Danish Whiting Tagging in the Period 1956-59.

by

E. Bertelsen and H. Knudsen.

Technique.

The whiting were caught in short hauls (30 minutes or less) with a
fine meshed cotton trawl and brought from the deck to a tank with slowly
running sea water. After being tagged the whiting were placed in a bucket
(Height: 35 cm, diameter 28 cm) and batches of about 30 were lowered in
the bucket to near the sea bottom and released. (For further information
see Bertelsen 1956).

Two different types of tags were used for whiting in this period.
One is a hydrostatic polystyrene tag attached with a one-piece bridle of
steel wire, the other an alkathene tag attached with a soft braided nylon
strap. Both types of tags were attached through the back of the fish in
front of the first dorsal fin.

Comparison of the two types of tags.

The alkathene tag was used for 660 fish in the first two years, while
6225 whiting were tagged with the hydrostatic tag. In two cases where a
reasonable number of both tags were used in the same month and in the same
area a comparison was made between the proportion of recaptures obtained
for the two types.

Below the results are set out in 2 x 2 tables and a χ^2 test is made
in each case.

Comparison between proportions of recaptures of alkathene tags and
hydrostatic tags, Skagerrak, January 1957:

	Recaptured	Not recaptured	Total
Alkathene tags	14	125	139
Hydrostatic tags	31	219	250
Total	45	344	389

$$\chi^2 = 0.473 \qquad 0.50 < P < 0.60$$

Comparison between proportions of recaptures of alkathene tags
and hydrostatic tags, NW, September 1956:

	Recaptured	Not recaptured	Total
Alkathene tags	4	316	320
Hydrostatic tags	9	276	285
Total	13	592	605

$$\chi^2 = 2.61 \qquad 0.80 < P < 0.90$$

For the numbers in question the differences in proportions recaptured
between the two types of tags are not significant and in the following
both tags are treated together.

Distribution of the tagged whiting.

Table 1

		NW	C	NE	Sk-K	SW	SE	Total
April-May	1956	194						194
June	"				331			331
Aug.-Sept.	"	605	160		100	65	66	996
Jan.-Feb.	1957		43		389	232	176	840
April-May	"	351	98	49	97	148	99	842
Aug.-Sept.	"	590		125	100	150		965
April-May	1958			25	181	354	130	690
November	"	475	75		335	165	110	1160
May	1959	97		93	321	284	72	867
Grand Total		2312	376	292	1854	1398	653	6885

Table 1 shows the number of whiting tagged in different areas and periods. The limits of the areas can be seen on Fig. 1. From the Table it is seen that taggings have been carried out at all seasons of the year although spring and autumn prevail.

Movements of tagged whiting.

On Fig. 2 arrows indicate the shortest possible migrations of tagged whiting who spent between 31 and 360 days at sea between release and re-capture, and Fig. 3 deals in the same way with whiting who spent more than 360 days at sea between release and recapture. No far reaching conclusions can be drawn from the few recaptures on Fig. 3, but it does not seem to reflect a general and irreversible migration of older whiting to the north; a theory suggested to explain the difference in age-distribution between the southern and northern North Sea.

On Fig 4 it is attempted to sort out from the movements on Fig. 2 what could be spawning migrations. It gives points of release and recapture of whiting tagged in the autumn and recaptured before the first of May next year. Only whiting larger than 25,9 cm at tagging are included so that all the fish considered can be expected to spawn. The results of the November-taggings suggest short spawning migrations from the central North Sea to the west and north. As these migrations mostly take place within the central and northern North Sea they are consistent with the separation of the whiting population in a northern and a southern component established by parasite studies and vertebral counts. If the same size category is sorted out from the spring taggings and only recaptures before the first of December are considered only six recaptures are left. They all show short migrations in southwestern direction but are too few to have any weight as evidence of a return from the spawning places.

All recaptures are related to quarters of the statistical rectangles and the shortest distance between release and recapture are calculated in units which are the side of this quarter-rectangle (about 15 naut. miles).

