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Some Characteristics of Winter Concentrations of Redfish in the Southern Gulf of St. Lawrence and Cabot Strait Areas

by

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Introduction

The speculation of seasonal migrations, concentrations and dispersal of redfish in the Gulf of St. Lawrence is long-standing. Research and commercial data have supplied some cursory information relative to these phenomena. Recent concern for the management of the Gulf redfish stock warrants at least a preliminary interpretation and assessment of such information. This paper examines the results of a vessel charter to the southern Gulf - Cabot Strait region in early 1977, reveals apparent trends evident from other research surveys and commercial fisheries in the area and generally introduces potential problems in redfish management.

Materials and Methods

Research

The M.V. Cape Hunter was chartered in January and February, 1977, to investigate the occurrence of heavy concentrations of redfish in the study area (Fig. 1). The purpose of the survey was to determine where, why and to what extent the concentrations occurred and whether the fish in question were from the Gulf or more southerly areas.

Initially, a search was conducted to locate the concentrations so heavily exploited by the commercial fishery over recent winters.

In addition, redfish samples were collected from fishing stations extending from the mid-Gulf region to the Rose Blanche - Burgeo Banks area (Fig. 1) as a means to determine stock identity from vertebral (Templeman and Pitt, 1961) and anal fin ray counts using x-rays. Subsequent cruises obtained extensive water temperature data using the expendable bathythermograph (XBT) in the areas of concentration, supplied additional samples for meristic study from mid-water trawled fish and attempted to gain some estimate of minimum biomass for bottom-trawled fish. Redfish length and sex data were collected from all fishing sets for each gear used and area surveyed.

Bottom sets were made using an Engel's high-lift, semi-pelagic trawl with a wing spread of 15 m (Carrothers and Foulkes, 1972) and a vertical opening of roughly 9 m. The midwater trawl was a Diamond XI with a wing spread of 23 m and a vertical opening of 16 m (information from National Sea Products Ltd., St. John's).

Meristic data were also collected from a research cruise of the A. T. Cameron to the St. Pierre Bank in April, 1977, and used as a comparison with those taken from the Gulf region.

Subsequent research cruises in the Gulf by the A. T. Cameron in September, 1977, and by the Gadus Atlantica in January, 1978, supplied additional information on redfish migration. Parity was established between effort and areas fished for the two vessels. Average catches in unit areas fished by both vessels were expressed as a percent of the total for each and compared as a crude indicator of migration.

Commercial

Length frequencies from the Gulf of St. Lawrence (ICNAF Divisions 4RST) and the southwest Newfoundland area (ICNAF Division 3Pn) were available from the years 1974 through 1977. Those available from the period of January to April were plotted to show any obvious trends and used as a comparison with the Cape Hunter data.

Results

Temperature Data

During the first cruise of the Cape Hunter two general areas of redfish concentrations were encountered (Fig. 2), one inside the Gulf off St. George's Bay and the other outside in the area off Rose Blanche and Burgeo Banks. Extensive water temperature data were obtained from both areas. Bottom temperatures are plotted in Figures 3 and 4. Most redfish catches were taken in bottom depths below 200 m, in temperatures of 5 to 5.5°C and do not coincide with the trough of 6° water around 160 and 180 m. Figure 5 shows temperature profiles in the positions of two of the largest midwater catches and the position of the net in relation to the bottom. One set was made in 6°C water, the other in 5°C.

Length Frequency Data

Commercial and research length frequency data (Fig. 6 and 7) show a definite trend in sex ratios. Invariably, data from Division 3Pn show that females constitute 60-70% of the catch. Conversely, those from Divisions 4RST show a similar predominance of males. The 1977 figure for the Gulf may be anomalous as it is based on only one length frequency from an area which is bordering both divisions. No 1978 commercial frequencies are available. A breakdown of these frequencies by midwater and bottom gear show the same phenomenon.

Meristic Data

No statistical analyses were applied to meristic data as individual and average vertebral and anal fin ray counts were sufficient to generalize the situation. X-ray counts from material collected in the areas of concentration are presented in Table 1 (a). All instances indicate average vertebral counts of 30 and fin ray counts of 8. The later cruise of the A.T. Cameron supplied data intended to distinguish the Gulf of St. Lawrence fish from those of St. Pierre Bank. Two of three sets showed fish with vertebral counts of 29 and anal fin ray counts of 7 (Table 1 (b)). The other resulted in counts of 30 and 8 respectively based on 33 fish which were similar to those encountered earlier in and near the Gulf. All three sets, when considering the individual fish, showed a greater mixing of meristic 'types' than those taken from the concentration area. These three sets were made at the southern tip of St. Pierre Bank, two in 345 and 410 metres and the set showing aberrant meristic counts in 560 metres.

Other Research Surveys

Catches from the A.T. Cameron and Gadus Atlantica are compared in Figure 8. The numerator represents the percent of the adjusted catch caught in that particular unit area by the A.T. Cameron in September, 1977. The denominator represents the percent caught during the January, 1978, cruise of the Gadus Atlantica. Although a crude measure of migration, a general shift to the south and east is evident.

Minimum Biomass Estimates

The calculated area covered by towing an Engel's trawl for one hour is 0.0288 square nautical miles. The total area surveyed in January and February, 1977, is approximately 2200 square nautical miles. The biomass estimate from bottom trawl data only for this area is roughly 30,000 metric tons (Table 2). The length frequencies from the charter (Fig. 7) show that most of this biomass is represented by commercial-size fish. The midwater net produced catches of commercial magnitude as far as 80 m from the bottom.

Discussion

Redfish Concentrations

The concept of winter concentration of redfish in this area has ample support of which recent commercial fishing practices are probably the most obvious. The by-catch of commercial-sized redfish in the northern Gulf shrimp fishery is increased in the later summer and fall months (Parsons, 1978) as the larger fish 'return'. The cruises of the *A.T. Cameron* and *Gadus Atlantica* indicate a movement out of the channels and a preference for the southwest Newfoundland area in winter months.

Temperature data do not elucidate the reasons for the concentrations, directly, as no correlation can be made between areas of highest density and an optimal temperature. Indirectly, however, it may be possible to account for at least part of the reason. Templeman (1959) suggests that in V-shaped channels, such as in the Gulf, fish can be concentrated on the bottom and the vertical distribution restricted as the deeper warm water layer becomes thinner towards the shallowing apex of the V. Decreasing water temperatures in winter may tend to drive the fish out of the channels to a more optimal area. This does not, on the other hand, account for the fact that juvenile redfish are found in the Esquiman Channel all year round. A study of temperature versus availability and distribution of food may produce some interesting results.

