

International Council for the
Exploration of the Sea

C.M. 1967 / H : 26
Pelagic Fish (Northern) Committee

NORWEGIAN HERRING TAGGING EXPERIMENTS IN THE
NORTHERN NORTH SEA, 1966

by
Steinar Haraldsvik^x

INTRODUCTION

Earlier tagging experiments (Høglund 1954, Dragesund and Haraldsvik 1966) have given evidence for a communication between the feeding and spawning herring in the north-western North Sea and the overwintering herring in the north-eastern North Sea and Skagerrak. To get a better understanding of the connection between the herring populations on both sides of the northern North Sea, a large number of herring were tagged with internal steel tags in the Shetland area and in the Egersund Bank area during the summer 1966.

This report presents some preliminary results which have emerged from the recaptures of these tagging experiments during the first year after liberation.

THE TAGGINGS

The tagging method was the same as described by Fridriksson and Aasen (1950 and 1952). All the tagged herring were caught by commercial purse-seiners, and the weather conditions were mostly favourable during the tagging operations. Each tagging experiment was brought to an end before any harmful descaling effect could be noticed, and it is suggested that the herring tagged were in good condition when released. A sample from the same catch as the tagged herring was secured for biological analysis.

The Shetland experiment

The taggings were carried out from the R.V. "Peder Rønnestad" during the period 25 July - 1 August (Haraldsvik 1966). This experiment

^x Mr. Steinar Haraldsvik, Fiskeridirektoratets Havforskningsinstitutt, Nordnesparken 2, Bergen, Norway.

consisted of 4 separate liberations, all in the area east of Bressay - Sumburgh Head, about 15 nautical miles off the coast. Altogether 4000 herring were tagged (Table 1).

The composition of autumn and spring spawners (separated on otolith characters) were 69% and 31% respectively. The age distribution within the two spawning-groups is shown in Table 2. It is noticed that the autumn spawned herring were dominated by the 1960 and the 1963 year-classes, while the spring spawners were strongly dominated by the 1964 year-class, followed by the 1961 year-class. The mean vertebral count for the autumn spawning component was 56.434 (n=53), which indicate that these herring belong to the "Bank" herring stock.

The corresponding figure for the spring spawning component was 56.921 (n=38). This component was probably composed of the northern North Sea spring spawning stock. It should be noted, however, that a few number of the spring spawners had otolith and scale characters similar to the northern type of the Norwegian spring spawning stock.

The north-eastern North Sea experiment

The taggings took place during the period 25 - 27 June. For this experiment the R.V. "G.O. Sars" was used (Haraldsvik 1966). In all 4000 herring were tagged, of which 2000 were released in the Sira Hole and 2000 on the Egersund Bank (Table 1).

The autumn spawning group, which constituted 91% of the herring, was dominated by the 1960 year-class. The 1963 and 1962 year-classes were also abundant and contributed a substantial part to this spawning group (Table 2). The mean vertebral count for the autumn spawners was 56.356 (n=177), which indicate that the released herring were an admixture of Kattegat autumn spawners and "Bank" herring.

THE RETURNS

A dominant part, about 99%, of the Norwegian catch from the northern North Sea and Skagerrak in the period July 1966 - July 1967, have been reduced to meal and oil. The overwhelming majority of the reduction plants have installed magnetic separators, and the present tagging experiments therefore have provided a fairly high number of recaptures to be dealt with. About 82% of the total recoveries have been detected at Norwegian factories equipped with magnets, and a special attention will be paid to these returns. The reliability of the returns from reduction plants with regards to fishing area and day of capture, the non-return of tags recovered, and the losses of tags not being detected have been discussed elsewhere (Dragesund and Haraldsvik 1966). In this report the returns have been allocated according to the information given by the factories and the non-return of tags recovered is regarded to be

negligible. The loss of tags not being detected have special interest for a quantitative treatment of the returns. In this respect the quantity reduced at each factory has been adjusted according to the efficiency of the magnets.

