.

In order that the data from the two areas may be summed for further analysis they are arranged in 5 cm. length groups. The number of recaptures are shown as percentages of the number released in each 5 cm. length group for first year recaptures only in Table 2 and the summed data for each tag are given in Figure 1.

Table 2

1951 releases and returns per 5 cm. length group (for first year returns only)

Area of release	Tag	5 cm. length groups 25	30	35	40	45	50	55	60	65	70
Hope Island releases	Lea	0	5	47	61	34	35	24	24	57	127
	Petersen	1	1	11	22	23	29	37	39	89	183
Spitsbergen releases	Lea	–	4	81	291	69	23	16	32	45	42
	Petersen	–	–	–	–	–	2	11	46	91	136
Total Lea released		–	9	128	352	103	58	40	56	102	169
% returned		–	–	–	1·7	1·9	5·2	5·0	8·9	11·8	10·0
Total Petersen released		1	1	11	22	23	31	48	85	180	319
% returned		–	–	–	–	–	–	5·0	5·4	4·9	9·5

		75	80	85	90	95	100	105	110	115
Hope Island releases	Lea	195	238	108	34	7	–	–	–	–
	Petersen	253	213	72	18	5	0	0	0	1
Spitsbergen releases	Lea	25	19	7	2	1	0	1	–	–
	Petersen	141	94	49	9	4	–	–	–	–
Total Lea released		220	257	115	36	8	0	1	0	0
% returned		15·9	21·0	33·0	25·0	28·6	–	–	–	–
Total Petersen released		394	307	121	27	9	0	0	0	1
% returned		5·0	9·3	7·0	2·8	–	–	–	–	–

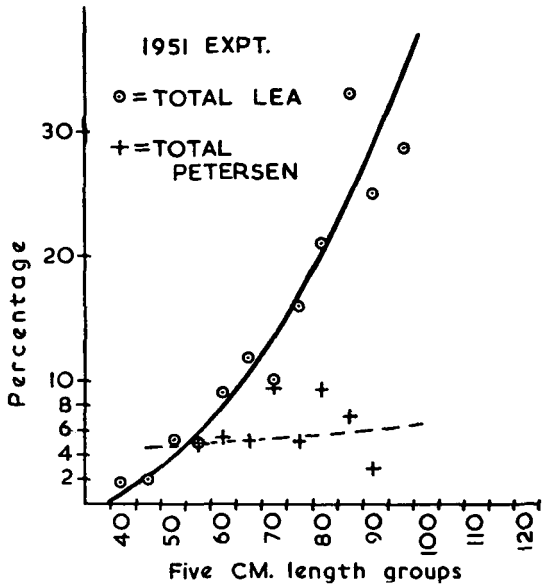

Figure 1. 1951. First year recaptures as percentages of each 5 cm. length group – total numbers of each tag.

A noticeable feature of the first year's returns for 1951 releases was the large number of tags recaptured during the spawning season. Figure 2 shows the recaptures by months, both tags. The remainder of the year brought only a small number each month, hence, the results could be subdivided roughly into two seasons which coincided with two geographical regions: (a) winter and early spring; the spawning season on the Norwegian coast and the approaches thereto, and (b) the summer and autumn on the more distant feeding grounds and the approaches thereto.

Besides the seasonal differences another major difference exists between the areas. The Norwegian coast is the scene of the great traditional "Skrei" fishery, carried out by several different gears. In addition, the outer banks, e. g., Malangensgrund and Andenes, are fished by trawlers of several nations during the spawning migration. The first area is therefore one of mixed gears. The more distant banks of the Barents Sea, including Bear Island, Hope Island, Skolpen Bank, and Goose Bank are almost wholly areas of heavy trawl fisheries.

The data were analysed, therefore, by areas into (i) "Norwegian coast" and (ii) "other banks" (Figure 3), and also by gears, into (i) trawl recaptures and (ii) recaptures by all other gears (Figure 4). These figures are based upon first year returns of the 1951 releases and, in the absence of lengths at recapture, their release lengths, in 5 cm. length groups.