The extent of the concentrations is also a matter of some conjecture. The two areas determined in the study (Fig. 2) were designed to enclose areas of heaviest concentration for subsequent investigation. Indeed, commercial fishermen know the concentrations so well that they will fish along one Decca bearing which coincides with the maximum density and will not deviate from this unless the fish are scattered due to intensive fishing.

The estimate of biomass (30,000 m tons) only includes the volume swept by the bottom trawl. It has been pointed out that substantial catches were obtained with the midwater trawl in depths above nine times the vertical reach of the bottom gear. Without making an adjusted estimate of biomass from these facts, the potential for biomass in the area can be appreciated.

Stock/Species Identity

Results of the collected meristic data in the area initially indicated the concentrations to be typical of 'Gulf' redfish, i.e. 30 vertebrae and 8 anal fin rays. This evidence is reinforced by the reversal of sex ratios from commercial and research data and compatibility of modes in length frequencies from the two areas of concentration. This convenient observation is somewhat complicated by the results of meristic data from a later research cruise to the southern St. Pierre Bank. They were supposed to show that ICNAF Division 3P fish on average have 29 vertebrae and 7 anal fin rays which was the case in two of three sets. The other, deeper set, which produced fish with 'Gulf' characteristics,presented a distinct complication even though only 33 fish were examined.

Barsukov and Zakharov (1972) suggest that *Sebastes fasciatus* are found in shallower water than *S. mentella* and usually have 7 anal fin rays. The former also has a lower vertebral count (30) than the latter (31). Our results may reflect this situation to some extent except the vertebral counts are 29 and 30 instead of 30 and 31 but show the same pattern. Their results, however, exclude the Gulf of St. Lawrence and take into account a much broader area, possibly accounting for this difference. It should also be pointed out that the fish with lower anal fin ray and vertebral counts from the *A.T. Cameron* have a smaller average size than the others, and year-class differences may be functional in this case (Templeman and Pitt, 1961) and may also account for the deviation from Barsukov and Zakharov's data.

If there are two species, then Gulf fish and those at greater depths on St. Pierre Bank may be *S. mentella* while those at shallower depths on St. Pierre Bank may be *S. fasciatus*. The age structure from the two areas tends to support this observation (Fig. 9 and 10) and go as far to indicate that *S. mentella* in both areas may be from the same stock. In recent years, ageing of Divisions 3P and 4RST fish have shown similar dominant peaks representing the 1956 and 1958 year-classes. Division 3P has shown this to a lesser extent,possibly as a result of dilution of the dominant ages by catches of *S. fasciatus*.

Conclusion

There is an abvious need for immediate investigation into the redfish complex of these areas. Material presented here is cursory but present a real problem to redfish management. Collection of data on catch and effort for early months in the Divisions 3Pn-4RST interface may cause bias results as far as catch/effort data are concerned, especially in the former area. The total situation appears to be highly dynamic and optimal management strategies may be quite complex. On the other hand, it may be possible to treat the areas as a single stock.

Protection and assurance of spawning stock is a high-priority objective. As yet, no stock/recruitment relationships have been demonstrated for Divisions 3P or 4RST redfish. These results show, however, that large concentrations of females occur from year to year in the area of Rose Blanche and Burgeo Banks. If fishing is permitted during the early months of the year when catch rates are unusually high, as prudent predators we should direct effort at that part of the concentration with a predominance of males to ensure against a disproportionate removal of females.

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Templeman, W. 1959. Redfish distribution in the North Atlantic. Fish. Res. Bd. Canada Bull. No. 120, 173 pp.

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Table 1. Average vertebral and anal fin ray counts.

(a) - Cape Hunter

	MALES				FEMALES			
	No.	Av. Length (cm)	Av. # Anal Fin Rays	Av. # Verte-brae	No.	Av. Length (cm)	Av. # Anal Fin Rays	Av. # Verte-brae
Northern Area								
Bottom Trawl	149	32.5	8.25	30.08	128	35.5	8.21	29.98
Midwater Trawl	165	32.5	8.28	30.05	133	35.5	8.23	30.07
Southern Area								
Bottom Trawl	160	32.5	8.24	29.96	231	35.5	8.33	30.00
Midwater Trawl	54	32.5	8.20	30.11	45	35.5	8.40	30.13

(b) - A.T. Cameron

	No.	Av. Length (cm)	Av. # Anal Fin Rays	Av. # Verte-brae	No.	Av. Length (cm)	Av. # Anal Fin Rays	Av. # Verte-brae
St. Pierre Bank								
Bottom Trawl 1)	61	26.0	7.16	29.21	38	28.5	7.34	29.15
2)	12	33.0	8.42	29.92	21	37.5	8.48	30.10
3)	20	27.0	7.30	29.25	47	30.0	7.32	29.35

Table 2. - Cape Hunter - Biomass Estimates.

	No. ('000's)	Wt. (M. tons)
Total	46,308	28,521
Upper limit	84,805	58,192
Lower limit	7,811	-1,150

Standard Tow = 1.8 nautical miles

Wingspread = 15 m.

