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Results of the 1985 winter acoustic survey of NAFO Div. 4WX herring stock

by

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Abstract

An acoustic herring survey was carried out on the winter fishing grounds of the SW Nova Scotia herring stock. As in previous years, herring were found concentrated in a small area. Replicate surveys of the area of concentration during five nights showed biomass to vary by a factor of about three. Differences in length distributions of herring caught on different nights raise the possibility of a different population of herring moving into the area between Jan. 24 and 30. The maximum biomass recorded was 74% of that recorded in 1984.

Résumé

On a procédé à un relevé acoustique des lieux de pêche d'hiver des stocks de harengs dans le sud-ouest de la Nouvelle-Ecosse. Comme par les années passées, les harengs étaient concentrés à l'intérieur d'une zone restreinte. Des relevés répétées de la zone de concentration au cours de cinq nuits ont indiqué une variation de biomasse correspondant à un facteur d'environ trois. Les différences dans les répartitions selon la longueur des harengs pêchés au cours de différentes nuits permettent de supposer qu'une population différente de harengs a circulé dans la zone, entre le 24 et le 30 janvier. La biomasse maximale enregistrée correspondait à 74 % de celle enregistrée en 1984.

Introduction

During the last 14 yr, a winter herring fishery has been active in an area between Liscomb Island and Fourchu Head, N.S., to about 50 km offshore. This area is thought to be the wintering ground for the NAFO Div. 4WX herring stock. The weather in this area is often windy with hazzards from ice and freezing spray. The fishery is conducted by purse seiners sporadically in periods of good weather.

Acoustic surveys have been carried out in the area since 1981. The 1981 survey benefitted from a long stretch of good weather and was able to complete a set of randomized zig-zag cruise tracks. The results (Shotton and Randall 1982) reported that most of the herring were concentrated in one small area of about 30 km^2.

The 1982 survey attempted to cover the area with a systematic cruise track with the intent to locate smaller areas of fish concentration which would be surveyed in more detail. Unfortunately, this time, the weather did not cooperate. The boat was able to work only a few days in a month of bad weather, and no results were obtained.

The 1983 survey was done with a newly developed cruise track that allows the survey to stop during bad weather and restart in good weather with a minimum of steaming. The survey was completed but very few fish were recorded. During several nights, the survey passed through areas where seiners were searching but recorded no fish. The survey continued to other track segments while the seiners remained in their areas and some hours later made good catches. In all probability, the herring were in the areas while the survey passed but were not available for acoustic detection because, as the seiners say, "they were on the bottom." Such observations lead to the unavoidable conclusion that surveying along predetermined survey tracks is not a good way to study herring distribution and abundance. It may be not only a waste of time and effort, but may lead to wrong information and conclusions.

In 1984, the emphasis of the survey was changed from covering the whole area to studying, in detail, the areas where seiners were active. That year, the seiners were active inside Chedabucto Bay and the acoustic survey was able to quantify a concentration of herring that is the largest ever reported (Buerkle 1985a), and probably contained the major portion of the entire 4WX herring stock that was estimated, by SPA, to be 475,000 tonnes (Stephenson et al. 1985). As in 1981 and 1983, the rest of the survey area was virtually devoid of fish.

The 1985 acoustic survey was done from Jan. 19 to Feb. 19, with the same plan and emphasis as the 1984 survey.

Methods and Results

The acoustic instrumentation, calibration, data editing and processing have been described (Buerkle 1984, 1985a, b). The method of survey in 1985 was similar to that of 1984. First, series of transects were run in the areas of fish concentration as identified by seiners, to delimit the boundaries and estimate the size of the concentrations. This was repeated for a satisfactory number of replicate estimates or as long as the fish were accessible. Then, as time permited, the whole area of the historical winter fishery was searched.

The search pattern for 1985 is shown in Fig. 1. Except for minor variations, it was the same pattern as used in 1983 and 1984. The design is based on historical catch records. Total catch in tonnes over the last 14 yr is shown by 10-min square of latitude and longitude in Fig. 2. There are two centers of high catches, one off Canso and one off Country Harbour. The catches decrease with distance from these centers. The cruise track shown (Fig. 1) reflects the distribution of catches by allocating higher sampling effort to areas of higher catches. This optimizes the finding of fish concentrations, which is the aim of the track, but makes quantitative statistics difficult. The track has other advantages in that track segments can be run as weather permits, and that the two centers of the tracks are easily reached from anchorages at Port Hawkesbury, Canso or Country Harbour. This minimizes the amount of steaming necessary during breaks due to bad weather.

As in 1984, the seiners in 1985 were active along the south shore of Chedabucto Bay. The survey concentrated in this area but was interrupted by wind and ice conditions several times.

