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DISTRIBUTION AND ABUNDANCE OF CAPELIN IN THE NORTHWESTERN GULF OF ST.LAWRENCE FALL TRAWL SURVEY

by

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ABSTRACT

A bottom trawl survey was carried out in the northwestern Gulf of St.Lawrence during October 1981 to determine the distribution and abundance of capelin. Capelin were taken in all sets with the highest concentrations located between 65°30' - 66°30'W and 49°30' - 50°00'N. Outside this area density dropped rapidly. The distribution pattern and abundance were very similar for males and females. Capelin caught during the survey were 1, 2 and 3 years of age, but the majority (80%) were 2 year-olds. The minimum trawlable biomass for the area surveyed (12972 km^2) in October 1981 was estimated at 6805 t. This type of survey seems promising and could be used in future to indicate trends in abundance. Timing is not as critical as for acoustic surveys which are limited to the pre-spawning period. It seems that most capelin present on the bottom may represent the spawning biomass of the following spring, since 1 year-old represented only a small proportion of the catch.

RESUME

Afin de déterminer la distribution et l'abondance des capelans dans le nord-ouest du golfe du Saint-Laurent, une campagne d'échantillonnage a été effectuée à l'aide d'un chalut de fond durant le mois d'octobre 1981. Des capelans ont été capturés à toutes les stations; les concentrations les plus élevées étant retrouvées dans la région sise entre 65°30' - 66°30' Ouest et

49°30' - 50°00' Nord. A l'extérieur de ce secteur, la densité de capelan diminuait très rapidement. Le patron de distribution et l'abondance des mâles et des femelles étaient presque identiques. Les individus capturés durant la mission étaient âgés de 1, 2 et 3 ans; la majorité (80%) cependant avaient 2 ans. Nous avons estimé une biomasse minimale chalutable de 6805 t pour la région échantillonnée (12972 km^2) en octobre 1981. Cette approche utilisée afin d'échantillonner le capelan semble très prometteuse et elle pourrait être utilisée dans l'avenir afin d'observer les variations d'abondance. Comparées aux missions d'évaluation acoustique qui doivent être synchronisées avec la pré-saison de fraye, les missions d'évaluation effectuées à l'aide du chalut de fond offrent une latitude beaucoup plus grande. D'autre part, il semble que la plupart des capelans retrouvés sur le fond durant la mission représentent la biomasse frayante du printemps suivant étant donné la faible proportion des capelans d'un an dans la capture.

INTRODUCTION

The capelin fishery in the Gulf of St.Lawrence is relatively new. Purse seine fisheries have developed in only two areas; Port-au-Port area (Div. 4R) and Miscou area (Div. 4T). Since the fishery is very limited, it is practically impossible to assess the status of the stock(s) with catch data. Consequently, fishery-independant methods have to be developed to estimate capelin abundance in the Gulf.

Carscadden and Miller (1980) showed that acoustic estimates of capelin biomass may be employed as relative indices of abundance. Such surveys have been conducted in the Gulf since 1978. Acoustic surveys are usually conducted in the spring, prior to the spawning period, and their success depends very much on correct timing relative to capelin movement to shore for spawning. Unfortunately, capelin do not cooperate very often. From April 29 to May 4, 1980, an acoustic survey was conducted along the east coast of New Brunswick up to the Gaspé Peninsula and only one school of capelin was observed near the Gaspé Peninsula. However, three weeks later, fishermen reported that capelin were abundant in this same area. Further, acoustic surveys in the eastern portion of the Gulf of St.Lawrence in April and May have not been successful in locating enough fish to provide reliable abundance indices (pers. comm. B. Nakashima). An acoustic survey to measure capelin distribution and abundance was also conducted during November 1980 in the northwestern Gulf of St.Lawrence. Transects covered more than 2000 km and only three small schools of juvenile capelin were detected near the coast. However, in the meantime, shrimp fishermen of this area reported that large capelin were abundant in their catches (on the bottom). Following this last indication, we decided to initiate a survey in the fall, using a bottom trawl with small mesh and high vertical opening. This paper presents the results of the survey.

MATERIALS AND METHODS

Fall distribution of capelin on the bottom was not known before the survey. The only piece of information available was that capelin were present in the same area as shrimp. Thus, in designing the survey plan, we decided to cover all trawlable area at depths greater than 150 m. (bottom is very rough in shallower water).

The capelin survey was carried out on board the E.E. Prince from October 24 to October 30, 1981, in the northwestern Gulf of St.Lawrence. Thirty-four stations were sampled during the survey (Fig. 1). The gear used was a Western II A shrimp bottom trawl with the following specifications: horizontal opening - 10 m., vertical opening - 4.5 m., mesh size stretched. - 32 mm, mesh size of the cod end liner - 13 mm. Tows were 30 min. in duration at a speed ranging from 3.7 to 6.5 km/hour. Trawling was carried out only during daylight hours to reduce bias, introduced by the possible diurnal migration of capelin.

For each set, the weights of capelin and of by-catches caught were recorded, and a random sample of 200 capelin was taken and frozen. Later in the laboratory, each fish was measured to the nearest mm and weighed to the nearest 0.1 g. Sex and maturity were determined and stomach content examined. Otoliths were removed (2 per 5 mm length group for males, females and indeterminates) and read following the method of Bailey et al. (1977 a).

Based on capelin density during the survey, the northwestern Gulf was poststratified and a minimum estimate of the capelin biomass in the strata was calculated using the swept area method. The minimum trawlable biomass per stratum is given by:

$$B_i = A_i \frac{\sum (Y_{ij} \div b_{ij})}{n_i}$$

Where B_i = biomass in stratum i,

A_i = surface area (km^2) in stratum i,

Y_{ij} = Catch per tow j in stratum i,

b_{ij} = area swept (km^2) per tow j in stratum i,

n_i = number of tows in stratum i.

Standard error ($S_{\bar{x}}$) were calculated using Mackett's method (1973).