In Table 2 a migration has been classified as short if the recapture has taken place in the same quarter-rectangle as the tagging or in a neigh-bouring one (30 naut. miles). If the fish has passed at least 8 rect-angles on its way between tagging and recapture, the migration is called long (120 naut. miles). All other movements are in the intermediate class. It is seen that among the recaptures taken as a whole long jour-neys are exceptions. Of the total number of returns with information on recapture position (274 fish) 59% had moved less than 30 miles and 92% less than 120 miles. If the fish recaptured in the first month after tagging are left out the observed migration of the remaining 159 recap-tures is 42% less than 30 miles and 87% less than 120 miles.

From the Skagerrak-Kattegat experiments not a single long migration has been observed. No whiting tagged here has been recaptured outside the area. Of the total number of 118 returns from the taggings in the North Sea only 2 came from the Skagerrak-Kattegat area.

Of a total of 21 long migrations 11 went north, 5 went south and only 4 in the direction west-east.

Returns in relation to length at tagging.

Table 3 gives the length distribution of the tagged whiting and the number and percentage of returns from each length group. From the areas where an appreciable number of returns has been obtained there are relatively more recaptures of the large fish. The differences are statistically significant. As an example the following test for the experiments in 1956-58 in the Skagerrak-Kattegat area is shown. Comparison between proportions of tags returned from different length groups in tagging experiments in Skagerrak-Kattegat 1956-58:

Length groups	11-19 cm	20-24 cm	25-29 cm	= 30 cm	Total
Number tagged	760	454	266	80	1560
Number of returns	49	56	37	14	156
Proportion of returns, h	0.06448	0.12335	0.13910	0.17500	0.1
$y = 2 \arcsin\sqrt{h}$	0.5135	0.7176	0.7644	0.8632	0.6336

From the h-values we have

$$\chi^2 = \frac{\sum n_i (h_i - \bar{h})^2}{\bar{h}(1 - \bar{h})} = 22.93$$

The arc sine transformation gives

$$\chi^2 = \sum n_i (y_i - \bar{y})^2 = 22.93, \quad \text{and}$$

with 3 d.f. we have $P > 0.9995$.

This difference may be due partly to a higher tagging mortality among the smaller fish, partly to the natural mortality in the time elapsed from the tagging till the fish reach commercial size. In Skagerrak-Kattegat, where fish below 20 cm are caught as by-catch in the young herring fishery and are landed unsorted for fish meal production or for fodder in pond and minkfarms, a considerable part of the tags in smaller fish is probably not observed.

Number of returns per time unit.

Table 4 gives the number of returns per 30 days from taggings in the northwestern area, in the first column the total number, in the second column only from fish 25-29 cm at tagging. In the same way Table 5 gives the number of returns per 14 days from taggings in the Skagerrak-Kattegat area, total number in the first column, returns from fish 25-29 cm at tagging in the second column.

It is hoped that the fact that all experiments are pooled in the tables will compensate for any seasonal changes in fishing intensity. In Fig. 4 a and 4 c the logarithms of the total number of returns are set out against time.

The slope of the lines are -0.1803 and -0.2695 respectively and converted into rate of decrease per year, it gives the following values

NW: 2.19
Skagerrak-Kattegat: 7.03

Those values however are not comparable as relatively more large fish were tagged in the NW area, and it was shown above that the number of returns is influenced by the size composition of the fish tagged.

In Fig. 4 b and d the returns from taggings where the fish were 25-29 cm at the time of tagging are treated in the same way giving the following values for the rate of decrease per year:

NW: 1.57
Skagerrak-Kattegat: 4.48

Ellis and Jones 1956 on basis of Explorer's trawlings estimate the total mortality for whiting in the northern North Sea (including dispersion from the area) to be 1.03, which leaves 0.54 as an estimate of the rate of loss of tags and additional mortality due to tagging. Compared with the rate of

Based on "Dana"'s trawlings in 1956-58 F + M for the year-classes 1955 og 1954 in Skagerrak-Kattegat was estimated to 1.74 and 1.70 respectively. This leaves 4.48 -(1.72 + 0.54) = 2.22 unaccounted for. This value could represent the rate of dispersion from the area, a dispersion which is veiled in the catch per unit fishing time of "Dana" by replacement from other areas (e. g. the Belt Sea). But unfortunately a regression analysis showed that the difference between the slope of the three lines representing the rate of decrease in number of year-class 1955, year-class 1954 and tagged whiting is not statistically significant (v^2 = 3.48, 0.90 < P < 0.95).