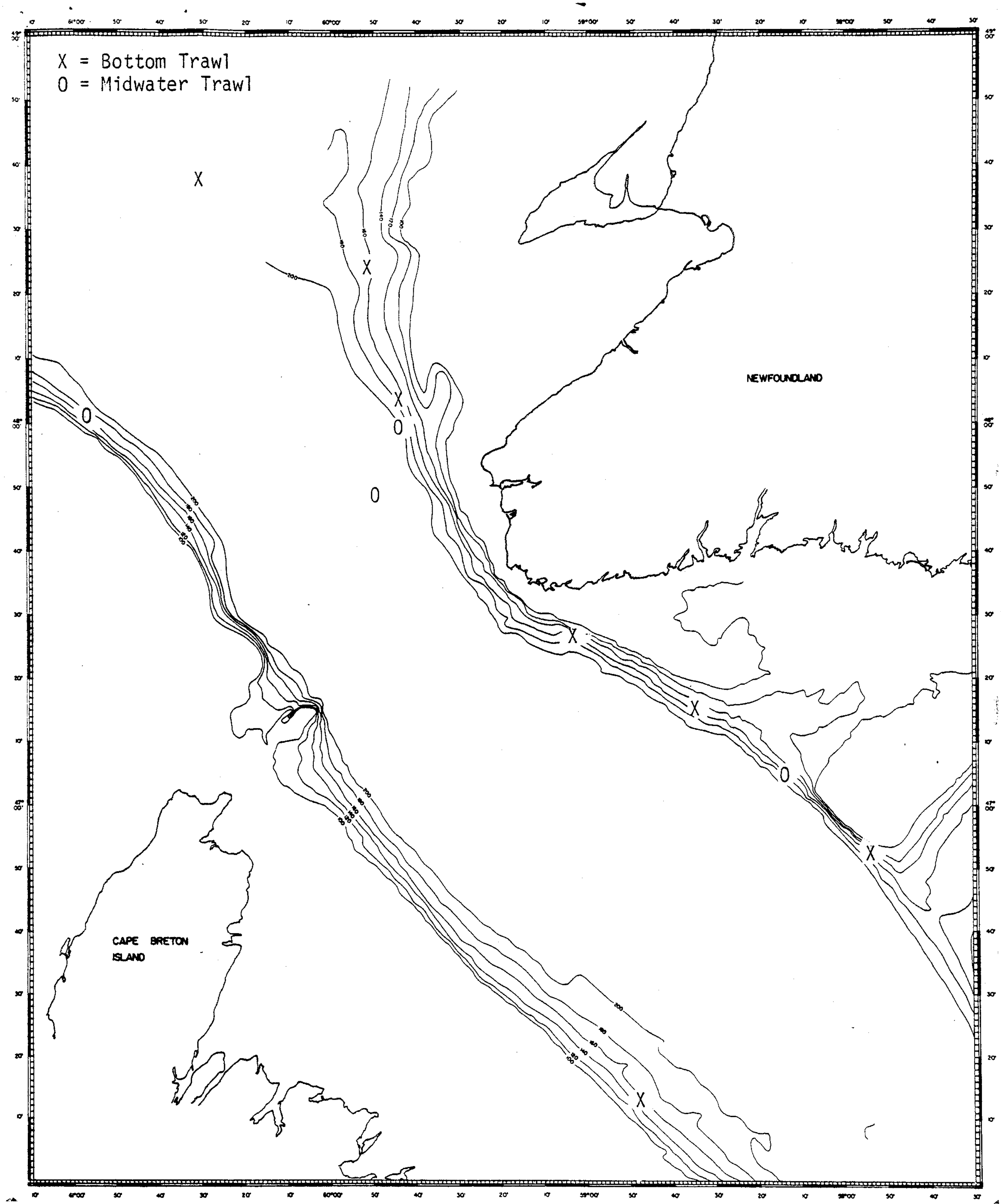


Fig. 1. Survey area and positions of sets from which meristic data were collected.

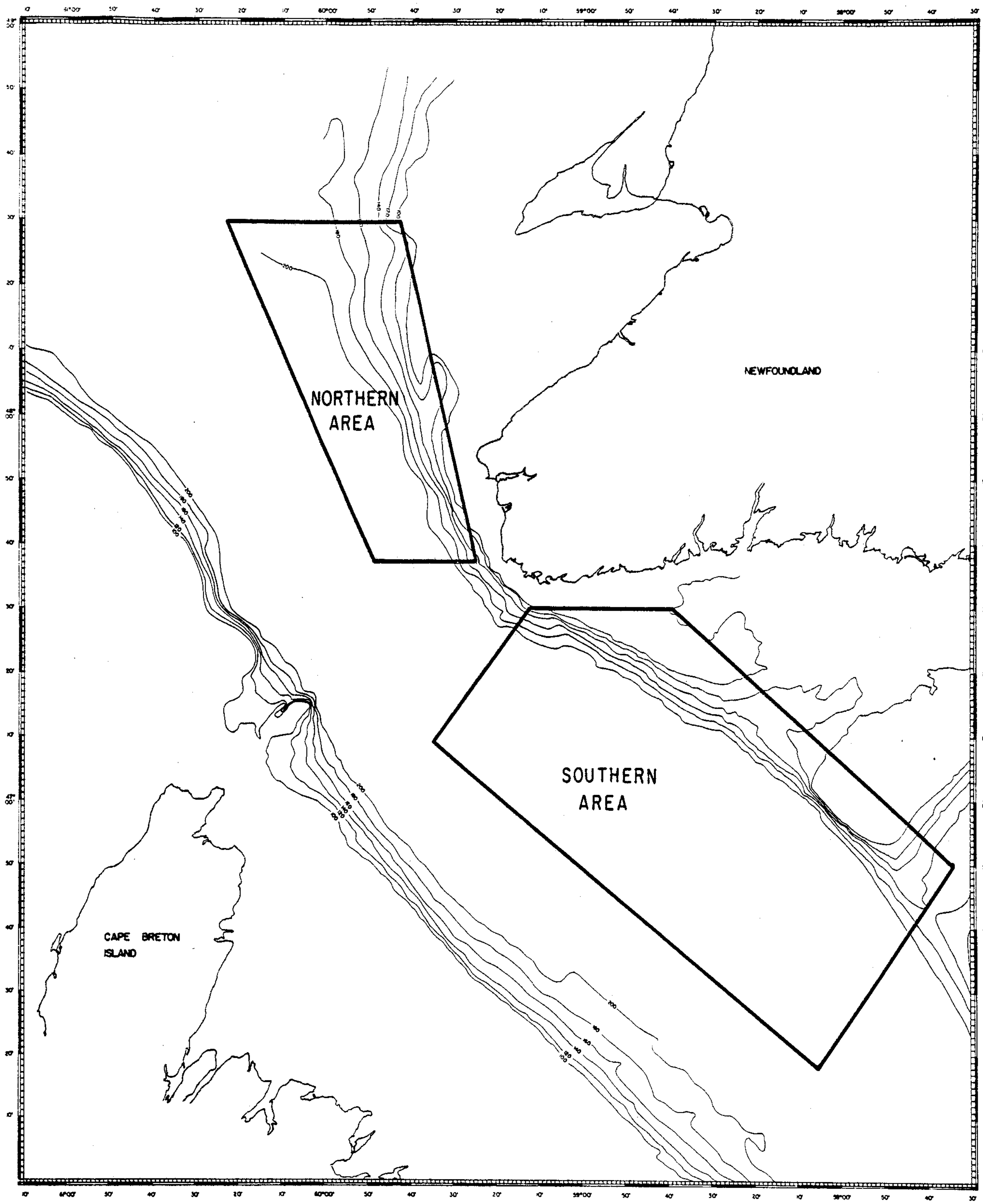


Fig. 2. General areas of redfish concentrations in winter.