The Norwegian fishing effort has not been dispersed evenly in the northern North Sea and Skagerrak, and consequently the distribution of the recoveries will show a grouping on the most prominent fishing grounds. It has been convenient to split the number of returns into groups, defined by the general area of recapture:

1. Shetland. This area covers the eastern waters of Shetland between Fair Isle and Muckle Flugga and from 12-25 nautical miles off.
2. NE North Sea. This area covers the outer edge of the Norwegian Deep between Lista and the Viking Bank. The dominant part of the returns derive from the Egersund Bank.
3. Skagerrak. The returns due to the Norwegian fishery come from the western entrance of the Skagerrak.

Returns from the north-eastern North Sea experiment

In Table 3 is given a complete list of all tag returns up to July 1967. A total of 463 recoveries have returned from this experiment, of which 407 tags were detected at Norwegian plants equipped with magnets.

It is seen that the majority of the returns derive from the north-eastern North Sea area, but a migration westward to the Shetland and eastward to the Skagerrak is clearly demonstrated.

Several of the returns classified as "North Sea uncertain" in Table 3, were from Danish reduction plants, without specification of time and area of fishing. The Danish catch reduced, however, had been received in the period January - April 1967, and since Skagerrak is the main fishing area during that period it is reasonable to assume that a high proportion of the uncertain returns come from the Skagerrak.

The low number of recoveries in the period November 1966 - April 1967 was due to a reduced effort in the ^{Norwegian} North Sea herring fishery. It should be mentioned that a fishing stop occurred in the two last months of 1966, and in the winter 1967 the fleet took part in other fisheries as those for mackerel, winter herring and capelin.

An interesting feature in the experiment was the three recoveries from outside the North Sea, namely the two returns in October from the east Icelandic area, and the one return in February from Møre.

These returns must be of the spring spawners of the tagged fish, and reveal an exchange of this spawning component and the Norwegian spring

spawning stock.

For a closer analysis of the recoveries it is necessary to deal with catch statistics and biological characteristics of the herring in the various areas. A total of 21 factories with tested magnets have received catches from the North Sea and the Skagerrak in the period under consideration. The efficiency of these magnets run from 0.66 - 0.96 and the effective quantity reduced (quantity \cdot efficiency) from the different areas is given in Table 4. If it is accepted that the tagged fish is randomly distributed among the untagged fish, the per mille returns per 1000 tons will illustrate the relative abundance of the tagged population in the different areas. From Table 5 it is seen that the north-eastern North Sea in all months has the highest per mille returns per 1000 tons. The high figures in early autumn 1966 in this area are probably insignificant due to the short time for the tagged fish to disperse randomly.

From Table 5 it is apparent that the movement of the herring present in the north-eastern North Sea during the summer 1966, only had minor importance for the herring stocks in the Shetland waters and in the Skagerrak the following year. During July - August 1966 the relative abundance of the tagged fish in the Shetland area was less than 5% of the abundance in the north-eastern North Sea. The corresponding figures for September 1966 and June 1967 were respectively 22% and 29%. The figures from Skagerrak are probably less significant due to the low number of recoveries from this area. Judging from the per mille returns per 1000 tons of herring in Table 5 it seems, however, to be a stronger communication eastward to the Skagerrak than westward to the Shetland. Also the uncertain recoveries support this judgement.

The mean vertebral count and the age composition of spring and autumn spawned herring in the different areas are given in Table 6 and Table 7. Comparing with the corresponding data for the tagged fish (Table 2) there is, however, a better agreement with the Shetland herring than with the Skagerrak herring. One explanation for this discrepancy, may be due to that the age composition given in Table 6 do not give a representative picture of the exploited stock present in the different areas. The number of samples for age determination are few, and some of the samples have also been taken by gears other than purse-seine.