This is for one thing due to the fact that the recaptures in the Skagerrak-Kattegat were obtained in a rather short period after the tagging.

It may be hoped that including the experiments in 1960-61 (see Table 6) will give better estimates and thus help to solve the question wether a dispersion from Skagerrak takes place. The fact that no recaptures outside the area are found is no final proof as the fishing intensity in the neighbouring area the northeastern North Sea is rather low.

Table 6.

Total number of taggings in 1956-61, distributed on areas.

	NW	C	NE	Sk-K.	SW	SE
1956-59	2312	376	292	1854	1398	653
1960-61	-	-	434	2317	-	311
	2312	376	726	4171	1398	964

Grand total 9947

References.

Bertelsen, E. 1956: Danish Whiting Taggings in 1956. I.C.E.S. C.M. 1956

Beverton, R. J. H. and S. J. Holt 1957: On the Dynamics of Exploited Fish Populations Fishery Invest.ser.2,vol. 19.

Ellis, R. W. and R. Jones 1956: The Whiting (Gadus merlangus L.) in the North Sea. Scot. Home Dep.,Mar. Research 1956 no 2.

Table 2.

Length of migration in relation to length of
period between tagging and recapture.

Skagerrak-Kattegat.

Length of migration:	Days at Sea.			
	1 – 30	31 – 180	181 – 360	Total
Short	81	42	2	125
Intermediate	8	31	1	40
Long	0	0	0	0
No information	8	6	0	14
	97	79	3	179

NW

Length of migration:	Days at Sea.				
	1 – 30	31 – 180	181 – 360	360	Total
Short	15	12	6	2	35
Intermediate	8	18	10	7	43
Long	0	4	7	2	13
No information	0	3	1	1	5
	23	37	24	12	96

SW

Length of migration:	Days at Sea.				
	1 – 30	31 – 180	181 – 360	360	Total
Short	1	1	0	1	3
Intermediate	2	2	1	1	6
Long	0	3	3	0	6
No information	1	1	1	1	4
	4	7	5'	3	19

Table 3.

Length group cm.	NW			C			NE		Sk.-K.			SW			SE		
	No. tag.	No. ret.	Ret. in %	No. tag.	No. ret.	Ret. in %	No. tag.	No. ret.	No. tag.	No. ret.	Ret. in %	No. tag.	No. ret.	Ret. in %	No. tag.	No. ret.	Ret. in %
0-43	474	29	6.1	37	1		17	0	77	15	19.5	92	6	6.2	24	0	
5-29	1033	44	4.3	120	1		114	0	273	38	13.9	366	10	2.7	105	1	
0-24	685	22	3.2	152	0		93	0	568	66	11.6	595	3	0.5	339	0	
5-19	87	0		66	0		66	0	891	58	6.5	327	0		168	0	
1-14	28	0		1	0		1	0	36	1	2.8	14	0		17	0	
Not measured	5	1					1	0	9	1		4	0				
Total	2312	96	4.2	376	2	0.5	292	0	1854	179	9.7	1398	19	1.4	653	1	0.2

Table 4.			Table 5.		

Number of returns per 30 days from tagging experiments in the NW area.

Number of returns per 14 days from tagging experiments in the Skagerrak-Kattegat area.