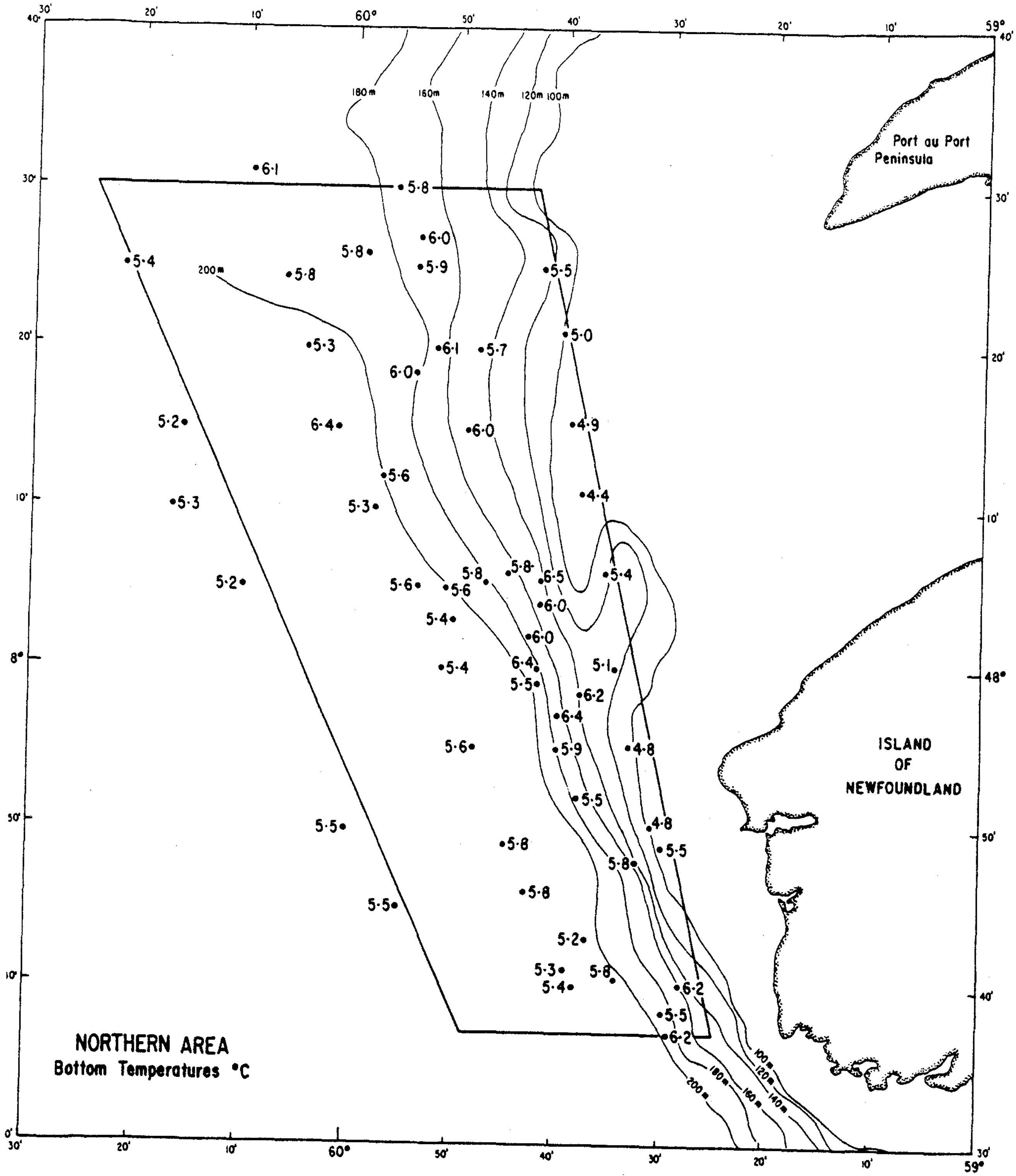


Fig. 3. Thermograph stations indicated by bottom temperatures taken by XBT - Northern Area.