Fish were recorded during the first night of the survey (Jan. 19-20) but were too close to shore for effective survey. The successful nights of mapping fish concentrations were Jan. 23-24 and the four nights between Jan. 29 and Feb. 2. The survey tracks and fish distributions are shown in Fig. 3. During four of the five nights the fish were distributed in several smaller patches rather than in one large patch as they were in 1984. The exception was Jan. 30-31 when they were distributed in one continuous patch as in 1984. In general, the fish concentrations were not as stable in time and space as they were in 1984 and it was impossible to obtain two or more estimates of total biomass during one night.

Length and weight were measured on 254 herring caught in four midwater tows and one seine set. The two tows made on Jan. 24 caught larger fish than the two tows and the seine on Jan. 30 (Fig. 4). The mean length and standard deviation of the five samples are shown in Table 1. It is interesting to point out that the midwater trawl (Engel 400 mesh) and the seine (630 x 64 m) fished in the same area caught the same size distribution of herring (Fig. 4). Any selectivity of the gears would thus be the same for both gears. Since their method of operation, however, is so different it seems more likely that the gears are not selective for size.

The average length for all five samples was 29.5 cm. The length-weight relationship from all five samples was:

$$Wt_{kg} = 3.72\ L^{3.20} \times 10^{-6} ; \qquad r^2 = .99$$

The two tows on Jan. 24 were made within about 2 km of each other. One of the Jan. 30 tows was made in the same area. The different size distribution of the Jan. 30 sample indicates that different fish have moved into that particular area between Jan. 24 and 30. This likely means that there is patchiness of fish sizes within the greater area of concentration, and that has implications on target strengths and estimates of biomass. On the other hand, since the sizes in both samples of Jan. 24 are similar and the sizes of the three samples of Jan. 30 are similar, the difference in size distribution between Jan. 24 and 30 could possibly mean that a whole new population of fish has moved into the area. In either case, the need for more sampling in future surveys is indicated.

On Feb. 2, ice moved into Chedabucto Bay and no surveying could be done until Feb. 11, when the ice had cleared sufficiently to allow boat movements. By this time, the seiners had left the area for the season because further effort would not be cost effective. No herring were found in the areas of previous concentration and the search along the cruise track in the larger area was started. The entire track was covered between Feb. 11 and 19. Scattered fish schools were recorded in an area of about 940 km^2 (Fig. 5). The total cruise track steamed in the area was about 410 km. Fish were recorded for a total distance of about 44 km. The total acoustic scattering in the area was calculated as:

$$S\bar{a} \times 940 \text{ km}^2 \times \frac{44 \text{ km}}{410 \text{ km}}$$

where $S\bar{a}$ is the average area scattering coefficient of the 202 fish schools in the area weighted by school length. These fish were not sampled because the distribution in small patches near the bottom makes successful tows with midwater gear difficult and risky. Sampling with a bottom trawl would have required considerable time to switch gears and for a lengthy tow to ensure an adequate sample. The small biomass recorded did not warrant this effort.

A summary of survey results is shown in Table 2. In 1985 as in 1984, there was large variation in acoustic abundance from night to night. In both years, abundance varied by a factor of about 3.

The largest acoustic abundance in 1985 was recorded during the night of Jan. 31-Feb. 1, with total scattering of 52,495 $sr^{-1}m^2$.

After Feb. 2, no fish were found in Chedabucto Bay. Although the fish recorded between Feb. 11 and 19 in the offshore area were not identified as herring by sampling, they are thought to be the herring moving out of Chedabucto Bay towards the summer feeding grounds.

The problem of conversion of acoustic abundance estimates to biomass remains. For the 1984 survey, the Icelandic target strength length relation of Halldorsson (1983) seemed most appropriate. It resulted in a biomass estimate of about 550,000 tonnes. It appears, however, that the Icelanders themselves do not use this target strength; there seem to be questions about the depth term of the equation. The Icelanders use the target strength of

Halldorsson and Reynisson (1982) (Reynisson 1984, pers. comm.). The Halldorsson and Reynisson (1982) relationship applied to the 1984 length-weight data results in a target strength of -36.2 dB/kg and a biomass of 313,000 tonnes. The same relationship applied to the 1985 length-weight data results in a target strength of -36.3 dB/kg and a biomass of 232,000 tonnes. It is interesting to note that although the average length of the 1985 fish was 0.6 cm longer, the target strength was essentially the same as in 1984. The maximum biomass in 1985 was 74% of that in 1984.

A low estimate of biomass, to include the uncertainty about target strength, can be made by applying the highest target strength published in the 1984 ICES FAST Working Group Report; the result is 153,000 tonnes. A high estimate can be made by applying the lowest target strength published; the result is 444,000 tonnes. Considering this uncertainty, the 26% difference in biomass between 1984 and 1985 is insignificant.