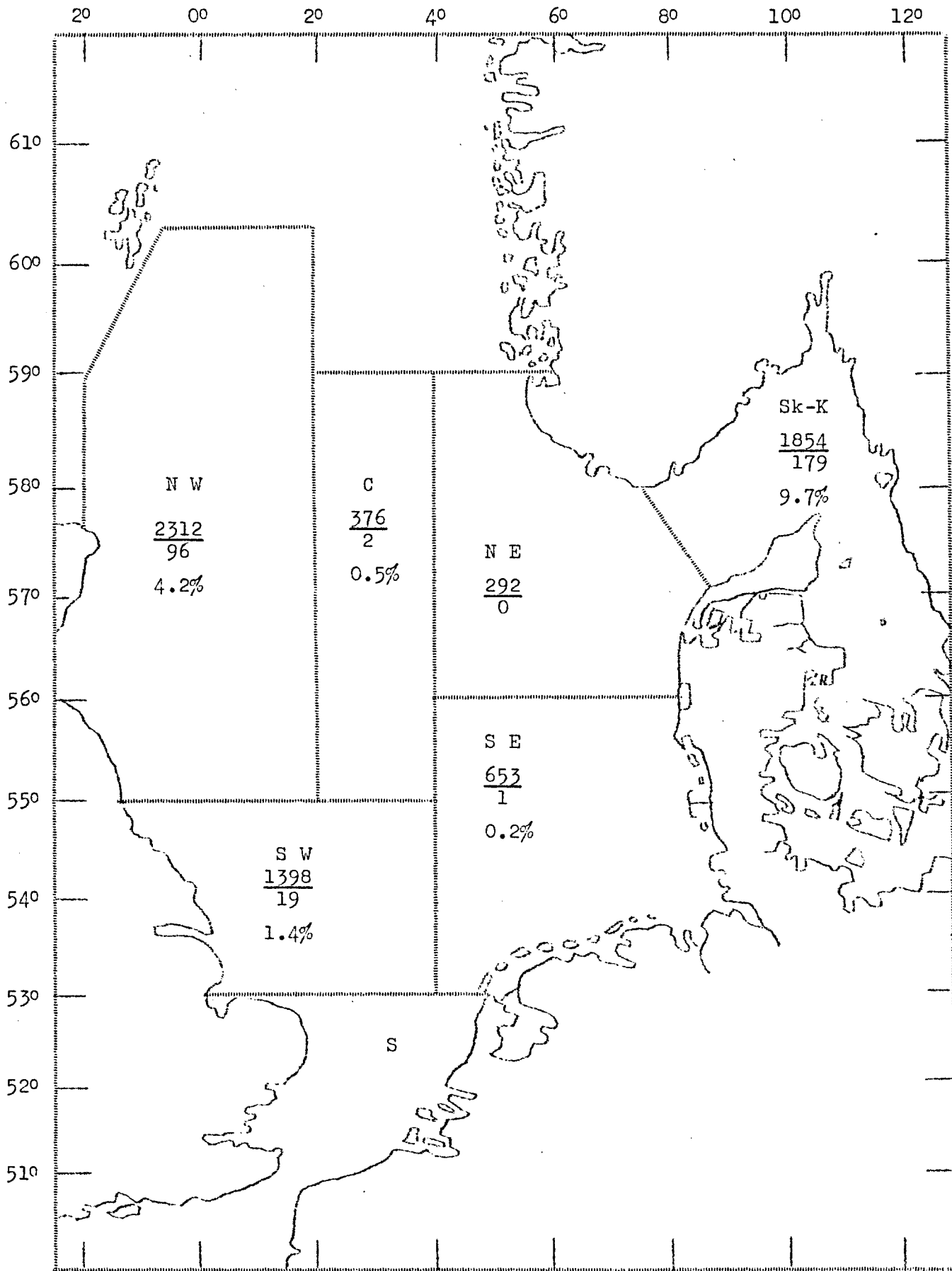| Days at sea	Total number of returns	Returns from fish 25-29 cm at tagging	Days at sea	Total number of returns	Returns from fish 25-29 cm at tagging
1 - 30	23	10	1 - 14	54	12
31 - 60	9	6	15 - 28	34	8
61 - 90	3	2	29 - 42	24	4
91 - 120	9	5	43 - 56	9	3
121 - 150	7	3	57 - 70	15	1
151 - 180	7	3	71 - 84	12	4
181 - 210	8	2	85 - 98	4	-
211 - 240	6	2	99 - 112	6	-
241 - 270	3	1	113 - 126	2	1
271 - 300	1	1	127 - 140	1	1
301 - 330	1	-	141 - 154	2	-
331 - 360	3	3	155 - 168	3	1
361 - 390	4	1	169 - 182	-	-
391 - 420	2	1	183 - 196	1	-
421 - 450	1	-	197 - 210	1	1
451 - 480	1	1	211 - 224	1	-
481 - 510	1	-		169	36
511 - 540	-	-			
541 - 570	1	-			
571 - 600	-	-			
601 - 630	-	-			
631 - 660	1	-			
	91	41			

Fig. 1.

