An overview of catch, effort and biological trends for the 1986 snow crab, Chionoecetes opilio, fisheries in Areas 18 and 19, western Cape Breton Island.

by

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ABSTRACT

Biological characteristics of the snow crab populations fished in Areas 18 and 19 (formerly Areas 7 and 1 respectively) were monitored during the 1986 fishing season by port sampling and sea sampling of the catches. Data obtained from fishermen's logbooks and processor's sales slips were used in Leslie analyses of catch/effort trends to give estimates of initial biomass (B_o) and exploitation levels (E.L.)

Area 19

A number of trends observed for the Area 19 fishery cause concern for the stability of the snow crab population in this area. Estimated B_o was 29% lower in 1986 than in 1985 (2343 t versus 3291 t respectively) resulting in an increase in E.L. from 34.8% in 1985 to 52.7% in 1986. Unlike 1985, frequent shifts in the spatial and temporal distribution of fishing effort failed to maintain CPUE levels. The mean CPUE in 1986 decreased 8% from the 1985 level (32.0 kg/trap haul versus 34.8 kg/trap haul respectively). Up to 40% of the sampled catch was composed of morphometrically immature (MI) males; this, coupled with the observation of up to 4.6% of sampled females being non-berried, is a cause for concern for the reproductive potential of the population. Seasonal mean size of captured males decreased from 111.0 mm carapace width (CW) in 1985 to 101.3 mm CW in 1986. Late season levels of undersize male crabs in the catch reached 55%.

Indications are that current recruitment into the fishery cannot sustain the present levels of fishing pressure. There is a need for a new management strategy for Area 19.

Area 18

Our results indicate that 1986 was a year of good recruitment and catches in Area 18. The estimated B_o for 1986 (1153 t) represents a 53% increase over that estimated for 1985 (753 t). Estimates of E.L. decreased from 71.3% in 1985 to 59.7% in 1986. Total effort decreased from 17109 trap hauls in 1985 to 11769 trap hauls in 1986. Mean CPUE, benefitting from increased biomass and decreased effort, increased 36.9% between 1985 and 1986 (31.4 kg/trap haul versus 43.0 kg/trap haul respectively).

As in previous years, a high percentage (seasonal mean of 34.2%) of white/soft crab was present in the landings sampled. A high percentage of newly molted crab in the early season landings is indicative of strong recruitment. As in Area 19, the fishery exhibits a heavy reliance on MI males thereby causing concern for the reproductive integrity of the population.

It is recommended that the current management policy be maintained for the 1987 season.

RESUME

Les caractéristiques biologiques des populations de crabe des neiges pêchés dans les zones 18 et 19 (auparavant 7 et 1 respectivement) ont été enregistrées pour la saison de pêche 1986 grâce à l'échantillonnage au port et l'échantillonnage des captures en mer. Les données obtenues des journaux de bord des pêcheurs et des récipissés d'achat ont été utilisés dans l'analyse de Leslie des tendances de l'effort de pêche, afin de donner une estimation de la biomasse initiale (B_o) et du niveau d'exploitation (EL).

Zone 19 - Plusieurs tendances observées pour la zone de pêche 19 met en doute la stabilité de la population de crabe des neiges dans cette zone. L'estimation de B_o était 29% plus basse en 1986 qu'elle ne l'était en 1985 (2343 t contre 3291 t respectivement) résultant en une augmentation du EL de 34,8 t en 1985 à 52,7% en 1986. Contrairement à 1985 les fréquents changements de la distribution spatiale et temporale de l'effort de pêche n'ont pas permi de maintenir les niveaux de PUE. La PUE moyenne en 1986 a diminué de 8% par rapport à celle de 1985 (32,0 kg/casiers levés contre 34,8 kg/casiers levés respectivement). Jusqu'à 40% des prises échantillonnées étaient composées de mâles morphométriquement immatures (MI); ceci, jumelés avec l'observation d'un pourcentage de femelle échantillonnée non-ovigènes de 4,6% indiquent que le potentiel reproductif de la population est affecté. La moyenne saisonnnière de taille capturées chez les mâles a diminué de 111,0 mm de largeur du céphalothorax (LAC) en 1985 à 101,3 mm de LAC en 1986. Le niveau de mâles sublégaux dans les prises a atteint 55% à la fin de la saison de pêche.

Les indications sont que le recrutement dans la pêcherie ne peut pas soutenir le niveau d'exploitation actuel. Il y a un besoin d'élaborer une nouvelle stratégie pour la gestion de la zone 19.

Zone 18 - Les résultats indiquent que 1986 a été une année où il y a un bon recrutement et de bonnes prises dans la zone 18. L'estimation de B_o pour 1986 (1153 t) représente une augmentation de 53% par rapport à celle de 1985 (753 t). L'estimation du EL a diminué de 71,3% en 1985 à 59,7% en 1986. L'effort total a diminué de 17109 casiers levés en 1985 à 11769 casiers levés en 1986. La PUE moyenne, qui grâce à l'augmentation de la biomasse et une réduction de l'effort, a augmenté de 36,9% entre 1985 et 1986 (31,4 kg/casiers levés contre 43,0 kg/casiers levés respectivement)

Comme les années précédentes, un pourcentage élevé (moyenne saisonnière de 34,2%) de crabe blanc à carapace molle était présent dans les débarquements échantillonnés. Un pourcentage élevé de crabe à carapace nouvelle dans les débarquements au début de la saison est indicatif d'un bon recrutement. Comme pour la zone 19, la pêcherie démontre une dépendance sur des crabes MI indiquant que le potentiel reproductif de la population est affecté.

Il est recommandé que l'actuel plan de gestion devrait rester en place pour la saison 1987.

INTRODUCTION

The commercial snow crab fishery off Cape Breton Island was initiated in the late 1960's by inshore fishermen based in Cheticamp and offshore vessels from New Brunswick and Quebec. The fishery initially concentrated in the "gully" region off the northwest coast but expanded gradually to include snow crab grounds in all of Cape Breton's coastal waters. Coinciding with the development of the fishery, a demand for a more regulated approach to snow crab resource management led to the establishment of inshore fishing areas (Figure 1) to be used exclusively by inshore vessels of under 13.7 m (45 ft) in length.

Area 19 (formerly Area 1)

Area 19, off the northwest coast (Figure 1) contains the "gully" region where the fishery first began and, historically, has been the most productive of Cape Breton's snow crab areas (in 1985, Area 19 accounted for approximately 66.5% of the total Cape Breton snow crab landings).

The area was closed to offshore snow crab vessels in 1978, at which time only 14 inshore boats were licensed for the area. The snow crab management strategy for this area has been to develop a multi-participant, supplementary fishery. In keeping with this goal, additional licenses were issued in 1979 and 1984 (Table 1). Estimates of total allowable catch (TAC) obtained from Leslie analyses of yearly biomass additions (Bailey, 1978; Elner and Robichaud, 1980, 1981; Elner, 1982; Bailey and Cormier, 1983; Cormier and Comeau, 1986; Davidson et al., 1986; Table 2) and boat quotas (Table 1) have been used for regulating catches in this fishery.

The decreases in mean seasonal catch per unit effort ($\overline{\text{CPUE}}$; Table 2), spacial expansion of the fishery, and frequent spacial and temporal shifts in fishing effort in recent years indicate that the snow crab resource in this area may be undergoing a heavier fishing pressure than suggested by the results of recent Leslie analyses (Davidson et al., 1986).

Area 18 (formerly Area 7)

Area 18 snow crab populations have been exploited by New Brunswick, Québec and P.E.I. offshore vessels since the early to mid 1960's (Elner and Robichaud, 1981). Inshore vessels did not participate in this fishery until 1979, at which time 14 experimental permits were issued (Table 3). These permits were upgraded to licenses the following year and 9 additional licenses were issued (Table 3). From 1979 to 1983, Area 18's only boundary was the southern border of Area 19 (Figure 1). In 1984, northwestern and southwestern boundaries were established and offshore boats were excluded from the Area 18 fishery (Figure 1).

Area 18's snow crab grounds are shallow (Elner and Robichaud, 1980) and are contiguous with the southern boundary of those of Area 19 (Bailey and Cormier, 1983). In the past, the majority of Area 18's snow crab fishermen have concentrated their fishing effort in a small region just south of this border. Geographical continuity combined with large proportions of sub-legal size male crabs in the catch (Elner and Robichaud, 1980) has led to the hypothesis that Area 19 serves as a "nursery" for the larger Area 19 snow crab fishery (CAFSAC Adv. Doc. 83/21).

Initially, the fishery in Area 18 was plagued by poor quality catches due to a high incidence of newly molted "white" crabs in the early season catch. The problem has been alleviated in recent years by monitoring white crab levels in the area and opening the fishery only when the incidence of white crab reaches an acceptable level.

Meaningful assessments of the Area 18 fishery were negated prior to 1983 due to unknown catches by offshore boats. Since 1983, estimates of initial available biomass for each season, obtained through Leslie analyses, indicate that the Area 18 snow crab biomass in 1985 had decreased to 50% of its 1983 level (Table 2). Trends in mean seasonal CPUE ($\overline{CPUE}$) support this observation ($\overline{CPUE}_{1985}$ = 31.4 kg/trap haul vs $\overline{CPUE}_{1982}$ = 62.0 kg/trap haul; Table 2). In response to this trend, decreased boat quotas were imposed for the 1986 season (Table 3).

Despite its small geographic size, a high percentage of undersize crabs, early season quality problems and declining catches, Area 18's snow crab ground remains second only to Area 19 in terms of landings in Cape Breton's snow crab fisheries (accounting for approximately 29% of Cape Breton's 1985 snow crab landings).

This paper provides a review of biological and catch trends for Area 18 and 19 snow crab fisheries in 1986.

MATERIALS AND METHODS

Sea sampling/Port sampling

In Area 19, both port samples and sea samples were obtained during the 1986 season (sea samples in weeks 3, 4, 5, and 9 and port samples in weeks 3 - 7 and 9, Table 4). Weekly percentages of undersize males, females, non-berried mature females, and soft-shelled/white crabs were plotted and/or tabulated for the sea sampling data (Table 4, Figure 2). In addition, weekly percentages of morphometrically immature males (Conan and Comeau, 1986) and weekly and overall size distributions and statistics were generated for males in both sea sampling and port sampling data (Table 4, Figure 2).

No sea samples were obtained for Area 18. Port samples were made in weeks T*, 1 and 3. The percentage of white/soft crabs and immature males for each week's samples were calculated (Table 5).

Weekly and overall size distributions and statistics were calculated for both areas (Figures 3-7).

Logbook/Sales slip data

Catch and effort data for both Area 18 and 19 fisheries were obtained from fishermen's logbooks and processor's sales slip data as collated by the Department of Fisheries and Oceans Electronic Data Processing and Statistics Branch. From these data, statistics for use in the Leslie analyses (Ricker, 1975) were calculated. Catch per unit effort (CPUE, daily catch in kg/daily # of trap hauls) was calculated from logbook data and summarized into weekly intervals for both areas (Tables 6 and 7).

Weekly catch and cumulative catch statistics were calculated from logbook data for both areas (K_{tl}, Tables 6 and 7). Experience has shown that the total catch calculated from fishermen's logbooks underestimates the total landings as indicated by sales slip records. In an attempt to better represent the actual population biomass losses imposed by the fisheries, sales slip data was used in the calculation of an additional weekly and cumulative catch variable for each area.

For Area 19, weekly and cumulative catch statistics were calculated directly from sales slip data (K_{ts}, Table 6). For Area 18, collation and entry of sales slip data had not been completed at the time of these analyses; however, a total sales slip catch of 618,322 kg was obtained from the area statistics officer (P. George, pers. comm.). It was assumed that sales slip catch was distributed throughout the season in the same manner as the logbook catch. Based on this assumption, weekly sales slip catches (C_{ta}, Table 7) were calculated as follows:

$$\text{sales slip catch}_t = \text{total sales slip catch (618,322 kg)} \times \frac{\text{logbook catch}_t}{\text{total logbook catch}}$$

where t = week number

* The fishery was opened on a trial basis from August 3 to August 9 (week T) on a trial basis. Crab quality was deemed too low due to a high percentage of soft/white crab and the fishery was closed again until August 28.