The biggest problem in acoustic estimation of herring abundance is the availability of the fish for acoustic detection. The 1984, 1985 and 1986 (recently completed and not reported) surveys all show herring to be available in the winter fishing grounds. Replicate surveys in all 3 yr show acoustic abundance in the area to vary from night to night by a factor of up to 3.

It is unclear, at this time, how to interpret these results. If the variation between replicates was regarded simply as sampling error, the mean, for any one year, would estimate the quantity present. There is, however, good evidence that fish can be present in an area but can not be detected by the acoustic gear (Buerkle 1985a), and that the variation is due largely to variable availability of the fish for acoustic detection. The mean then includes low estimates because of undetected fish and is not a good estimate of the quantity present. A better estimate is the maximum quantity encountered at one time. Even during this time, however, there likely is some proportion of fish undetected. The maximum quantity encountered at one time during the year therefore is an estimate of the minimum quantity of fish that could have been present at that time.

This presents difficulties in relating the acoustic estimates to stock size. The maximum quantity detected may represent a different proportion of the quantity present from one year to the next, and the quantity present in the area may represent a different proportion of the stock from year to year.

These uncertainties shoud be addressed by extending the time series of acoustic data and studying trends in relation to stock estimates based on population analysis methods.

Acknowledgments

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		No.	Mean	SD
Half I. Cove	Jan. 24	182	30.46	2.34
Phillip Hbr.	Jan. 24	151	30.80	2.48
Off Huss Hd.	Jan. 30	213	28.84	4.02
3mi. off Fox I.*	Jan. 30	177	28.71	3.46
3mi. off Fox I.	Jan. 30	183	28.69	4.23

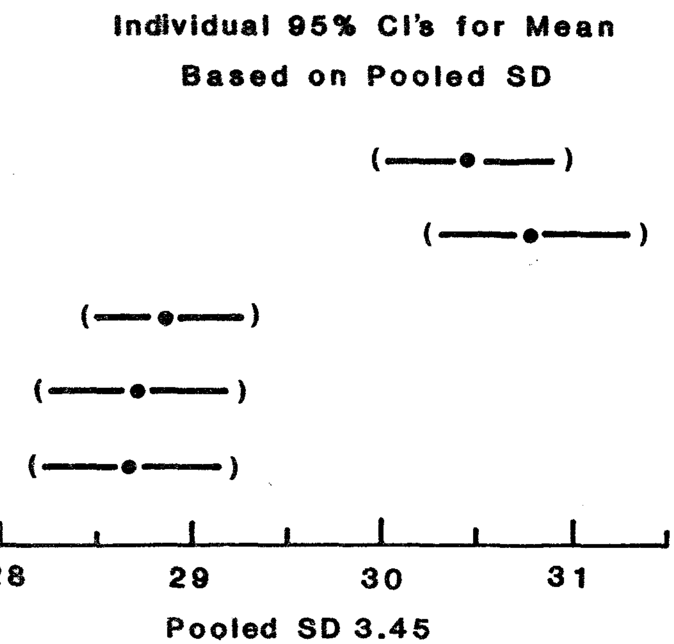

Table 1. Length statistics in four samples of herring taken by midwater trawl and one sample (*) taken from a purse seine catch.

Table 2. Summary of results of the 1985 winter acoustic herring survey.

Date	Samples	Area km^2	Average area scattering sr^{-1}	Standard error	Total scattering $sr^{-1} m^2$	Nightly total $sr^{-1} m^2$	Relative biomass
Jan. 24-Jan. 25	12	5.0	$.114 \times 10^{-2}$	$.252 \times 10^{-4}$	5723	37609	.72
	31	21.4	$.149 \times 10^{-2}$	$.384 \times 10^{-4}$	31886		
Jan. 29-Jan. 30	20	16.8	$.131 \times 10^{-2}$	$.281 \times 10^{-4}$	21909	35833	.68
	48	38.2	$.365 \times 10^{-3}$	$.104 \times 10^{-4}$	13924		
Jan. 30-Jan. 31	53	20.4	$.554 \times 10^{-3}$	$.174 \times 10^{-4}$	11322	11322	.22
Jan. 31-Feb. 1	15	20.1	$.950 \times 10^{-3}$	$.165 \times 10^{-4}$	19081	52495	1.00
	7	4.7	$.834 \times 10^{-3}$	$.501 \times 10^{-4}$	3905		
	6	2.3	$.663 \times 10^{-3}$	$.118 \times 10^{-4}$	1552		
	51	25.8	$.108 \times 10^{-2}$	$.736 \times 10^{-4}$	27956		
Feb. 1-Feb. 2	1	0.3	$.102 \times 10^{-3}$	$.683 \times 10^{-5}$	31	15543	.30
	15	15.7	$.417 \times 10^{-3}$	$.178 \times 10^{-4}$	6490		
	20	9.7	$.913 \times 10^{-3}$	$.509 \times 10^{-4}$	8869		
	3	0.4	$.122 \times 10^{-3}$	$.106 \times 10^{-4}$	54		
Feb. 12-Feb. 19	202	100.0*	$.122 \times 10^{-3}$	$.181 \times 10^{-4}$	12230	12230	.23

*Offshore area - refer to text for explanation.