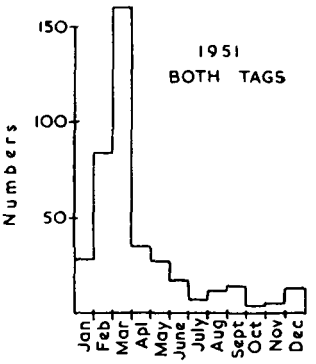

Figure 2. 1951. Total numbers of both tags, by months.

Table 3

1952 releases and returns per 5 cm. length group for first year 1951 returns for comparison of black and yellow Petersen tags

1952 Petersen (yellow)	5 cm. length groups												
	40	45	50	55	60	65	70	75	80	85	90	95	100
Plain button releases	14	469	634	270	157	109	108	104	73	39	6	1	3
Flagged button releases	10	416	639	298	177	99	126	104	77	51	16	6	4
Flagged ..... No.	0	6	24	11	13	7	8	7	12	11	0	1	0
Recaptures ..... %	–	1·4	3·7	3·6	7·3	7·1	6·4	6·8	15·6	21·6	–	16·6	–
Plain ..... No.	0	8	16	10	5	5	5	6	1	3	0	0	0
Recaptures ..... %	–	1·7	2·5	3·7	3·2	4·6	4·6	5·8	1·3	7·7	–	–	–
1951 Petersen (black) .. No.	–	–	–	2	3	5	16	11	24	8	1	–	–
Recaptures ..... %	–	–	–	5·0	5·4	4·9	9·5	5·0	9·3	7·0	2·8	–	–

The 1952 Experiment

The obvious superiority of the Lea tag was shown up in the first year of returns and it was chosen for future tagging programmes. Lea tags, however, could not be obtained in time for the 1952 June cruise, and Petersen tags were substituted, this time in bright yellow "Ivorine". The main aim was again to determine, in more detail, the summer movements of the Bear Island shoals. In addition, secondary aims were (a) to investigate the poor showing of the Petersen tag and (b) to attempt to improve the supply of information accompanying tags by using a more readily seen message than that carried by the Lea. It had been found in 1951 that approximately 65% of all Lea tags were returned unopened — the message therefore unread. Printed paper slips in polythene envelopes 5 cm. × 1 cm. were therefore stuck to the yellow buttons in alternate hundreds. These flags lay along the gill cover when the buttons were attached in the usual manner and did not appear to affect the cod in any way. (The text could be read without removing the tag.) Work-hardening, soft annealed stainless steel wire was used in place of silver wire.

A total of 4,121 cod were released in three areas in June close to Bear Island. Length compositions of plain and flagged populations and their returns are given in Table 3. In the first two areas, the N.W. Gully and S.S.W. of Cape Bull, tagging took place on small fish in exceptionally poor physiological condition. Between 20 and 30 trawlers of several countries were also fishing these grounds. The third area, S.S.E. of Cape Bull, contained no trawlers and was characterized by the presence of larger fish in good condition.

Returns for the five complete years since release are shown in Table 4 for

Table 4

1952 plain/flagged Petersen comparison

(numbers of fish recaptured)

1952	Year of recapture				
	1	2	3	4	5
Plain yellow buttons	60	20	8	5	0
Flagged yellow buttons	103	35	15	6	2
Flagged returns ..... %	63·0	63·6	65·2	–	–

plain and flagged buttons. No direct test was made between black and plain yellow Petersen tags, but data from the two experiments have been arranged in a comparable manner, Table 3, and it is thought that such a comparison is valid.

Comparison of Results from the two Experiments

(i) 1951 Lea/Petersen comparison

Returns for the six years show a gross ratio of 3·5 to 1 in favour of the Lea. From the Hope Island releases, where each tagged population had roughly comparable length compositions, the first year gave 3·16:1, the second year 3·44:1 (Table 1). A rapid increase in effectiveness of the Lea occurred subsequently, whilst no Petersen returns were made for the last two years. In addition to the black Petersen tag proving less effective, presumably due to poor visibility of the black button, there was evidence that they were either shed or, in some cases, overgrown by tissue.