The seasonal distribution of fishing effort (given as Loran C coordinates) was obtained from logbook data and was plotted for both areas (Figures 8 and 10). In addition, the number of trips to 2" X 2" sub-areas were summarized and plotted for weeks 1-3, 4-6, and 7-10 for Area 19 (Figure 9) and week T, 1-3, and 4-6 for Area 19 (Figure 11).

RESULTS

Area 19

The size distributions for both port and sea samples show a decrease in the magnitude of the larger size classes as the season progresses (Figures 3 and 4). For port samples, mean size decreases from 115.2 mm carapace width (CW) in week 3 to 104.5 mm CW in week 9 (Figure 4). Sea samples exhibit a decrease in mean size from 106.2 mm CW in week 3 to 93.4 mm CW in week 9 (Figure 3) corresponding to an increase in the percentage of undersize male crabs from 22.0% in week 3 to 54.0% in week 9 (Table 4, Figure 2). Seasonal means were 108.3 mm CW and 101.1 mm CW for port samples and sea samples respectively.

The percentage of morphometrically immature males (MI-males) present in sea samples and port samples exhibit parallel trends during weeks 3 to 5 with decreases in week 4 followed by increases in week 5 (Table 4, Figure 2). By the 7th week, the incidence of MI-males in port samples had risen to 40% and was at that level again during the 9th week, at which time only 16.5% of sea sampled males were morphometrically immature (Table 4, Figure 2). Overall means are similar (24.4% for sea samples and 22.1% for port samples, Table 4).

The percentage of white/soft crab and females in sea samples show trends similar to those of the immature males for weeks 3 to 5 except the decrease in the 4th week and the increase in the 5th week are more pronounced (Table 4, Figure 2). By the seventh week, levels of both had dramatically decreased (Table 4, Figure 2).

The mean percentage of non-berried females in sea samples was 1.6% with a maximum of 4.3% during the second week (Table 4).

The overall seasonal distribution of fishing effort (Figure 8) indicates that all available crab habitat is being exploited within this area with the majority of the fishing concentrated in the southern half. Effort distribution shows a considerable amount of dispersion and movement during the season with a trend towards the creation of southern and northern groups as the season progresses (Figure 9).

CPUE drops rapidly for the first three weeks of the fishery and then fluctuates slowly downward for the following 8 weeks (Table 6). The mean CPUE was 32.0 kg/trap haul (Table 6).

The results of the Leslie analyses and their corresponding estimates of initial biomass (B_o) and exploitation level (E.L.), assuming a total catch (TC) of 1235219 kg (as given by sales slips), are as follows:

1) Using logbook cumulative catches (Table 6, Figure 12):

$$CPUE = 46.95 - 2.11 \times 10^{-2} K_t$$
$$r = -0.90$$
$$B_o = 2219t \ (1839t - 3001t, P \leq 0.05)$$
$$E.L. = \frac{TC}{B_o} = 64\%$$

2) Using sales slip cumulative catches (Table 6, Figure 13):

$$CPUE_t = 46.73 - 2.00 \times 10^{-2} K_t$$
$$r = -0.90$$
$$B_o = 2343 \text{ t } (1884 \text{ t} - 3418 \text{ t p} \leq 0.05)$$
$$E.L. = 52.7\%$$

Area 18

As in Area 19, port sample size distributions indicate a reduction in larger size classes as the season progresses with a reduction in mean size from 107.0 mm CW in week T to 106.6 mm CW in week 3 (Figure 6). Overall mean size for all three weeks was 106.5 mm CW (Figure 7).

The mean percentages of white/soft crab and morphometrically immature males were high over the early part of the season (34.2% and 39.9% respectively, Table 5).

The overall distribution of fishing effort indicates that the majority of fishermen concentrate their effort just south of the Area 18/19 border (Figure 10). The effort seems to displace slightly southward late in the season (Figure 11).

CPUE gradually decreased over the season except for the last week when it increased up approximately 50% (Table 7). Mean CPUE was 43.0 kg/trap haul (Table 7). The CPUE during the last week was deemed inordinately high due to low effort and competition for fishing grounds; therefore, it was excluded from the Leslie analysis. The resulting analyses and their corresponding B_o and E.L. (estimated assuming the sales slip catch of 618322 kg) are as follows:

1) Using logbook cumulative catches (Table 7, Figure 14):

$$CPUE_t = 63.03 - 7.33 \times 10^{-2} K_t$$
$$r = -0.95$$
$$B_o = 899 \text{ t } (737 \text{ t} - 1189 \text{ t}, P \leq 0.05)$$
$$E.L. = 69.5\%$$

2) Using sales slip adjusted cumulative catches (Table 7, Figure 15):

$$CPUE_t = 61.90 - 5.37 \times 10^{-2} K_t$$
$$r = -0.95$$
$$B_o = 1153 \text{ t } (954 \text{ t} - 1540 \text{ t, } P \leq 0.05)$$
$$E.L. = 59.7\%$$

DISCUSSION

Area 19

The total catch indicated by sales slip data exceeds that of the logbook data in 1986 by more than 53 t (4.5%). It is deemed by the authors to more accurately reflect the biomass attrition incurred by the fishery; for this reason, the result of the Leslie analysis using sales slip cumulative catch statistics was preferred (Table 6, Figure 13). The B_o estimate given by this analysis (2343 t, Figure 13) is 29% lower than that calculated for 1985 (Davidson et al., 1986, Table 2) and is comparable to 1982 and 1984 values (Table 2). The associated exploitation level of 52.7% falls within the 50-60% range prescribed by the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC Adv. Doc. 82/2).

In addition to the decreased B_o a number of other trends observed for the 1986 fishery question the stability of the Area 19 fishery given current fishing practices.

The observed decrease in the abundance of large crabs as the season progresses and the corresponding decrease in mean size (Figures 3 and 4) has been observed during previous seasons and is attributable to the reliance of the fishery on males larger than 95 mm CW. Of more concern is the overall mean size which, for sea samples, has decreased from 111.0 mm CW in 1985 to 101.3 mm CW in 1986 (Davidson et al., 1986, Figure 5). It is thereby indicated that recruitment into larger size classes in 1986 was lower than 1985 levels. It could be argued that this size decrease is an anomaly caused by commencing sampling earlier in the 1985 season.In this case, the validity of the observed size decrease can be substantiated by the observation that the mean size in July, 1986 (Figure 3) was smaller than that observed by Davidson et al., (1986) for August of 1985 (106.2 mm CW and 109.3 mm CW respectively).

The observed similarity in the percentage of MI-males in sea and port samples implies that the fishery is relying on immature crabs to provide up to 40% of the catch (Table 4, Figure 2) and that the number of sublegal morphometrically mature males (MM-males) is increasing. The increasing percentage of MI-males in port samples,

and their decreasing percentage in sea samples as the season progresses suggests the following:

1) the catchability of MI-males increases as the season progresses and/or the catchability of MM-males decreases (due to heavier exploitation early in the season and/or behavioural characteristics).

2) that recruitment as indicated by the high percentage of white/soft crab in week 5 (Table 4, Figure 2), is largely (totally?) composed of immature males undergoing a "pre-terminal" molt.

Fishermen and sampling personnel have suggested that the incidence of non-berried females in the catches is increasing in recent years. The mean percentage of non-berried females observed in our 1986 samples (1.6%, Table 4) falls well below values observed in other Cape Breton snow crab grounds (Elner and Robichaud, 1985), nevertheless, this phenomenon is virtually non-existent in other Gulf snow crab fisheries and should be monitored in future seasons. Knowledge of the relationship between the incidence of non-berried females and the availability of functionally mature males (males possessing both the physical and behavioural attibutes necessary for successful mating) and their size at functional maturity * is paramount to understanding the possible effects of both immature males and non-berried females on recruitment processes.

Mean CPUE ($\overline{CPUE}$) for this fishery has exhibited a dramatic decline since 1982 (Table 2, Figure 16). Although not as pronounced as in past seasons, this decline continued in 1986 with an 8% decrease in $\overline{CPUE}$ from 1985 levels (32.0 kg/trap haul and 34.8 kg/trap haul respectively, Table 2). As in previous seasons, the decrease in $\overline{CPUE}$ can be attributed to increasing effort exploiting a finite resource. Effort (total trap hauls) increased 5.9% in 1986 over 1985 levels (37613 trap hauls and 35503 trap hauls respectively, Table 2).

In 1985, frequent shifts in the spatial and temporal distribution of fishing effort helped maintain CPUE levels (Davidson et al., 1986). Fishermen exhibited similar shifts in the deployment of effort in 1986 (Figure 9) but the ameliorative effect of their actions on declining CPUE's met with less success compared to 1985.

In summary, the above observations, coupled with fishermen's observations concerning the increased incidence of undersize crabs and a dearth of legal sized old crabs in their catches, indicate

* observation of mating crabs in aquaria and while SCUBA diving indicates that morphometrically mature male crabs must be at least 95 mm CW to successfully mate (Conan and Comeau, 1986).

that the snow crab fishery in this area is entirely recruitment based. Decreases in mean size and CPUE, despite spacial and temporal shifts in effort and apparently reasonable E.L.'s, indicate the current recruitment into the fishery cannot sustain the present levels of fishing pressure. Furthermore, if morphometric immaturity of males is equatable to functional maturity, and given the apparent increase in non-berried females, the management assumption that the fishery does not effect the reproductive capacity of the population (Bailey, 1978; Elner, 1982) is no longer valid. There is a need for a new management strategy for Area 19 which will reduce fishing effort and utilize current changes/advances in biological knowledge.

Area 18

For the reasons mentioned above for Area 19, the results of the Leslie analysis using cumulative catch statistics derived from sales slip data (K_{ts}, Table 7) were preferred. The B_o estimate obtained from this analysis represents a 53% increase over that estimated for the 1985 season (1153t and 753t respectively, Table 2). Estimates of E.L. decreased from 71.3% in 1985 to 59.7% in 1986 (an 11.6% decrease, Table 2). Total effort decreased 31% from 17109 trap hauls in 1985 to 11767 trap hauls in 1986 (Table 2). Area 18's snow crab grounds are limited in their extent and undergo heavy concentrations of fishing effort which exhibits only limited spatial and temporal shifts. Despite this concentrated effort, mean CPUE (benefitting from increased biomass and decreased effort) increased 36.9% between 1985 and 1986 (31.4 kg/trap haul versus 43.0 kg/trap haul respectively, Table 2).

Catch quality in Area 18 has historically suffered from the presence of large number of white/soft crab in the catch (Elner and Robichaud, 1981; Bailey and Cormier, 1983). The 1986 season was no exception with a mean of 34.2% white/soft crab present in the landings sampled (Table 5). On the positive side, the maintenance of a high proportion of newly molted crab in the early season landings is indicative of strong recruitment which, no doubt, is reflected in the elevated B_o estimate.

The fishery in this area relies heavily on MI-males (sample mean of 39.9%, Table 5) therefore, like Area 19, the assumption that the fishery is not effecting reproductive and recruitment processes may no longer be valid.

In summary, our results indicate that 1986 was a year of good recruitment and catches in Area 18 and that the area's snow crab population is benefitting from the management changes initiated in 1986 (reduced quotas, Table 3). It is recommended that the current management policy be maintained for the 1987 season.

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Table 1: Number of participants, trap quotas, seasons, TAC regulations and total catch for the Area 19, Cape Breton Island snow crab, Chionoecetes opilio, fishery: 1978-1986.

Year	# of licensed boats	*Traps/boat	Season	TAC (t)	Catch (t)
1978	14(1)	30	May 13-Sept.30 (1)	--------	1941 (1)
1979	27	30	June 16-Sept. 16 (2)	1406 (2)	1390 (2)
1980	27	30	July 15-Sept. 15	**980 (36,288 kg/license) (3)	1158 (4)
1981	27	30	July 15-Sept. 15	1002 (4)	913 (4)
1982	27	30	July 15-Sept. 15	980 (36,288 kg/license)	953 (5)
1983	27	30	July 15-Sept. 15	980 (36,288 kg/license)	906 (6)
1984	61	20	July 15-Sept. 15	1385 (22,680 kg/license)	1315 (7)
1985	61	20	July 15-Sept. 15	1385 (22,680 kg/license)	1234 (8)
1986	59	20	July 15-Sept. 15	1338 (22,680 kg/license)	

* standard box traps - 1.5m x 1.5m x 0.5m or 1.8m x 1.8m x 0.6m

** was adjusted in mid-season to 1224 t (45,360 kg/license)

1) Bailey, 1978
2) Elner and Robichaud, 1980
3) Elner and Robichaud, 1981
4) Elner, 1982
5) Bailey and Cormier, 1983
6) Cormier and Bailey, unpublished data
7) Cormier and Comeau, 1986
8) Davidson et al., 1986

Table 2: Trends in initial (B_o) and final (B_f)Biomass estimates, exploitation level, and initial ($CUPE_o$), final ($CPUE_f$) and mean (CPUE) catch per unit effort for the snow crab, *Chionoecetes opilio*, fishery off western Cape Breton Island.