When considering the per mille returns per 1000 tons of herring by month for the north-eastern North Sea (Table 5) it is seen that the relative abundance of the tagged fish is decreasing throughout the period from early autumn 1966 to the summer 1967. The abundance of tagged fish is influenced by several factors such as: mortality due to the tagging, handling and bad condition of tagged fish, losses of tags by shedding and migration of herring into and out from the area. The effect of mortality

of tagged fish and losses of tags due to shedding have been investigated earlier (Dragesund and Haraldsvik 1966) and was found to be of minor importance. Losses of tagged fish may also take place by segregation, mainly of old herring migrating to the Shetland area. It is, however, most likely that the decrease in abundance of the tagged fish was caused by an immigration of young herring. During autumn 1966 the 1964 year-class of the autumn spawned group recruited the north-eastern North Sea area. This year-class became more and more abundant the following winter and spring (Table 6).

Returns from the Shetland experiment

This tagging experiment has yielded altogether 494 returns, of which 381 were detected at Norwegian plants equipped with magnets. The returns according to month and area of capture are summarized in Table 9 and Figure 2.

Also in this experiment most of the recoveries came from the area of release. Movements of herring in easterly directions are demonstrated very clearly with 92 returns and 11 returns from the north-eastern North Sea and the Skagerrak respectively.

The autumn spawners among the tagged fish were just in time for spawning, and the considerable number of returns from the north-eastern North Sea in August reveal a rapid movement of spent herring across the northern North Sea.

The dominant part of the returns classified as "North Sea uncertain" (Table 9) are from factories in the northern part of Western Norway. These factories have received catches mainly from the Shetland area, and it is therefore most likely that the majority of the uncertain returns were from this area.

Some of the returns from the Shetland tagging experiment do not conform with the main pattern of movement. Six fish have been recaptured in February 1967 on the spawning grounds off Møre. Since herring belonging to the Norwegian spring spawning stock have been identified among the tagged fish, the records cannot be regarded as exceptional.

Far more interesting are the 5 returns in June 1967 from the west of Shetland. These tags have been detected in catches of purse-seiners from the Faroe Island. The Norwegian fleet has not fished in this area. However, a Norwegian purse-seiner M/S "Havdrøn" was hired by the Directorate of Fisheries for a survey in the second half of May 1967 to the area west of Shetland (Haraldsvik and Revheim, in press).

The age composition (Table 10) and the mean vertebral count for the two spawning groups (56.501 and 56.950) in samples collected on this survey were in good conformity with the herring tagged east of Shetland the summer 1966 (Table 2). The fact that good concentrations of herring were recorded, together with a rich Scottish herring fishery in May-June in this area, indicate that a substantial part of the herring distributed east of Shetland in summer 1966 had moved to the west of Shetland. Information is not available on when this westward migration took place, but the possibility of an overwintering area on the west side of Shetland cannot be ruled out. According to an echo-survey (Haraldsvik 1967) and to the catch statistics for the north-eastern North Sea and the Skagerrak, the abundance of herring during the winter 1967 in these areas was less than in the foregoing years.

The per mille returns per 1000 tons by month and area are shown in Table 9. The high figures for August - September in the Shetland area are most likely insignificant, due to the short time since the release. Table 9 demonstrates that the movements of herring eastward to the north-eastern North Sea were more prominent than the westward movements of the herring tagged in the north-eastern North Sea (Table 5). The figure for January in the north-eastern North Sea together with those for the Skagerrak are probably not reliable due to the low number of recoveries.

In May-June 1967 the relative abundance of tagged herring were low in the north-eastern North Sea and in the Shetland areas (Table 9). The low figures for the north-eastern North Sea seem reasonable when taking the age compositions into consideration (Table 2 and Table 10). When making the same comparison for the figure from the Shetland area, the relative abundance was less than expected. The possibility that a part of the tagged population were distributed west of Shetland in May - June, should not influence the per mille returns per 1000 tons if the tagged fish were dispersed randomly.