RESULTS AND DISCUSSION

Distribution and abundance

Capelin were taken in all sets. Catches per 30 min. tow are illustrated in Figure 2. The largest catch (340 kg) was obtained at 65°40'W - 50°00'N. Other catches were much smaller, ranging from near 0 to 40 kg. Male and female capelin were present in each set. Figures 3, 4 and 5 show their distribution. For males, females and "unknown-sex" capelin the highest concentrations were located between 65°30' - 66°30'W and 49°30' - 50°00'N. The distribution pattern and abundance were very similar for males and females (Figs. 3, 4). Outside this area, capelin density dropped very rapidly. Based on these densities, we subdivided the area sampled into 6 strata (Fig 6). Strata I, II and III have less than 100 kg of capelin/km^2; stratum IV: 101 to 500 kg/km^2; stratum V: 501 to 2500 kg/km^2; and stratum VI: more than 2500 kg/km^2. Table 1 gives the density/km^2 with its standard error ($S_{\bar{x}}$) per stratum and the mean biomass per stratum.

The minimum trawlable biomass for the area surveyed (12972 km^2) in October 1981 was estimated at 6805 MT. This is a very minimum estimate for the following reasons: the method used to estimate the biomass excludes those capelin which are too small to be retained by the trawl, and no correction for selectivity has been made; the biomass calculated represents only fishes present in the first 4.5 m. above the bottom; a large number of capelin are probably capable of avoiding the trawl; and it is not known to what extent capelin stay on the bottom all day long. Consequently, this estimate is to be used as a relative biomass index.

This type of capelin survey seems to have considerable potential. The timing does not appear to be as critical as for acoustic surveys, which are limited to prespawning period. In the northwestern Gulf, capelin are caught by shrimp trawlers from the end of August to the end of the fishing season (November) and from the beginning of the fishing season (March) to early May. Furthermore, such surveys make it possible to evaluate the status of the stock(s) several months before the fishing season. Such surveys, if made on an annual basis, could form the basis for an abundance index for capelin.

BIOLOGICAL INFORMATION

Length-frequency and age composition

Capelin sampled during the survey ranged from 105 mm to 175 mm for males and from 105 mm to 165 mm for females. It was impossible to determine

the sex of a small portion of young capelin which ranged from 55 mm to 145 mm (Fig. 7). Otoliths revealed males and females of 1, 2 and 3 years of age. "Unknown-sex" capelin were 1, 2 years old. Approximately 80% of males and females caught were 2 year-olds. More than 80% of "unknown-sex" were 1 year of age. (Fig. 8).

Mean length and mean weight-at-age

The length-weight relationship established for capelin caught in the northwestern Gulf during October 1981 is presented in Figure 9. Differentiation between males and females occurs around 130 mm. Under this length, length-weight relationship is the same for males, females and "unknown-sex" capelin. Mean length and mean weight-at-age are given in Table 2. It is interesting to note that 2 year-olds "unknown-sex" capelin have approximately the same length and weight as 1 year-old male and female.

Sex ratio and numbers-at-age

Table 3 presents the total number of male, female and "unknown-sex" capelin estimated from the survey. For the whole area, the sex ratio was: male: 34.3%; females: 64.9%; sex unknown: 0.8%. However, if we do not consider stratum VI where 80% of the capelin caught were female, males are less abundant than females only by 7% which is very similar to the ratio males: females (0.45 : 0.55) estimated by Bailey et al. (1977 b) for capelin caught in the estuary and western Gulf of St.Lawrence in 1974 and 1975.

Table 4 shows the total number of capelin-at-age (sex combined) estimated from the survey. Age 1 accounts only for 18.4% of the population. This could be explained by:

(1) The selectivity of the trawl;
(2) a weak age class compared to the 1979 year-class (age 2);
(3) or the partial recruitment of the 1980 year-class (age 1) to the area surveyed.

This third hypothesis seems the most probable. During the acoustic survey carried out in the same area in November 1980, small capelin (mean length 100 mm) were only found in shallow water near the coast. Larger capelin were absent from this area. Consequently, it seems that capelin found on the bottom, during the October 1981 survey, may represent the 1982 potential spawners. So, the biomass estimated would represent an abundance index of the spawning biomass in the northwestern Gulf in 1982.

Feeding

Analysis of stomach contents of capelin caught during the October 1981 survey revealed two main food items: euphausiids and amphipods. Amphipods represented more than 30% of stomach contents. Euphausiids which were dominated by two species, Meganyctiphanes norvegica and Thysanoessa raschii, represented practically the remaining 70%. Daytime depth distribution maximum of T. raschii occurs at about 100-200 m and near the seafloor in water deeper than 100 m for M. norvegica. (Berkes, 1976). Stomach contents of capelin tend to confirm their close relation to the bottom during the survey.

CONCLUSION

This type of survey for capelin seems very promising. A time series of such surveys could indicate trends in abundance. The timing does not appear as critical as for acoustic surveys which are limited to the prespawning period. Trawl surveys may be carried out from September to April, which makes it possible to evaluate the status of the stock(s) several months before the fishing season.

Stomach contents of capelin tend to confirm their close relation to the bottom during the fall. It seems that most capelin present on the bottom may represent the spawning biomass of next spring since one year-old represent only a small proportion of the population.

REFERENCES

Bailey, R.F.J., K.W. Able, and W.C. Leggett. 1977a. Evidence for the presence of a metamorphic check in capelin (Mallotus villosus) otoliths and implications for age determination. J. Fish. Res. Board Can. 34: 2008-2014.

Bailey, R.F.J., K.W. Able and W.C. Leggett. 1977b. Seasonal and vertical distribution and growth of juvenile and adult capelin (Mallotus villosus) in the St.Lawrence estuary and western Gulf of St.Lawrence. J. Fish. Res. Board Can. 34: 2030-2040.

Berkes, F. 1976. Ecology of euphausiids in the Gulf of St.Lawrence. J. Fish. Res. Board Can. 33: 1894-1905.

Carscadden, J.E., and D.S. Miller. MS, 1980. Analytical and acoustic assessments of the capelin stock in Subarea 2 and Div. 3K, 1980. NAFO SCR Doc. 80/II/13, Ser. No. N045, 19 p.

Mackett, P.J. 1973. Manual of methods for fisheries resource survey and appraisal. F.A.O. Fish. Tech. Rep. 124, 29 p.

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Table 1. Minimum trawlable biomass of capelin in the northwestern Gulf of St.Lawrence. October 1981.