	Area 19								Area 18							
Year	Exploitation (level%)	B_o (t)	B_f (t)	Estimated** production	Trap hauls	$\underline{CPUE_o}$ (kg/trap haul)	$\underline{CPUE_f}$ (kg/trap haul)	$\overline{\underline{CPUE}}$(max-min) (kg/trap haul)	Exploitation (level%)	B_o (t)	B_f (t)	Estimated** production	Trap hauls	$\underline{CPUE_o}$ (kg/trap haul)	$\underline{CPUE_f}$ (kg/trap haul)	$\overline{\underline{CPUE}}$(max-min) (kg/trap haul)
1978	64	3016(6)	1075	-	26301*	86.4	55.0	73.8(86.4-51.8)		-	-	-		-	-	-
1979	62	2239(5)	848	1164	20436	69.3	45.2	68.0(75.1-45.2)	49.7	428(5)	215.7	-	4449	37.3	30.7	47.8(61.0-37.3)
1980	60	1838(7)	733	990	12360	112.0	52.6	89.4(112.0-52.6)		-	-	-	10242	61.2(7)	47.7	48.3(61.2-39.4)
1981	47	1690(8)	894	957	13413	-	-	59.3		-	-	-	7554	-	-	48.4(8)
1982	44.7	2282(3)	1329	1388	9896	114.0	45.0	96.0(114.0-45.0)		-	-	-	13365	98.0(3)	23.0	62.0(122.0-23.0)
1983	54.7	1654(4)	748	325	10541	98.5	36.3	81.8(98.5-32.8)	45.8	1577(2)	854	-	16669	41.4	34.0	43.4(49.9-33.8)
1984	67.2	2240(1)	925	1492	26034	93.2	51.5	50.5(93.2-33.9)	40.1	1147(1)	687	293	12877	41.9	27.2	35.8(41.9-27.2)
1985	34.8	3291(9)	2057	2366	35503	47.1	26.3	34.8(47.1-26.3)	71.3(9)	753	216	66	17109	49.1	24.1	31.4(49.1-17.2)
1986	52.7	2343	1235	551	37613	49.8	22.1	32.0(49.8 -22.1)	59.7	1153	465	937	11767	61.8	55.3	43.0(61.8-26.6)

(1) Cormier and Comeau, 1986
(2) Cormier and Bailey, 1984
(3) Bailey and Cormier, 1983
(4) Cormier and Bailey, unpublished data
(5) Elner and Robichaud, 1980
(6) Bailey, 1978
(7) Elner and Robichaud, 1981
(8) Elner, 1982
(9) Davidson et.al. 1986

* 23616 (1.5m x 1.5m) trap hauls + 4540 conical trap hauls - see Bailey 1978 for calculation of total trap hauls.

** = $B_o^t - B_f^{t-1}$ - where t = year

Table 3: Number of participants, trap quotas, seasons, TAC regulations and total catch for the Area 18, Cape Breton Island snow crab, Chionoecetes opilio, fishery: 1979-1986.

Year	# of licensed boats	*Traps/boat	Season	TAC (t)	Catch (t)
1979	**14	30	July 1-Sept.30 (1)	--------	***213 (2)
1980	23	30	July 15-Sept.15 (2)	--------	***519 (3)
1981	23	30	April 15-June 15 (4)	****835(36288 kg/license)	***494 (3)
1982	23	30	July 22-Oct. 13 (5)	****835(36288 kg/license)	***824 (5)
1983	23	30	Aug. 15-Nov. 3 (6)	****835(36288 kg/license)	***822 (6)
1984	23	30	Aug. 25-Nov. 10 (7)	****835(36288 kg/license)	722 (5)
1985	23	30	Aug. 3-Oct. 31 (8)	****835(36288 kg/license)	537 (8)
1986	23	30	Aug.4-8; Aug.28-Oct.28	****627(27273 kg/license)	

* standard box traps - 1.5m x 1.5m x 0.5m or 1.8m x 1.8m x 0.6m

** experimental permits

*** does not include landings caught by offshore vessels

**** CAFSAC has advised TAC's ranging from 519 t (CAFSAC Adv. Doc 81/1) to 900 t (CAFSAC Adv. Doc. 85/3); nevertheless, the functional TAC has been based upon boat quotas = number of licenses x quota/license

1) Bailey, 1978
2) Elner, 1982
3) CAFSAC Adv. Doc. 84/3
4) Réjean Hébert, pers. comm.
5) Bailey and Cormier, 1983
6) Cormier and Bailey, 1984
7) Cormier and Comeau, 1986
8) Davidson et al., 1986

Table 4: Biological characteristics of snow crabs, Chionoecetes opilio, present in sea samples and port samples during the Cape Breton Island, Area 19 snow crab fishing season - 1986

	Sea samples					Port samples
Week	% Females (N)	% Non-berried Mature Females (N)	% Undersize Males (N)	% Soft/White Crab (N)	% Immature Males (N)	% Immature Males (N)
1. July 13-19	---	---	---	---	---	---
2. July 20-26	---	---	---	---	---	---
3. July 27-Aug. 2	36.0(235)	0.0(72)	22.0(163)	22.4(232)	30.4(161)	17.0(393)
4. Aug. 3 - 9	12.2(392)	4.3(47)	26.7(344)	13.0(422)	19.7(340)	8.8(638)
5. Aug. 10-16	41.3(416)	0.0(172)	32.4(244)	69.7(416)	34.8(244)	26.4(655)
6. Aug. 17-23	---	---	---	---	---	15.0(547)
7. Aug. 14-30	---	---	---	---	---	40.0(321)
8. Aug. 31 Sept. 6	---	---	---	---	---	---
9. Sept. 7-13	0.0(237)	2.7(262)	54.0(237)	12.2(500)	16.5(237)	39.5(340)
10. Sept. 14-20	---	---	---	---	---	---
11. Sept. 21-27	---	---	---	---	---	---
12. Sept. 28-Oct. 4	---	---	---	---	---	---
Mean=	23.8(1280)	1.6(553)	33.9(988)	29.2(1570)	24.4(982)	22.1(2892)

Table 5: Percentage of white/soft and morphometrically immature male of snow crabs, Chionoecetes opilio, present in sea samples and port samples during the Cape Breton Island, Area 18 snow crab fishing season - 1986.

	Week	% white/soft crab (N)	% Morphometrically Immature Males (N)
T	Aug. 3-9	7.4(203)	58.6(203)
1)	Aug. 28-Sept. 3	48.3(346)	34.2(345)
2)	Sept. 4-10	---	---
3)	Sept. 11-17	37.6(157)	28.7(157)
4)	Sept. 18-24	---	---
5)	Sept. 25-Oct. 1	---	---
6)	Oct. 2-8	---	---
7)	Oct. 9-15	---	---
8)	Oct. 16-22	---	---
	Mean	34.2(706)	39.9(706)

Table 6: 1986 Cape Breton Island, Area 19 snow crab, Chionoecetes opilio, fishery CPUE and cummulative catch (K) statistics used in Leslie analyses.

Week	CPUE (kg/trap haul)	# of trap hauls	Weekly Logbook Catch, C_{tl} (kg)	$C_{tl}/2$ (kg)	K_{tl} (t)	Weekly Sales Slip Catch C_{ts} (kg)	$C_{ts}/2$ (kg)	K_{ts} (t)
1) July 13-19	49.8	5159	238557	119278	119.3	243408	121704	121.7
2) July 20-26	41.1	4755	197037	98519	337.1	204638	102319	345.7
3) July 27-Aug.2	30.2	5215	152964	76482	512.1	157655	78828	526.9
4) Aug. 3-9	26.9	6483	174434	87217	675.8	195840	97920	703.6
5) Aug. 10-16	25.8	5798	144901	72450	835.4	156893	78447	880.0
6) Aug. 17-23	30.0	3698	110292	55146	963.0	116259	58130	1016.6
7) Aug. 24-30	27.8	2134	58824	29412	1047.6	61119	30560	1105.3
8) Aug. 31-Sept. 6	25.3	2715	68762	34381	1111.4	71524	35762	1171.6
9) Sept. 7-13	21.7	1253	27011	13506	1159.3	19725	9863	1217.2
10) Sept. 14-20	22.8	343	7803	3901	1176.7	4400	2200	1229.3
11) Sept. 21-27	22.1	60	1317	658	1181.2	-	-	-
Mean=	32.0	Total= 37613	Total=1,181,902			Total=	12352189*	

* Total of all the sale slips

Table 7: 1986 Cape Breton Island, Area 18 snow crab, Chionoecetes opilio, fishery CPUE and cumulative catch (K) statistics used in Leslie analyses.

	Week	CPUE (kg/trap haul)	# of trap hauls	Weekly Catch C_t (kg)	% of Total Catch	$C_t/2$ (kg)	K_{tl} (t)	Adjusted* Weekly Catch C_{ta} (kg)	$C_{ta}/2$ (kg)	K_{ta} (t)
T)	Aug.3-9	61.8	780	47708	9.99	23854	23.8	61771	30885	30.9
1)	Aug. 28-Sept. 3	50.3	2241	113343	23.74	56672	104.4	146791	73395	135.2
2)	Sept. 4.-10	44.9	3348	151750	31.78	75875	236.9	196504	98252	306.8
3)	Sept. 11-17	47.0	631	29484	6.17	14742	327.5	38151	19075	424.1
4)	Sept. 18-24	35.8	2093	74853	15.68	37426	379.7	96953	48477	491.7
5)	Sept. 25-Oct. 1	29.4	1097	31855	6.67	15927	433.1	41242	20621	560.8
6)	Oct. 2-8	26.6	4012	11607	2.43	5804	454.8	15025	7513	588.9
7)	Oct. 9-15	30.7	350	9732	2.04	4866	465.5	12614	6307	602.7
8)	Oct. 16-22	55.3	84	7085	1.48	3543	473.9	9151	4576	613.6
	Mean =	43.0	Total= 11767	Total= 477417						

* % of total catch (as estimated above) x 618326 kg (total sales slip catch as recorded by the area status offices).

