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The 1986 southwest Gulf of St. Lawrence midshore snow crab, Chionoecetes opilio, fishery - a review of catch effort and biological trends

by

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ABSTRACT

Biological characteristics of snow crab populations exploited by the southwestern Gulf of St Lawrence midshore fishery in 1986, were monitored through an extensive sea sampling program. Catch and effort data were obtained from fishermen's logbooks and processor's sales slips and were used in a Leslie analysis to provide initial biomass (B_0) and exploitation level (EL) estimates.

Total catch, total effort, and mean CPUE decreased 3.5%, 5.3% and 2.8% respectively compared to 1985 values. Fishermen were not able to prevent decreases in CPUE as the season progressed by changing their fishing location. Unlike previous years, the mean CPUE of the Quebec fleet exceeded that of the New Brunswick fleet.

Estimated B_0 (46,691 t) decreased 46.6% from the 87,418 t 1985 estimate resulting in an increased EL estimate of 52.0% (versus 18.8% in 1985). EL's of 46.3% and 52.5%, calculated in 1985 for zones within the southwestern Gulf, correspond to the overall 1986. The 1986 B_0 and EL estimates are deemed to be more accurate than 1985 figures based on the -0.95 correlation coefficient (r) obtained for the Leslie analysis (r=-0.74 in 1985).

Size distributions and seasonal size decreases observed for 1986 samples differed little from those of 1985. Low percentages of females, undersize males, and soft/white crabs indicate a low discard rate in 1986. The sampled catch was composed of up to 26.5% morphometrically immature males (MI males). The effect of the removal by the fishery of MI males on the reproductive capacity of snow crab populations warrants further research.

Given current effort levels, there is no strong evidence that the fishery should not be able to maintain similar catch levels in 1987.

RESUME

Un programme d'échantillonnage en mer a été établi en 1986 afin de surveiller des caractéristiques biologiques des populations de crabes des neiges pêchés dans le sud-ouest du golfe du Saint-Laurent. Les données sur l'effort de pêche et les prises ont été obtenues des journaux de bord des pêcheurs et des récipissés de vente. Ces données ont été utilisés dans l'analyse de Leslie afin d'estimer la biomasse initiale (B_0) et le niveau d'exploitation (EL)

Les prises, l'effort de pêche et la PUE moyenne ont diminué de 3,5%, 5,3% et 2,8% respectivement par rapport à ceux de 1985. Les déplacements saisoniers de la distribution d'effort n'ont pas réussi à empêcher la diminution des PUE tout au long de la saison. Con-

trairement aux années passées, la PUE moyenne de la flotte du Québec a dépassé celle de la flotte du Nouveau-Brunswick.

La biomasse initiale estimée (46 691 t) pour 1986 a diminuée de 46,6% par rapport à celle de 1985 qui était de 87 418 t. Il en découle une augmentation du EL de 52,0% (comparé à 18,8% en 1985). Les EL de 46,3% et 52,5% calculés en 1985 pour les zones dans le sud-ouest du golfe s'accordent à la valeur estimée pour 1986. Les estimations de B_0 et du EL calculées pour 1986 semblent être plus exactes que celles obtenues en 1985, car le coefficient de corrélation (r) obtenu pour 1986 (-0,95) est plus élevé que celui de 1985 (-0,74).

Les distributions de taille et les diminutions saisonnières des tailles qui ont été remarquées pour les échantillons de 1986, s'accordent avec ceux de 1985. Les faibles pourcentages de femelles et de mâles sous la taille légale de même que de crabes à carapace molle, indiquent que le taux de rejet à la mer était bas en 1986. Les prises échantillonnées étaient composées jusqu'à 26,5% de mâles morphométriquement immatures (mâles MI). La conséquence des mâles MI dans les prises demande de plus amples recherche concernant la capacité reproductive des populations de crabes des neiges.

Etant donné le niveau d'effort de pêche qui existait jusqu'à maintenant, il n'y a aucune évidence que la pêcherie ne pourra pas maintenir les prises similaires de 1986 en 1987.

INTRODUCTION

The southwest Gulf of St. Lawrence snow crab, Chionoecetes opilio, fishery was initiated in the mid-1960's and has grown steadily in importance to its present status as the largest, in terms of landings, in Atlantic Canada (Table 1). The history of the fishery can be partitioned into exploratory, industry development and growth phases, as documented by Elner and Bailey (1986).

The fishery is currently composed of 128 midshore vessels (79 from N.B., 44 from Quebec and 2 from western Cape Breton Island) and is of major economic importance to the southwest Gulf Region.

Assessments of the southwest Gulf snow crab populations have been limited. Bailey (1978), proposed catch-effort and yield models for providing insight into Gulf snow crab biomass and production levels. The use of Leslie analysis (Ricker, 1975) has become generally accepted for snow crab assessments and has been used to estimate levels of initial biomass (B_0), recruitment, and exploitation levels for the southwest Gulf's snow crab populations (Bailey, 1978; Cormier, 1984; Davidson et al., 1986).

An overview of catch, effort and biological trends for the 1986 southwest Gulf snow crab fishery is presented in this paper.

MATERIALS AND METHODS

An extensive sea sampling program was initiated in 1986 using DFO sampling personnel from the Quebec and Gulf regions, and contracted observers. Sex, location of capture, size (carapace width, CW-mm) and shell condition (either hard or soft-subjectively measured) was noted for all crabs sampled. Chela length and height was measured for males to determine morphometric maturity using the method described by Conan and Comeau (1986). The presence/absence of eggs, and their state of development (orange, non-eyed or eye spots discernible) was noted for all females sampled.

Sampling location was plotted for samples taken aboard Quebec and New Brunswick vessels (Figs. 1 and 2). Weekly percentages of immature males, females, undersize males, and soft shelled crabs for Quebec samples (crabs caught by Quebec fishermen), New Brunswick samples (crabs caught by New Brunswick fishermen), and overall samples (both fleets combined) were calculated and plotted (Tables 2 - 5, Figs 3 - 5). Monthly and seasonal size distributions and statistics were generated for male crabs in Quebec, New Brunswick and overall samples (Figs 6 - 8).

Logbook/sales slip data:

Catch and effort data were obtained from fishermen's logbooks and processor's sales slips as collated by Gulf and Quebec Region DFO Electronics Data Processing and Statistics Branches.

For New Brunswick and Cape Breton Island vessels (Gulf Region data) catch per unit effort, CPUE (daily catch in kg/daily number of trap hauls) was calculated from logbook data. Experience has shown that the total catch calculated from fishermen's logbooks tends to underestimate the total landings estimated from sales slip records, therefore, sales slip data was used in the calculation of catch statistics for the New Brunswick/Cape Breton Island fleet.

For Quebec vessels, both the CPUE and catch statistics were calculated from the available sales slip data. When sales slip catch information was not available for a given trip, the fishermen's logbook catch estimates were substituted.

Some Quebec vessels use Japanese conical traps instead of the box traps (1.5 x 1.5 m, 1.8 x 1.8 m) used by the New Brunswick and Cape Breton Island vessels. In order to standardize to box trap CPUE's, 2 Japanese trap hauls were considered to be equivalent to 1 box trap haul.

CPUE and catch/statistics were summarized into weekly periods for both the New Brunswick and Cape Breton Island vessels and the Quebec vessels (Table 6). In addition, the two data sets were

combined to give overall weekly CPUE, catch, and cumulative catch statistics (Table 6) which were used in a Leslie analysis (Ricker, 1975).

To determine the monthly and seasonal distribution of fishing effort, fishing position, given as Loran C or latitude/longitude coordinates, was plotted for New Brunswick/Cape Breton Island vessels (Figs 9 and 10). No data concerning the geographic position of fishing effort of Quebec vessels (other than that collected by sea samplers, Fig. 1) was available at the time of analyses.

RESULTS

The overall distribution of fishing effort of the New Brunswick /Cape Breton Island fleet (Fig. 9) shows that fishing is concentrated in the gully/slope regions bordering the Bradelle and Orphan Banks and corresponds closely to the geographic distribution of sea samples taken aboard New Brunswick vessels during the 1986 season (Fig. 2).

The monthly distributions of fishing effort for the New Brunswick/Cape Breton Island fleet indicate temporal relocation of fishing effort as the season progresses (Fig. 10). During April, the bulk of the fleet's fishing effort is concentrated in the southwest Bradelle Bank region (Fig. 10A). In May, a major portion of the effort shifts to the eastern Bradelle Bank region (Fig. 10B). During the final weeks of the season, the effort shifts back westward to concentrate along the slopes of the southwestern Bradelle Bank and Orphan Bank region (Fig. 10C).

The geographic distribution of sea samples taken aboard Quebec vessels (Fig. 1) indicates a more diffuse distribution of fishing effort than that observed above for New Brunswick/Cape Breton Island vessels.

The size distribution for New Brunswick samples in May is symetrical with a mean size of 110.4 mm CW and a mode at 111-113 mm CW (Fig. 6). In June, the size distribution is again symetrical. The mean size has decreased to 108.2 mm CW and the mode has shifted to the left at 108 - 110 mm CW (Figure 6). The seasonal size distribution (Fig. 7) is symetrical with a mean of 109.1 mm CW and a mode at 108 - 110 mm CW.

The size distribution for Quebec sea samples in May is roughly symetrical with a mean of 107.6 mm CW and modes at 102 -104 mm CW and 108 - 110 mm CW (Fig. 6). For Quebec samples in June, the size distribution is skewed to the right. The mean size has decreased to 104.6 mm CW with a mode at 96 - 99 mm CW (Fig. 6). The seasonal size distribution for Quebec samples is slightly skewed to the right with a mean of 106.8 mm CW and a mode at 103 - 104 mm CW (Fig. 7).

The seasonal size distribution for all Gulf samples (Fig. 8) is roughly symetrical with a mean of 108.0 mm CW and a mode at 102 - 104 mm CW.

The percentages of females and undersize males in Quebec, New Brunswick and total Gulf sea samples generally fluctuated below 15% (the majority of weekly percentages were below 10%) for the entire sampling season (Tables 2-5, Figs 3 - 5). The single exception to the above was in week 12 when the percentage of undersize males reached 17.1% in New Brunswick samples (Table 3). The mean percentages of both females and undersize males was slightly higher in Quebec samples (6.5% and 7.6% respectively versus 4.1% and 5.8% respectively for New Brunswick samples). The mean percentages for total Gulf samples of females and undersize males were 4.7% and 6.5% respectively (Tables 2, 3).