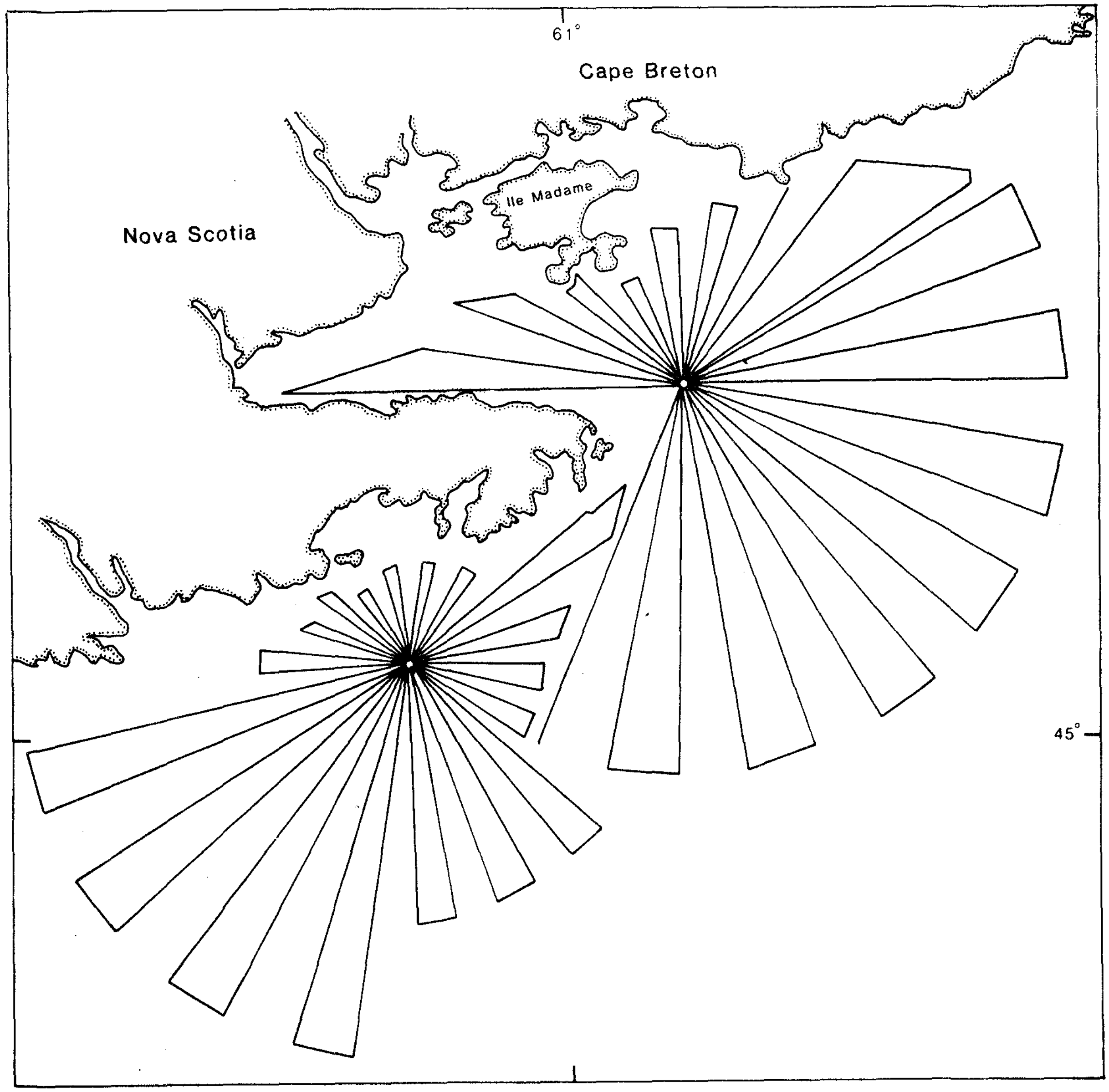

Fig. 1. 1985 acoustic herring survey cruise track for searching the whole area of the winter purse seine fishery.

