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IMMIGRATION AND EMIGRATION OF COD IN THE SPAWNING AREAS OF
LOFOTEN AND MØRE.

by

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ABSTRACT

Abundance estimates of the spawning stock of north-east Arctic cod have in recent years been given on the basis of acoustic surveys. Migration in and out of the surveyed areas during investigation has been considered as a possibly major source of error in the estimates. By studying the migration of tagged cod in the spawning grounds of Lofoten and Møre between 1975 and 1981, it was found that the main immigration to these spawning grounds is completed by March 20 and that considerable emigration starts around April 10. It is thus concluded that the most favourable time to estimate the spawning stock, when taking into account migration alone, is between these dates.

INTRODUCTION

Acoustic surveys of the spawning stock of north-east Arctic

cod based on acoustic survey results have been carried out in Lofoten and off Møre since 1982 (Godø et al 1982 and 1983). Migration in and out of the surveyed areas during the period of investigation, has been considered a possible major source of error in the estimates.

Migration of cod within the spawning area Lofoten during the spawning season has been previously studied by Dannevig(1955) using tagging experiment results. This method has also been used to map the migration of north-east Arctic cod between the feeding- and spawning grounds (Dannevig 1953, Trout 1957, Lebed, Ponomarenko and Yagarina 1983, Godø in press). This paper analyses the results from tagging experiments carried out in the period 1975 - 1981 to illustrate the time of migration in and out of the Lofoten and Møre spawning areas. On the basis of rates of recapture, the most favourable period for accurate acoustic surveillance of the cod is given.

MATERIAL AND METHODS

Cod were tagged during the spawning season(March-April) in the years 1975 - 1981. Further details are given in Table 1.

Purse seine was the gear of capture in all experiments in Lofoten as well as off Møre in 1981. In 1975, 1979 and 1980 the catching off Møre was mainly carried out with Danish seine. Some few were caught with gill net in 1975. The tagging was accomplished with hydrostatic Lea-tags attached anterior to the first dorsal fin. The locations for release were roughly the same in all years, and are indicated in Fig. 1. This figure also shows the statistical areas and locations according to which the recaptures were recorded. In this instance the Lofoten area includes area 00, and Møre includes both area 07 and northern portion of area 28.

Table 1. Numbers of tagged cod(N) released in the Lofoten and Møre spawning areas in the period 1975 - 1981.

	LOFOTEN		MØRE	
	N	Period of release	N	Period of release
1975	2800	March 6 - 26	220	March 11-April 15
1976	4000	March 10 - April 2	-	
1977	2000	March 14 - April 2	-	
1978	2500	April 1 - 7	-	
1979	2800	March 21 - April 5	350	March 13-April 10
1980	1500	March 21 - April 1	740	April 1-14
1981	3800	March 16 - April 9	2000	March 30-April 6

RESULTS AND DISCUSSIONS

Geographic distribution of recaptured cod

Figs. 2 and 3 present the geographic distribution of the total number of recaptures from all the Lofoten experiments during March - May of the tagging years and during the months January - April in subsequent years. Corresponding data from the Møre are shown in Fig.4 and 5. In both spawning areas the numbers of recaptures increased between January and March. During the years of tagging, the first recaptures outside the Lofoten and Møre areas were observed in April.

This indicate that data on the main migration periods around the spawning areas must be obtained from the recapture results in March and April.

Immigration

The following discussion is based on the assumption that variations in the number of recaptures per time unit are related to variations in the number of spawning cod in an

area. Thus the recapture rate becomes the number recaptured per day. The recapture results are summed up for all years in each area, and the moving five day means of the recapture rates are presented.

Figs. 6 and 7 present the recapture rates for March - April in the years subsequent to tagging for Lofoten and Møre respectively. The rate increased steadily, peaking on March 20 whereupon the rate decreased, although a clear second maximum occurred at the end of the month in the Lofoten area.

In Lofoten there was a steady increase in the recapture rate from the beginning of February while the main immigration off Møre seem to occur during a shorter time period in the middle of March.

Fig. 6 shows the combined recaptures for seven years of experimentation in Lofoten. The bimodal form of the graph may be due to changing catchability in connection with the maturation and spawning. The tagged cod represent the part of the stock which have spawned before. Rollefsen (1938) found that first time spawners reach the spawning grounds later than those having spawned before. The results thus indicate that the immigration of the multiple times spawners is going on at least till March 20, and according to Rollefsen (1938) probably first time spawners will still be arriving after that date.

The recapture rate off Møre in the years following the years of tagging (Fig. 7) decreased to a plateau during the first part of April and then decreased further around April 10. The pattern thus is quite similar to that observed in Lofoten except for the second peak.