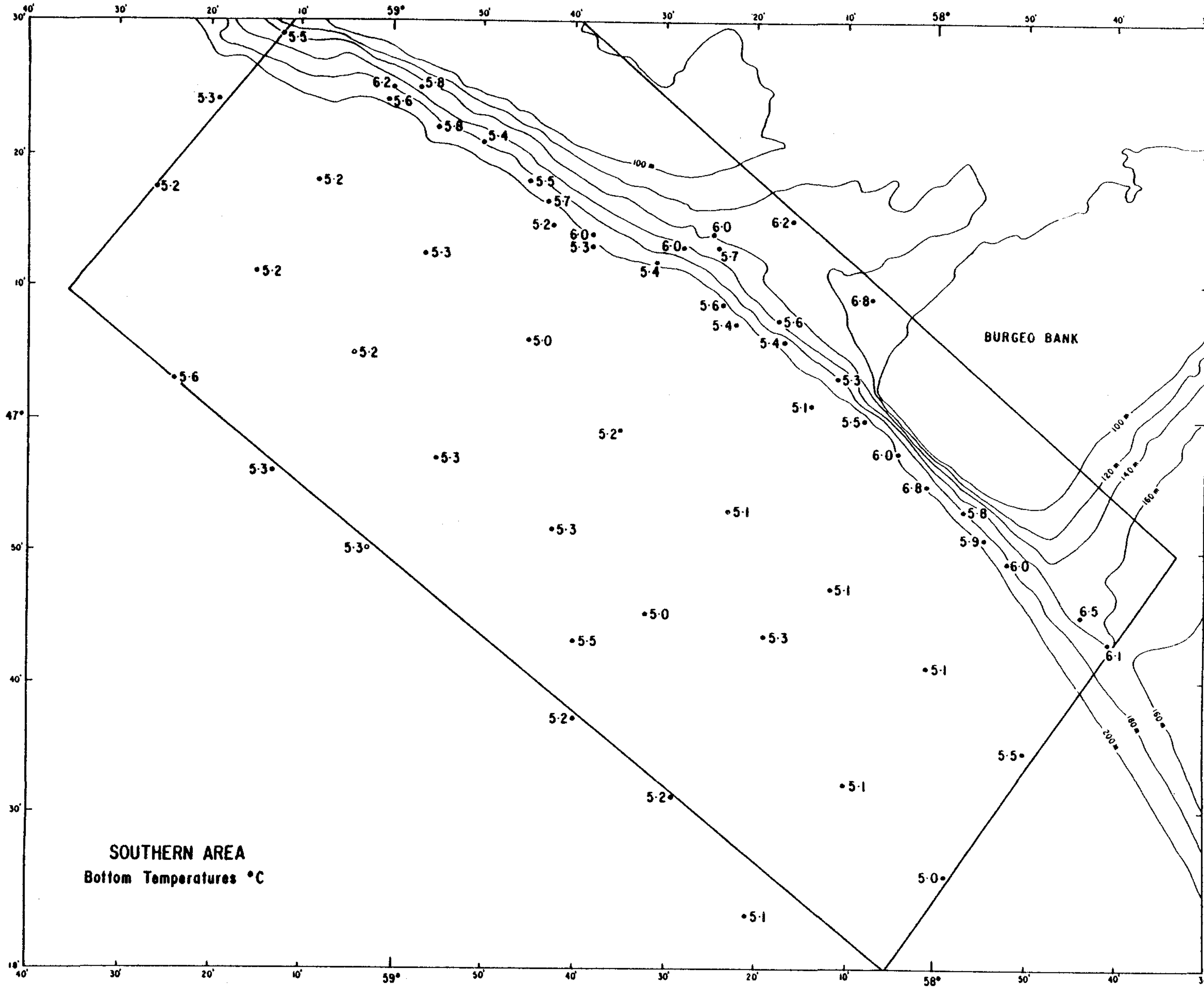
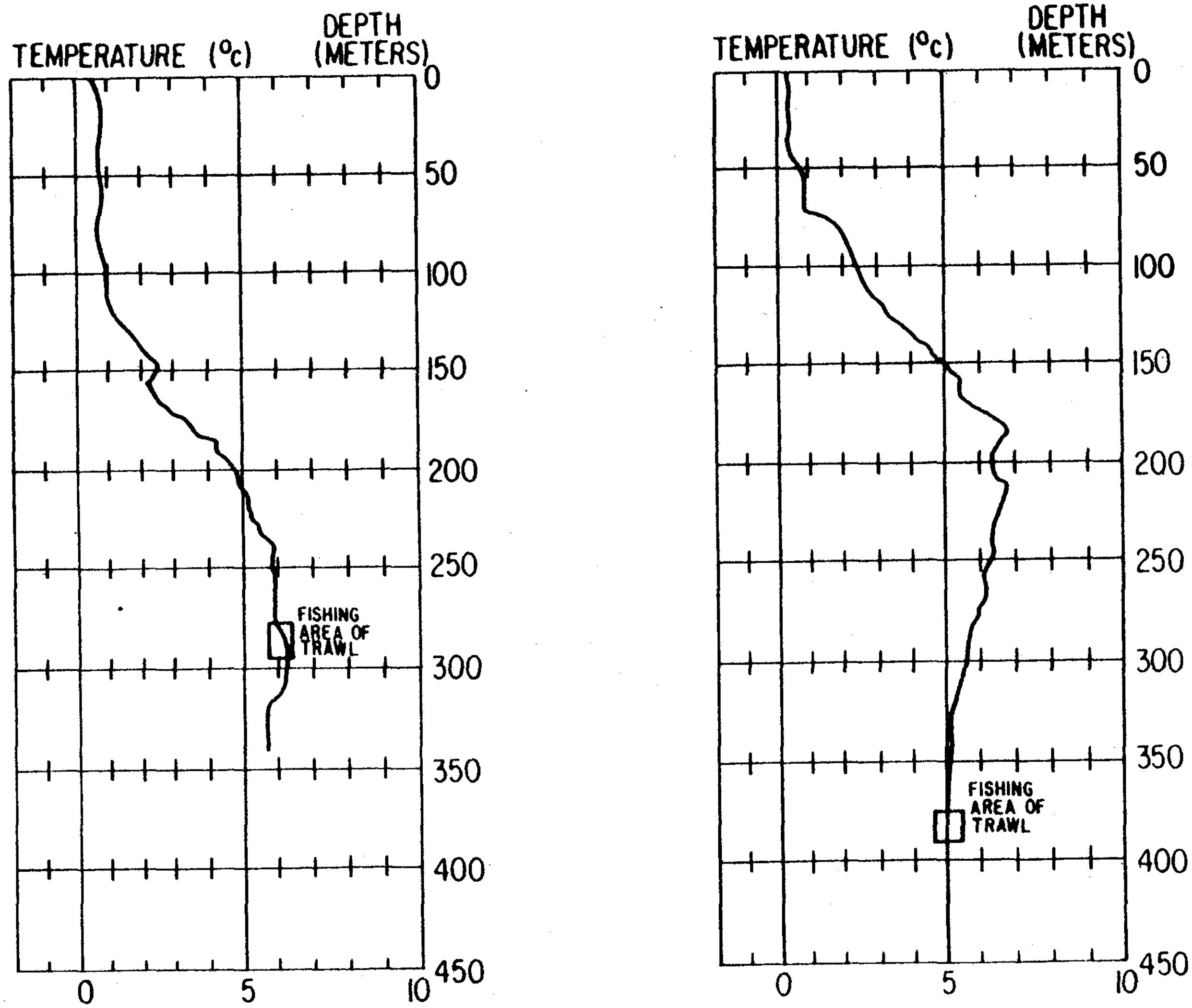


Fig. 4. Thermograph stations indicated by bottom temperatures taken by XBT - Southern Area.



Set # 15 - Inside
60,000 lbs M.W.T.

Set # 27 - Outside
30,000 lbs M.W.T.

Fig. 5. Temperature profiles from two of the largest catches using midwater gear.