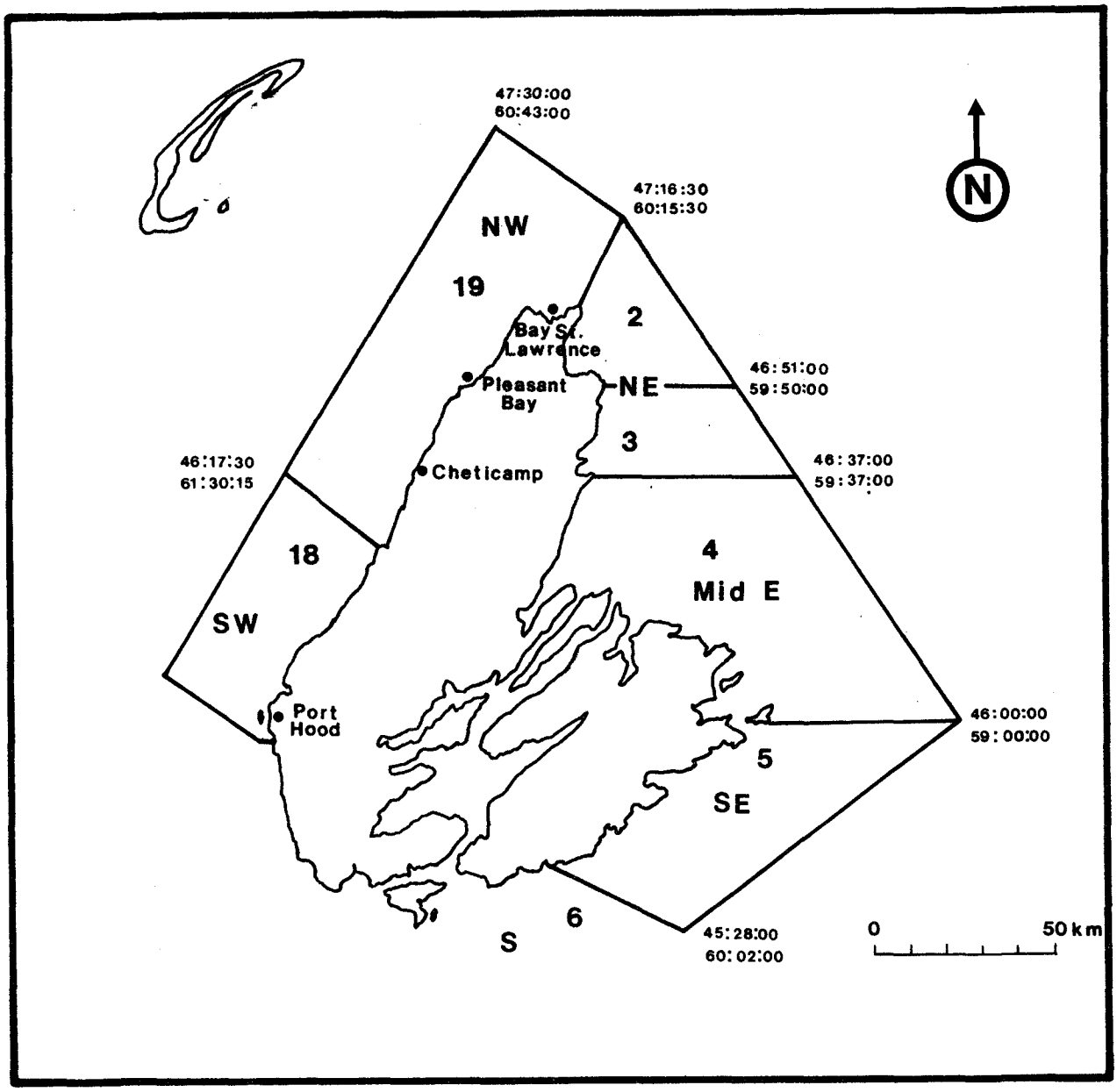


Figure 1: Cape Breton Island snow crab management areas.

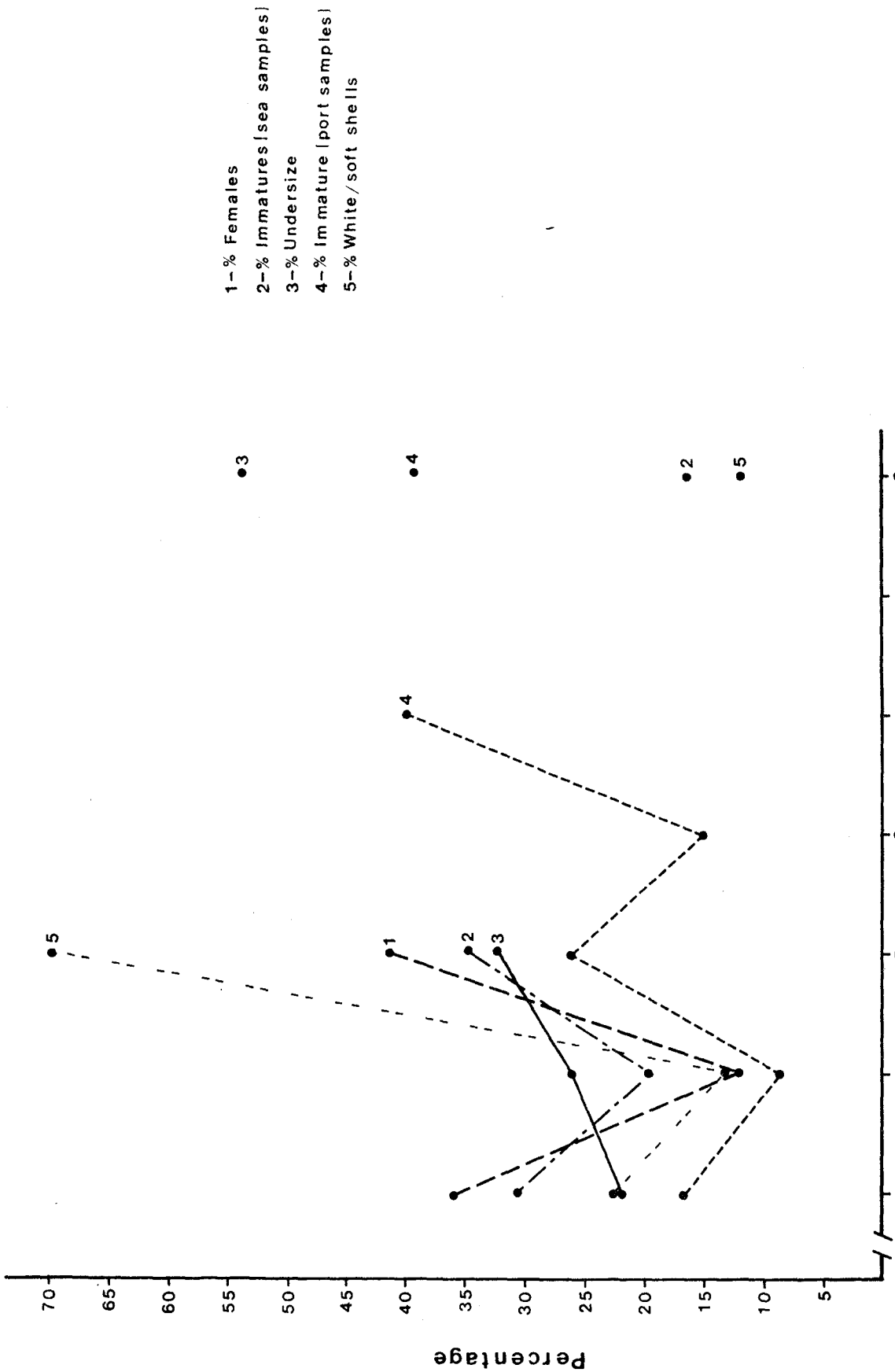


Figure 2: Weekly fluctuations in the percentage of female, immature male, undersize male and white/soft shelled snow crab, Chionoecetes opilio, present in sea samples and percentage of immature males in port samples sampled during the 1986, Area 19 Cape Breton snow crab fishery.

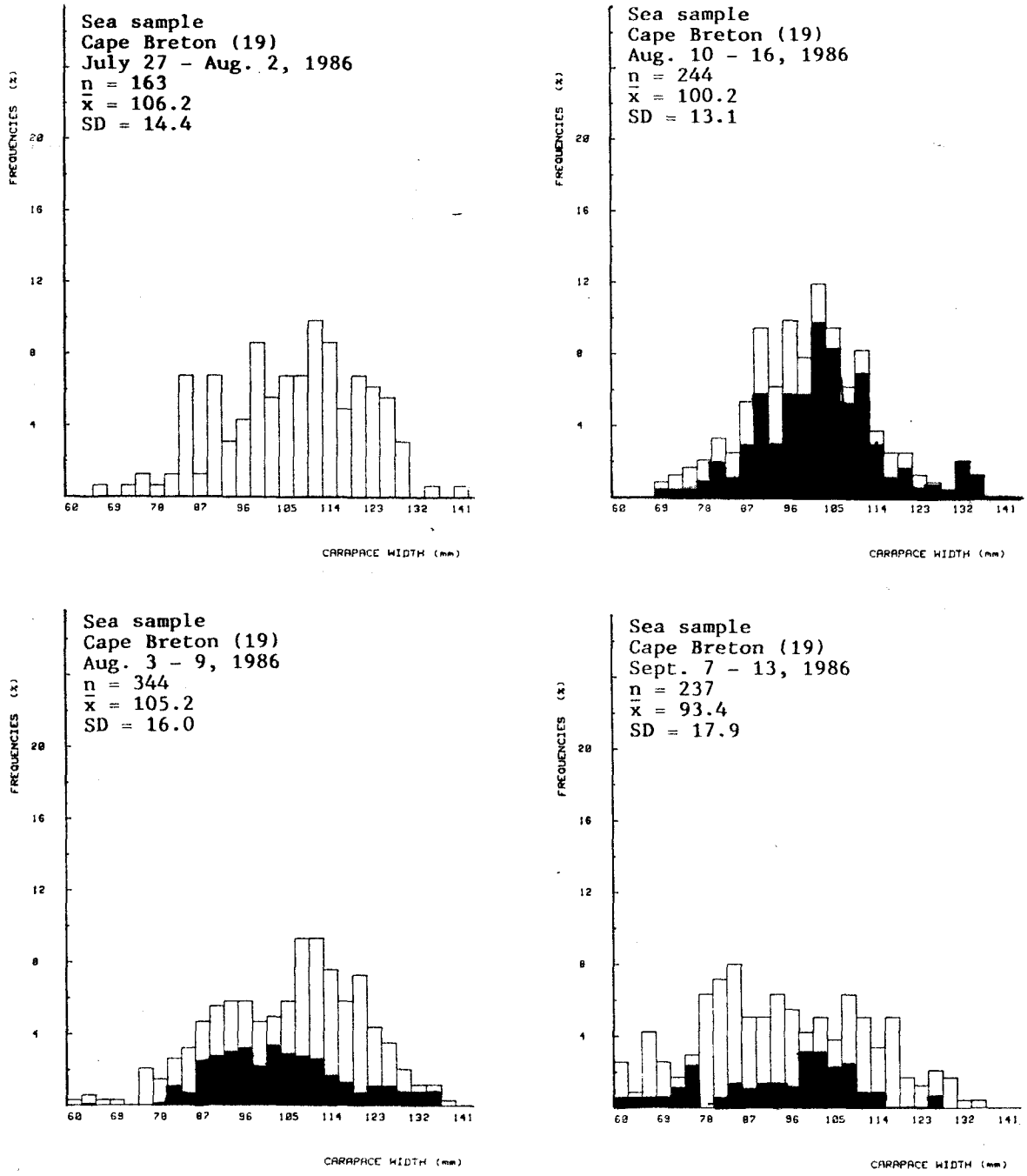


Figure 3: Weekly size distributions of male snow crab, Chionoecetes opilio, present in sea samples taken during the 1986, Area 19 Cape Breton Island snow crab fishery.