(ii) 1951/1952 Petersen comparison

There is apparently no significant difference in the efficiency of the yellow over the black button — in fact the 1951 results are better than those of 1952. This is thought to be due to the very poor condition of the cod in June, mentioned earlier, when the probably heavy post-tagging mortality could have masked any improvement expected from the higher visibility of the yellow button (Table 3).

(iii) 1952 plain flagged Petersen comparison

Visibility undoubtedly improved with the use of the message flag and gave a remarkably constant difference in percentage return of the two types. This remained for the first three years 63·0%; 63·6% and 65·2% of the yearly total of recaptures (Table 4).

(iv) 1952 flagged Petersen button returns

Individual English ships and skippers were circularized by letter at the beginning of the tagging experiment in 1951 and publicity was continued in 1952. In addition to the usual request for recapture position and date, the flat message flag asked for the fish to be kept—so that growth and age data might be obtained. Table 5 gives the number of instances in which the request was carried out. A comparison can be made with the returns from the plain button tag. It will be seen that, in the first year, there was a significant difference between the number of whole fish returned to the Laboratory with the flagged and the plain button. It was also evident that publicity had had its effect — as shown by the return of fish with plain buttons. In later years the difference between the two types was not so high, probably because the habit of keeping the fish had become more widely established. A further value of this type of flat message lies in the fact that the text can be altered, readily, to meet the specific requirements of a new or modified tagging programme.

Table 5

1952 experiment. Number of yellow Petersen tags accompanied by fish or fish length and otoliths

Year	Plain button		Flagged button	
	With fish or otoliths	Tag only	With fish or otoliths	Tag only
1.....	38	22	77	26
2.....	17	3	29	6
3.....	7	1	13	2
4.....	2	3	5	1
5.....	–	–	1	1

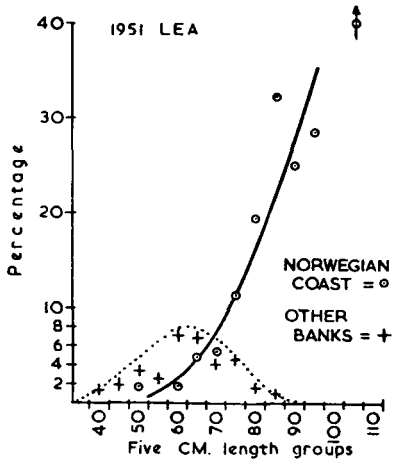

Figure 3.

Figure 3. 1951. By areas. First year recaptures of Lea tags only, as percentages of each 5 cm. length group.

Figure 4. 1951. By gears. First year recaptures of Lea tags only, as percentages of each 5 cm. length group.

Figure 5. 1955. By gears. First year recaptures of Lea tags as percentages of each 5 cm. length group.

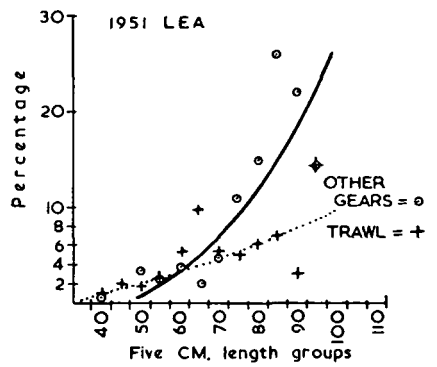

Figure 4.

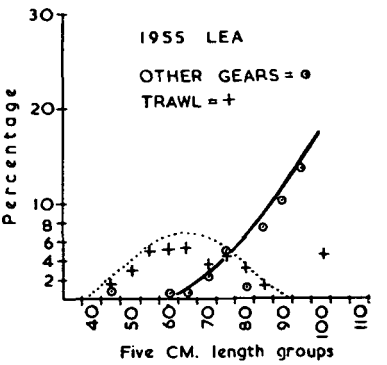

Figure 5.