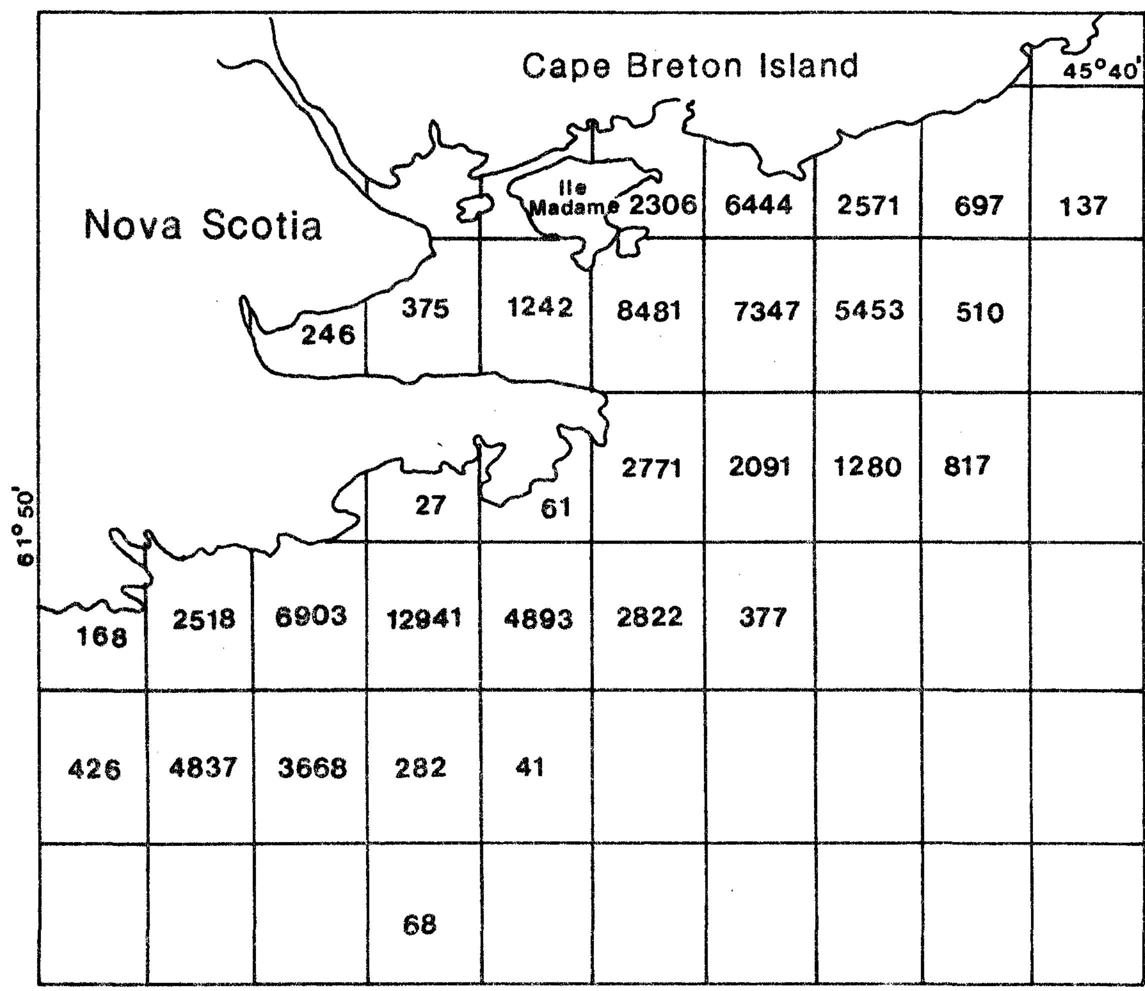

Fig. 2. Total herring catches (tonnes) reported by 10-min square of latitude and longitude over the past 14 yr.