■ = white/soft crab

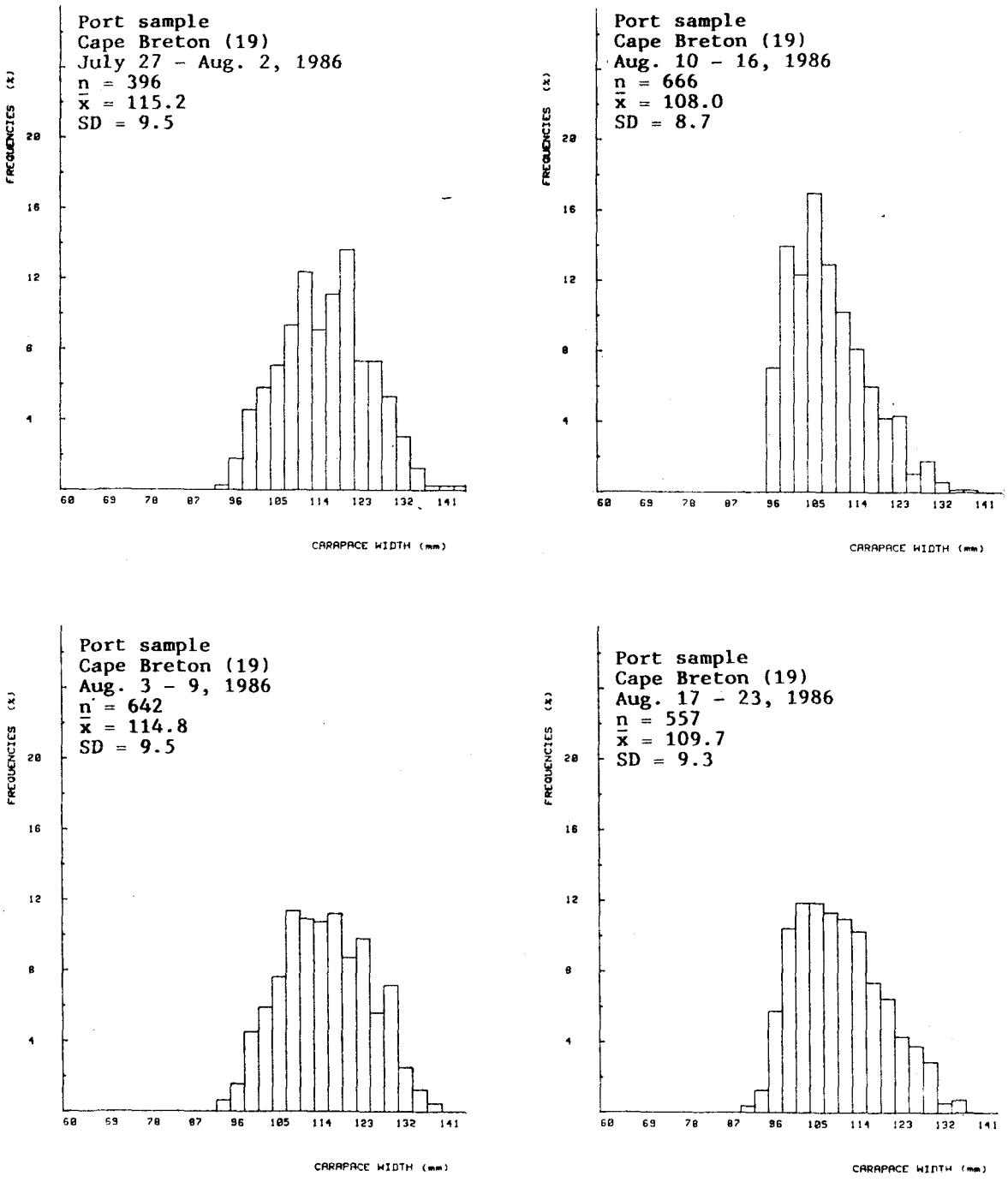
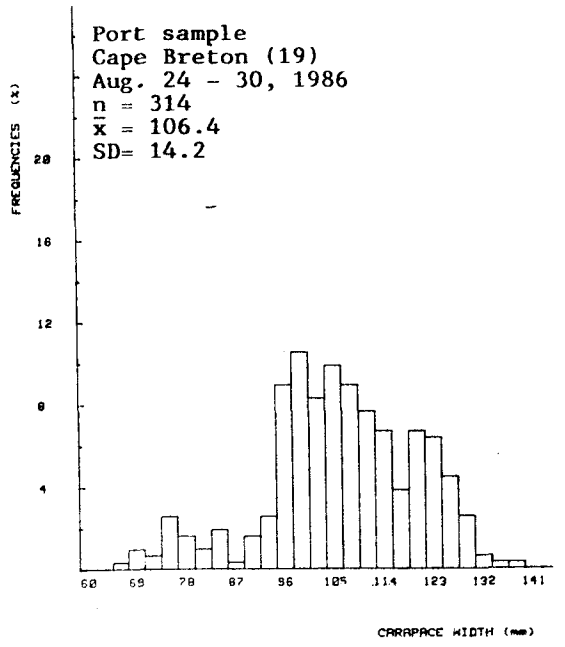


Figure 4: Weekly size distributions of male snow crabs, Chionoecetes opilio , present in port samples taken during the 1986, Area 19 Cape Breton Island snow crab fishery.



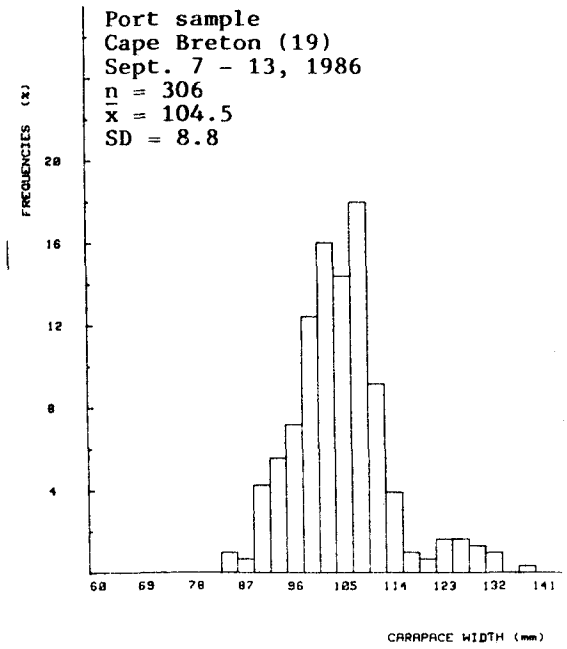


Figure 4: cont.

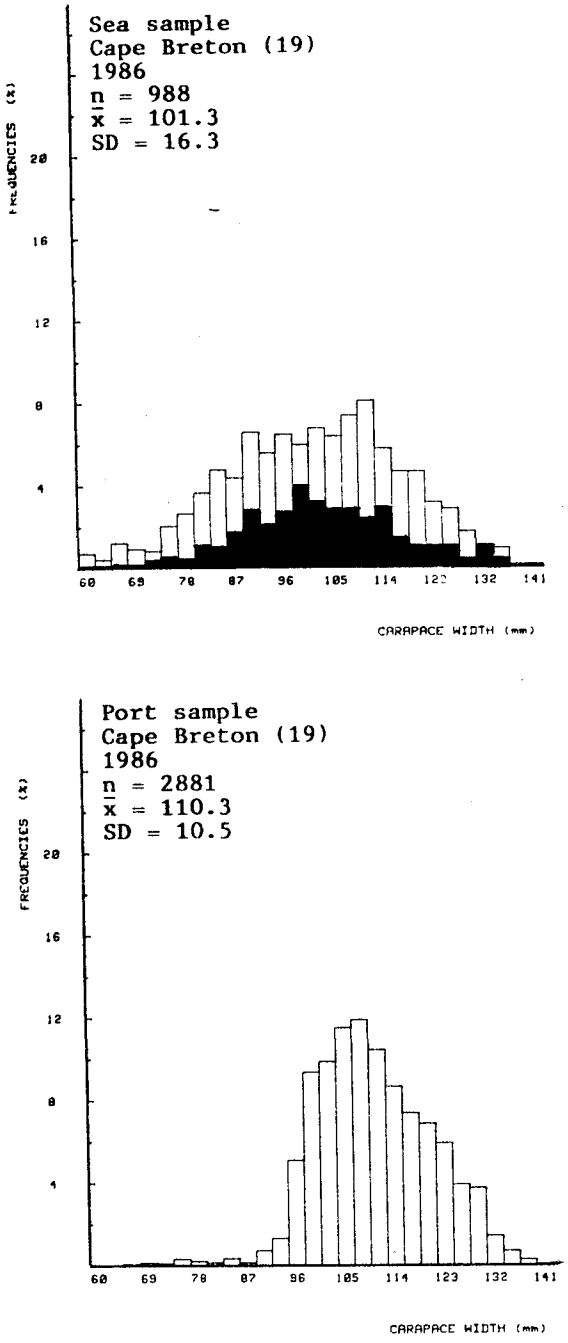
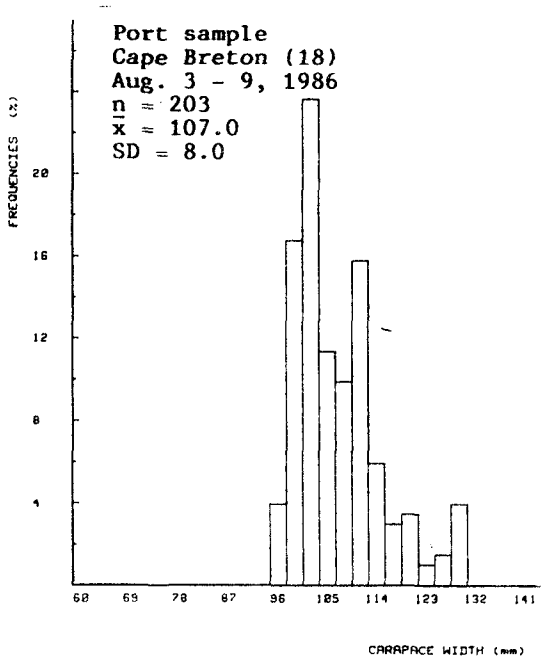
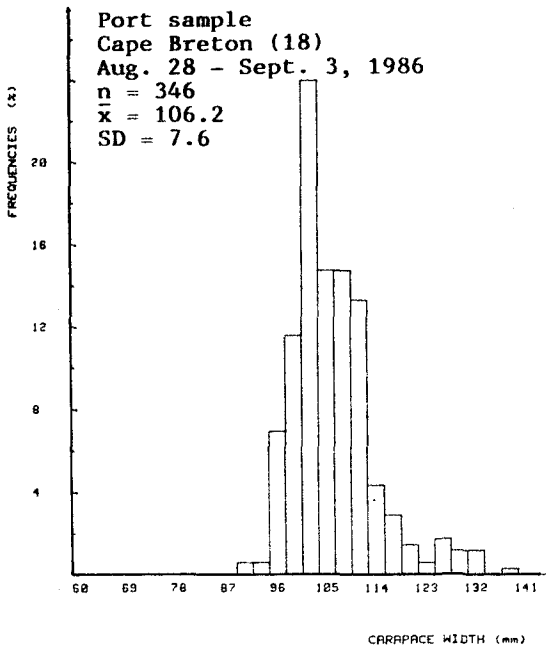


Figure 5: Overall size distributions of male snow crab, Chionoecetes opilio , present in sea and port samples taken during the 1986, Area 19 Cape Breton Island snow crab fishery.

■ = white/soft crab.





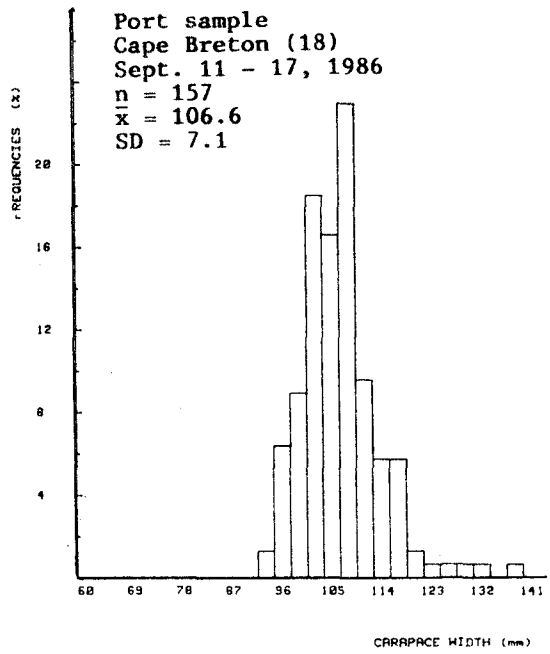


Figure 6: Weekly size distributions of male snow crab, Chionoecetes opilio , present in port samples taken during the 1986, Area 18 Cape Breton Island snow crab fishery.