			DENSITY (Kg/Km^2)		
Stratum	Area (Km^2)	# sets	$\bar{x}$	$S_{\bar{x}}$	Biomass (MT)
I	1429	7	35	14	50.0
II	1041	2	50	40	52.1
III	3088	9	37	10	114.3
IV	5594	10	242	48	1353.8
V	1669	5	1474	285	2460.1
VI	151	1	18378	-	2775.1
Total	12972	34	525	50	6805.4

Table 2. Mean length and mean weight-at-age of capelin from the northwestern Gulf of St.Lawrence. Oct. 1981.

	SEX	AGE			
		1	2	3	Mean
Mean length (mm)	Male	129.8	151.6	156.0	150.0
	Female	126.1	141.9	148.4	139.6
	Sex Unknown	108.9	131.7	-	113.4
Mean weight (g)	Male	9.7	17.7	19.8	17.0
	Female	8.6	13.0	15.3	12.3
	Sex Unknown	4.9	9.8	-	5.7

Table 3. Number ($x10^{-6}$) and proportion (%), by sex of capelin in the northwestern Gulf of St.Lawrence. Oct. 1981.

Stratum	MALES N ($x10^{-6}$)	MALES %	FEMALES N ($x10^{-6}$)	FEMALES %	SEX UNKNOWN N ($x10^{-6}$)	SEX UNKNOWN %	TOTAL N ($x10^{-6}$)
I	1.74	42.8	1.93	47.3	0.40	9.9	4.07
II	2.02	60.7	1.31	39.3	0	0	3.32
III	3.75	45.7	4.10	49.9	0.36	4.4	8.21
IV	43.27	46.2	49.20	52.6	1.13	1.2	93.60
V	74.43	45.3	88.17	53.6	1.86	1.1	164.46
VI	42.92	19.8	173.88	80.2	0	0	216.80
Total	168.13	34.3	318.58	64.9	3.76	0.8	490.47
I to V	125.21	45.8	144.70	52.9	3.76	1.3	273.67

Table 4. Number ($x10^{-6}$) of capelin at age (males, females and unknown sex) in the northwestern Gulf of St.Lawrence. Oct. 1981.

Stratum	Age 1	Age 2	Age 3
I	0.94	2.98	0.15
II	0.52	2.67	0.14
III	1.61	6.28	0.33
IV	16.44	73.32	3.83
V	28.96	128.76	6.74
VI	41.53	166.34	8.93
Total	90.00	380.34	20.12
Percent	18.4%	77.5%	4.1%

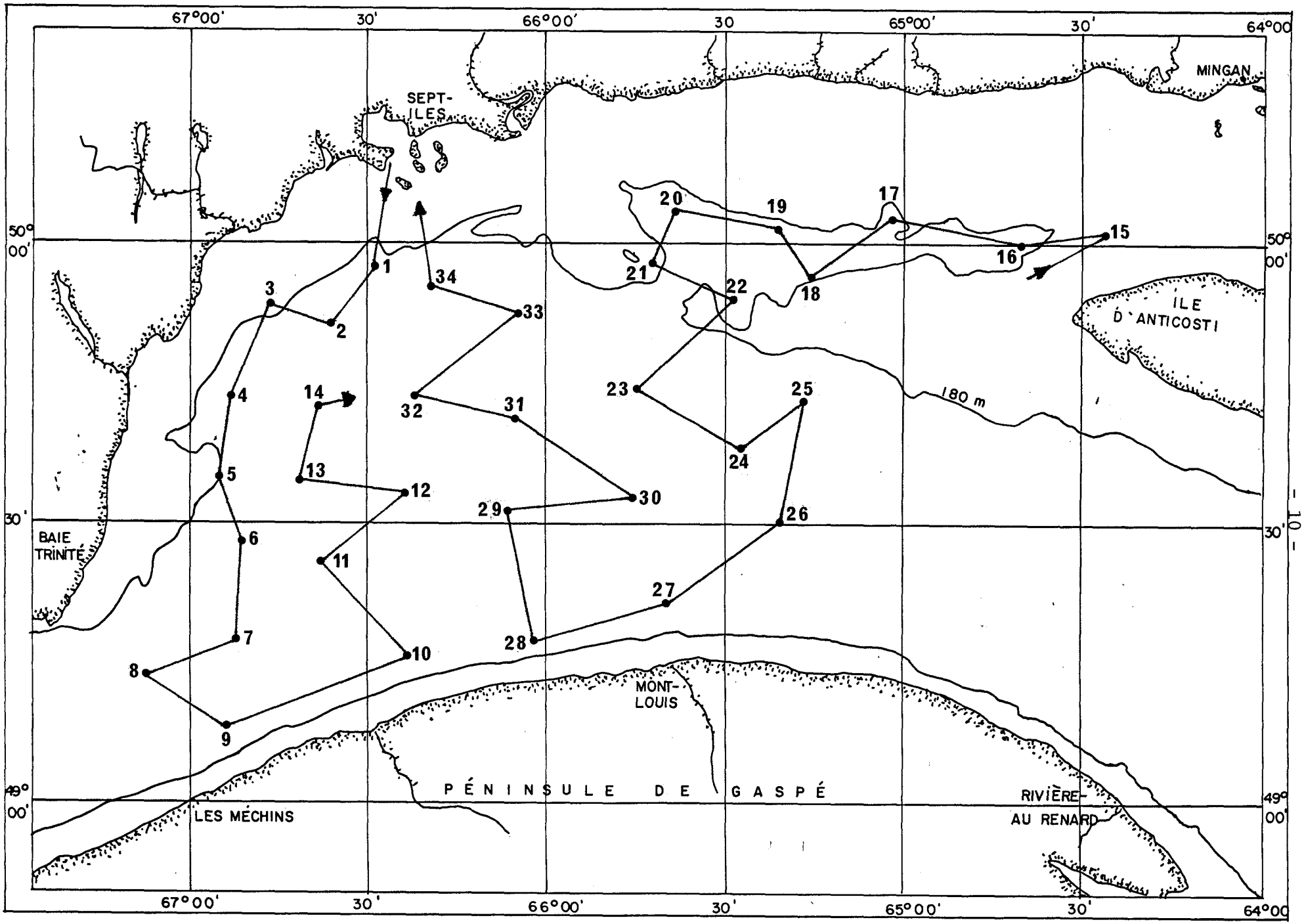

Fig. 1. Stations occupied during the October 1981 capelin survey.