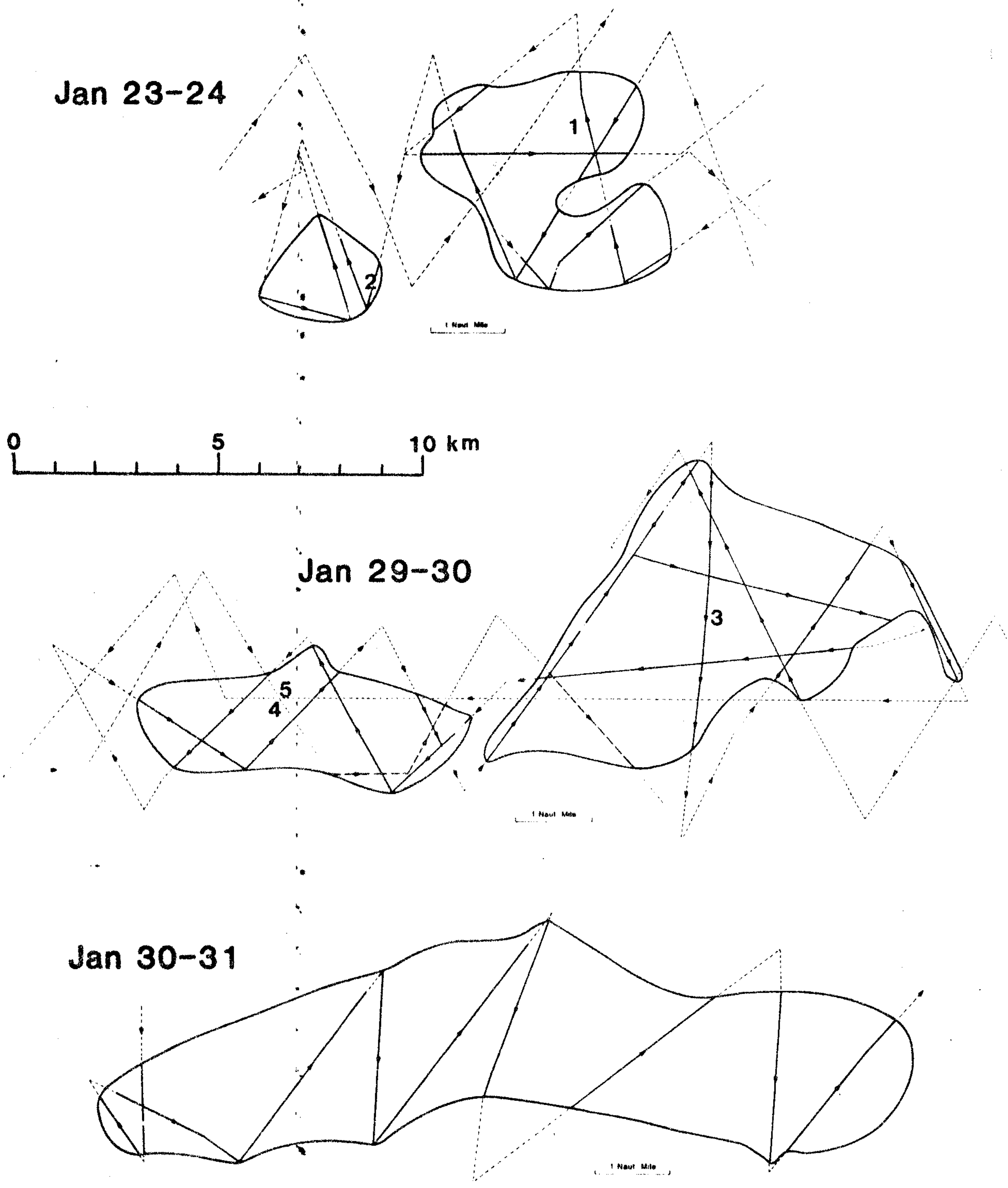

Fig. 3. Survey tracks and herring distribution during five nights detailed study in Chedabucto Bay. Numbers 1, 2, 3 and 5 indicate locations of midwater trawl tows, 4 indicates location of purse seine set.