Emigration

Figs. 8 and 9 show the recapture rate in April in the years of tagging for the Lofoten and the Møre experiments respectively. For Lofoten the results have been subdivided into an inner and outer locality (Fig. 8a and 8b). The inner locality is where most of the cod were released. A sharp

decrease of the recapture rate is observed in the inner locality from April 10 and onwards and from April 20 in the outer region. This seem to place the time of the main emigration from Lofoten at about April 10.

Comparing with Fig. 6, which indicates an decreasing concentration of tagged fish already in the beginning of April, there seem to be a contradiction. The maximum recapture rate rercorded around March 30 in Fig.6 may be due to an increase in the Danish seine catches which usually surges in the last part of that month. The lower and relatively stable recapture rate in the period April 1 - 10 is probably partly due to a decline in the fishing effort coinciding with the Easter holidays. In Figs. 8 and 9 this is followed by another drop corresponding with the decrease in Fig.6. This may be another indication for the main emigration out from Lofoten starting around April 10.

During the period of investigation the Danish seiner effort off Møre was negligible compared to other gear types. This may be the main explanation of differences in the Lofoten and the Møre recapture results in the years subsequent to tagging.

Table 2. Weely recaptures (summed) from area 05 during April of the years of tagging and during subsequent years. The Lofoten tagging experiments.

Date	Weekly recapture rate during tagging year	Weekly recapture rate during subsequent years
1-7.4	6	7
8-14.4	14	4
15-21.4	9	3
22-28.4	12	3
29-30.4	6	1

Table 2 show the weekly number of recaptures in April in area 05 in April. The recaptures outside Lofoten in April

were very few compared with those taken in the spawning area. As the distance between the spawning location and the main location of recapture in area 05 is short (Fig.4), the maximum recapture rate during the tagging year can be related to the main emigration from Lofoten. Recaptures rates from subsequent years are more difficult to interpret as it is impossible to know if a tagged cod is caught on its way out of or into the spawning grounds.

The results seem to indicate that there is a minor migration out of Lofoten during the first week of April, but the main emigration probably starts during the second week of April.

Fig.9 show a decline in the recapture rate off Møre during the tagging year around April 10 corresponding with observations made from Lofoten (Fig.8a). Main emigrations are therefore believed to occur simultaneously in both areas.

CONCLUSION

The main cod migrations in both Lofoten and Møre seem to occur during the same interval, with immigration taking place before March 20 and emigration taking place after April 10. To obtain the most reliable acoustic estimates of cod stock abundance (with respect to migration), survey cruises should be conducted between these dates.

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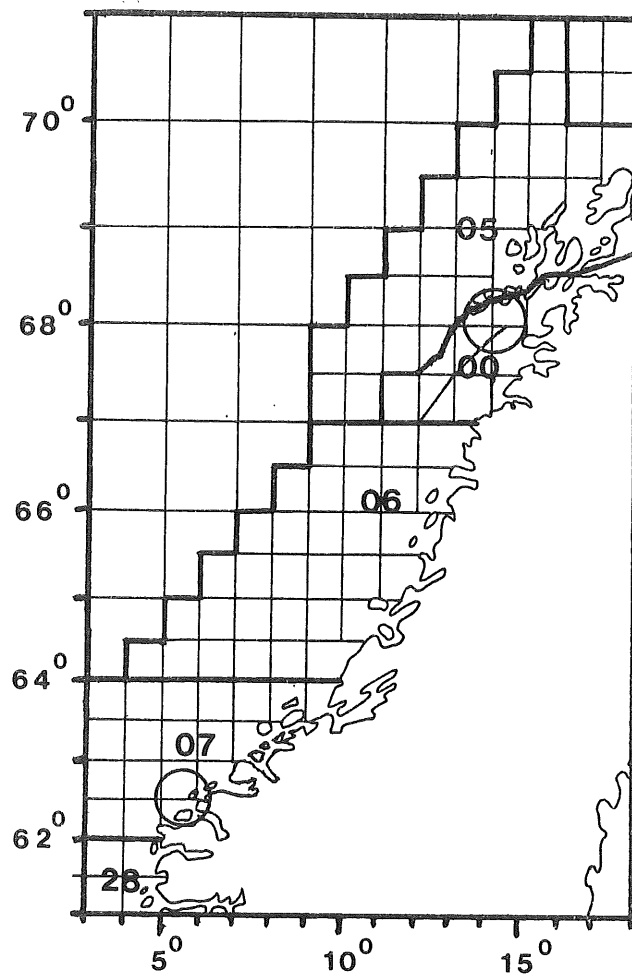


Fig.1. The area of investigation. The locations of release are encircled.