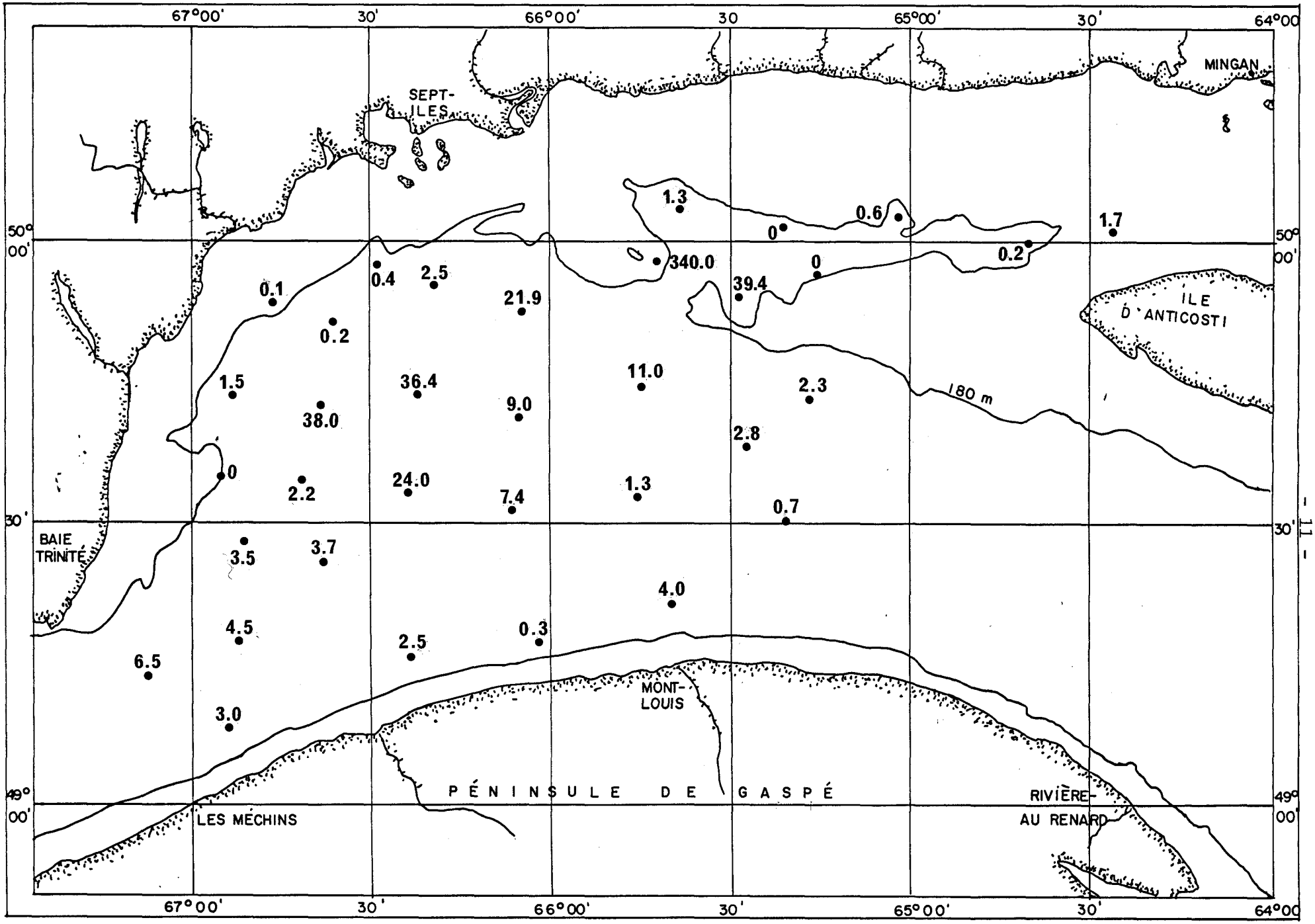

Fig. 2 . Catches of capelin (kg) per 30-min tow in October 1981. (Capelin present at all stations; "0" marked represents very low catches).