The percentage of soft/white crabs in N.B. samples remained below 10% for the entire sampling season (Table 4, Fig. 4). The incidence of soft/white crab in Quebec samples increased rapidly in weeks 11 and 12 (Table 4, Fig. 3). The mean seasonal percentages of soft/white crab present in sea samples were 5.8% for New Brunswick samples, 4.2% for Quebec samples, and 5.1% for total Gulf samples (Table 4).

Percentages of morphometrically immature males (MI-males) in New Brunswick and Quebec samples exhibit dramatic differences, especially after week 8 when the incidence of immatures in Quebec samples averages twice that of New Brunswick samples (Table 5, Figs 3, 4). The seasonal mean percentage of MI-males in Quebec samples is 8.9% greater than that of the New Brunswick samples (22.9% versus 14.8% respectively, Table 5). The mean percentage of MI-males in the total Gulf samples was 17.9% (Table 5). The percentage of MI-males peaked in week 10 for New Brunswick and total Gulf samples and in week 11 for Quebec samples (Table 5).

The percentage of legal sized ($\geq$ 95 mm CW) MI-males can be estimated by substracting the percentage of undersize males from the percentage of MI-males (Tables 3 and 5). Using this method, the maximum percentage of legal sized MI-males was found to occur in week 10 for New Brunswick, Quebec and total Gulf samples (23.4%, 36.7% and 26.5% respectively, Tables 3 and 5). The respective seasonal mean percentages of legal sized MI-males in New Brunswick, Quebec and total Gulf samples were 8.2%, 15.3% and 11.4% (Tables 3 and 5).

Catch and effort in the first and last weeks of the season (Table 6) were low and were not interpreted to be indicative of fishery trends for the overall fleet, thus, they were excluded from the Leslie analysis. Using the remaining data (weeks 2 - 12, Table 6), a Leslie analysis gave the following results (Figure 11):

$$CPUE_t = 78.33 - 1.68 \times 10^{-3} K_t$$
$$r = -0.95$$
$$B_0 = 46,691 \text{ t } (40290\text{t} - 56967 \text{ t}, p > 0.05)$$

Given a total catch of 24,266.8 t (Table 6) the above B_0 estimate yields an exploitation level (E.L.) estimate of 52% (42.6% - 60.0%, $p < 0.05$).

DISCUSSION

Total catch, total effort (trap hauls), mean CPUE, and biomass estimates have decreased compared to 1985 (Table 6, Fig. 22, Davidson et al., 1986).

Total catch exhibited a 3.5% decline between 1984 and 1985 (26062 t versus 25158 t, Table 7) and another 3.5% decline from 1985 to 1986 (25158 t to 24267 t, Table 7).

Total effort decreased 5.3% from 439,096 trap hauls in 1985 to 415,670 trap hauls in 1986 (Table 7).

Mean CPUE declined 2.8% between 1985 and 1986 (57.3 kg/trap haul and 55.7 kg/trap haul respectively, Table 7). The mean CPUE for the New Brunswick fleet has historically exceeded that of the Quebec fleet (Table 7). In 1985, the mean CPUE for the New Brunswick and Quebec fleets were 58.8 kg/trap haul and 53.1 kg/trap haul respectively (K.G. Davidson unpublished data). In 1986, the above trend was reversed with mean CPUE for the Quebec fleet surpassing that of the New Brunswick/Cape Breton Island fleet (65.5 kg/trap haul versus 48.2 kg/rap haul respectively, Tables 6 and 7). The above observation can be attributed to three factors:

1) In the fishery's early years, vessels in the Quebec fleet were considerably smaller on average than those in the New Brunswick fleet thereby limiting their comparative fishing power (Lamoureux and Lafleur, 1982). Since 1981, this difference in vessel size has steadily decreased (Lamoureux and Lafleur, 1982; Anonymous, 1985) and the convergence in the relative fishing power is no doubt reflected in converging CPUE's.

2) Use of a constant 2 to 1 factor for converting the number of Japanese trap hauls to box trap hauls for the Quebec fleet is debatable. Factors such as crab density, behavior and size (Dufour, 1984) can be expected to effect the ratio of catches of different trap types.

3) New Brunswick vessels tend to concentrate the majority of their fishing effort in the troughs bordering the Bradelle and Orphan Banks (Fig. 9, Davidson et al., 1986). The position of sea sampling locations for the samples taken aboard Quebec vessels in

1986, plus observations made from the Quebec fleet in 1985 (Fig. 12) indicate that the Quebec fleet exhibits a more diffuse pattern of effort distribution with zones of concentration in the baie des Chaleurs/eastern Gaspe coast regions, the western Bradelle Bank region, and the eastern Bradelle Bank region. Higher crab biomass and recruitment in these regions in 1986 compared to the heavily fished Bradelle and Orphan Bank regions may be reflected in the higher CPUE's enjoyed by the Quebec fleet.

The estimated B_0 for 1986 (46,691 t, Fig. 11) was down 46.6% from the 87,418 t 1985 estimate given by Davidson et al., (1986) resulting in an increase in estimated E.L. from 18.8% in 1985 (Davidson et al., 1986) to 52.0% in 1986 (Fig. 11). For 1985, where data was sufficient, Davidson et al., 1986) calculated EL's for zones within the southwestern Gulf. The best of these EL estimates, 46.3% and 52.5%, are comparable to the 52.0% overall 1986 value.

In comparing overall B_0 and EL estimates between 1985 and 1986, it is important to note that, in 1985, periodic increases in CPUE were observed and are attributed to shifts in the geographic location of fishing effort. The authors contend that these CPUE's resulted in a decreased slope in the Leslie regression thereby increasing (overestimating) the B_0 estimate which in turn decreased (underestimated) the EL. Seasonal shifts in the geographic distribution of fishing effort in 1986 (Fig. 10) were not observed to result in elevated CPUE's. The CPUE's showed a relatively stable decrease as the season progressed (Table 7), the linearity of which is reflected in the correlation coefficient (r) of -0.95 (for 1985, r= -0.74, Davidson et al., 1986) therefore the 1986 B_0 and EL estimates are deemed to be more accurate than those presented for 1985 (Davidson et al., 1986).

Size distributions and seasonal size decreases in 1986 exhibit little difference from those presented by Davidson et al., (1986) for 1985. All sea sampling data presented by Davidson et al., (1986) was collected aboard New Brunswick vessels therefore, the 1986 size distributions for New Brunswick samples will be used for comparison (Figs 6 and 7). In May, the mean size was 110.1 mm CW in 1985 and 110.4 mm CW in 1986 (modes were at 109-111 mm CW in 1985 and 111-113 mm CW respectively). In June, the mean sizes were 105.9 mm CW in 1985 and 108.2 mm CW in 1986. The mode in both years was 108-110 mm CW. The seasonal means were 109.2 mm CW and 109.1 mm CW for 1985 and 1986 respectively. The mode in 1985 was 109-111 mm CW and 108-110 mm CW in 1986.

The decrease in mean size as the season progressses (Fig. 6) is to expected due to the selective removal of the larger size classes from the fishery.

Low percentages of females, undersize males, and soft/white crabs in the 1986 sea samples (Tables 2 - 4, Figs 3 - 5) indicate an overall low discard rate in the catch. The differences observed in

these percentages, as well as the percentages of MI-males in sea samples taken aboard Quebec and New Brunswick vessels (Tables 2 - 4, Figs 3 - 5), coupled with the differences in the geographic locations of these samples (Figs 1 and 2) accentuate regional differences in the population structure and biology of the southwestern Gulf's snow crab populations.

The general increase in the incidence of MI-males in the catch coupled with a decrease in size as the season progresses (Figs 3 -5) indicates:

1) that the catchability of large, morphometrically mature males has decreased, either as a result of fishing exploitation or due to behavioral changes;

and/or

2) the catchability of MI-males has increased.

The fishery relies on MI-males to compose up to 26.5% of the legal catch. Morphometric maturity has been directly correlated to functional maturity (for males larger than 0.95 mm CW having both the physical and behavioral attributes necessary for successful mating; Conan and Comeau, 1986), therefore the earlier assumption that the fishery does not effect the reproductive capacity of snow crab populations (Bailey, 1978; Elner, 1982) may not be valid. The effect of harvesting non-mature males on recruitment warrants further investigation.

The overall prognosis for the 1986 southwestern Gulf of St. Lawrence midshore fishery is that biomass and exploitation levels appear to be at acceptable levels and size distributions have remained constant therefore, despite slight decreases in CPUE and total catch, the fishery has maintained itself well and should be able to continue doing so given current effort levels.

BIBLIOGRAPHY

Anonymous. 1985. Summary of statistics for the Gulf of St. Lawrence snow crab seminar. Prepared by Department of Fisheries and Oceans, Ottawa, November 1985.

Anonymous. 1986. Canadian Fisheries Landings Vol. 8, no. 6. Department of Fisheries and Oceans, Ottawa, Canada.

Bailey, R. 1978. Status of snow crab (Chionoecetes opilio) stocks in the Gulf of St. Lawrence. Can. Atl. Fish. Sci. Adv. Comm., Res. Doc. 78/27: 39 pp.

Conan, G.Y. and M. Comeau. 1986. Functional maturity of male snow crab, Chionoecetes opilio. Can. J. Fish. Aquat. Sci. Vol. 43(9): 1710-1719.

Cormier, R.J. 1984. A preliminary analysis of the New Brunswick snow crab (Chionoecetes opilio) fishery in the southwestern part of the Gulf of St. Lawrence. Can. Atl. Fish. Sci. Adv. Comm., Res. Doc. 84/83: 10 pp.

Cormier, R.J. and M. Comeau. 1986. Exploitation levels of the Cape Breton snow crab fishery (Areas 1 and 7) for 1984. Can. Atl. Fish. Sci. Adv. Comm., Res. Doc. 86/5: 15 pp.

Davidson, K., M. Comeau, P. Mallet and M. Moriyasu. 1986. Fishery trends and stock assessments for four snow crab, Chionoecetes opilio, fisheries in the Gulf of St. Lawrence, 1985. Can. Atl. Fish. Sci. Adv. Comm., Res. Doc. 86/51: 50 pp.

Dufour, R. 1984. Rendements comparatifs et sélectivité de trois types de casiers à crabes des neiges. Can. Atl. Fish. Sci. Adv. Comm., Res. Doc. 84/1: 25 pp.