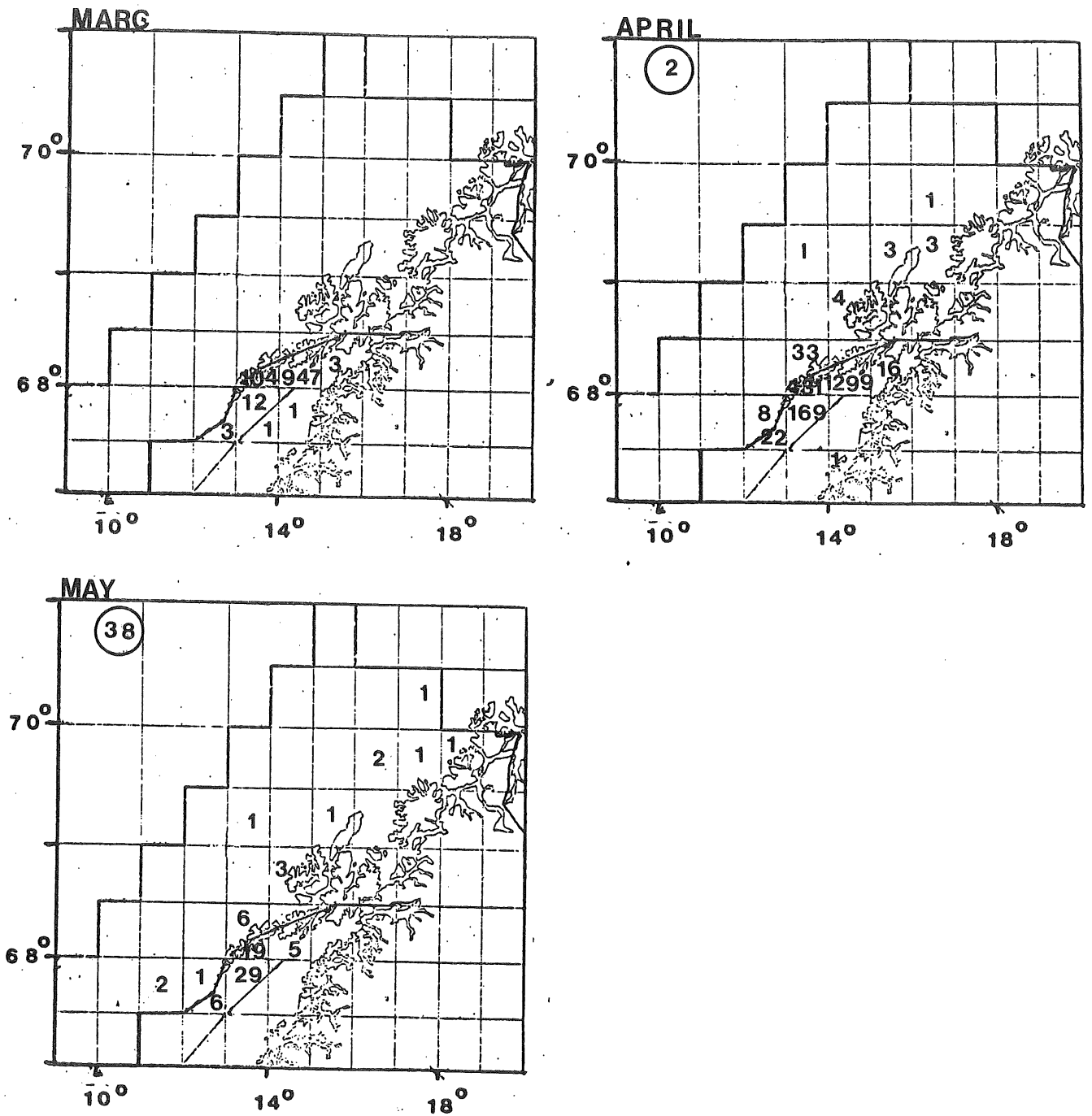


Fig. 2. The Lofoten experiments. Number of recaptures per statistical location during March, April and May in the years of tagging. Encircled figures indicate the number of recaptures taken north of area 05 (see Fig. 1).