Danish whiting tagging

1956 - 59

Number tagged (above)
and returns   (below)
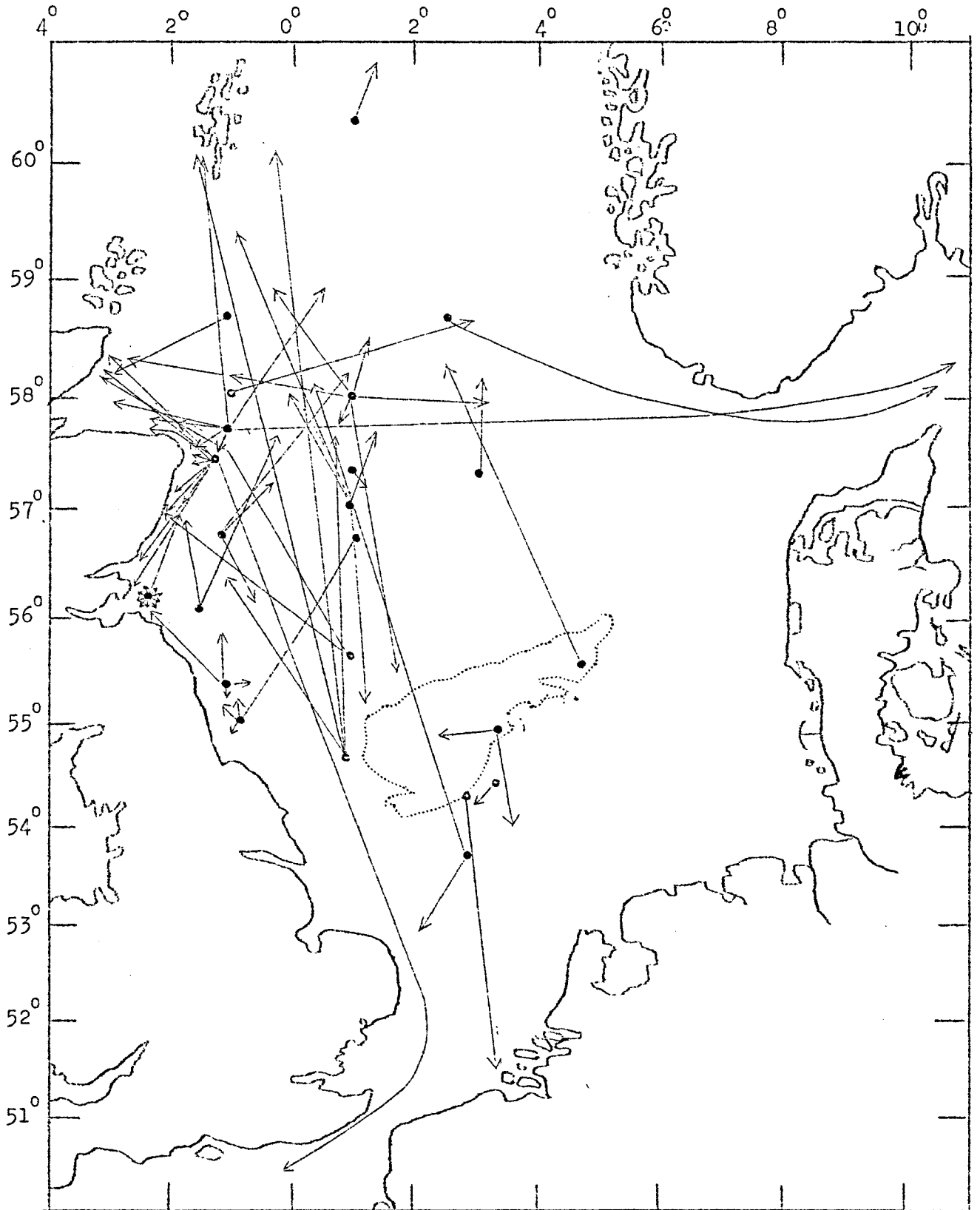
Returns in per cent.