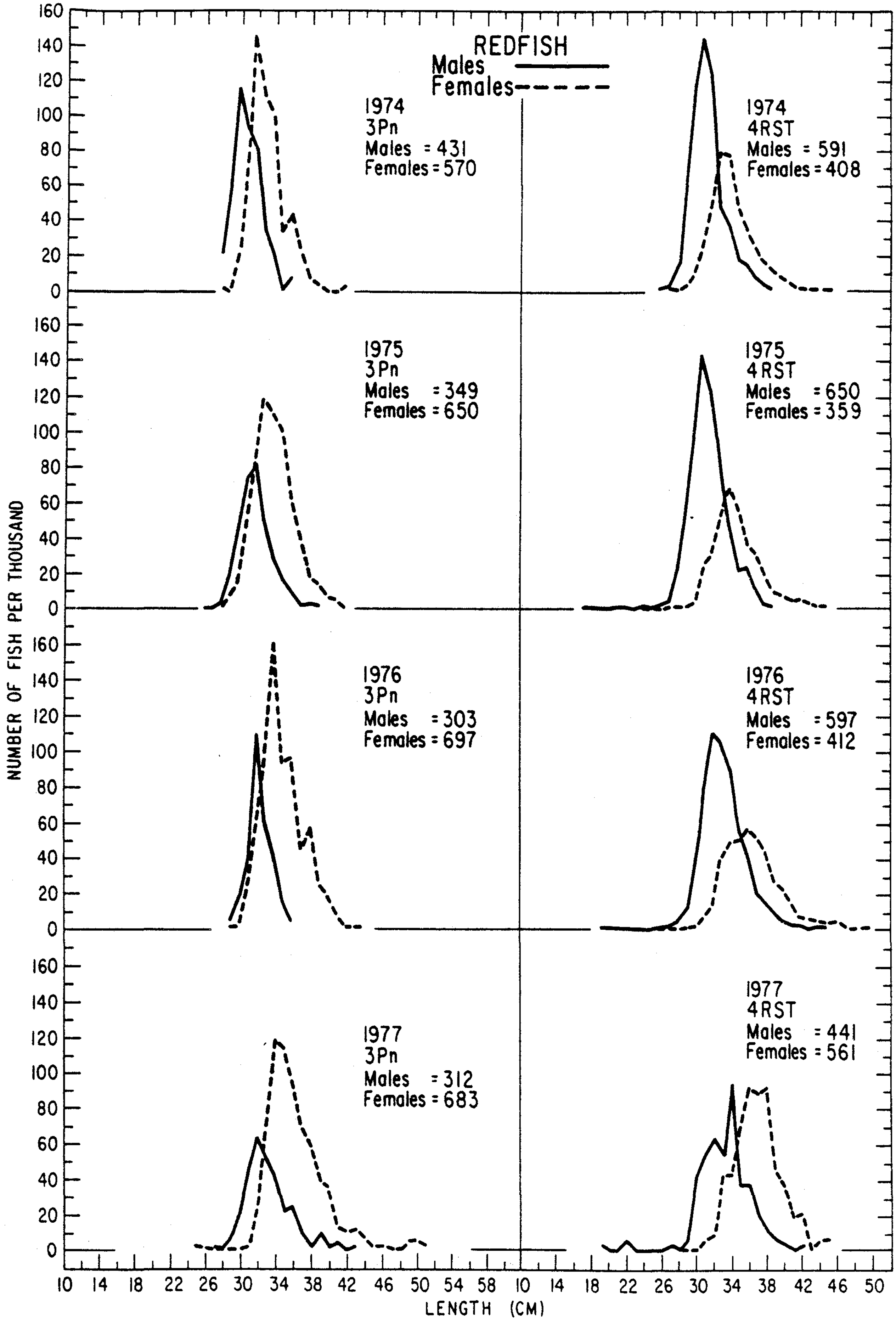


Fig. 6. Commercial length frequencies 1974-77, Jan. - Apr.

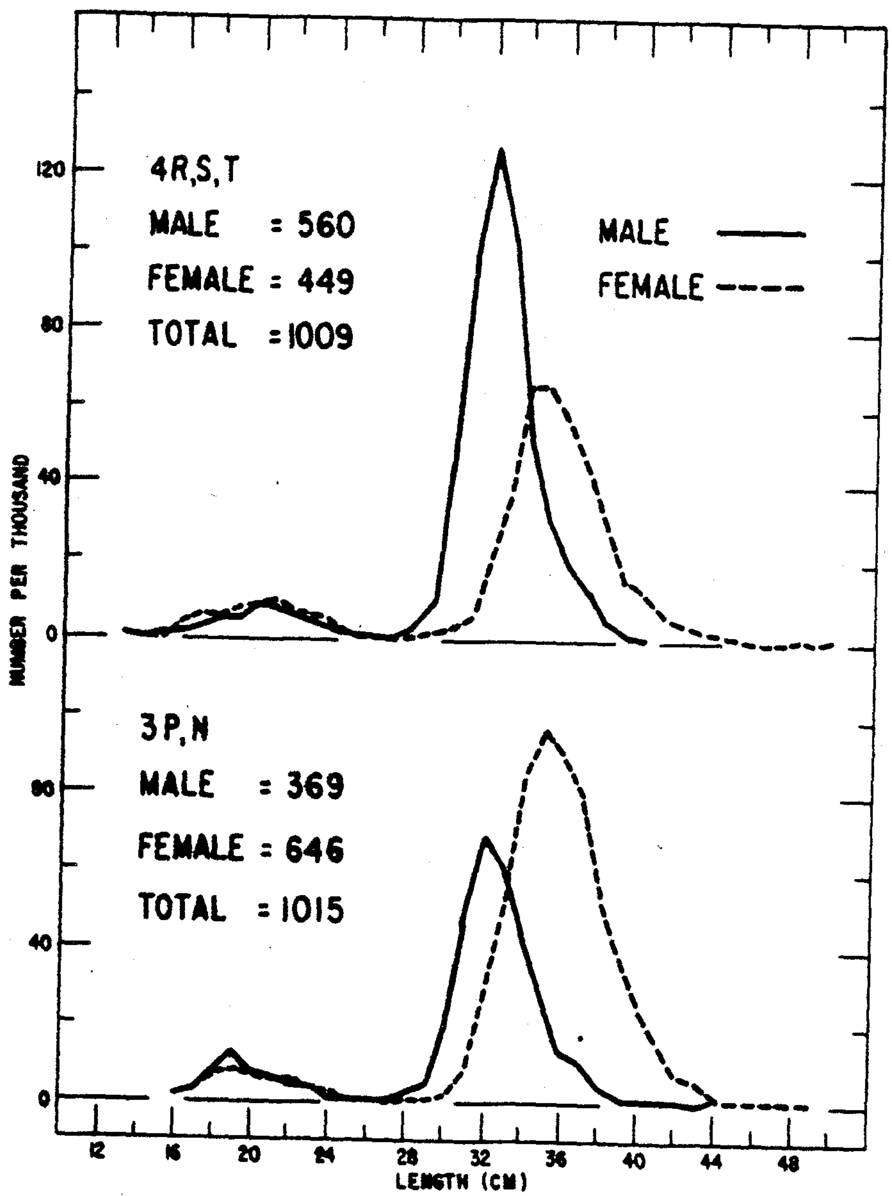


Fig. 7. Length frequency data - Cape Hunter 1977.