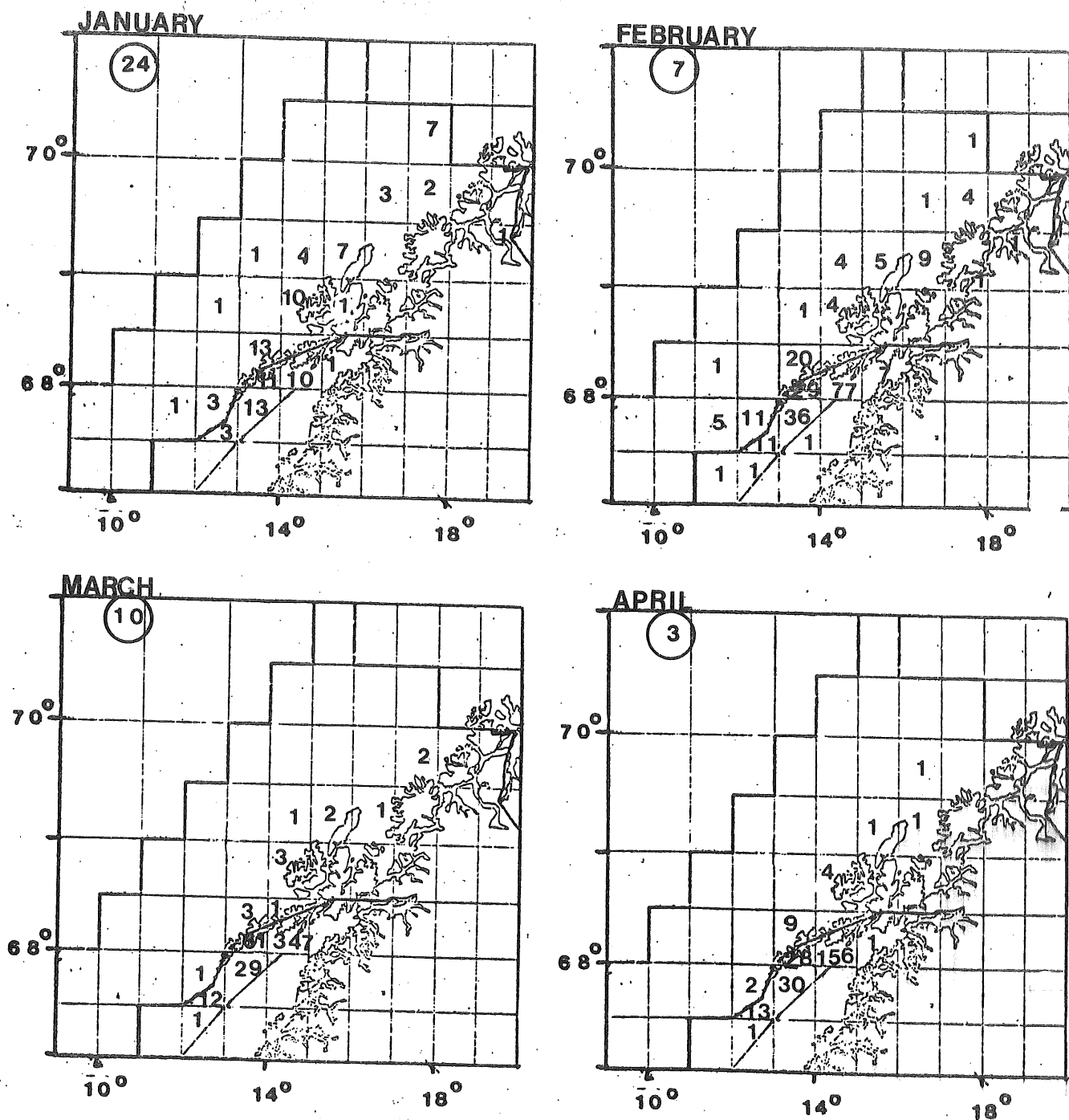


Fig. 3. The Lofoten experiments. Number of recaptures per statistical location during January - April in the years following the years of tagging. Encircled figures indicate the number of recaptures taken north of area 05 (see Fig. 1).