Elner, R.W. 1982. Characteristics of the snow crab, Chionoecetes opilio, fishery off Cape Breton Island. In "Proceedings of the International Symposium on the Genus Chionoecetes". Alaska Sea Grant Rep. no 82-10: 657-680.

Elner, R.W. and R.F.J. Bailey. 1986. Differential susceptability of Atlantic snow crab, Chionoecetes opilio, stocks to management. 335-346. In G.S. Jamieson and N. Bourne (ed.) North Pacific Workshop on Stock Assessment and Management of Invertebrates. Can. Spec. Publ. Fish. Aquat. Sci. 92.

Elner, R.W. and D.A. Robichaud. 1986. Assessment of the fishery for snow crab off the Atlantic Coast of Cape Breton Island in 1985. Can. Atl. Fish. Sci. Adv. Comm., Res. Doc. 86/10: 30 pp.

Lamoureux, P. and P.-E. Lafleur. 1982. The effects of exploitation on snow crab populations of the southwestern Gulf of St. Lawrence between 1975 and 1981. In "Proceedings of the International Symposium in the Genus Chionoecetes". Alaska Sea Grant Rep. 82-10: 443-481.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Board Can. 191: 382 pp.

Table 1 - Estimated snow crab landings and landed values for Atlantic Canada, 1966-1986.

Year	SW Gulf of St.Lawrence (N.B.,Quebec)	Cape Breton Island (Nova Scotia)	Atlantic Canada total (t)	Landed values ($000)	Average price to fishermen (¢/kg)
1966(1)	30	---	30	2.4	8
1967(1)	158	241	496	84	17
1968(1)	3939	713	5029	1005	20
1969(1)	7580	98	8223	1664	20
1970(1)	5634	90	7534	1582	21
1971(1)	5374	136	6992	1246	18
1972(1)	5392	51	6718	1948	29
1973(1)	6969	122	9549	3724	39
1974(1)	6704	217	10046	3817	38
1975(1)	4632	379	6849	2397	35
1976(1)	7568	489	10500	4619	44
1977(1)	9537	936	14099	7331	52
1978(1)	10462	3189	21936	12503	57
1979(1)	15793	3225	30681	20556	67
1980(1)	14854	2500	28539	16838	59
1981(1)	21877	1615	37453	21723	58
1982(1)	31585	2190	47004	43243	92
1983(1)	24342	2209	37255	53274	143
1984	26062(2)	1916(4-5)			
1985	25158(2)	1856(2-5)	30565(6)	32292(6)	106(6)
1986	24263(3)		29479(6)	39540(6)	134(6)

(1) Elner and Bailey, 1986
(2) Davidson et al., 1986
(3) Preliminary
(4) Cormier and Comeau, 1986
(5) Elner and Robichaud, 1986
(6) Canadian Fisheries - Landings, Economic and commercial analysis directorate, Fisheries and Oceans, Vol. 8 no. 6, June 1986. (Anon, 1986).

Table 2 - Percentage of female snow crabs (% females), Chionoecetes opilio, present in sea samples taken during the 1986 southwestern Gulf of St. Lawrence offshore fishing season.

WEEK		N.B. samples %females (N)*	P.Q. samples %female (N)*	Total Gulf %female (N)*
1 April	6-12	-	-	-
2 April	13-19	-	-	-
3 April	20-26	-	-	-
4 April	27-May 3	-	-	-
5 May	4-10	-	-	-
6 May	11-17	2.4% (3605)	5.6% (1634)	3.3% (5239)
7 May	18-24	7.6% (1128)	8.0% (187)	7.6% (1315)
8 May	25-31	4.9% (2404)	14.1% (1050)	7.7% (3454)
9 June	1- 7	3.8% (1493)	2.4% (539)	3.4% (2032)
10 June	8-14	1.3% (2635)	1.7% (463)	1.3% (3098)
11 June	15-21	6.5% (2747)	3.1% (810)	5.7% (3557)
12 June	22-28	6.0% (942)	7.5% (308)	6.4% (1250)
13 June	29-July 5	-	-	-
	Mean =	4.1%(14954)	6.5% (4991)	4.7%(19945)

* Number sampled

Table 3 - Percentage of undersize male snow crabs (% unders), Chionoecetes opilio, present in sea samples taken during the 1986 southwestern Gulf of St. Lawrence offshore fishing season.

WEEK		N.B. samples %Unders.(N)*	P.Q. samples %Unders.(N)*	Total Gulf %Unders.(N)*
1 April	6-12	-	-	-
2 April	13-19	-	-	-
3 April	20-26	-	-	-
4 April	27-May 3	-	2.9% (68)	2.9% (68)
5 May	4-10	-	-	-
6 May	11-17	4.6% (1504)	5.8% (1634)	5.2% (3138)
7 May	18-24	5.3% (469)	9.6% (187)	6.6% (656)
8 May	25-31	2.6% (954)	5.4% (1050)	4.1% (2004)
9 June	1- 7	4.5% (683)	10.4% (539)	7.2% (1222)
10 June	8-14	4.2% (1040)	5.2% (463)	4.5% (1503)
11 June	15-21	7.4% (920)	11.2% (810)	9.2% (1730)
12 June	22-28	17.1% (519)	7.8% (308)	13.7% (827)
13 June	29-July 5	-	-	-
	Mean =	5.8% (6089)	7.3% (5059)	6.5%(11148)

* Number sampled

Table 4 - Percentage of soft/white snow crabs (% soft), Chionoecetes opilio, present in sea samples taken during the 1986 southwestern Gulf of St. Lawrence offshore fishing season.

WEEK		N.B. samples % Soft (N)*	P.Q. samples % Soft (N)*	Total Gulf % Soft (N)*
1 April	6-12	-	-	-
2 April	13-19	-	-	-
3 April	20-26	-	-	-
4 April	27-May 3	-	-	-
5 May	4-10	-	-	-
6 May	11-17	2.0% (1504)	0.1% (1634)	1.0% (3138)
7 May	18-24	9.6% (469)	2.7% (187)	7.6% (656)
8 May	25-31	5.6% (954)	0.0% (1050)	2.7% (2004)
9 June	1- 7	8.5% (683)	4.6% (539)	6.8% (1222)
10 June	8-14	8.0% (1040)	0.2% (463)	5.6% (1503)
11 June	15-21	5.9% (920)	12.1% (810)	8.8% (1730)
12 June	22-28	5.6% (519)	23.4% (308)	12.2% (827)
13 June	29-July 5	-	-	-
	Mean =	5.8% (6089)	4.0% (4991)	4.9%(11080)

* Number sampled

Table 5 - Percentage of morphometrically immature male snow crabs (% imm.), Chionoecetes opilio, present in sea samples taken during the 1986 southwestern Gulf of St. Lawrence offshore fishing season.

WEEK	N.B. samples		P.Q. samples		Total Gulf	
	% Imm.	(N)*	% Imm.	(N)*	% Imm.	(N)*
1 April 6-12	-		-		-	
2 April 13-19	-		-		-	
3 April 20-26	-		-		-	
4 April 27-May 3	8.3%	(12)	0%	(68)	1.3%	(80)
5 May 4-10	6.4%	(156)	-		6.4%	(156)
6 May 11-17	7.8%	(1404)	5.7%	(1478)	6.7%	(2882)
7 May 18-24	12.7%	(442)	4.7%	(169)	10.5%	(611)
8 May 25-31	10.0%	(914)	22.2%	(863)	15.9%	(1777)
9 June 1- 7	12.5%	(637)	25.4%	(481)	18.0%	(1118)
10 June 8-14	27.6%	(1027)	41.9%	(453)	32.0%	(1480)
11 June 15-21	15.9%	(882)	47.3%	(747)	30.3%	(1629)
12 June 22-28	13.2%	(499)	31.0%	(352)	22.2%	(851)
13 June 29-July 5	-		-		-	
Mean =	14.8%	(5973)	22.9%	(4611)	17.9%	(10584)

* Number sampled

TABLE 6 - Weekly effort and catch data for the 1986 southwestern Gulf of St. Lawrence snow crab, Chionoecetes opilio, fishery.

WEEK	CPUE[1] N.B.	CPUE[1] P.Q.	CPUE[1] Overall	Trap hauls N.B.	Trap hauls P.Q.	Trap hauls Overall	Catch N.B. (t)	Catch P.Q. (t)	Catch, C_t Overall (t)	$C_t/2$ (t)	Cumulative Catch K_t (t)
1 Apr. 6-12	19.2	67.4	58.4	1050	660	1710	-	39.4	39.4	19.7	19.7
2 Apr. 13-19	72.9	78.0	75.1	22405	12152	34557	1739.1	787.9	2527.0	1263.5	1302.9
3 Apr. 20-26	63.5	80.6	70.2	30785	13970	44755	2390.0	1008.5	3398.5	1699.3	4265.7
4 Apr. 27-May 3	60.3	83.0	69.3	32423	14342	46765	2019.3	1119.9	3139.2	1569.6	7534.6
5 May 4-10	56.6	75.0	63.8	32892	16178	49070	2135.2	1124.8	3260.0	1630.0	10734.2
6 May 11-17	45.8	67.9	55.8	30401	16408	46809	1601.7	1058.8	2660.5	1330.3	13694.5
7 May 18-24	37.1	60.3	47.1	28291	13538	41829	1239.1	759.9	1999.0	999.5	16024.3
8 May 25-31	34.6	50.3	42.0	23878	14139	38017	967.2	692.6	1659.8	829.5	17853.7
9 June 1- 7	28.7	54.7	41.7	22127	13634	35761	737.2	719.6	1456.8	728.4	19412.0
10 June 8-14	35.0	61.1	49.0	14998	10755	25753	665.4	647.3	1312.7	656.4	20796.8
11 June 15-21	38.1	55.3	45.7	18035	9026	27061	1051.3	555.0	1606.3	803.2	22256.4
12 June 22-28	33.9	44.1	37.7	15267	7511	22772	797.1	380.7	1177.8	588.9	23648.5
13 June 29-July 5	20.5	26.6	23.0	437	374	811	17.4	12.4	29.8	14.9	24252.3
Mean=	48.2	65.5	55.7	Total=272983	142687	415670	15360.0	8906.8	24266.8		

[1] CPUE - kg/trap haul

TABLE 7 - Annual catch, effort and quotas for the southwestern Gulf of St. Lawrence snow crab, Chionoecetes opilio, fishery from 1968 to 1986.