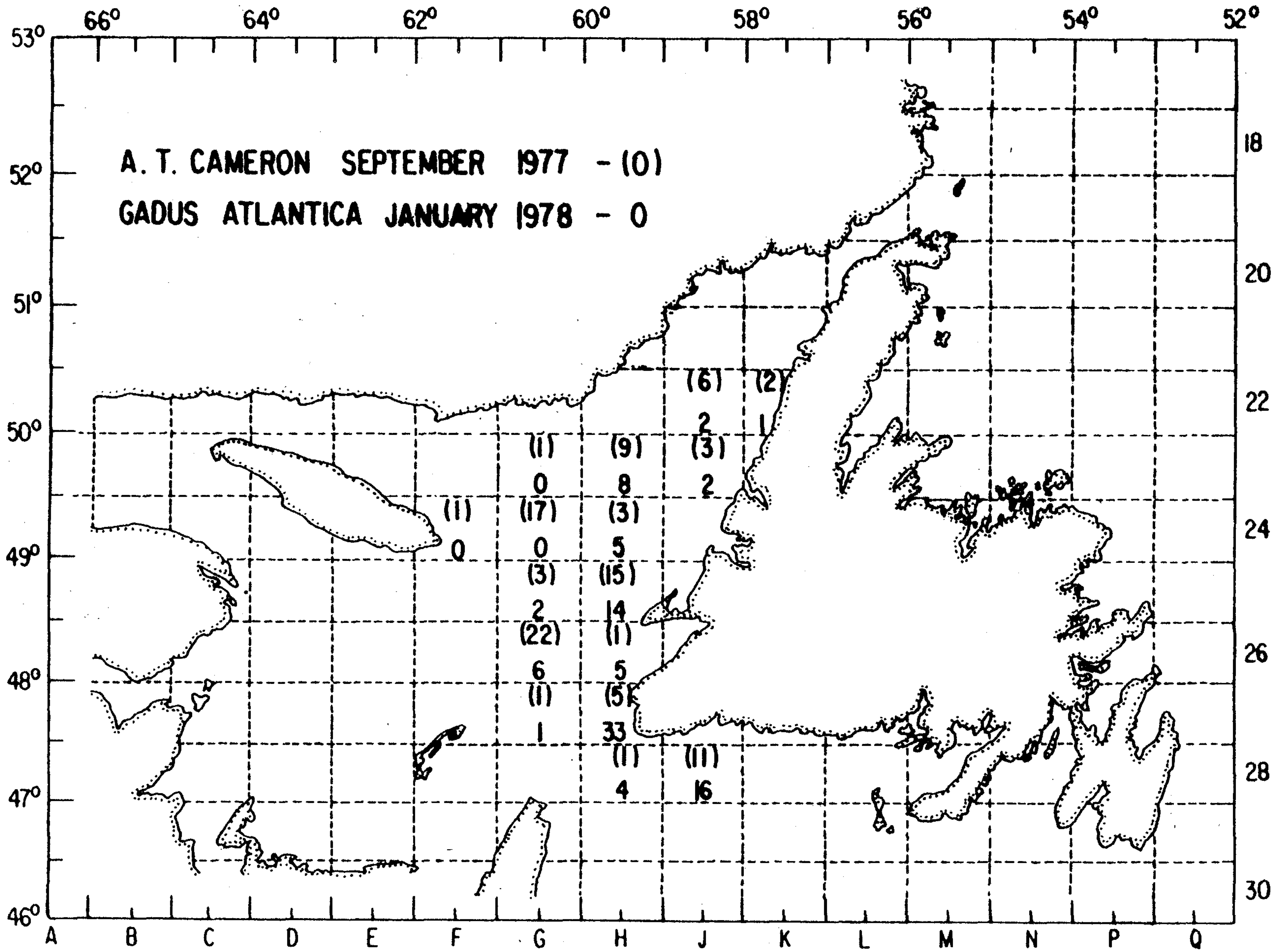


Fig. 8. Catches of two research cruises compared by unit area. The numerator represents percent of total average catch by the A.T. Cameron. The denominator represents percent of total average catch by the Gadus Atlantica.