Sources for the bias may be the high number of uncertain recoveries and the loss of tags due to the shedding effect. The herring released at Shetland were in immediate prespawning stages, and according to earlier experiments the shedding rate will be relatively high in such fish (Dragesund, unpublished data).

SUMMARY

During the summer 1966, 4000 herring were tagged in the north-eastern North Sea, and another 4000 were tagged east of Shetland. All of the fish were tagged with internal steel tags.

Up to July 1967 the experiments have given 957 returns, of which 788 were detected at Norwegian plants equipped with magnets. The dominant

part of the returns were from the areas of release. The release in the north-eastern North Sea reveal a migration of herring both to the eastern Shetland area and to the Skagerrak area. The low relative abundance of tagged fish in these areas indicate, however, that the movements were of minor importance to the fishery in these areas.

The release east of Shetland have given evidence for an easterly migration to the north-eastern North Sea and the Skagerrak. Some of the returns were from the west of Shetland in June 1967, and it is likely that part of the tagged population was distributed in this area during the spring 1967.

From both tagging experiments, herring have been recaptured at the spawning grounds of the Norwegian spring spawning stock.

REFERENCES

- Dragesund, O. and Haraldsvik, S. 1966. Norwegian tagging experiments in the north-eastern North Sea and Skagerrak, 1964 and 1965. Coun. Meet. Int. Coun. Explor. Sea, 1966. H:27, 1-28 (Mimeo.).
- Fridriksson, A. and Aasen, O. 1950. The Norwegian-Icelandic herring tagging experiments. Report No. 1. FiskDir. Skr. Ser. Havunders., 9 (11):1-43.
- " - 1952. The Norwegian-Icelandic herring tagging experiments. Report No. 2. Rit. Fiskid., 1 (1):1-54.
- Haraldsvik, S. 1966. Sildeundersøkelser i Nordsjøen sommeren 1966. Fiskets Gang, 51 : 958-962.
- " - 1967. Sildeundersøkelser i Nordsjøen og Skagerak med F/F "Johan Hjort" 18. oktober - 5. november 1966. Fiskets Gang, 22 : 361-365.
- Höglund, H. 1964. Swedish herring tagging experiments 1949-1953. Rapp. Cons. Explor. Mer, 140 (2) : 19-29.

Table 1. Norwegian tagging experiments in the north-eastern North Sea and Shetland, 1966

Date	Position	Mode of catch	Lib No	Type of tag	Serial numbers	Total
25 June	N 58°03' E 03°42'	Purse-seine	1	Internal	N 266001-268000	2000
27 - " -	N 57°46' E 05°04'	- " -	2	- " -	N 268001-270000	2000
Total NE North Sea...						4000
25 July	N 59°52' W 00°48'	- " -	1	- " -	N 264301-265000	700
27 - " -	N 60°33' W 00°19'	- " -	2	- " -	N 265001-265950	950
31 - " -	N 60°15' W 00°26'	- " -	3	- " -	N 265951-266000	50
31 - " -	- " - - " -	- " -	3	- " -	N 270001-271200	1200
1 Aug.	N 60°16' W 00°23'	- " -	4	- " -	N 271201-272300	1100
Total Shetland.....						4000
Grand total.....						8000

Table 2. Age composition (in %) of autumn and spring spawners in samples taken from the same catches as the tagged herring

Year-class	NE North Sea		Shetland	
	Autumn-spawners	Spring-spawners	Autumn-spawners	Spring-spawners
1965	-	-	-	2.8
1964	-	29.4	0.4	53.3
1963	22.8	17.6	30.0	2.8
1962	22.8	17.6	5.5	1.9
1961	17.2	11.8	8.4	24.3
1960	32.2	5.9	38.4	10.3
1959	0.6	5.9	-	4.6
1958	1.1	-	2.5	-
1957	-	5.9	4.3	-
1956	3.3	5.9	10.1	-
1956 ⁺	-	-	0.4	-
Total	100.0	100.0	100.0	100.0
Numbers	180	17	237	107