Year	C.P.U.E. (kg/trap haul)	Total catch (t)	# of trap haul	Quota (t)
1968	30.32(1)	3939(7)	129914(*)	-
1969	38.28(1)	7580(7)	198015(*)	-
1970	52.22(1)	5634(7)	107890(*)	-
1971	47.51(1)	5374(7)	113113(*)	-
1972	42.18(1)	5392(7)	127833(*)	-
1973	19.74(1)	6969(7)	353040(*)	-
1974	25.80(1)	6704(7)	259845(*)	-
1975	31.88(1)	4632(7)	145295(*)	-
1976	23.01(1)	7568(7)	328900(*)	-
1977	29.38(1)	9537(7)	324608(*)	-
	N.B. Quebec			
1978	27.9(3) 18.0(3)	10462(4)	438697(4)	-
1979	35.7(3) 23.8(3)	15794(2)	506853(4)	-
1980	50.6(3) 34.9(3)	14854(2)	328178(4)	-
1981	61.8(3) 34.7(3)	21877(7)	396759(4)	-
1982	66.8(3) 41.2(3)	31585(7)	499709(4)	-
1983	65.5(3) 42.7(3)	24342(2)	362772(7)	-
1984	66.7(3) 43.9(3)	26062(2)		26000
1985	58.8(6) 53.1(6) 57.3 - combined(5)	25158(5)	439096(5)	28000
1986	48.2(6) 65.5(6) 55.7 - combined(6)	24267(6)	415670(6)	-

(1) Bailey, R. 1978 CAFSAC Res. Doc. 78/27
(2) CAFSAC Advisory Document 85/20
(3) CAFSAC Advisory Document 86/2
(4) CAFSAC Advisory Document 83/12
(5) Davidson et al., 1986, CAFSAC Res. Doc. 86/51
(6) Present paper
(7) Elner R.W. and R. Bailey (personnel communication)
(*) Estimated by dividing landing data by CPUE

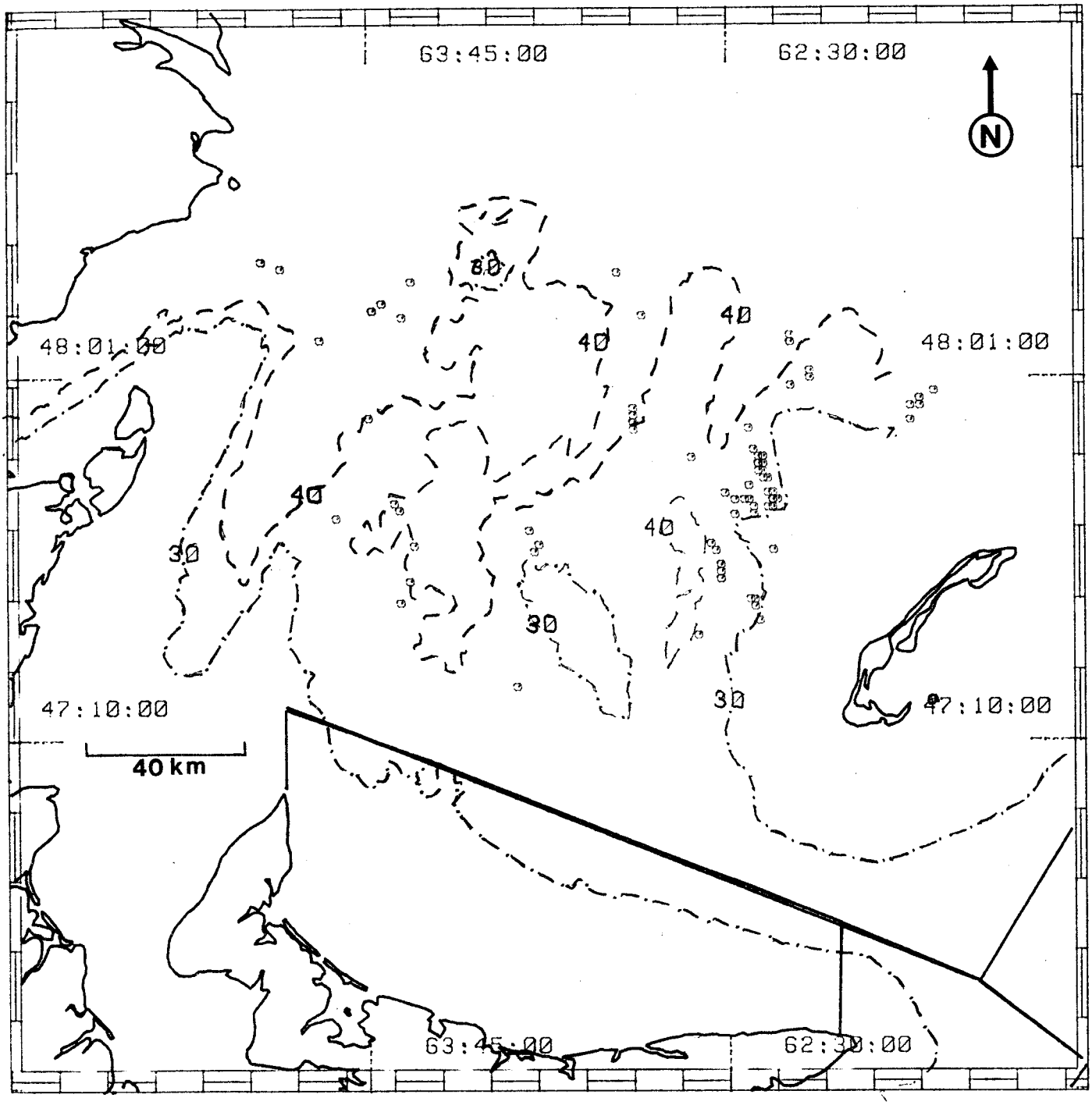


Figure 1: Geographic distribution of sea samples taken aboard Quebec vessels during the 1986, SW Gulf of St. Lawrence snow crab, Chionoecetes opilio, fishery.

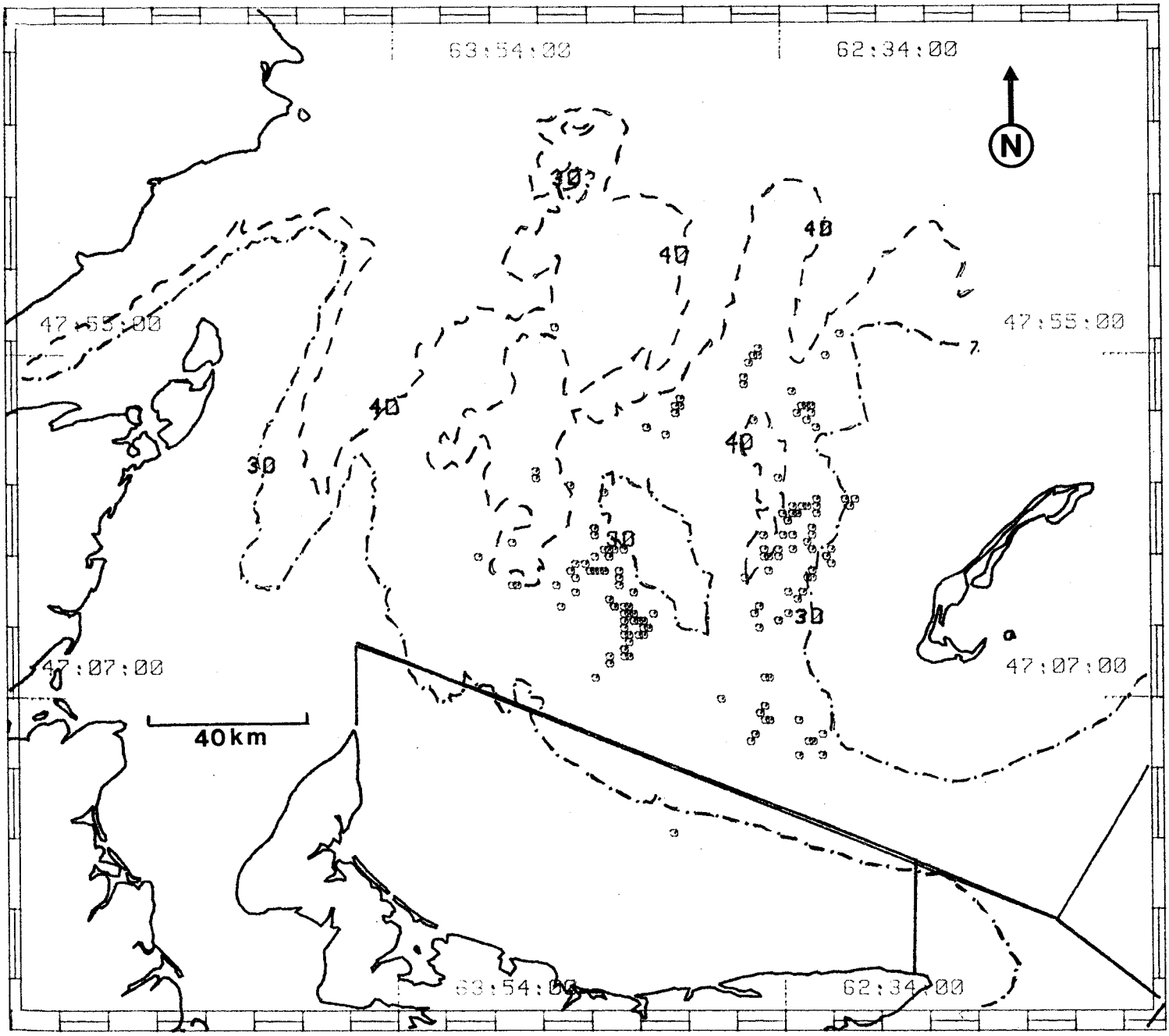


Figure 2: Geographic distribution of sea samples taken aboard New Brunswick vessels during the 1986, SW Gulf of St. Lawrence snow crab, Chionoecetes opilio, fishery.