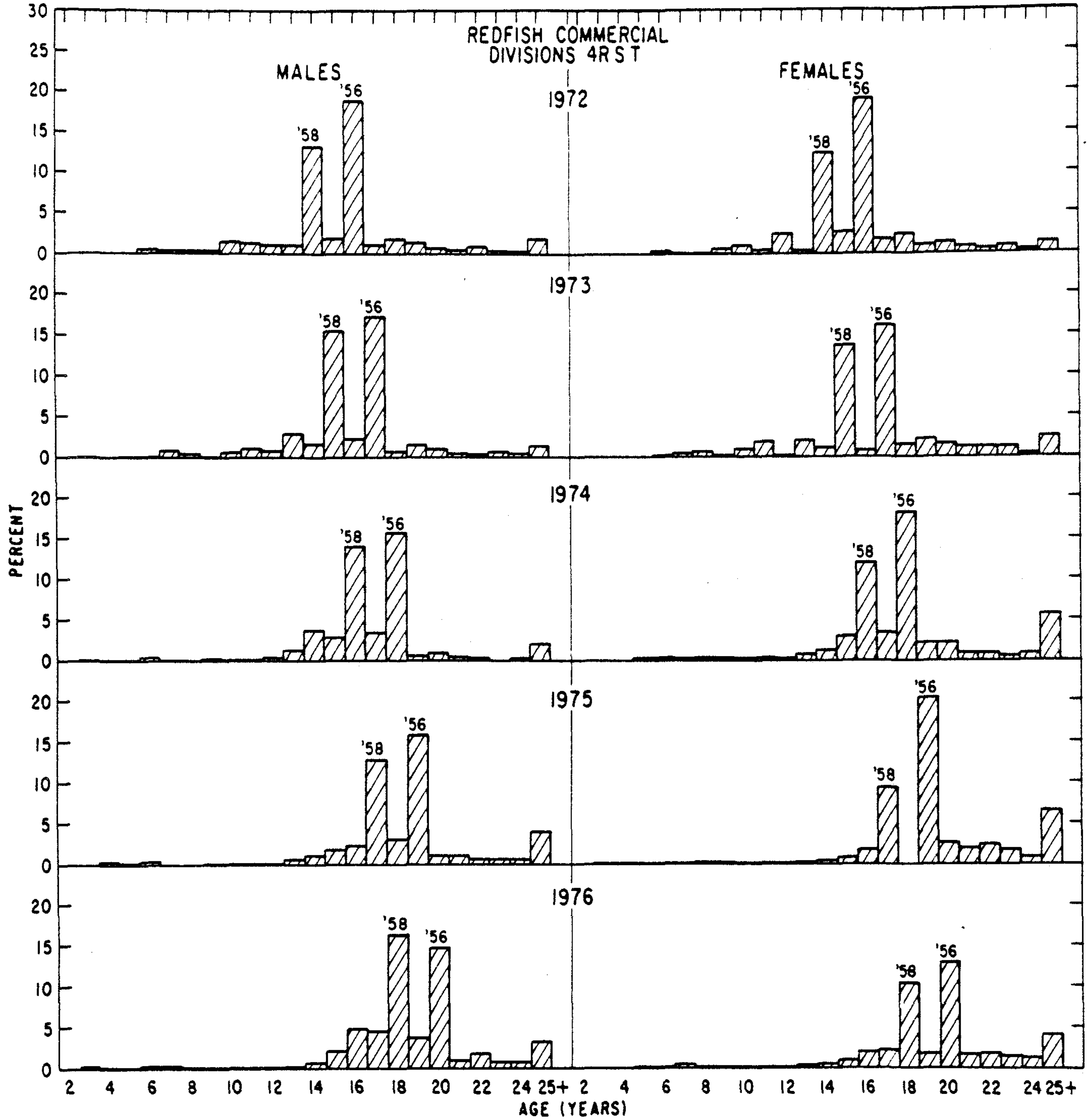


Fig. 9. Redfish commercial age structure in recent years from the Gulf of St. Lawrence.

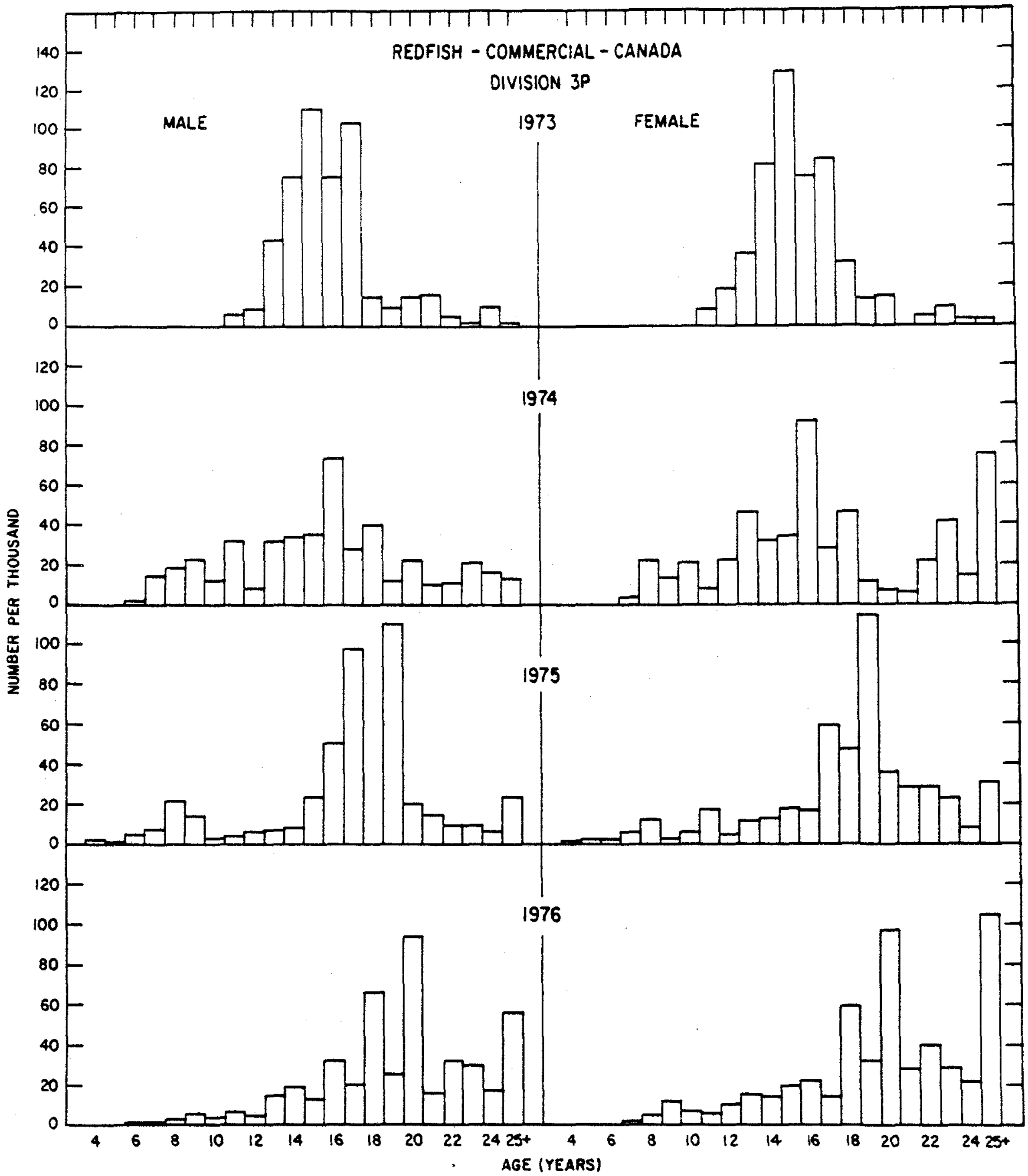


Fig. 10. Redfish commercial age structure in recent years from ICNAF Division 3P.