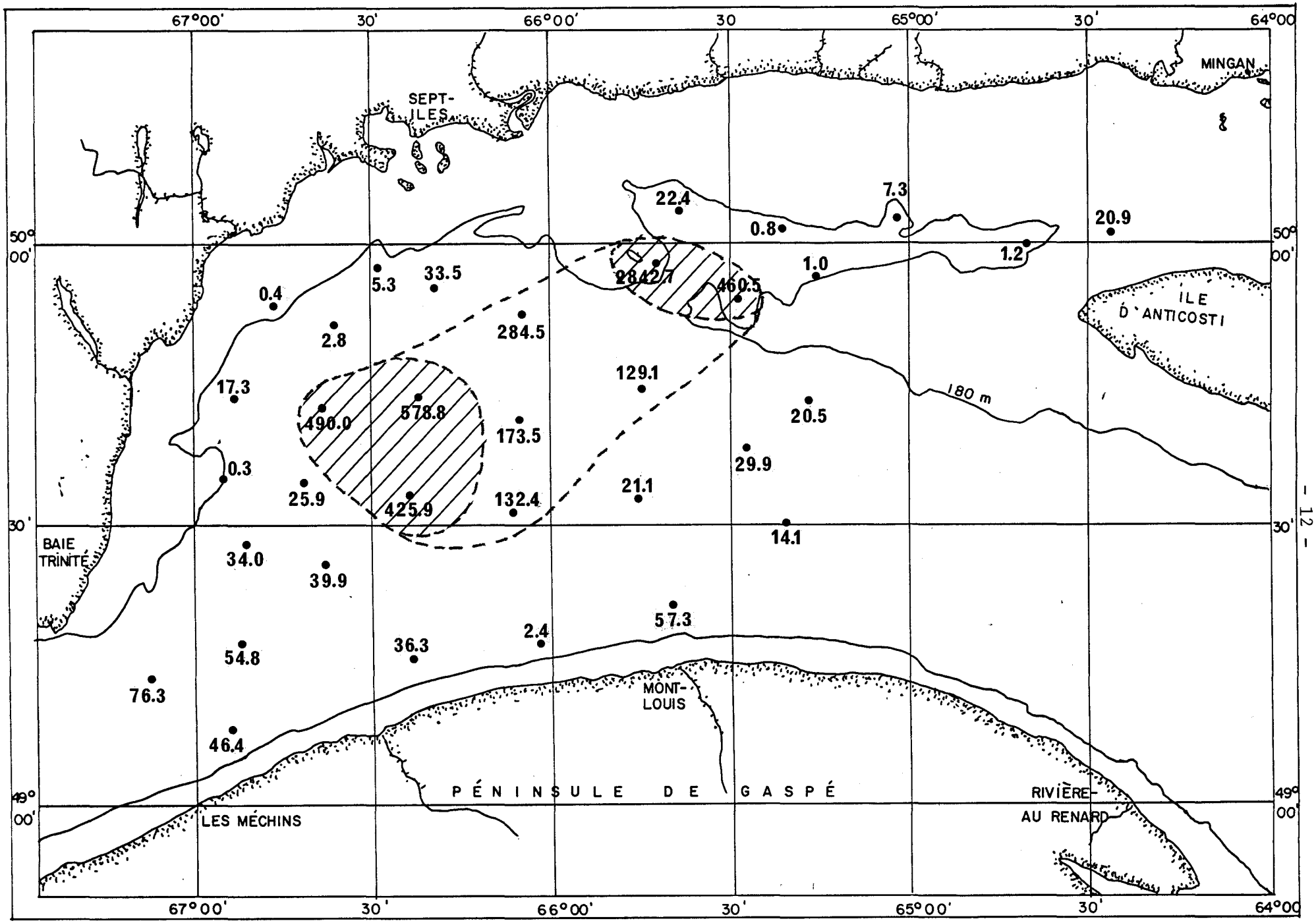

Fig. 3 . Distribution of male capelin in October 1981. Numbers represent capelin ($x10^{-2}$) per km^2. Circled area > 10000 fishes/km^2; Dashed areas > 40000 fishes/km^2.

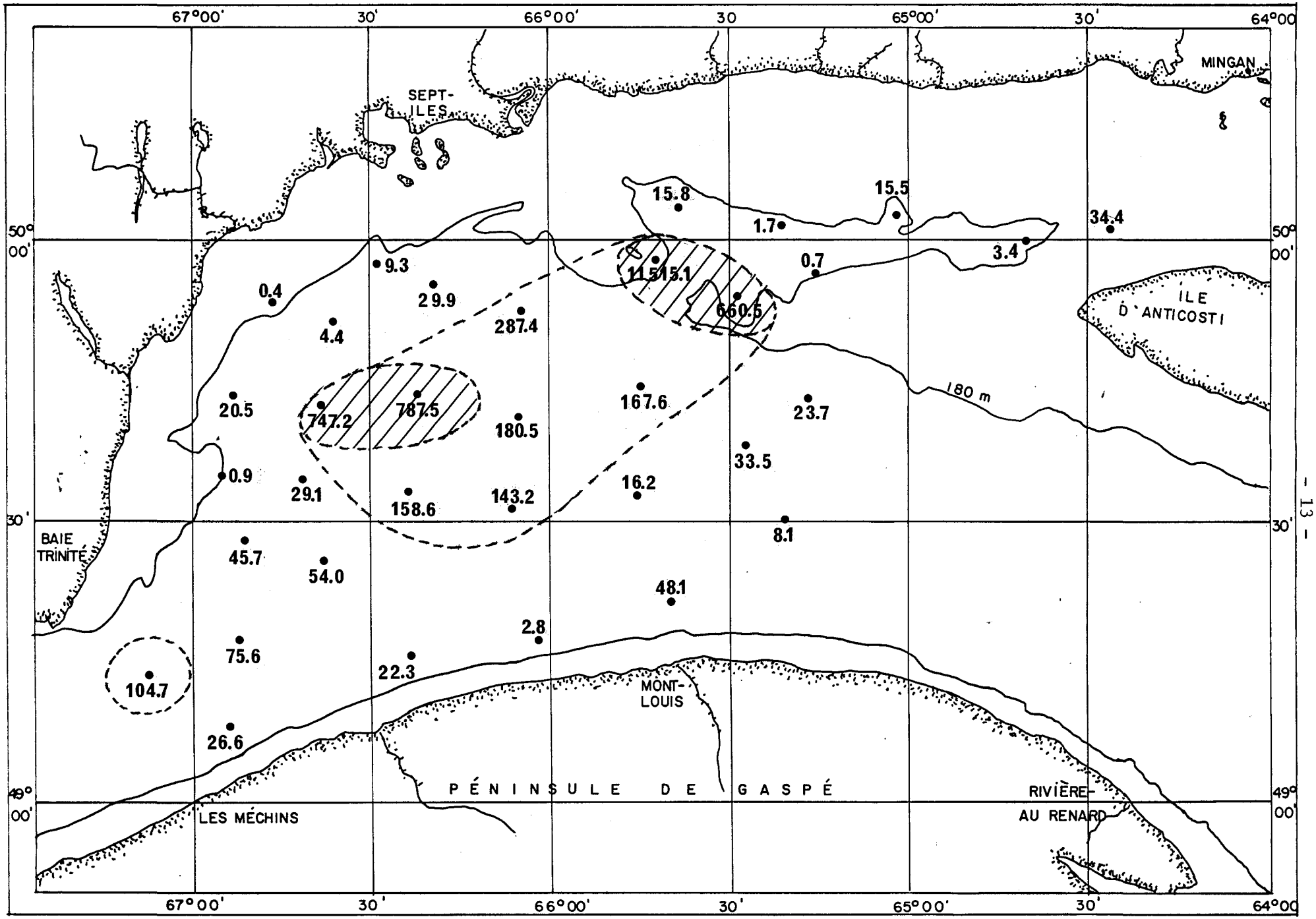

Fig. 4 . Distribution of female capelin in October 1981. Numbers represent capelin ($x10^{-2}$) per km^2. Circled areas > 10000 fishes/km^2; Dashed areas > 40000 fishes/km^2.