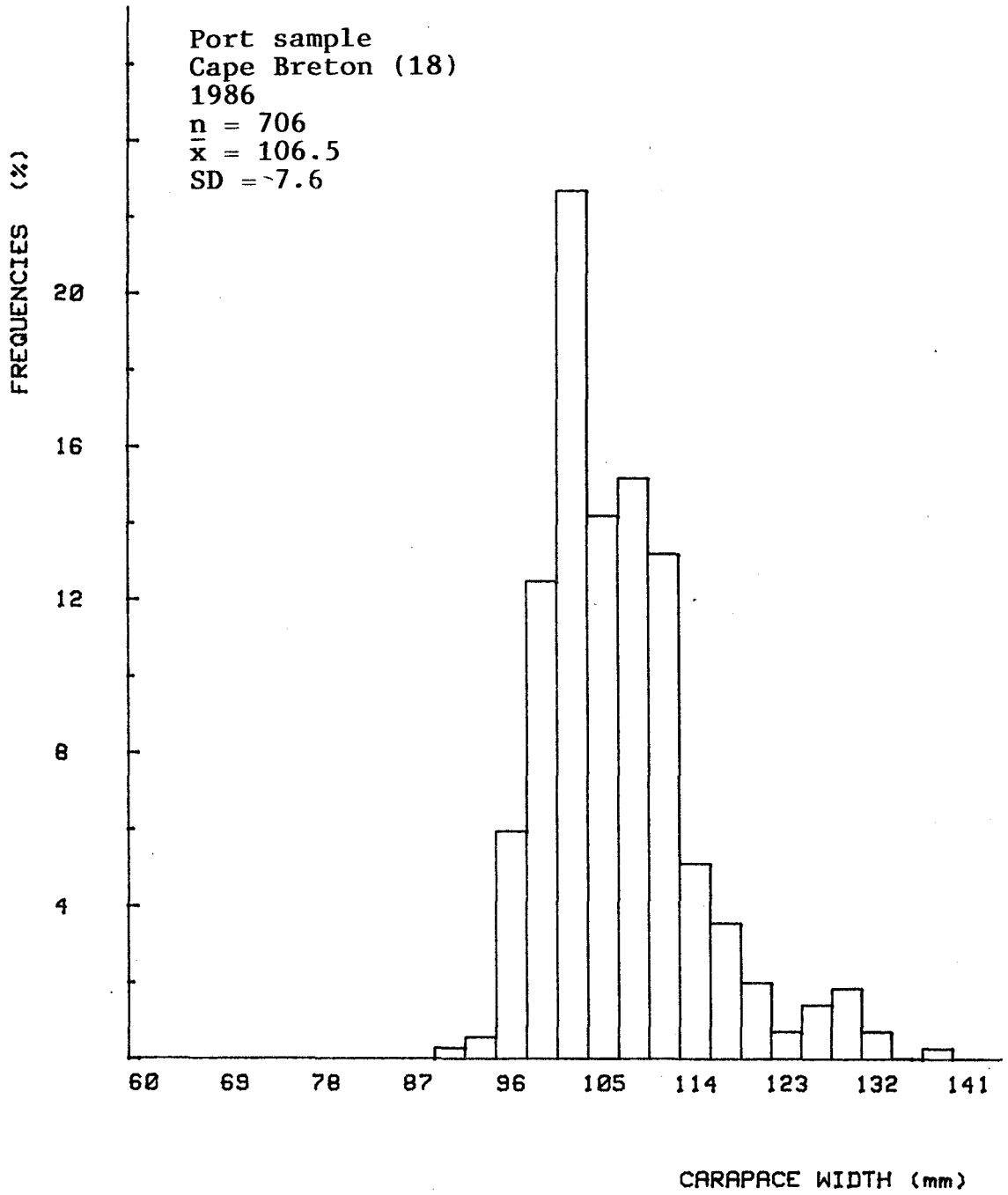


Figure 7: Overall size distribution of male snow crab, Chionoecetes opilio, present in port samples taken during the 1986, Area 18 Cape Breton Island snow crab fishery.

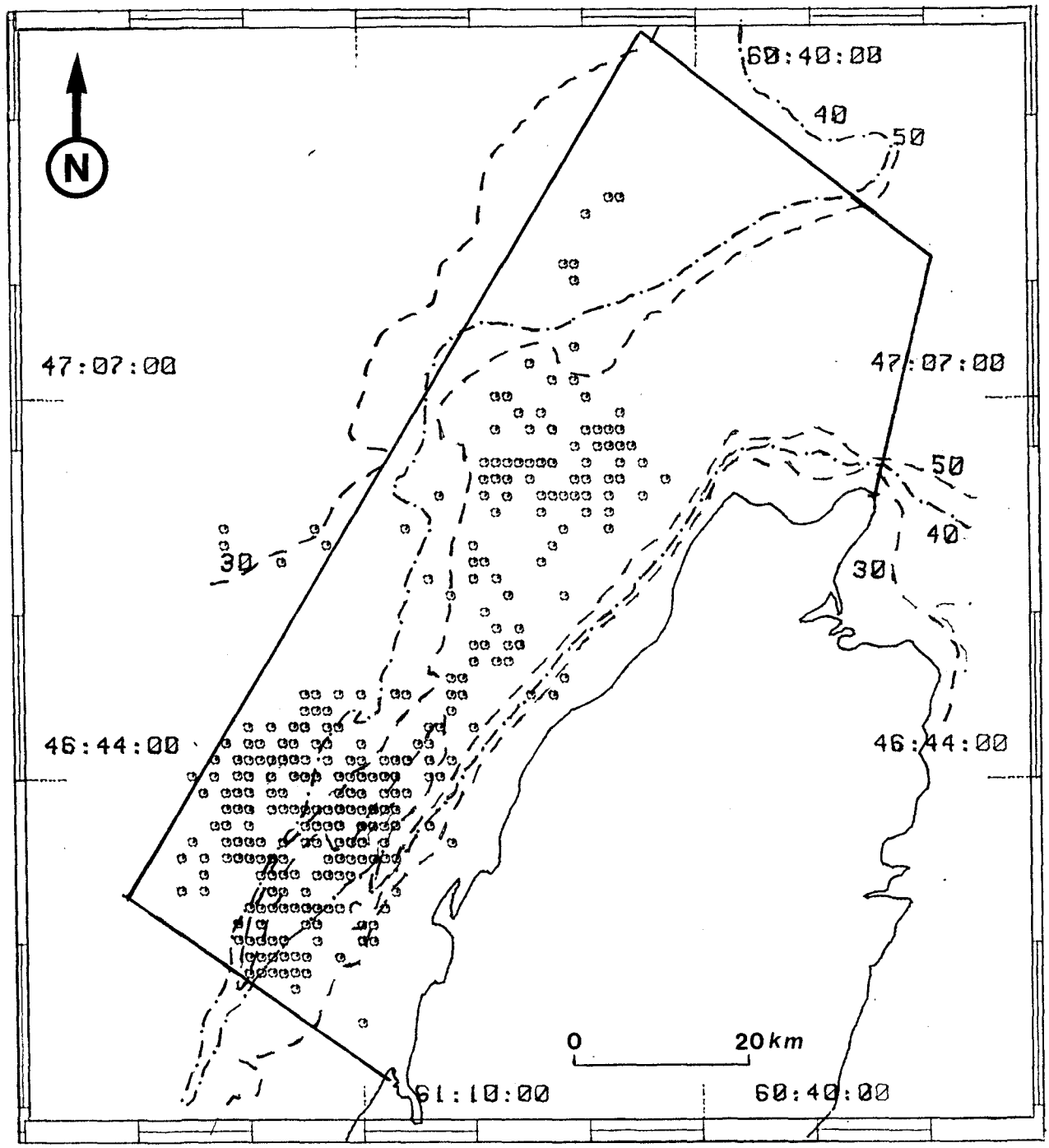


Figure 8: Overall distribution of fishing effort for the Area 19 Cape Breton Island snow crab, Chionoecetes opilio , fishery- 1986.
0= location given by fisherman.

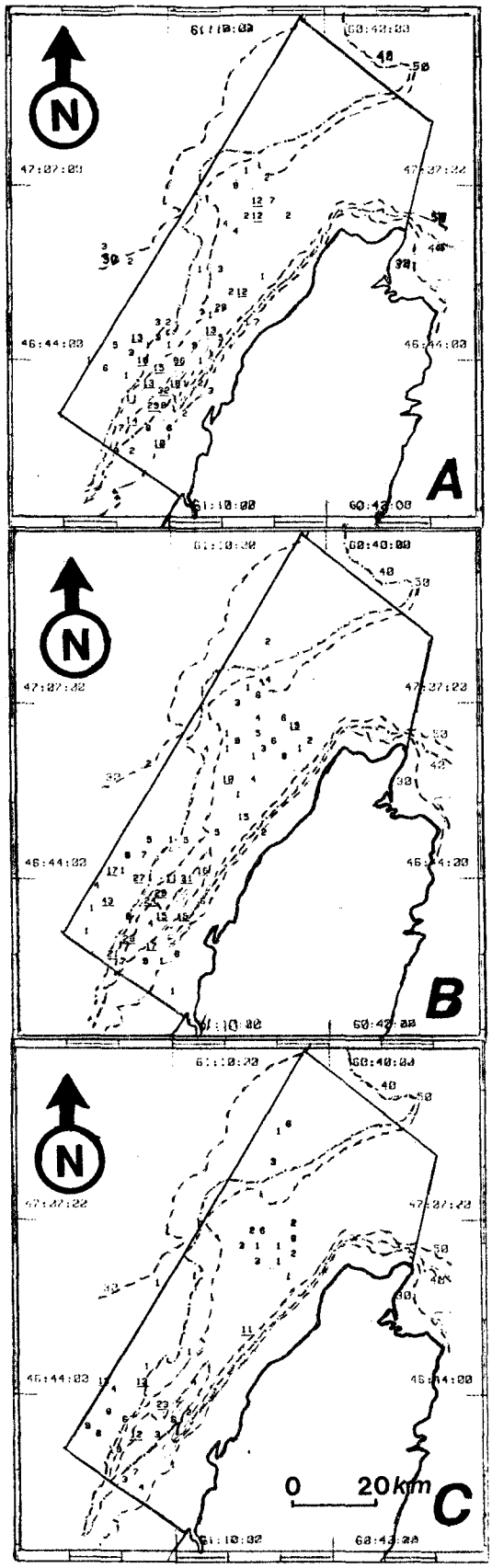


Figure 9: Distribution of fishing effort for the Area 19 Cape Breton Island snow crab, Chionoecetes opilio , fishery- 1986.
A= weeks 1-3, B= weeks 4-6, C= weeks 7-10.
#= number of fishing trip.

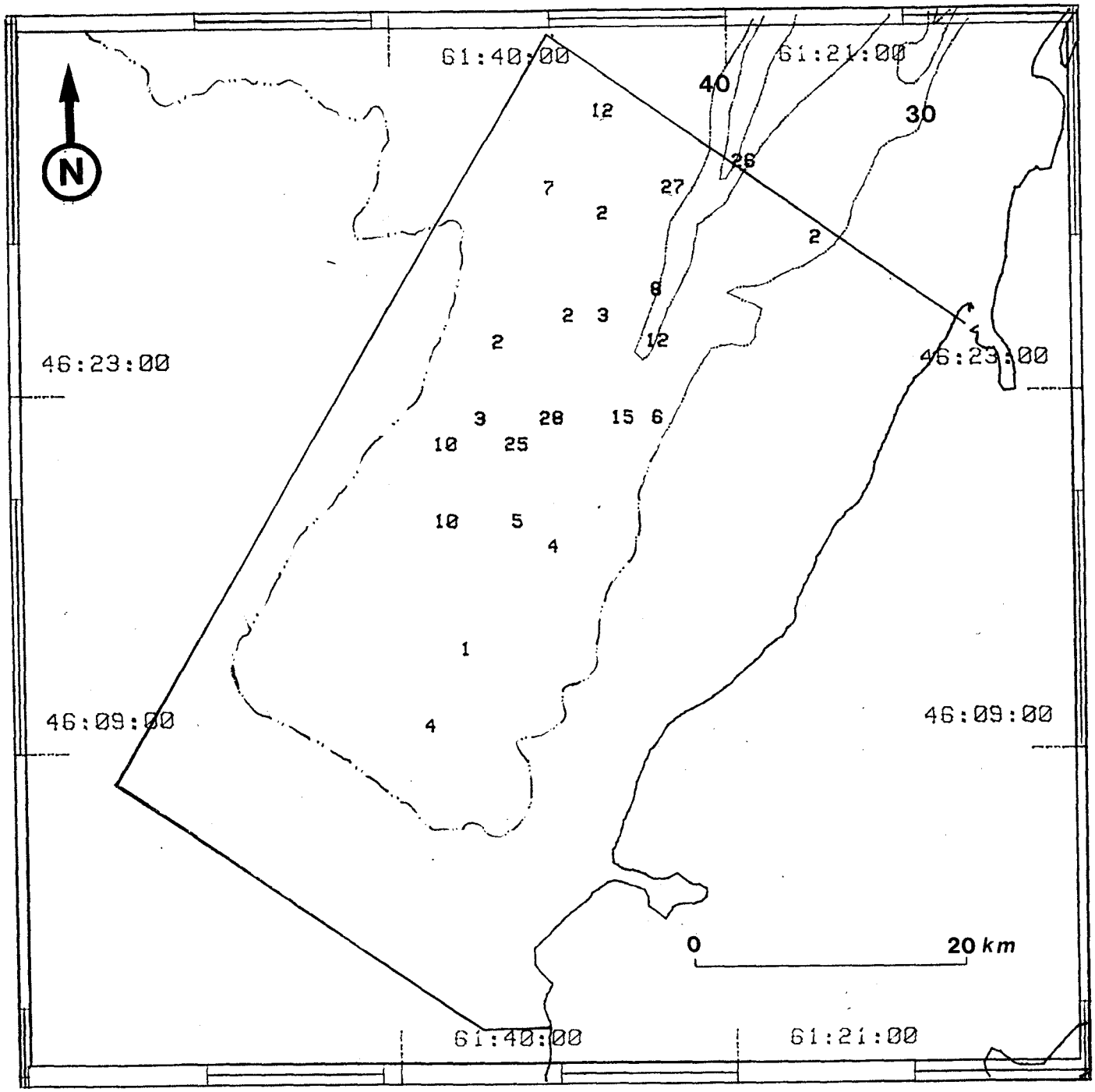


Figure 10: Overall distribution of fishing effort for the Area 18 Cape Breton Island snow crab, Chionoecetes opilio, fishery- 1986.
#= number of fishing trip.