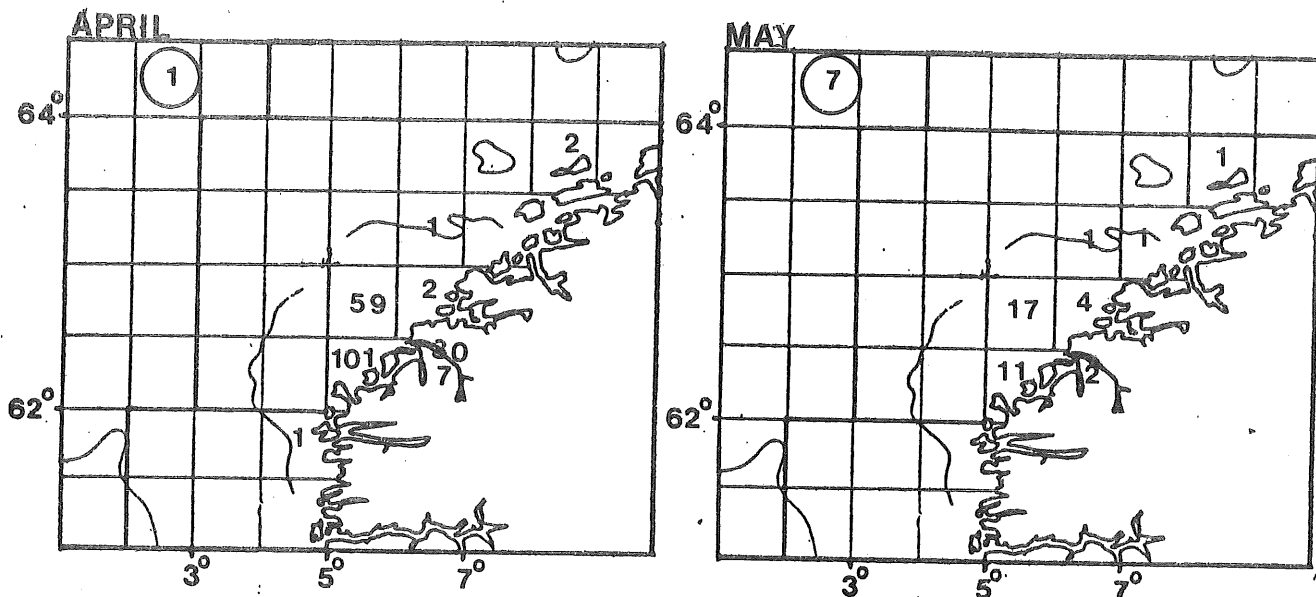


Fig. 4. The Møre experiments. Number of recaptures per statistical location during April and May in the years of tagging. Encircled figures indicate the number of recaptures taken north of area 07 (see Fig. 1).