Table 3. Summary of returns in 1966/67 of the NE North Sea tagging experiment arranged according to area and month. The figures in brackets are number of tags recovered at Norwegian plants equipped with magnets

Month	Area				Total	
	Shetland	NE North Sea	Skagerrak	North Sea uncertain		Other
June 1966	- (-)	8 (8)	- (-)	- (-)	- (-)	8 (8)
July "	7 (5)	114 (114)	4 (4)	- (-)	- (-)	125 (123)
Aug. "	14 (12)	115 (113)	- (-)	1 (-)	- (-)	130 (125)
Sept. "	1 (1)	37 (36)	1 (1)	- (-)	- (-)	39 (38)
Oct. "	- (-)	40 (31)	6 (4)	- (-)	2* (-)	48 (35)
Nov. "	- (-)	- (-)	2 (1)	- (-)	- (-)	2 (1)
Dec. "	- (-)	2 (-)	3 (-)	- (-)	- (-)	5 (-)
Jan. 1967	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)
Febr. "	- (-)	- (-)	- (-)	1 (-)	1** (-)	2 (-)
March "	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)
April "	- (-)	3 (2)	- (-)	- (-)	- (-)	3 (2)
May "	- (-)	21 (20)	- (-)	- (-)	- (-)	21 (20)
June "	9 (7)	49 (46)	- (-)	- (-)	- (-)	58 (53)
Uncertain	- (-)	- (-)	- (-)	22 (2)	- (-)	22 (2)
Total	31 (25)	389 (370)	16 (10)	24 (2)	3 (-)	463 (407)

* From east of Iceland, the wintering area for the Norwegian spring spawning stock.

** From Møre, the spawning grounds for the Norwegian spring spawning stock.

Table 4. The effective quantity of herring (in tons) processed at Norwegian plants equipped with magnets arranged according to month and fishing area

Month	Shetland	NE North Sea	Skagerrak	Other	Total
July 1966	39325.7	30837.7	1597.4	-	71760.8
Aug. "	44371.1	15041.8	11733.6	185.9	71332.4
Sept. "	1325.1	10663.0	6425.8	45.2	18459.1
Oct. "	-	12031.7	2243.9	4.4	14280.0
Nov. "	-	-	-	-	-
Dec. "	-	-	-	-	-
Jan. 1967	-	65.2	36.7	-	101.9
Febr. "	-	35.4	2.3	-	37.7
March "	-	25.8	-	2.3	28.1
April "	-	945.9	-	-	945.9
May "	-	12848.9	612.8	1092.2	14553.9
June "	18983.7	36617.5	-	12464.6	68065.8
Total	104005.6	119112.9	22652.5	13794.6	259565.6

Table 5. Per mille returns pr. 1000 tons of herring reduced at Norwegian plants equipped with magnets according to month and area, the NE North Sea tagging experiment

Month	Area		
	Shetland	NE North Sea	Skagerrak
July 1966	0.032	0.924	0.626
Aug. "	0.068	1.878	-
Sept. "	0.189	0.844	0.039
Oct. "	-	0.644	0.446
Nov. "	-	-	-
Dec. "	-	-	-
Jan. 1967	-	-	-
Febr. "	-	-	-
March "	-	-	-
April "	-	0.529	-
May "	-	0.389	-
June "	0.092	0.314	-
Total	0.060	0.777	0.110

Table 7. Mean number of vertebrae of herring from Skagerrak and NE North Sea arranged according to period, area and type (figures in brackets, number)

Period	Area	Mean number of vertebrae	
		Autumn spawners	Spring spawners
July - Dec. 1966	Skagerrak	56.422 (173)	57.077 (13)
July - Dec. "	NE North Sea	56.459 (370)	56.818 (77)
Jan. - April 1967	NE North Sea	56.409 (472)	56.632 (87)
May - June "	Shetland	56.453 (316)	56.847 (72)
May - June "	NE North Sea	56.470 (83)	57.500 (6)