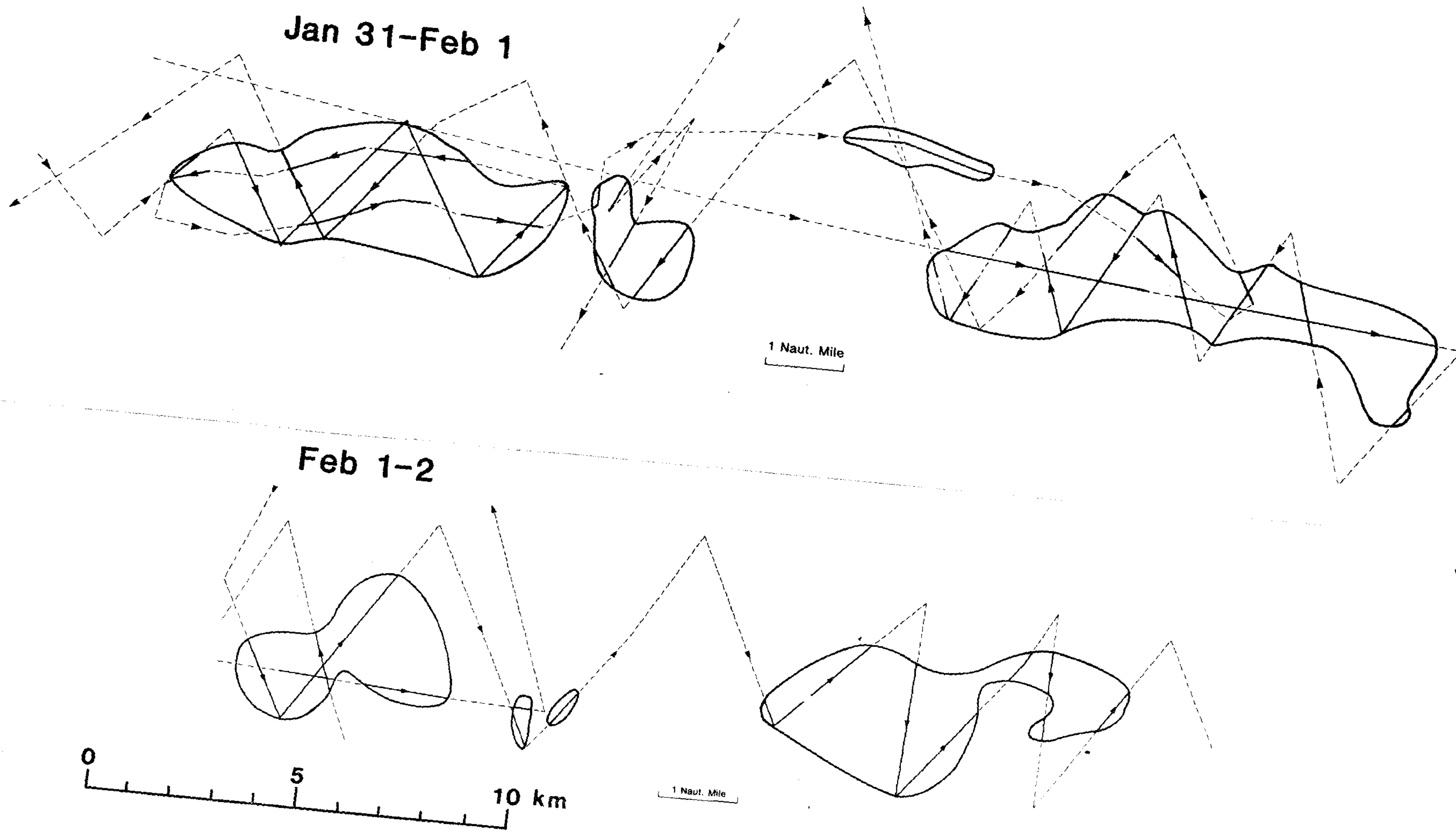

Fig. 3. (cont'd.)