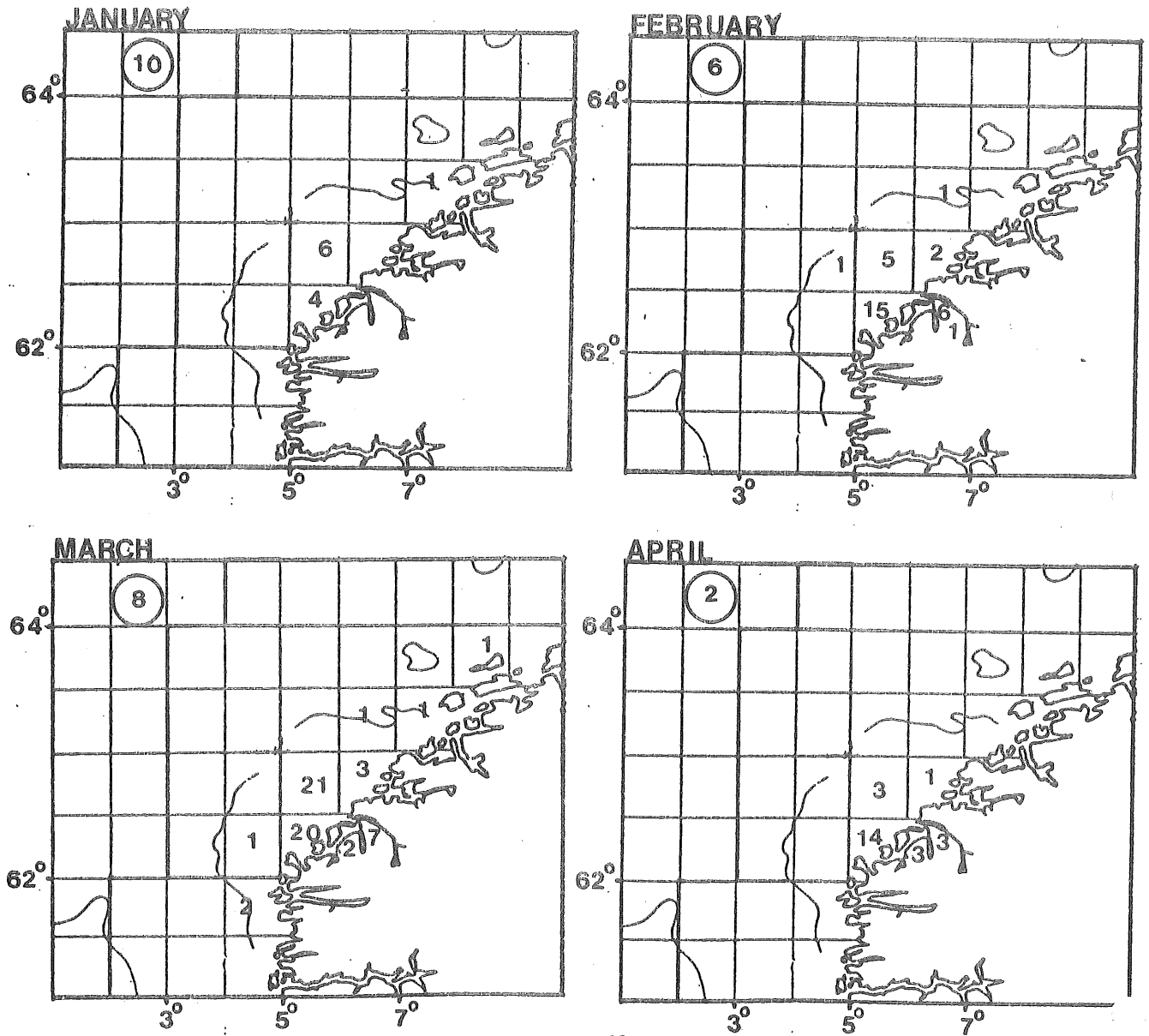


Fig. 5. The Møre experiments. Number of recaptures per statistical location during January - April in the years following of tagging. Encircled figures indicate the number of recaptures taken north of area 07 (see Fig. 1).

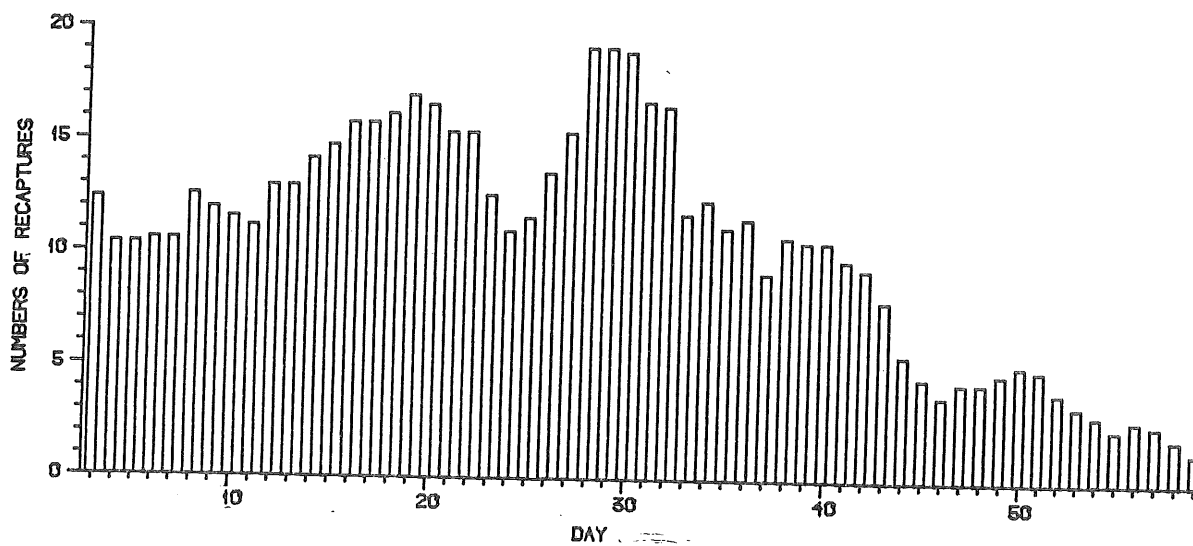


Fig. 6. The Lofoten experiments. Recaptures per day from Lofoten in March and April in the years following tagging.