Table 8. Summary of returns in 1966/67 of the Shetland tagging experiment arranged according to area and month. The figures in brackets are number of tags recovered at Norwegian plants equipped with magnets

Month	Area					Total
	Shetland	NE North Sea	Skagerrak	North Sea uncertain	Other	
July 1966	17 (17)	- -	- -	- -	- -	17 (17)
Aug. "	254 (234)	18 (17)	- -	15 (11)	- -	287 (262)
Sept. "	14 (8)	29 (24)	1 (1)	4 (1)	- -	48 (34)
Oct. "	- -	27 (23)	4 (4)	2 -	- -	33 (27)
Nov. "	- -	- -	2 -	- -	- -	2 -
Dec. "	- -	4 -	4 -	- -	- -	8 -
Jan. 1967	- -	2 (1)	- -	- -	- -	2 (1)
Febr. "	- -	- -	- -	2 -	6* (2)	8 (2)
March "	- -	- -	- -	- -	- -	- -
April "	- -	1 -	- -	- -	- -	1 -
May "	- -	4 (4)	- -	- -	- -	4 (4)
June "	18** (13)	6 (6)	- -	- -	- -	24 (19)
Uncertain	- -	1 (1)	- -	59 (14)	- -	60 (15)
Total	303 (272)	92 (76)	11 (5)	82 (26)	6 (2)	494 (381)

* From Møre the spawning grounds for the Norwegian spring spawning stock

** Include 5 returns from west of Shetland

Table 9. Per mille returns pr. 1000 tons of herring reduced at Norwegian plants equipped with magnets according to month and area, the Shetland tagging experiment

Month	Area		
	Shetland	NE North Sea	Skagerrak
July 1966	0.108	-	-
Aug. "	1.318	0.283	-
Sept. "	1.509	0.563	0.039
Oct. "	-	0.478	0.446
Nov. "	-	-	-
Dec. "	-	-	-
Jan. 1967	-	3.834	-
Febr. "	-	-	-
March "	-	-	-
April "	-	-	-
May "	-	0.078	-
June "	0.171	0.041	-
Total	0.654	0.160	0.055

Table 10. Age composition (%) of spring and autumn spawned herring from west of Shetland, May - June 1967

Year-class	Autumn-spawners	Spring-spawners
1965	-	2.4
1964	0.8	48.8
1963	22.5	4.9
1962	10.3	7.3
1961	16.3	17.1
1960	32.8	12.2
1959	1.3	4.9
1958	2.3	2.4
1957	4.9	-
1956	8.5	-
<1956	0.3	-
Total	100.0	100.0
Number	387	44