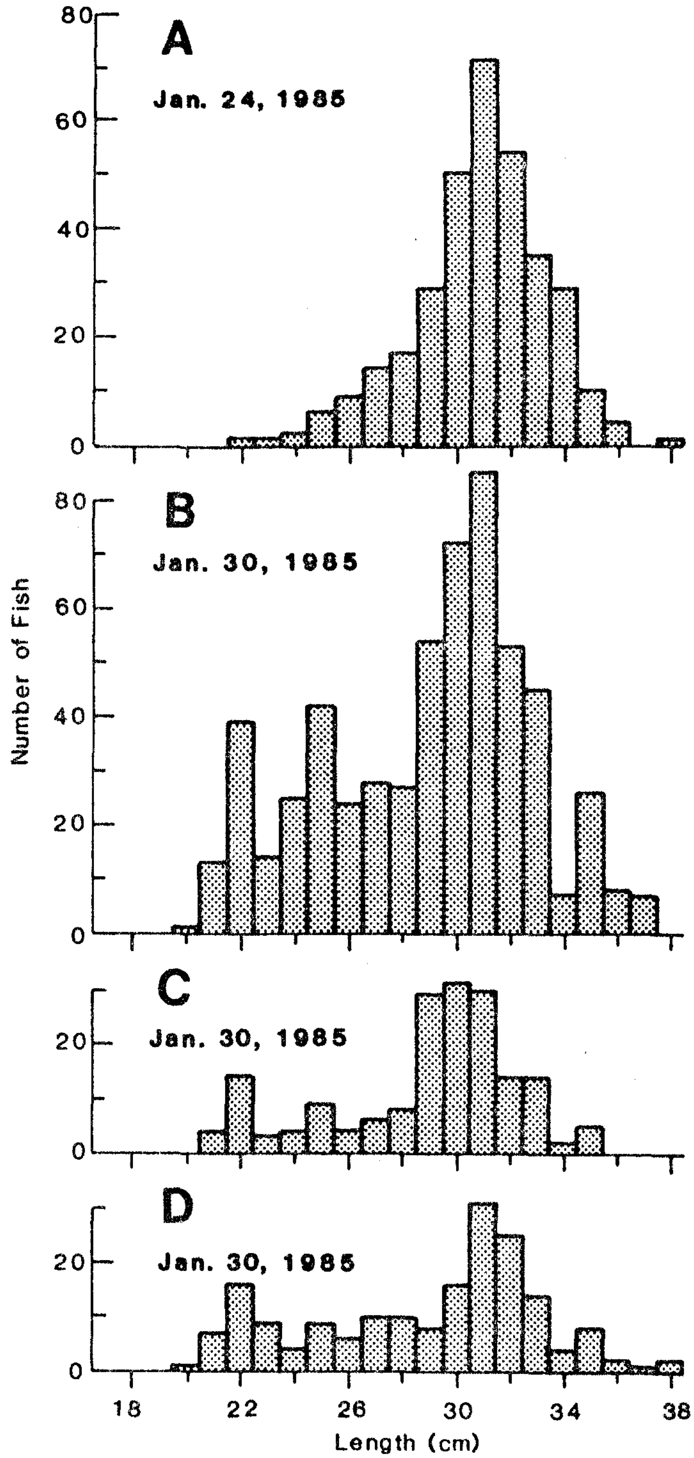

Fig. 4. Length-frequency distribution of herring samples from Jan. 24 (a) combined and from Jan. 30 (b) combined, and length-frequenices of a midwater trawl sample (c) and a purse seine sample (d) from the same area.

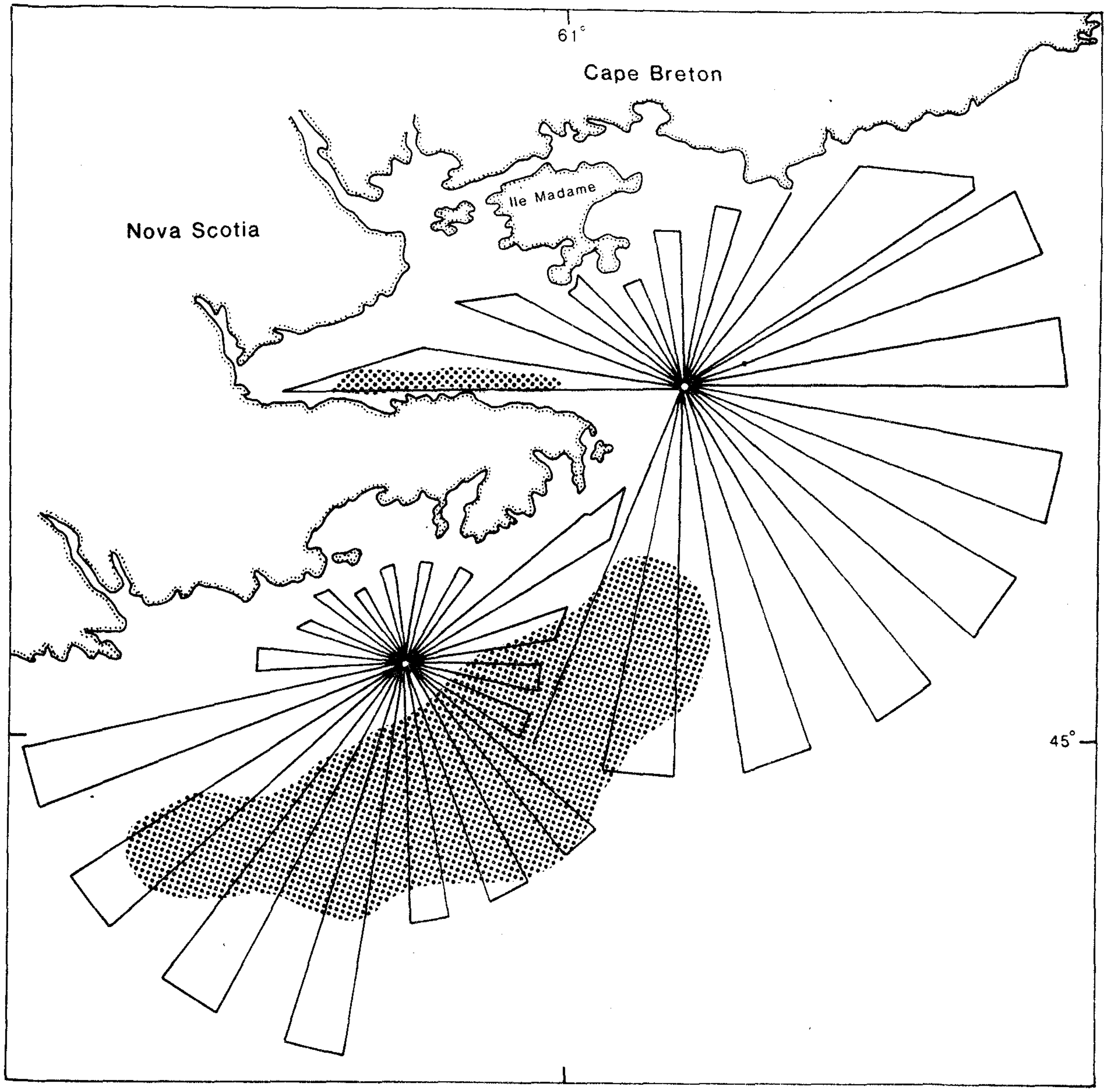

Fig. 5. Distribution of inshore and offshore fish schools.