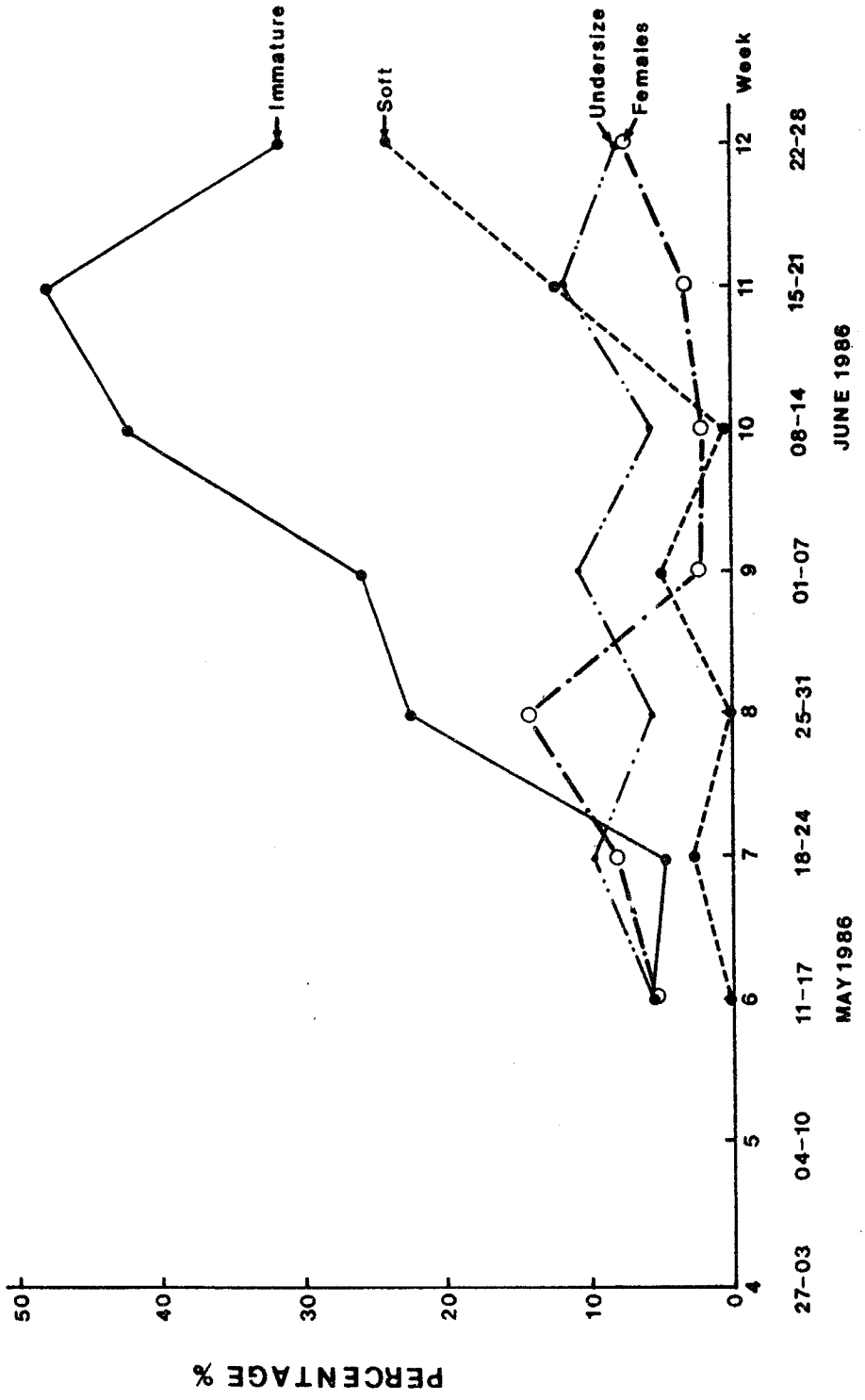


Figure 3: Weekly percentages of female, undersize male, soft/white, and morphometrically immature male snow crabs, Chionoecetes opilio, present in sea samples taken aboard Quebec vessels during the 1986 SW Gulf of St. Lawrence fishery.

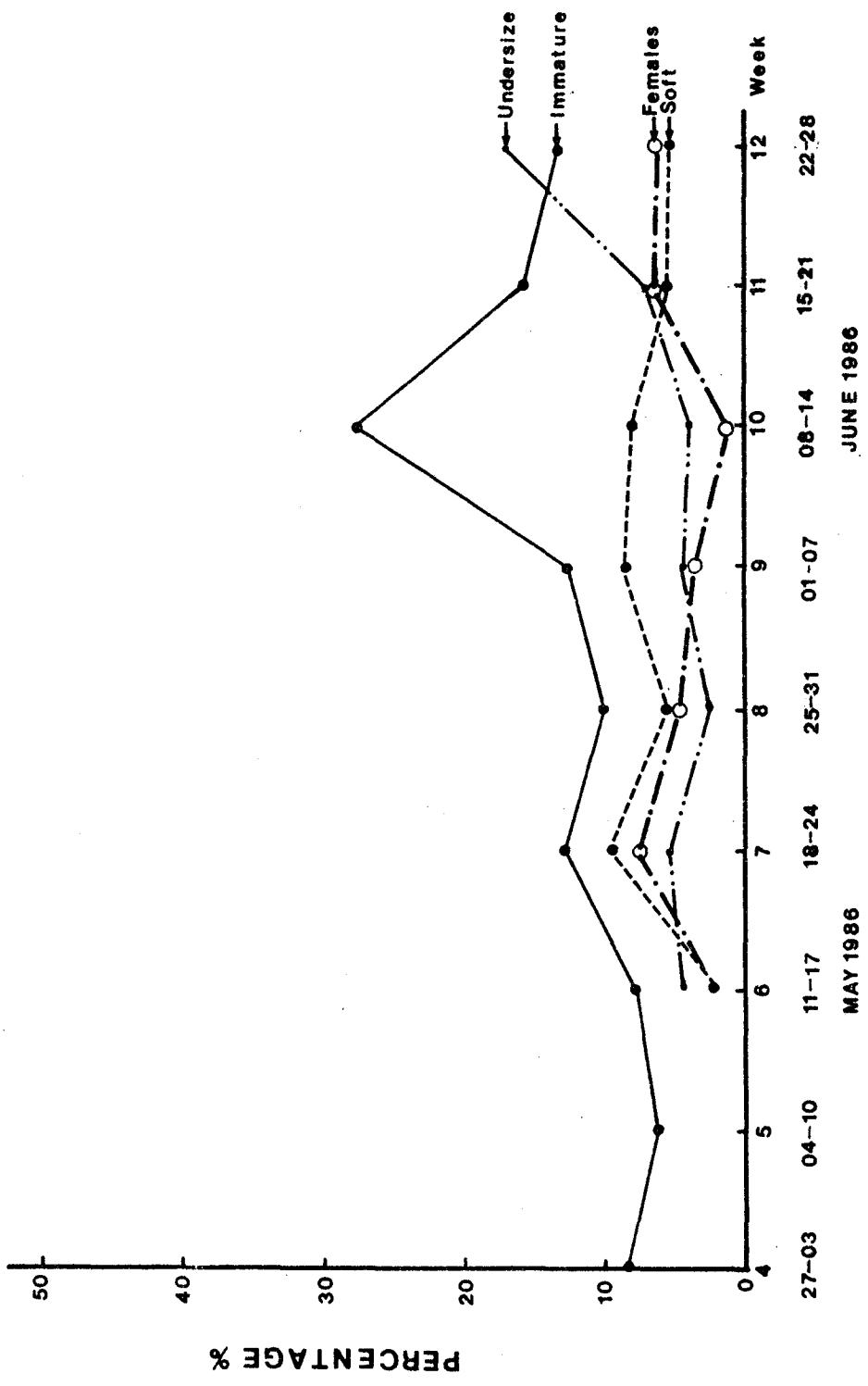


Figure 4: Weekly percentages of female, undersize male, soft/white, and morphometrically immature male snow crabs, Chionoecetes opilio, present in sea samples taken aboard New Brunswick vessels during the 1986 SW Gulf of St. Lawrence fishery.

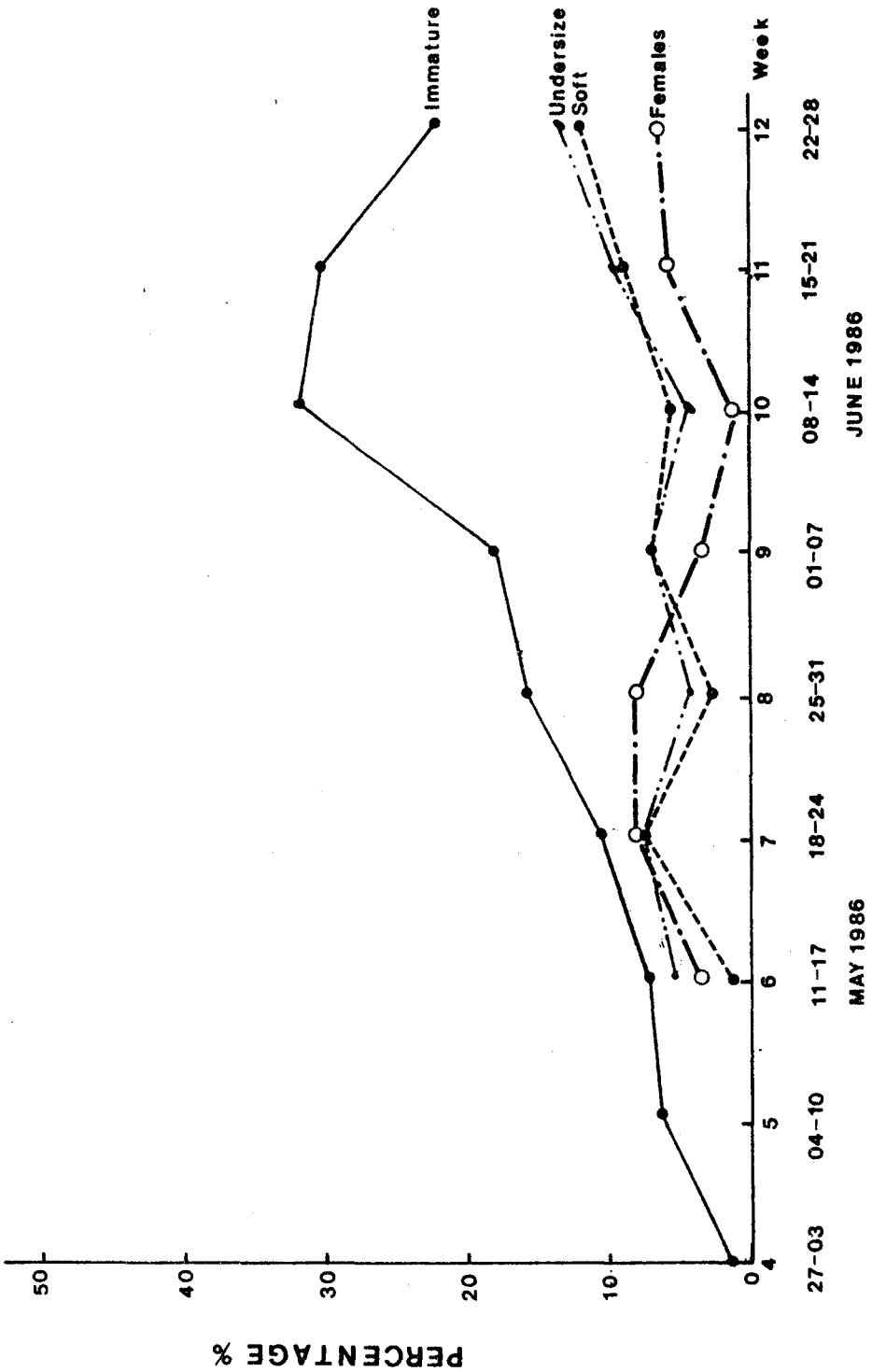


Figure 5: Weekly percentages of female, undersize male, soft/white, and morphometrically immature male snow crabs, Chionoecetes opilio, present in all sea samples taken during the 1986, SW Gulf of St. Lawrence fishery.