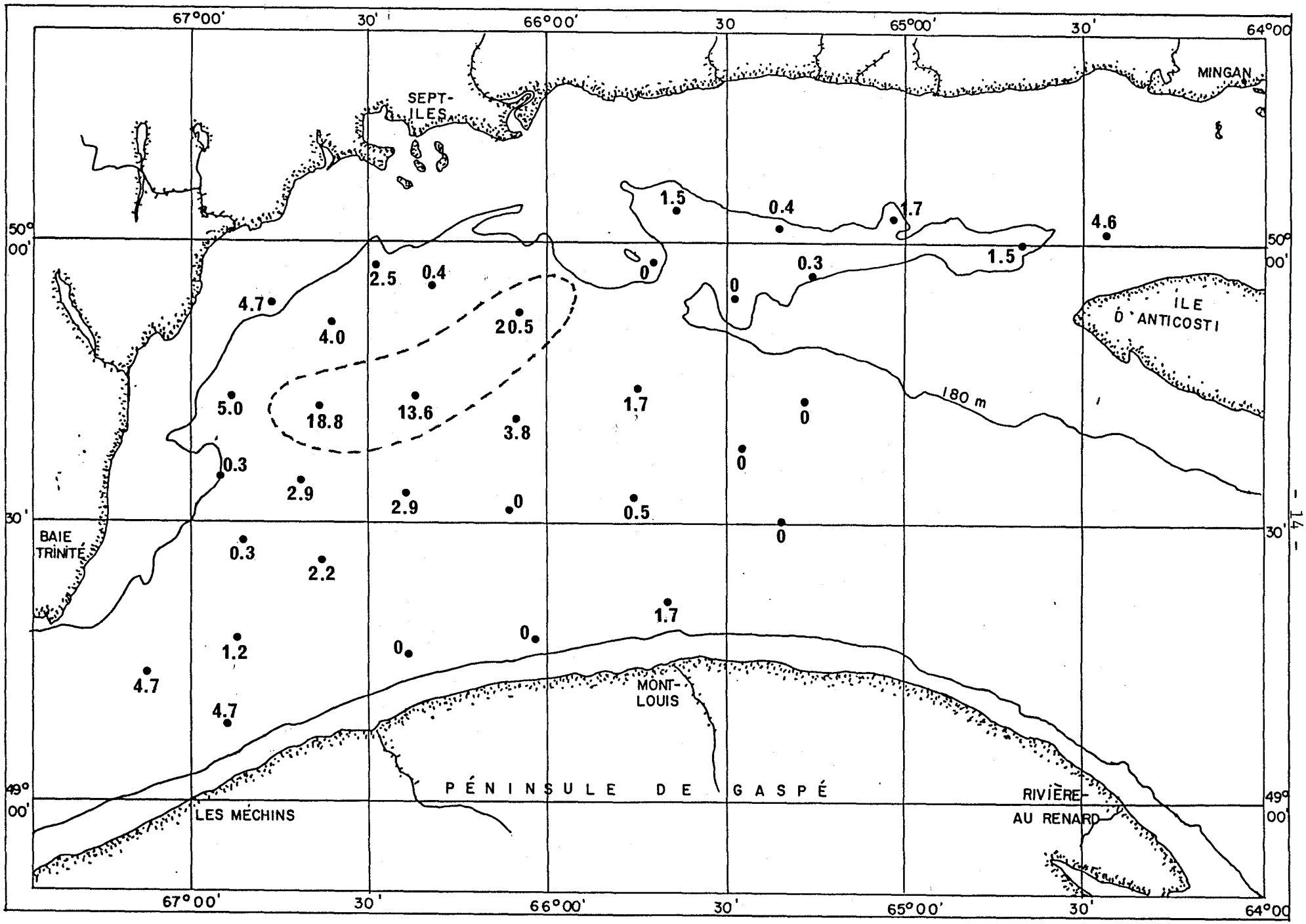

Fig. 5 . Distribution of "unknown sex" capelin in October 1981. Numbers represent capelin ($x10^{-2}$) per km^2. Circled area > 1000 fishes/km^2.