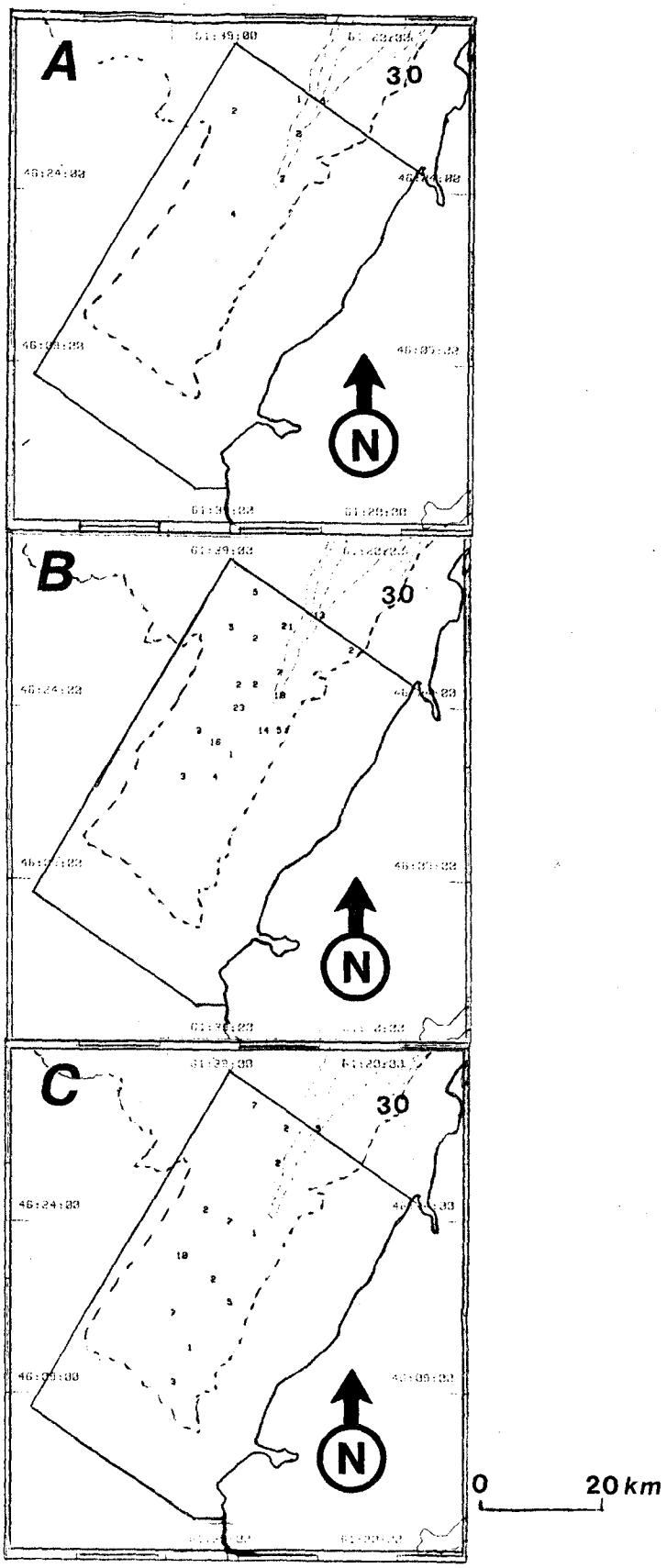


Figure 11: Distribution of fishing effort for the Area 18 Cape Breton Island snow crab, Chionoecetes opilio, fishery- 1986.
A= week T (trial opening), B= weeks 1-3, C= weeks 4-6.
#= number of fishing trip.

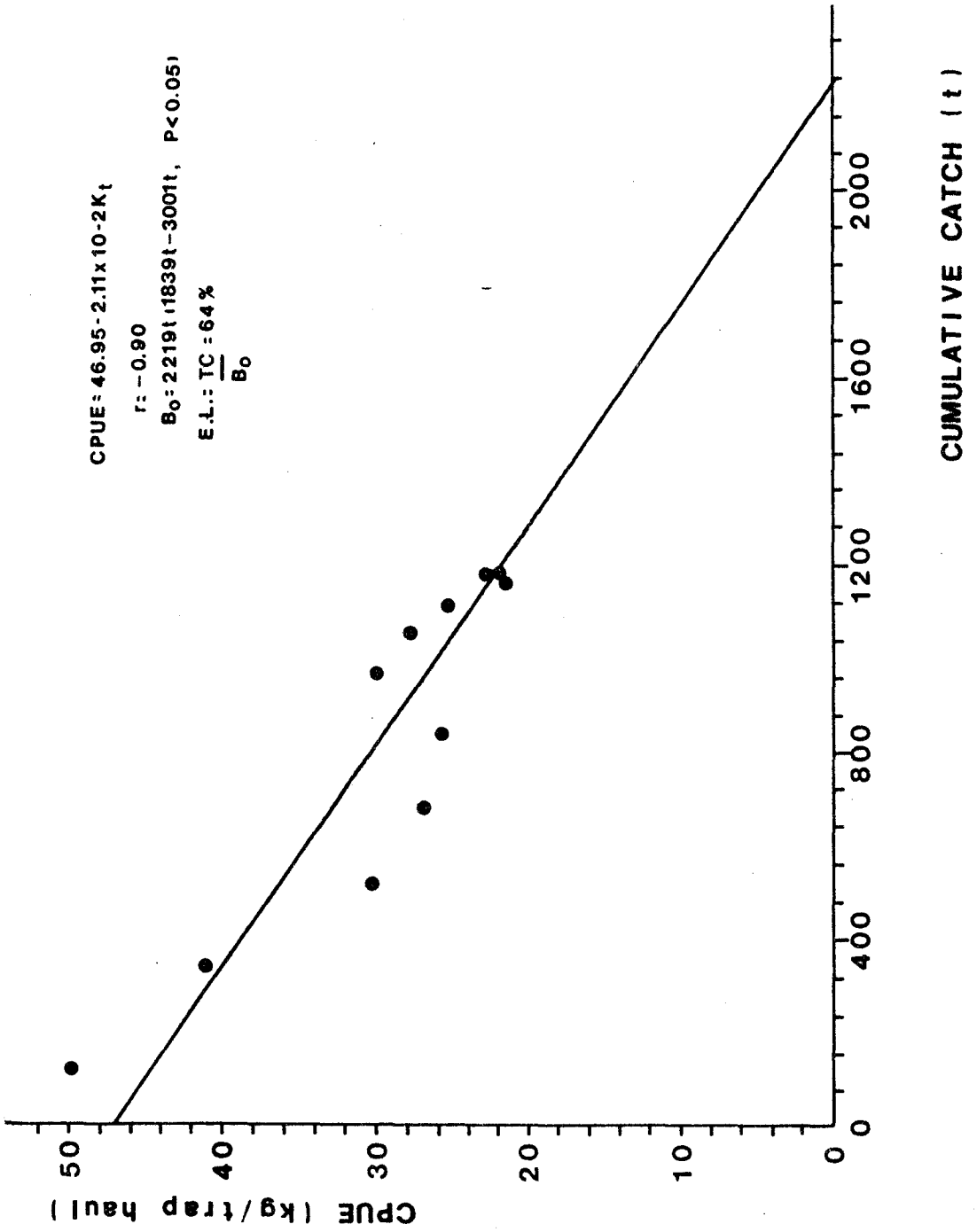


Figure 12: Cumulative logbook catch (t) versus mean weekly catch per unit effort (kg/trap haul) and Leslie analysis results for the 1986 Cape Breton Island snow crab, Chionoecetes opilio, fishery-Area 19.

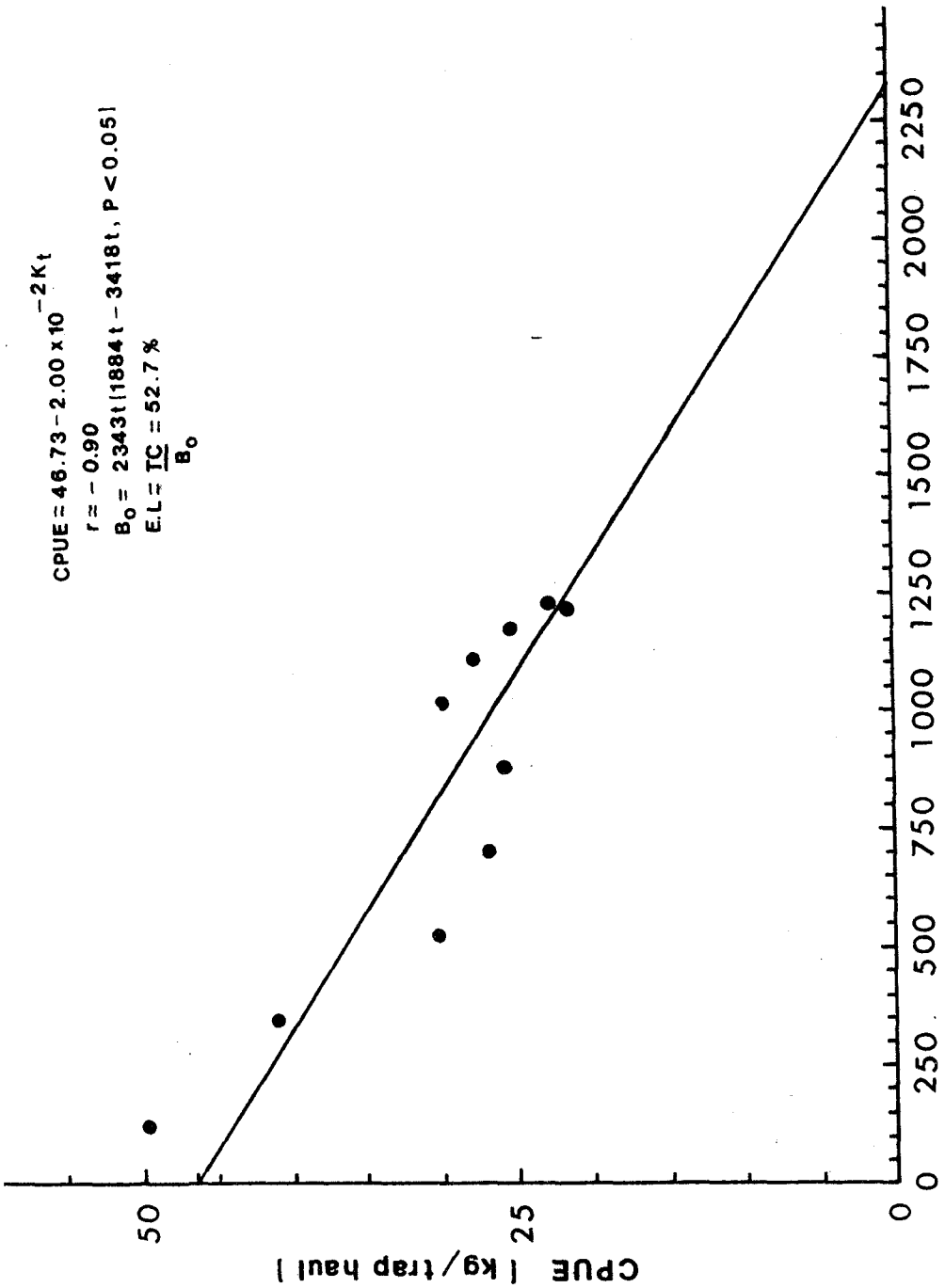


Figure 13: Cumulative sales slip catch (t) versus mean weekly catch per unit effort (kg/trap haul) and Leslie analysis results for the 1986 Cape Breton Island snow crab, Chionoecetes opilio, fishery-Area 19.