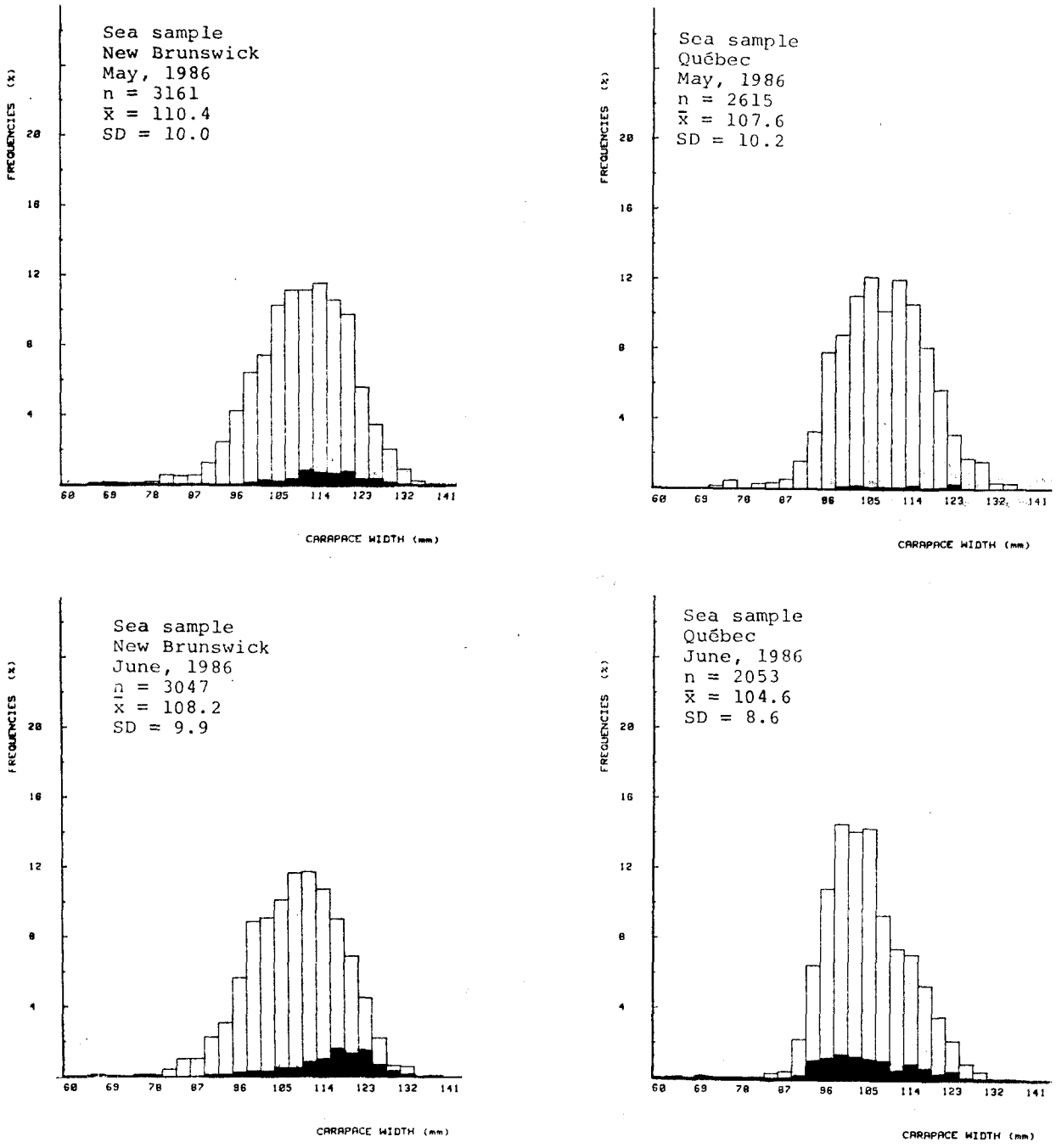
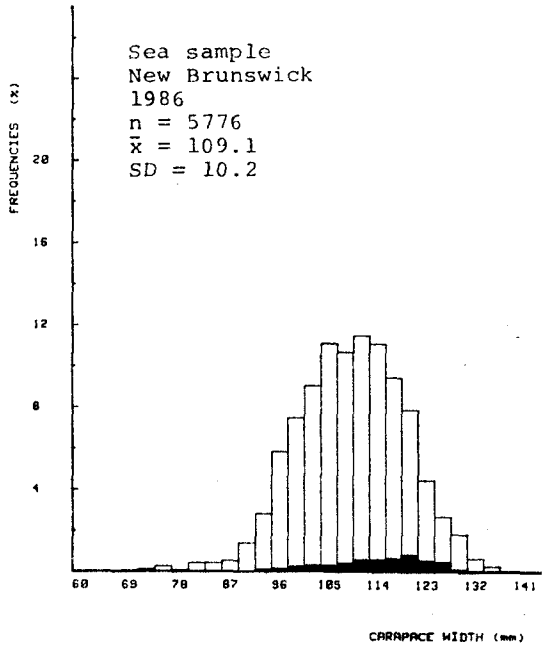


Figure 6: Monthly size distributions for sea samples of male snow crabs, Chionoecetes opilio, caught by Quebec and New Brunswick vessels during the 1986, SW Gulf of St. Lawrence fishery.

■ white/soft crab



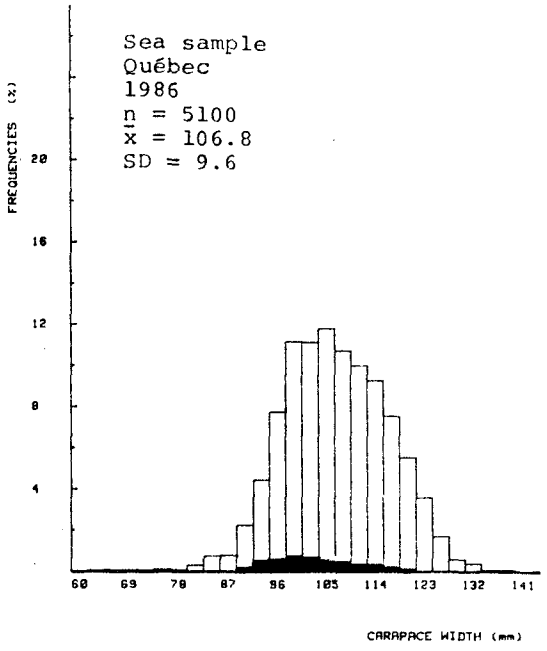


Figure 7: Seasonal size distributions for sea samples of male snow crabs, Chionoecetes opilio, caught by Quebec and New Brunswick vessels during the 1986, SW Gulf of St. Lawrence fishery.