Table 6

1951 releases. Numbers of fish recaptured, by countries

Country	Year of recapture 1	2	3	4	5	6
Faroes	3	1	1	–	–	–
Germany	23	7	2	1	1	3
Iceland	1	–	–	–	–	–
Norway	162	68	28	15	8	3
United Kingdom	58	13	9	3	2	1
USSR	9	6	3	1	–	-

Table 7

1954 and 1955 releases. Numbers of fish recaptured in first year after release, by countries

Country	1954 releases Trawl	Other gears	Year 1 totals	1955 releases Trawl	Other gears	Year 1 totals
Faroes	1	–	1	6	–	6
France	1	–	1	1	–	1
Germany	9	–	9	20	–	20
Iceland	–	–	–	1	–	1
Norway	15	25	40	29	47	76
Spain	–	–	–	9	–	9
United Kingdom	42	–	42	79	–	79
USSR	7	–	7	8	–	8

Discussion

It appears probable that two main factors are responsible for the "area/gear" differences seen in this analysis — a biological factor and a gear effect.

Area. Norwegian coast returns are seen (Figure 3) to increase markedly with length and indeed it is to be expected that a high proportion of a tagged population containing large numbers of cod over 70 cm. would be caught during the intensive traditional Norwegian "Skrei" fishery. That the length composition itself is important is brought out clearly in Tables 6 and 7" returns by countries" for 1951 and for 1954/1955. There has been, previously, some speculation as to the efficiency of the reporting of tagged fish in some countries. During DANNEVIG's 1947–1953 tagging experiments, where over 4,300 mature cod of 100 cm. or more were released, United Kingdom trawlers returned only 14 of these cod in the seven years. (I wish to acknowledge DANNEVIG's kindness in providing these data at the 1955 Bergen Meeting.) Reference to Table 2 will show that the 1951 tagged population contained some 60% of cod more than 70 cm. in length. In contrast are the returns for the first years of 1954 and 1955, when predominantly small cod were tagged (TROUT, 1957b). Recaptures within the "Skrei" fishery dropped from the 1951 figure of 63% of the total number recaptured in the first year, to 23% in 1955, for gears other than the trawl (see Table 7).

Gears. Separation of both 1951 and 1955 results into recaptures by (a) trawl and (b) other gears, Figures 4 and 5, demonstrates the greater effectiveness

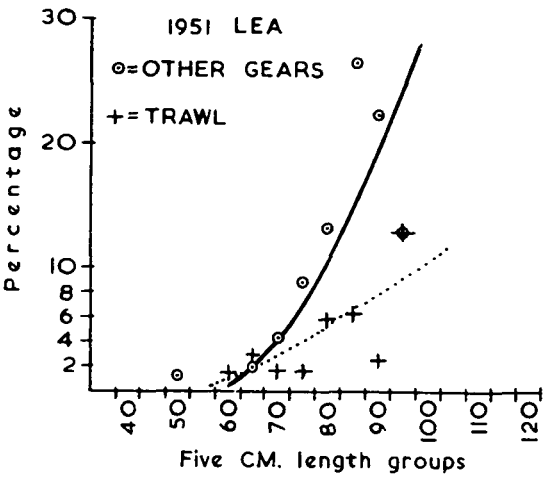

Figure 6. 1951. By gears. Norwegian coast only. First year recaptures of Lea tags as percentages of each 5 cm. length group.

of the latter in catching the larger length groups. The trawl appears to have, in effect, a selective action in point of size, at the upper as well as the lower size ranges of the population. The reason for the similarity between Figure 3 and Figure 5 is that the bulk of the 1955 first year recaptures were made on the feeding grounds. The curve thus tends to be an "area" curve.

There are probably two factors which bring this about. Firstly, a biological one: on the feeding grounds away from the spawning area, the cod, at least on the Spitsbergen Shelf, is diurnally pelagic (TROUT, 1957a). The length of the pelagic period increases progressively with the increase in penetration of daylight in the earlier part of the year, even when the cod are not yet feeding actively upon their largely pelagic, or bathypelagic, food. Thus the cod are less vulnerable to the trawl, since they spend a considerable time above the height at which the headline fishes. This is well known in echo-sounding surveys. Echo surveys have also encountered conditions of high signal count but low catch. When such catches have contained a few large fish it appears possible that more large fish were on the ground but were able to escape the trawl, or were sufficiently far above the bottom to avoid the headline. Mere size, and so possibly speed, could enable them to avoid the net.