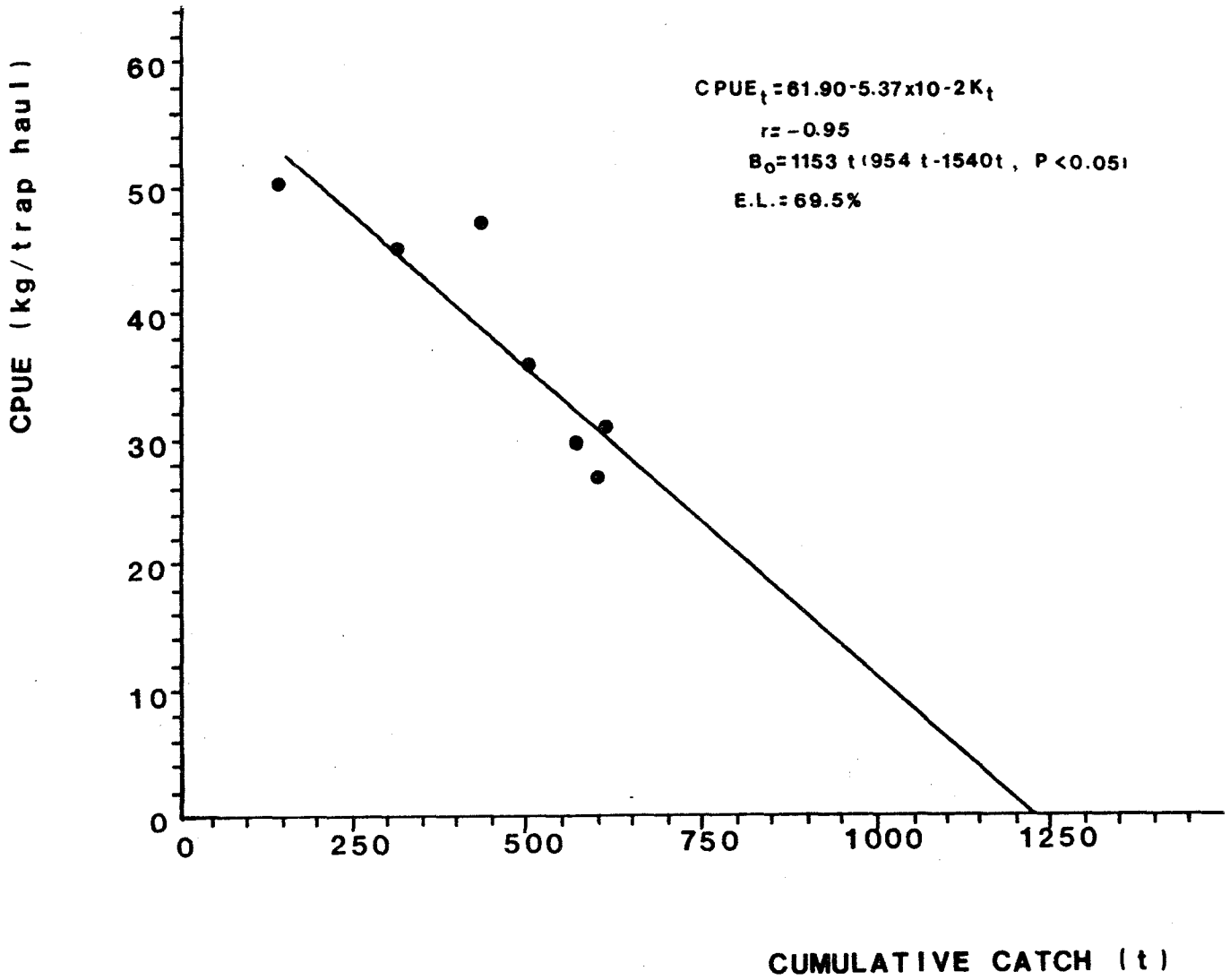


Figure 14: Cumulative logbook catch (t) versus mean weekly catch per unit effort (kg/trap haul) and Leslie analysis results for the 1986 Cape Breton Island snow crab, Chionoecetes opilio, fishery-Area 18.

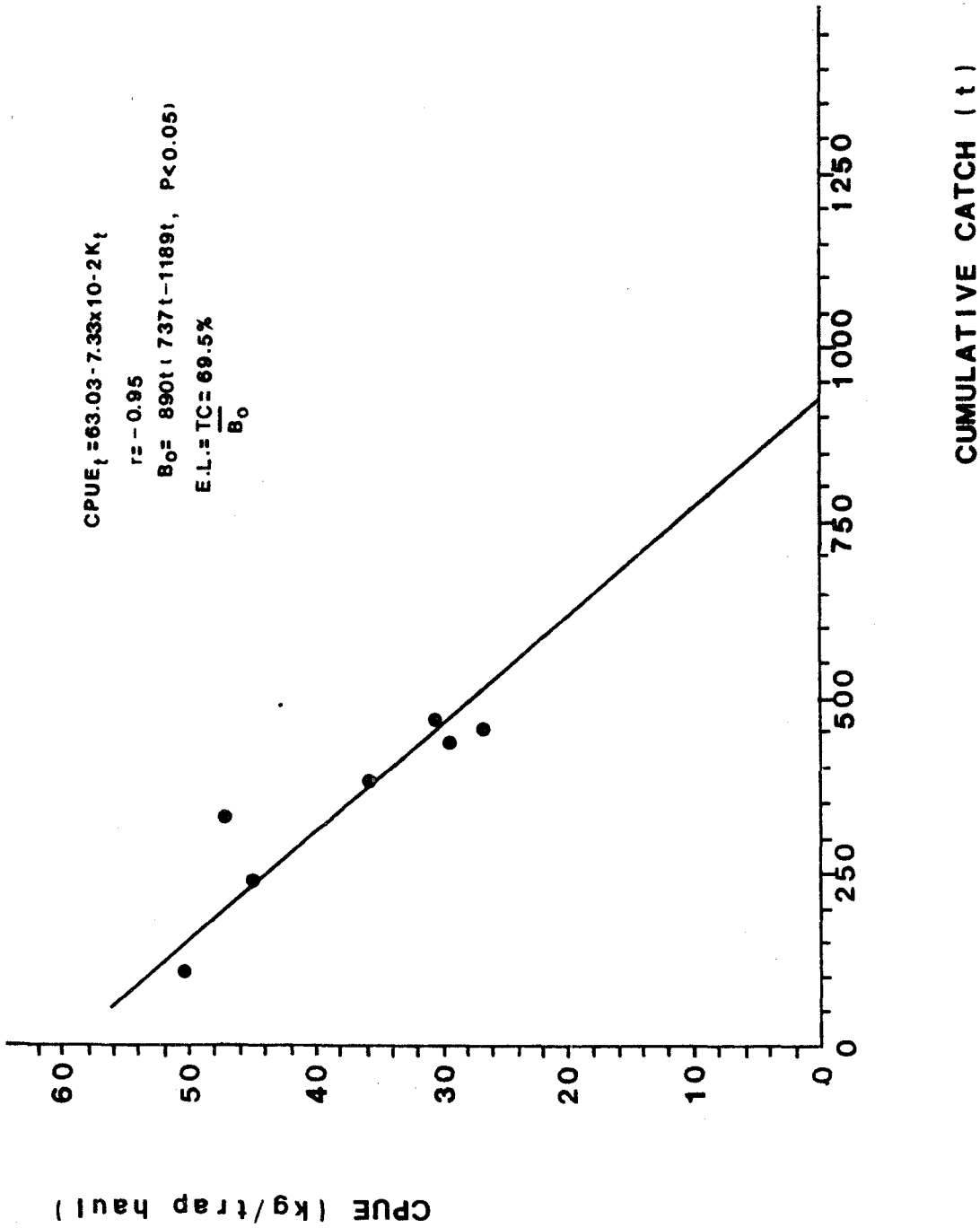


Figure 15: Cumulative sales slip catch (t) versus mean weekly catch per unit effort (kg/trap haul) and Leslie analysis results for the 1986 Cape Breton Island snow crab, Chionoecetes opilio, fishery - Area 18.

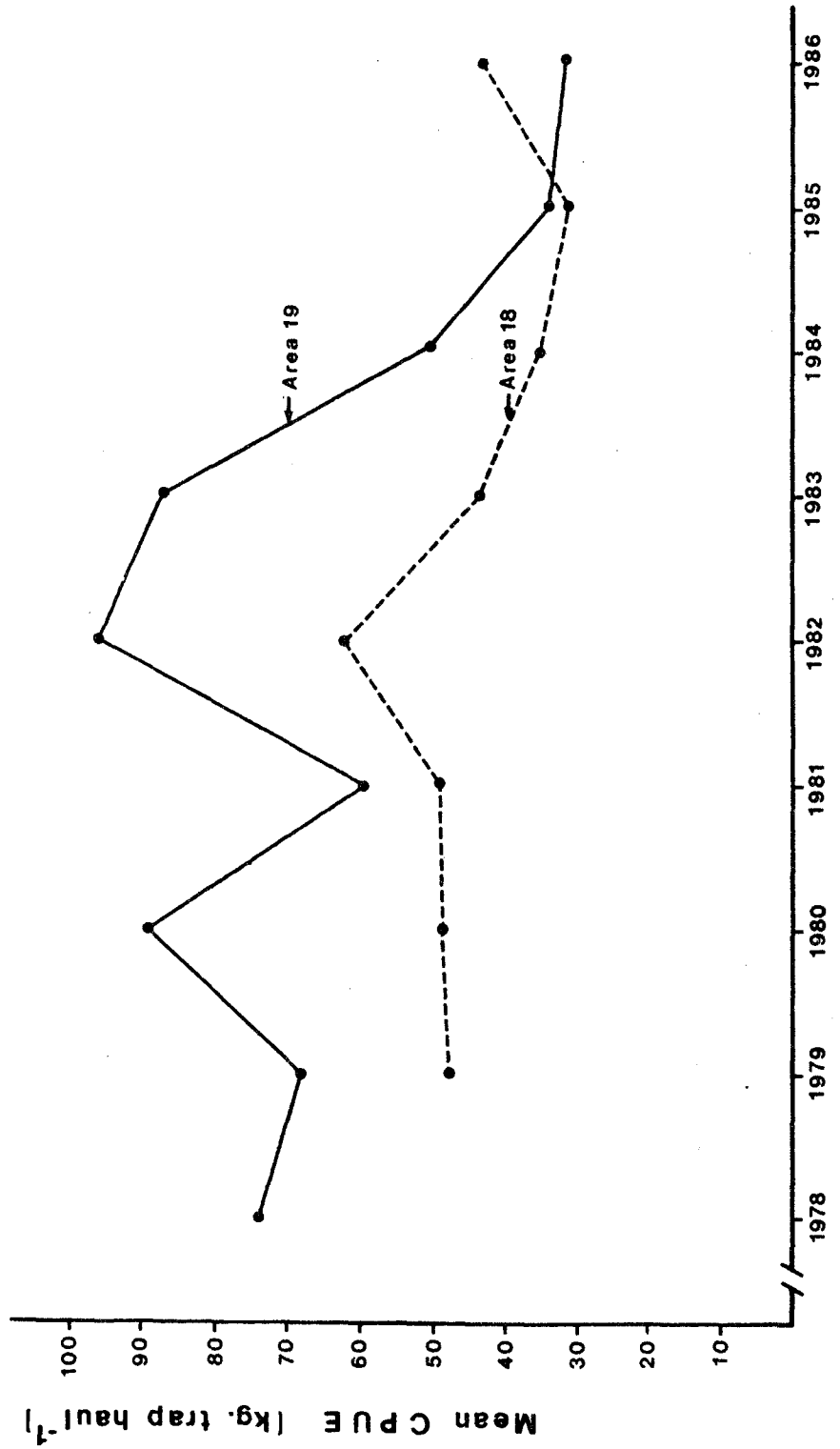


Figure 16: Trends in mean CPUE (kg/trap haul) for the snow crab, Chionoecetes opilio, fishery off western Cape Breton Island (Areas 18-19) from 1978-1986.