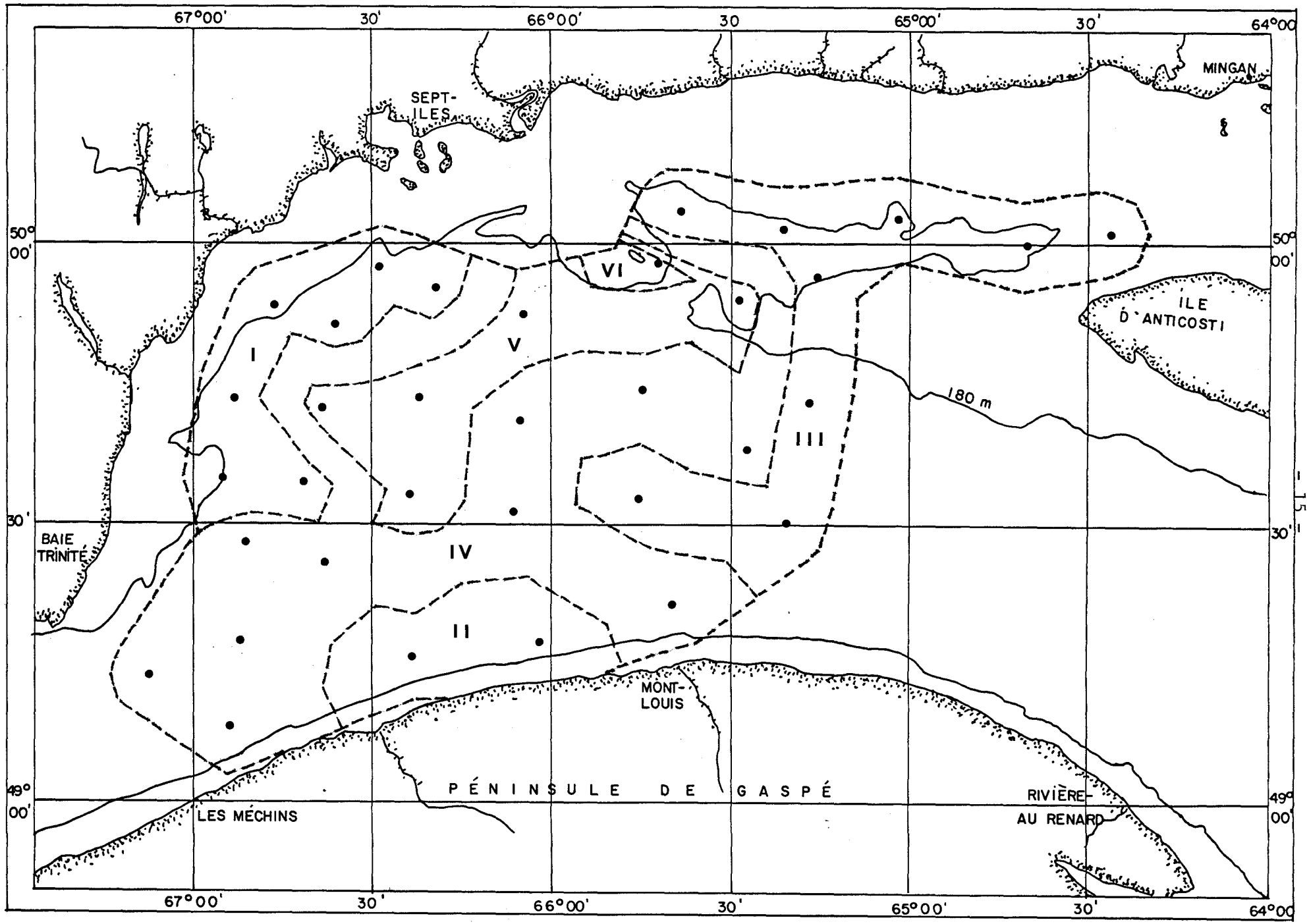

Fig. 6. Stratification scheme based on capelin density during the October 1981 survey.

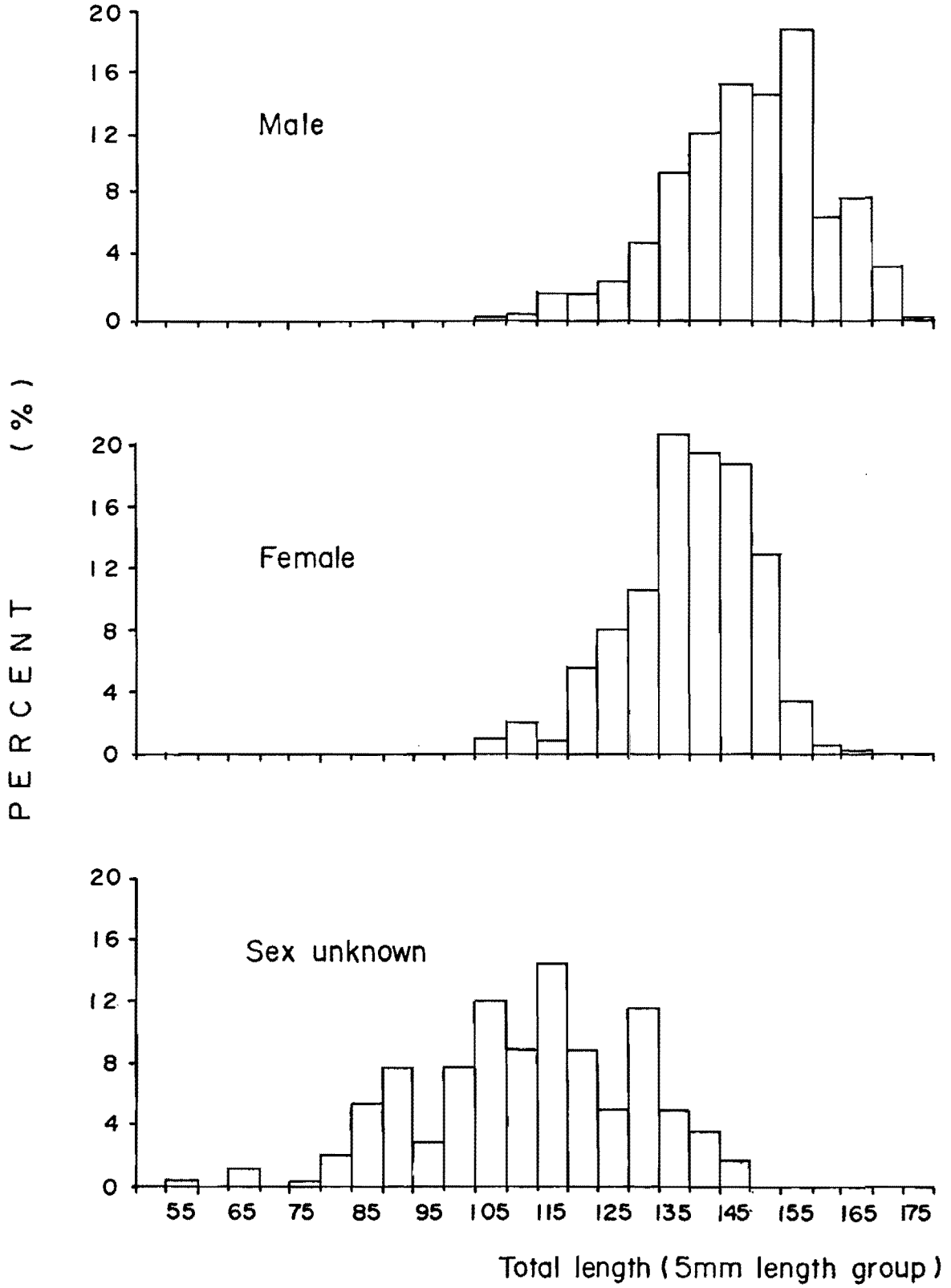

Fig. 7. Length frequency distribution of capelin from the northwestern Gulf of St. Lawrence. Oct. 1981.