Secondly, there may be a physical effect dependent upon filtration of the trawl and therefore upon mesh size. ROLLEFSEN (1953) has shown that in the spawning fishery at Lofoten, cod taken by different gears differ in size — the purse seine takes the largest fish and the longline the smallest. At Greenland, in 1952, the "Ernest Holt's" trawl caught cod of one age-group with a mean length 3 cm. lower than those of the same age-group taken by lines — 67·0 cm. against 70·2 cm. for the 1945 year-class — here again suggesting that the trawl, even with 110 mm. mesh, has a lower size selection.

This difference between the gears persists even on the Norwegian coast (Figure 6) so that it is not due to an area bias. The comparison must not be pressed too far, however, because there are, within the Norwegian coast region, two entirely different fisheries; (a) on the outer banks where the cod are on

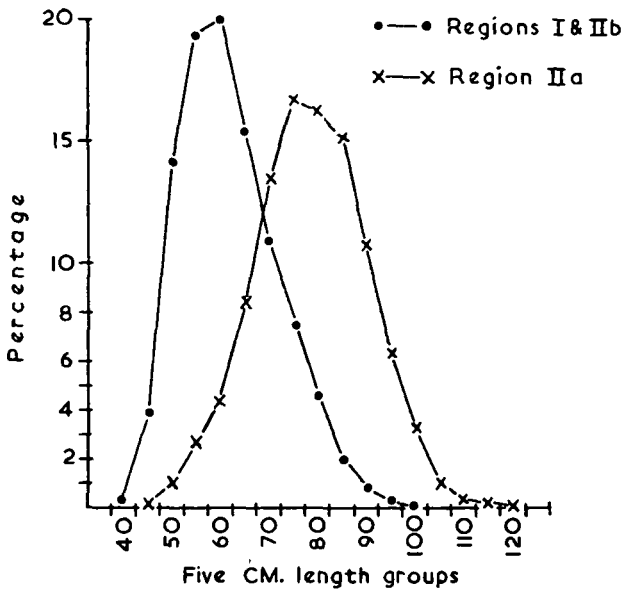

Figure 7. Mean lengths of cod landed from Regions I and IIb and from Region IIa (Norwegian coast), respectively. Hull and Grimsby market measurements 1951–1955 inclusive.

the bottom and (b) in the fjords and sounds where the cod are pelagic during spawning and where they are not, of course, subjected to a trawl fishery.

Figure 7 gives the mean length composition of the English landings at Hull and Grimsby for the two main areas, i. e., the feeding grounds of the Spitsbergen Shelf and South-East Barents Sea and the grounds over which the spawning migration takes place — Regions I and IIb and Region IIa, respectively.

Davis (1934) first showed that by increasing the mesh of a trawl, the catch tended to be greater and also there was a greater number of larger fish in the catch. It would appear possible that a mesh size greater than 110 mm. could reduce the disparity in size of cod caught by the trawl compared with other gears in the areas discussed and also effect a reduction in mortality amongst the lower and less valuable size groups.

Summary

1. The Lea tag is shown to be superior to the Petersen.

2. The rate of return of the Lea tag and therefore of fishing mortality increases with the length of cod.

3. It follows that in treatment of tagging data it is essential that the length composition of the tagged and recaptured populations should be taken into account. An overall percentage of recapture can be misleading and may frequently be of little value.

4. The size difference of cod caught by trawl and by other gears is demonstrated.

5. It follows that method of recapture should also be taken into account when dealing with returns from fisheries carried out by mixed gears.
6. The advantages of a readily seen message flag are demonstrated.

References

DAVIS, F. M., 1934. "Mesh experiments with trawls, 1928–1933." Fish. Invest., Lond., Ser. 2, **14** (1).
ROLLEFSEN, G., 1953. "The selectivity of different fishing gear used in Lofoten." J. Cons. int. Explor. Mer, **19**: 191–94.
TROUT, G. C., 1957a. "The Bear Island cod: migrations and movements." Fish. Invest., Lond., Ser. 2, **21** (6).
TROUT, G. C., 1957b. "English cod tagging in 1954 and 1955." Ann. Biol., Copenhague, **12**: 139–40.