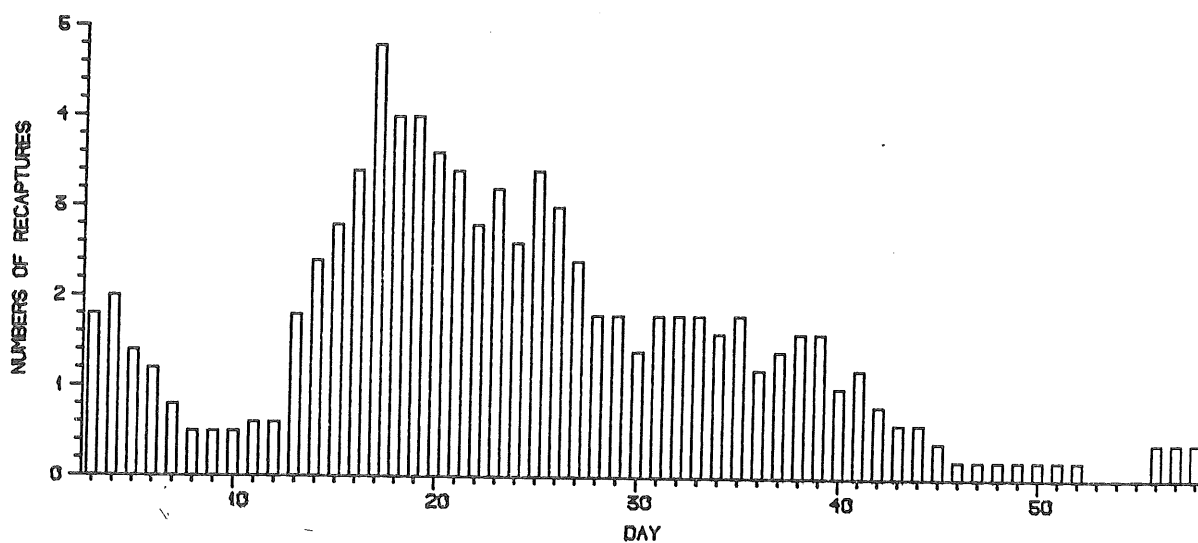
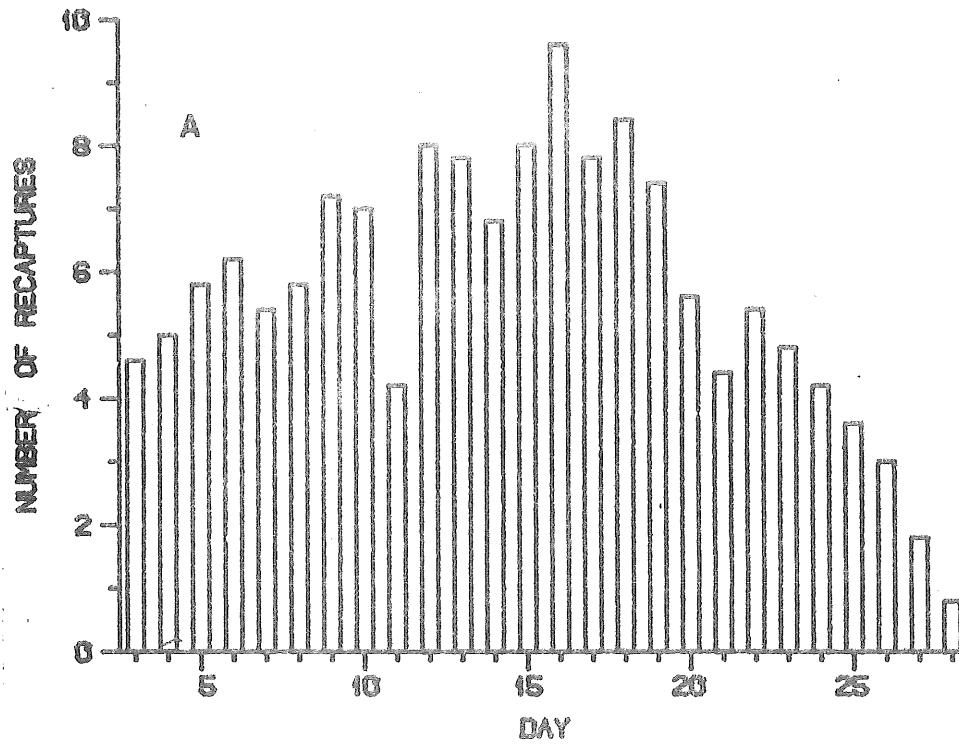


Fig. 7. The Møre experiments. Recaptures per day from the Møre coast in March and April in the years following tagging.