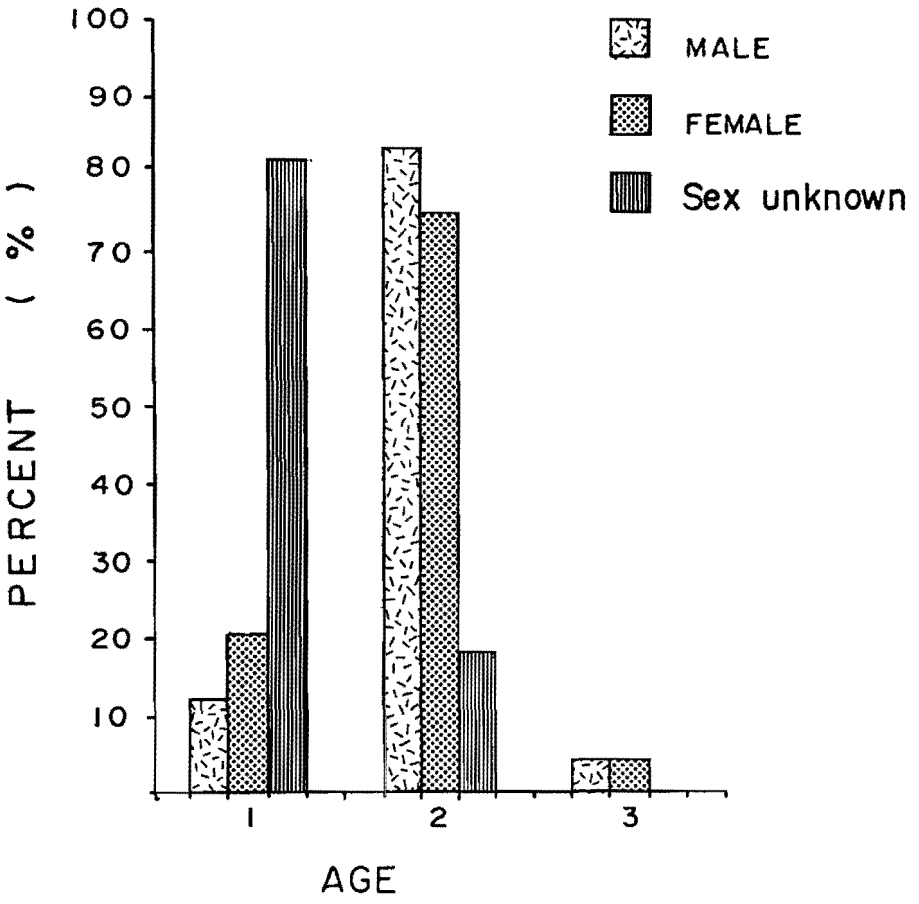

Fig. 8 . Age composition, by sex, of capelin from the northwestern Gulf of St. Lawrence. Oct. 1981.

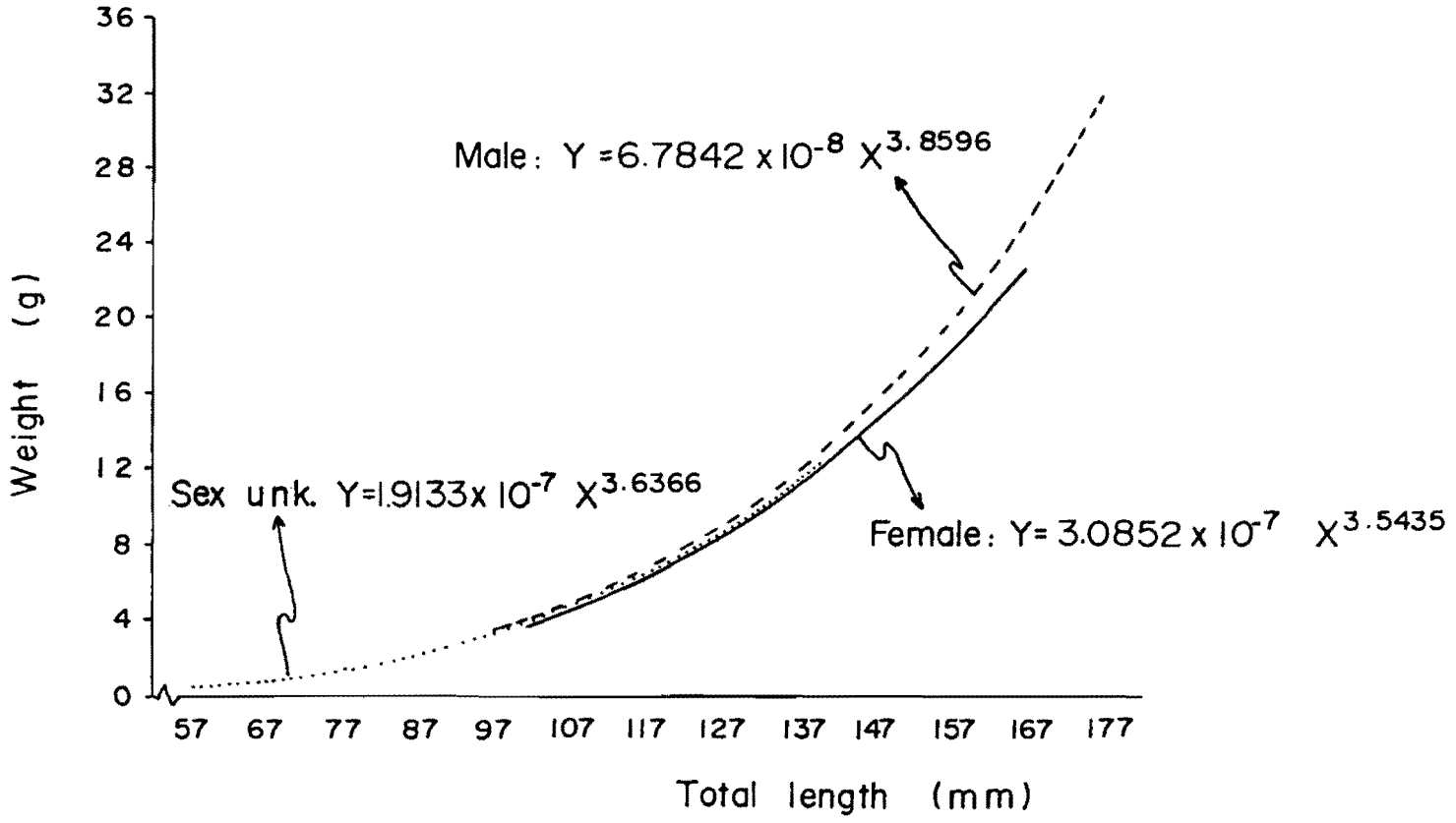

Fig. 9 . Length-weight relationships of capelin from the northwestern Gulf of St. Lawrence. Oct. 1981.