■ white/soft crab

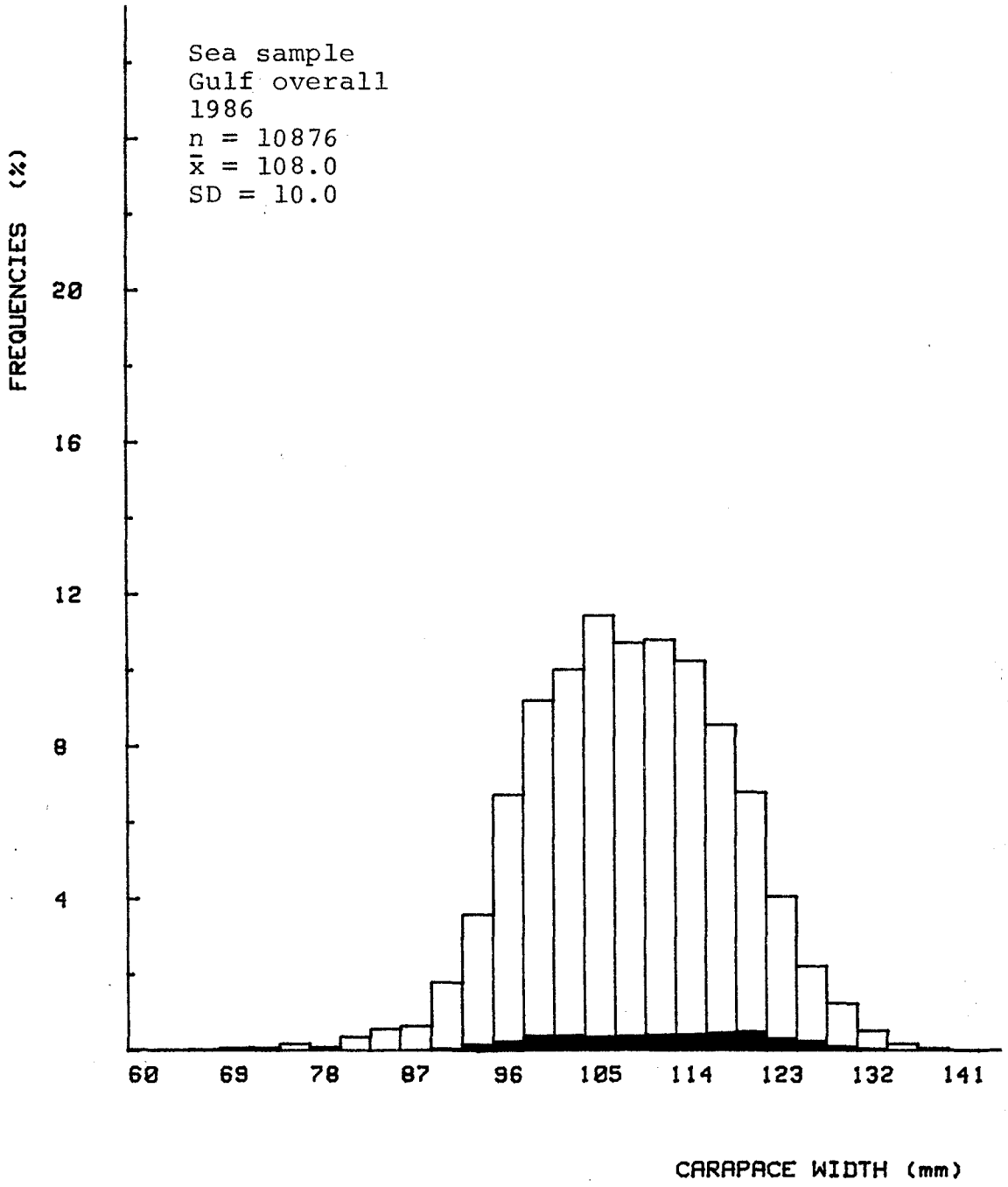


Figure 8: Overall size distribution for male snow crabs, Chionoecetes opilio, present in sea samples measured during the 1986, SW Gulf of St. Lawrence fishery.

■ white/soft crab

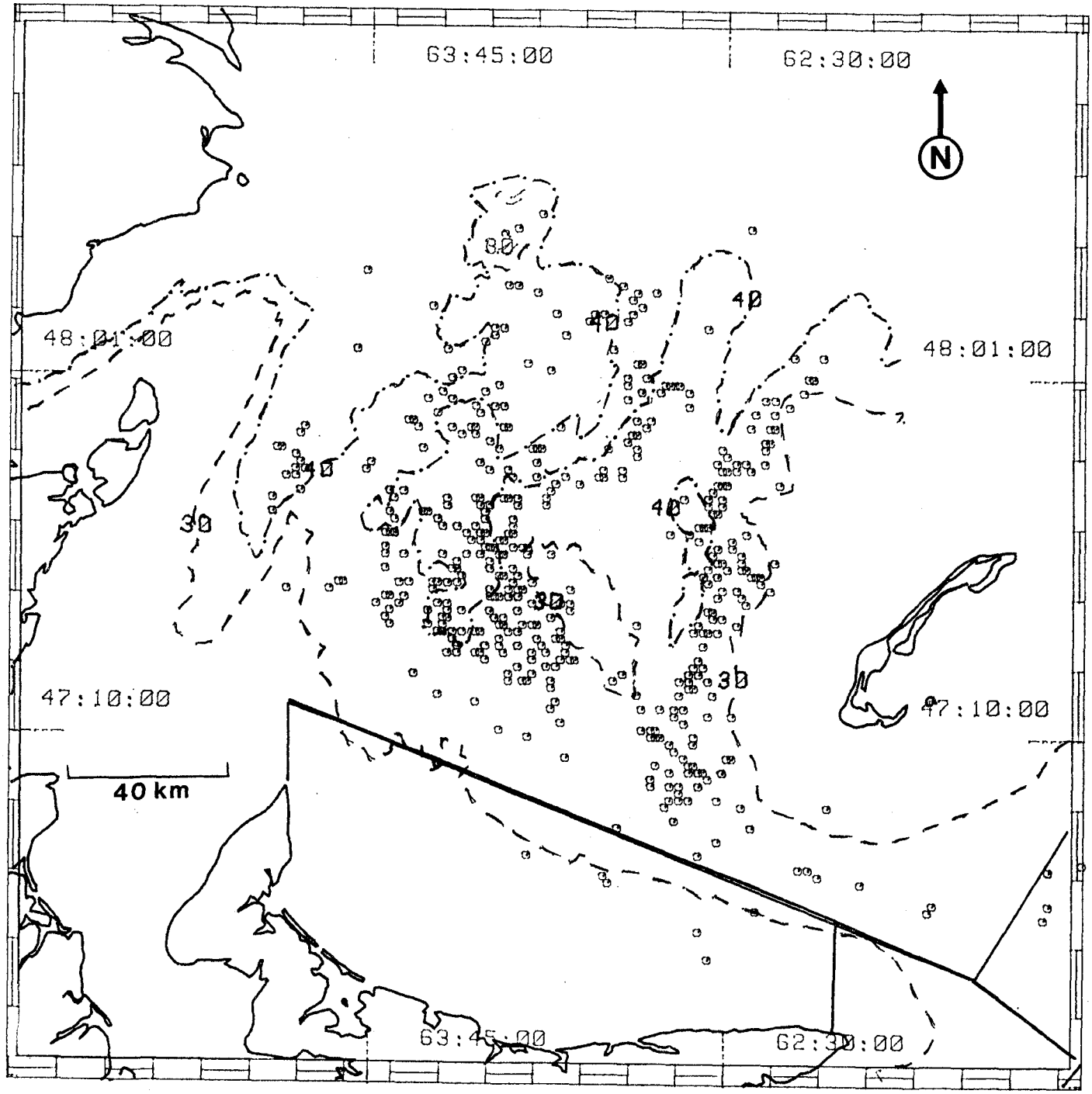


Figure 9: Overall distribution of fishing effort for New Brunswick/Cape Breton Island snow crab, Chionoecetes opilio, fishing vessels participating in the 1986, SW Gulf of St. Lawrence fishery.

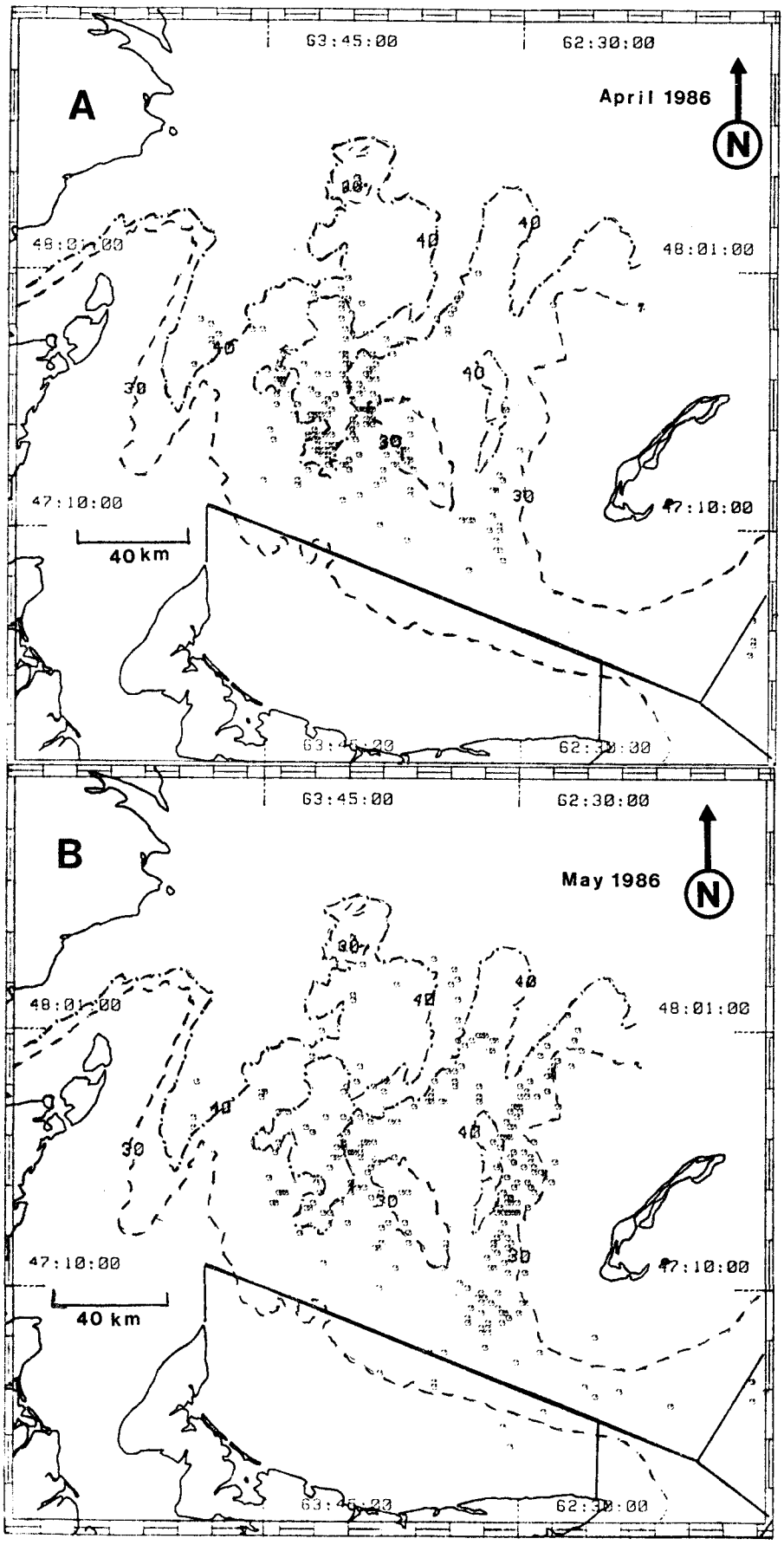


Figure 10: Monthly distributions of fishing effort for New Brunswick/Cape Breton Island snow crab, Chionoecetes opilio, fishing vessels participating in the 1986, SW Gulf of St. Lawrence fishery.