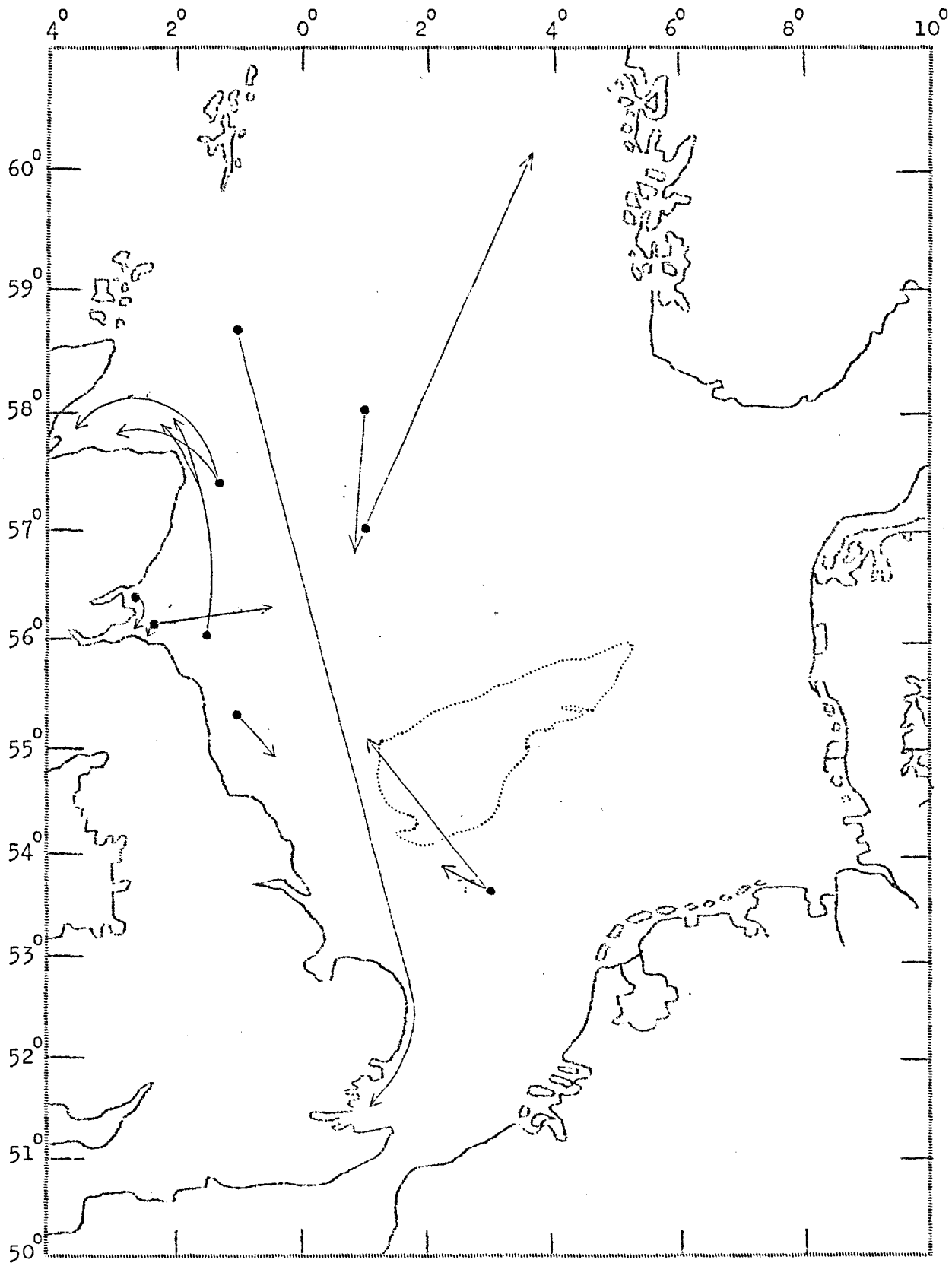Fig. 2.

Recaptures of whiting
after 31-360 days at sea.

Fig. 3.