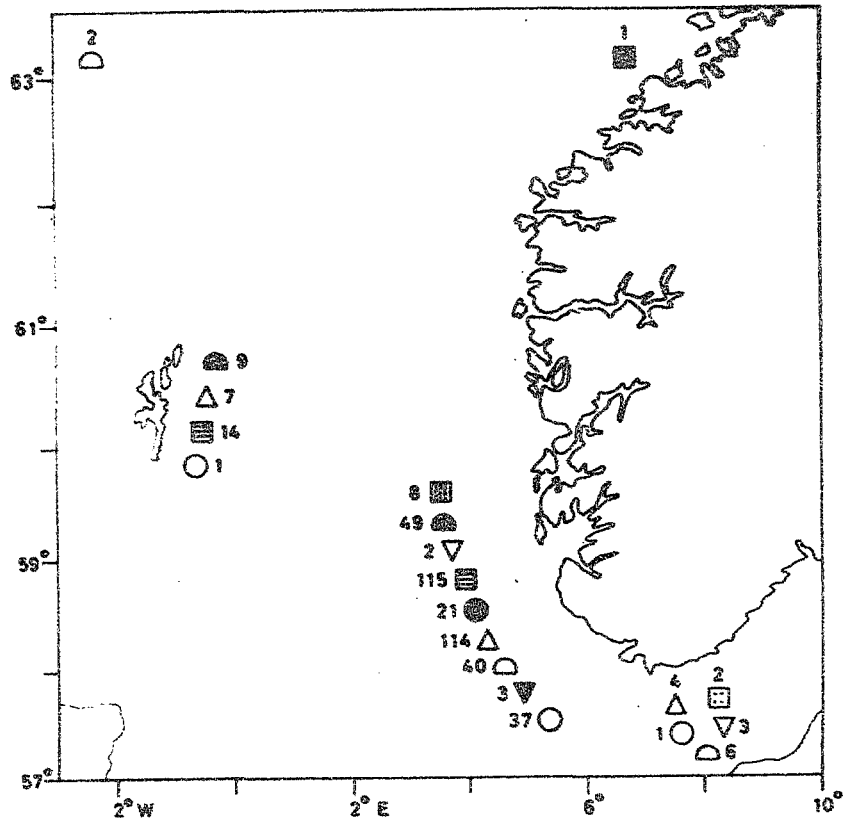


Fig. 1. Returns from the north-eastern North Sea experiment

■ June ▨ Aug. ◐ Oct. ▽ Dec. ■ Febr. ● May
 △ July ○ Sept. ▩ Nov. ▾ April ◐ June

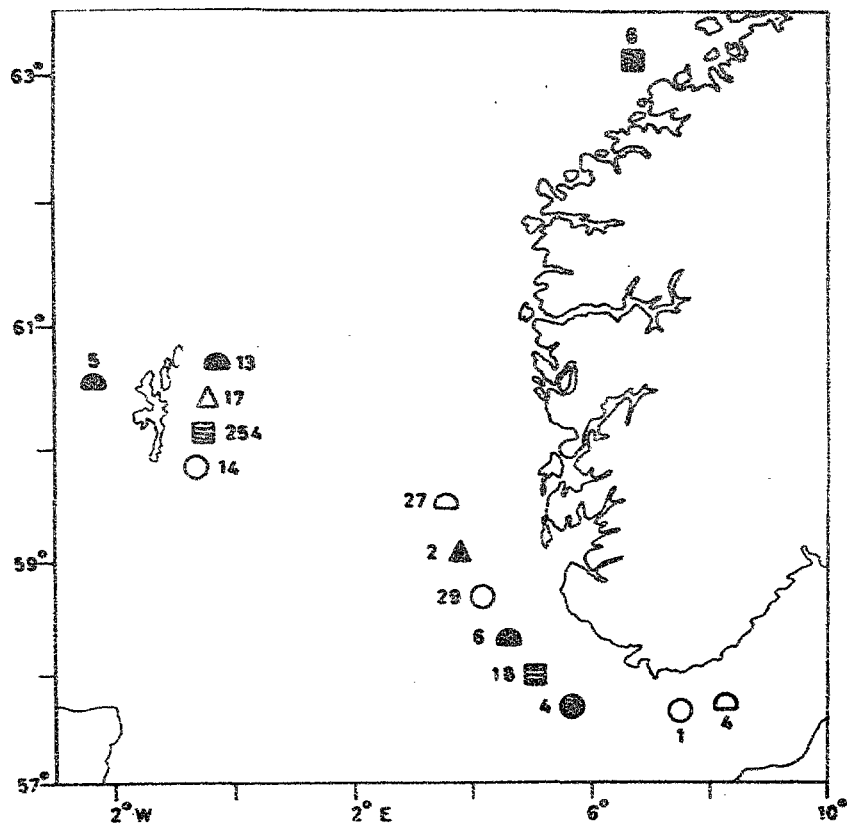


Fig. 2. Returns from the Shetland experiment

△ July ○ Sept. ▩ Nov. ▲ Jan. ▽ April ◐ June
 ▨ Aug. ◐ Oct. ▽ Dec. ■ Febr. ● May