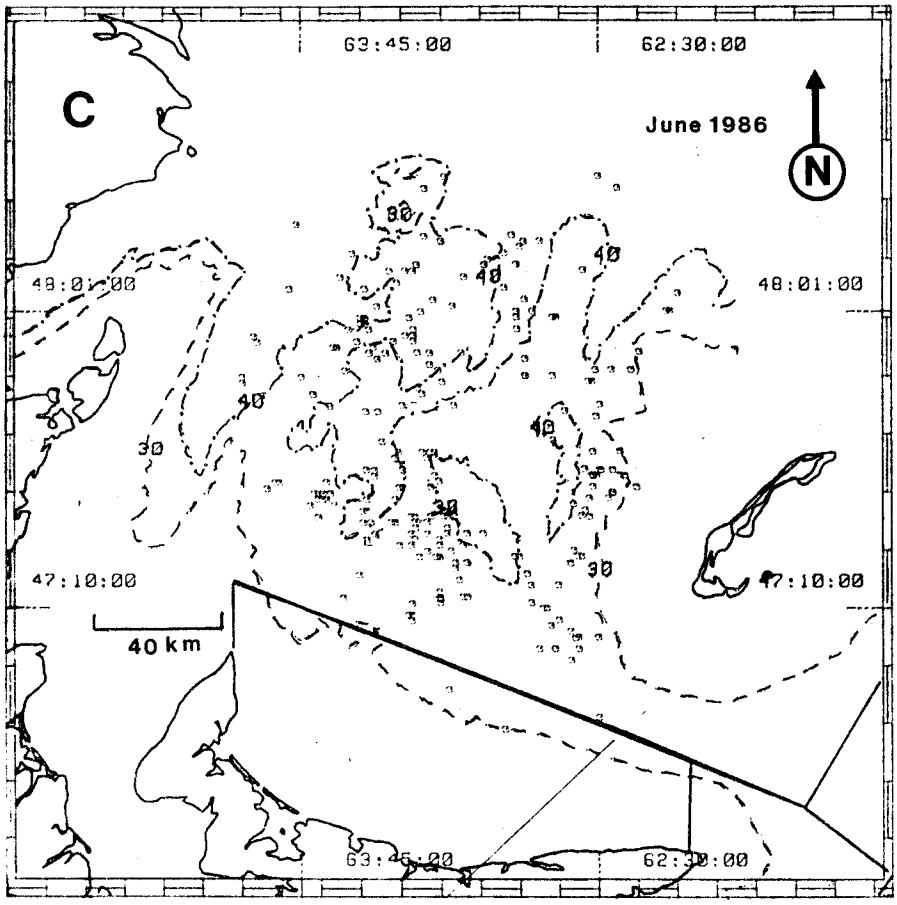

C
63:45:00
62:30:00
June 1986
N
48:01:00
48:01:00
47:10:00
47:10:00
40 km
63:45:00
62:30:00

Fig.10 Cont.

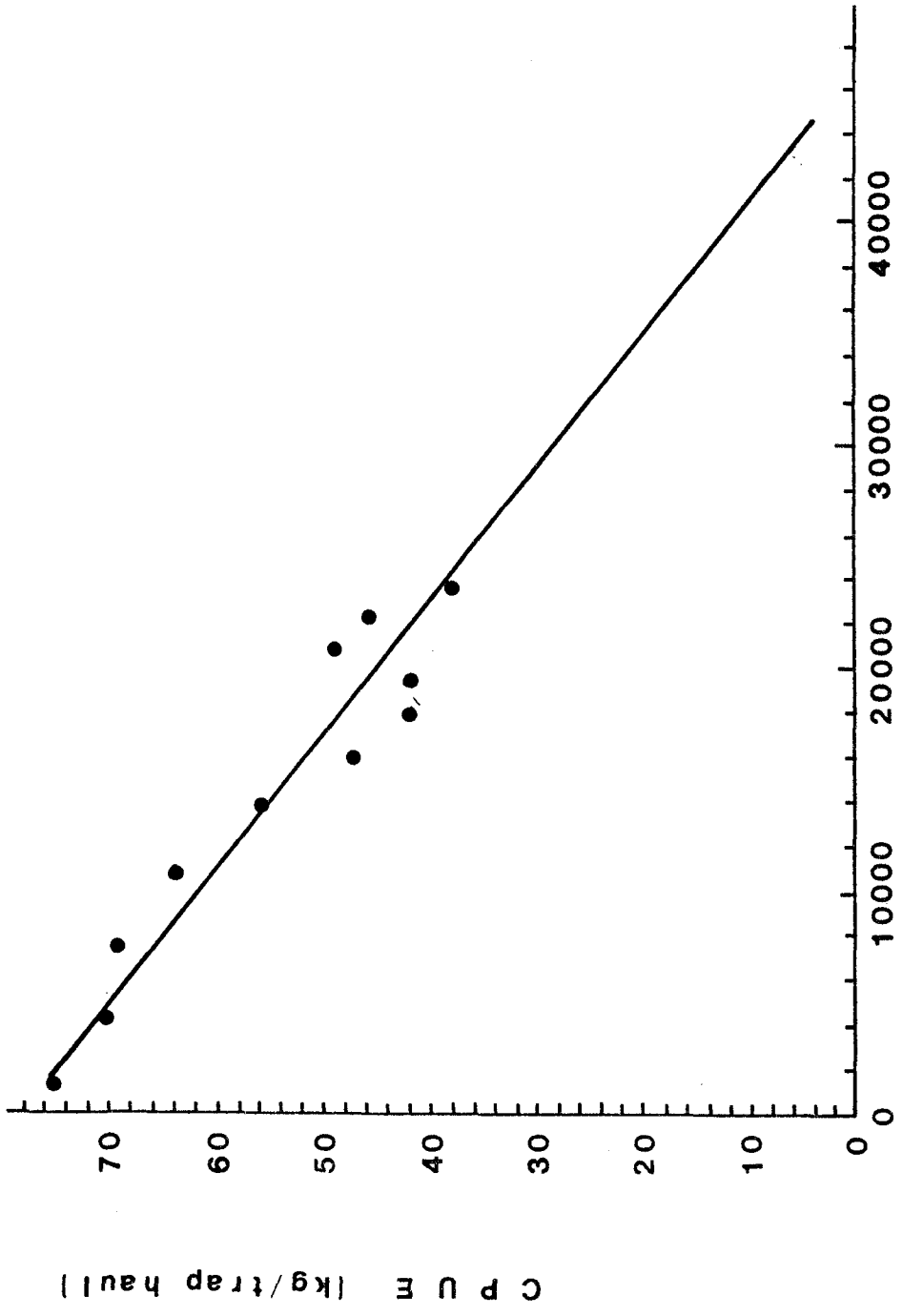


Figure 11: Leslie analysis results for catch (t) and effort CPUE data collected from fishermen's logbooks and processors sales slips for the 1986, SW Gulf of St. Lawrence snow crab, Chionoecetes opilio, midshore fishery.

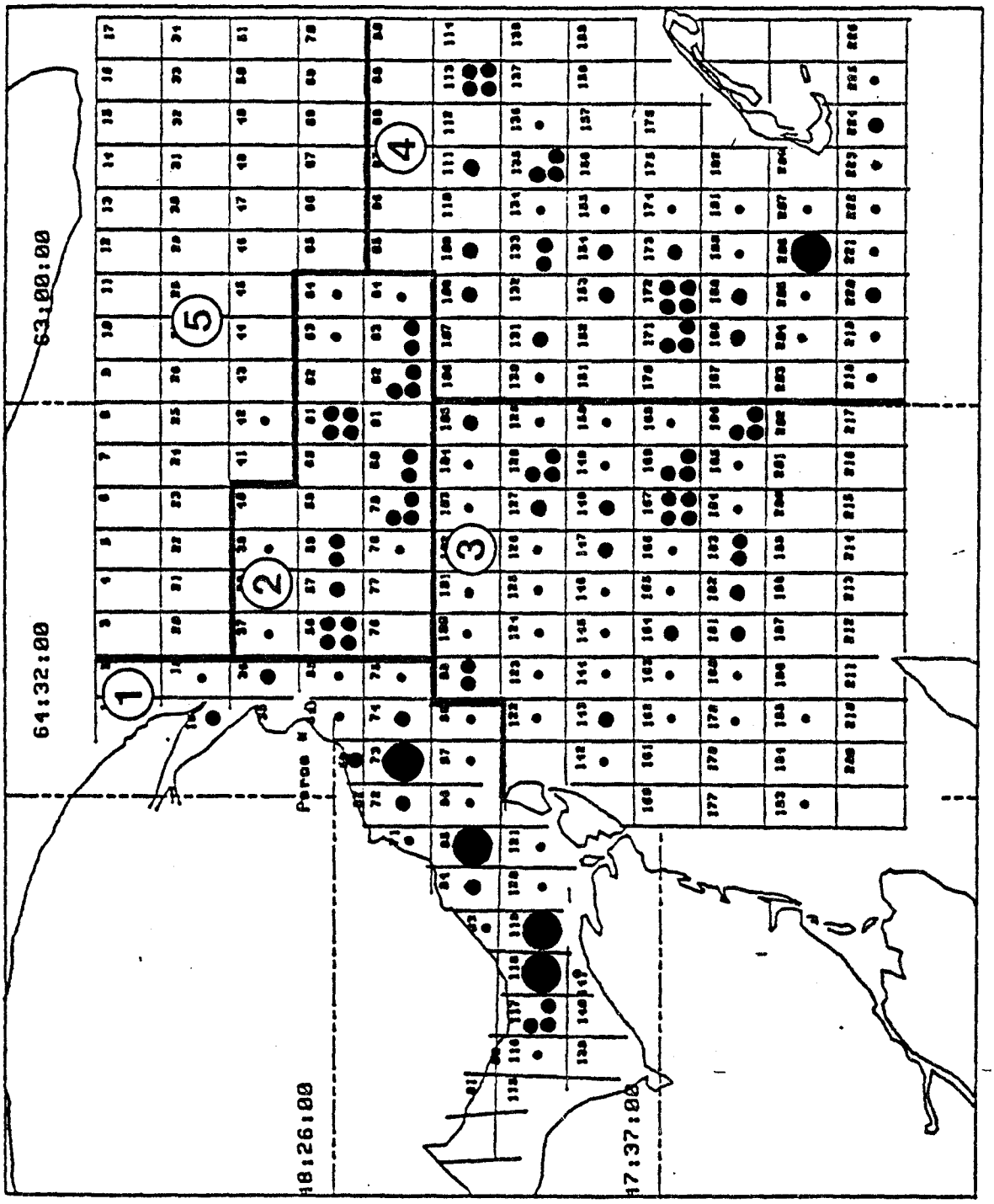


Figure 12: Distribution of fishing effort for the southwestern Gulf of St. Lawrence snow crab, Chionoecetes opilio, fishery in 1985 - the Quebec fleet. (after Davidson et al., 1986)