Recaptures of whiting
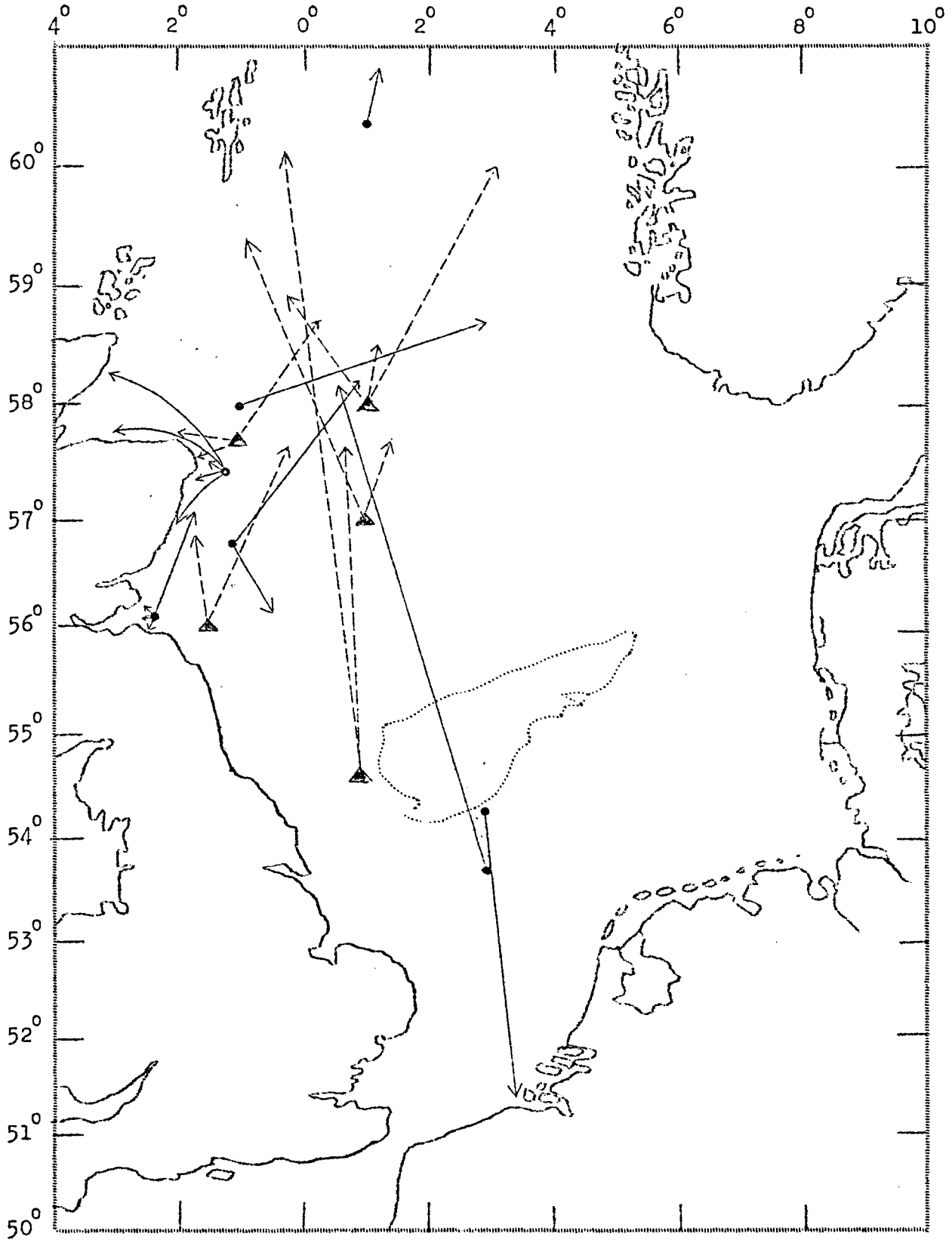after more than 360
days at sea.

Fig. 4.

Whiting $\geqq$ 26 cm tagged in autumn and recaptured later than
30 days after tagging but before the first of May next year.

● : Tagged in September.

▲ : " " November.

Fig. 5.

a.
NW area
Total number of recaptures

b.
NW area
Recaptures of whiting 25-29 cm at tagging

c.
Skagerrak-Kattegat
Total number of recaptures

d.
Skagerrak-Kattegat
Recaptures of whiting 25-29 cm
at tagging

log recaptures

time units

-12-