AREA 00046 APRIL YEAR OF TAGGING

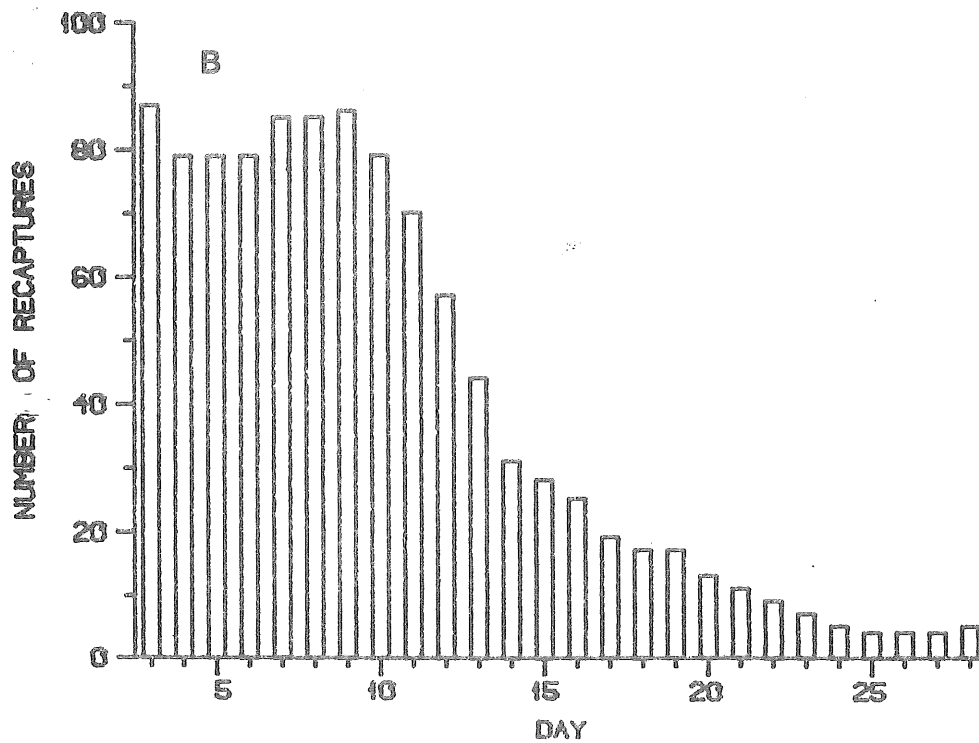


Fig. 8. The Lofoten experiments. Recaptures per day in April in the years of tagging. A) outer locality. B) inner locality.

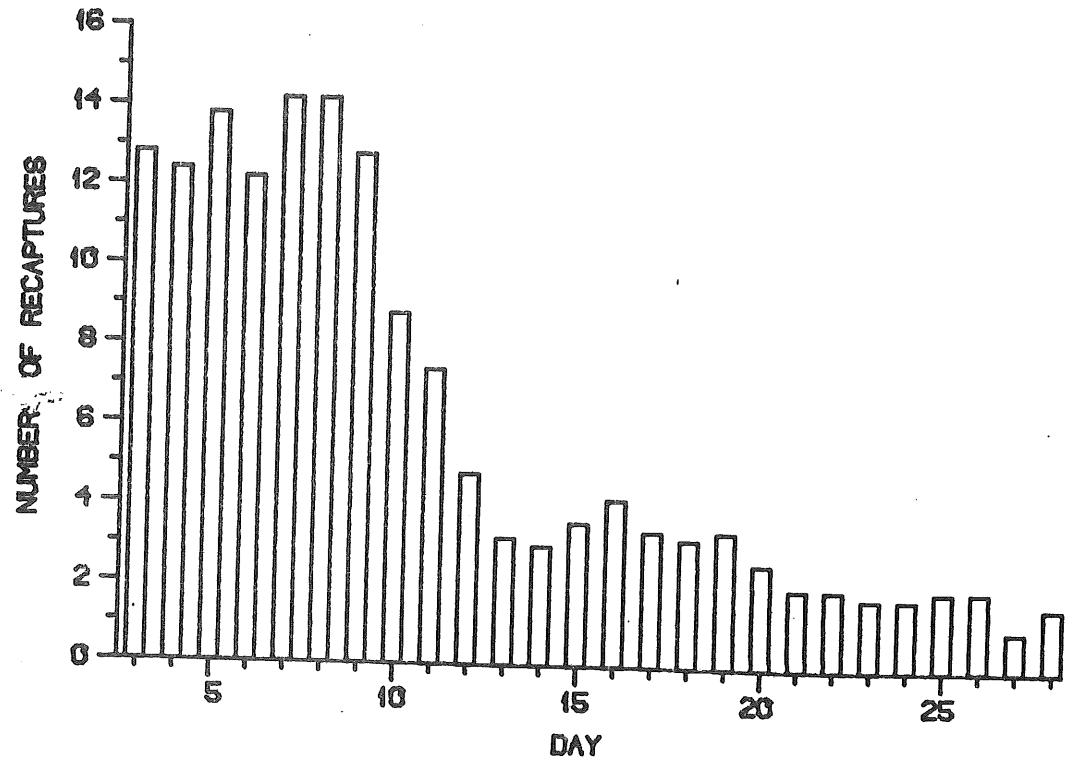


Fig. 9. The Møre experiments. Recaptures per day from the Møre coast in April in the years of tagging.

