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Prince Edward Island Snow Crab, Chionoecetes opilio Fishery Stock Assessment - 1988 Fall Season

by

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ABSTRACT

An exploratory snow crab fishery was established off northern Prince Edward Island (PEI) with the issuance of 16 exploratory permits in 1985 and 14 new permits in 1986. The 16 original permits were reissued as licenses in 1987. The fishery has been under no quota limitations.

Despite CAFSAC advice not to open a fall fishery for the 1988 season, the fishery was opened for four weeks in October and a total landing of 229 t was recorded. During the season, no biological sampling was conducted and only logbook data have been analyzed for assessment purposes. Within the framework of the post season trawl survey in the S.W.Gulf of St. Lawrence, nineteen grids within the PEI fishery have been surveyed and analyzed for biomass estimation.

The distribution of fishing effort in the 1988 fall season reveals the presence of a main fishing ground at the north eastern boundary of Zone 25. The mean catch per unit of effort (CPUE) for the fall season continuously decreased from 38.2 kg per trap haul in 1985 to 29.5 kg per trap haul in 1987, then increased to 47.6 kg per trap haul in 1988. In two consecutive years, the mean CPUE was higher in the fall season than in the spring season. The total catch for the fall season increased from 168.7 t in 1987 to 229.1 t in 1988. Although the relationship between the adjacent areas of the Cape Breton and PEI Zone 25 fisheries is uncertain, the fisheries and biological characteristics in the fall season seem to be similar. An experimental tagging project on newly molted crabs was conducted in 1988 in Cape Breton Area 18. Tag returns are anticipated and some information on the relationship between adjacent fishing areas should be forthcoming.

Although accuracy of the results of biomass estimation is uncertain, the estimated total exploitation rate estimated according to the standard Leslie method recommended by CAFSAC (64-73%) exceeds the level of 50-60% used as a reference by CAFSAC. In addition, a disappearence of old large males from the fishery and a continuous decrease in the mean size for three consecutive seasons (from the 1986 to the 1988 spring season) also indicate a depressed stock condition. The extremely high percentage of newly molted crab in the catch (70%) suggests that the PEI fishery depends highly on annual recruitment. The closure of a fall season may be beneficial to the fishery, because the meat yield and commercial quality of newly molted crabs increases during the winter months so no discards are made at sea and this also allows newly molted crabs to reproduce at least once. Proper management of the exploitation of the renewed part of the stock is of most importance for this fishery.

RESUMÉ

Une pêche exploratoire du crabe des neiges a été établie au nord de l'Ile-du-Prince-Edouard (I.-P.-E.) avec l'émission de 16 permis exploratoires en 1985 et 14 nouveaux permis en 1986. Les 16 permis originaux ont été ré-émis comme licenses en 1987. Aucun contingent n'a été établi pour cette pêcherie.

Malgré les recommendations du CSCPCA de ne pas ouvrir la pêcherie à l'automne 1988, la pêcherie a été ouverte pour quatre semaines en ocotobre et 229 t ont été débarquées. Aucun échantillonage biologique n'a été mené et seulement les carnets de bord ont été analysés pour

l'évaluation du stock. Lors du chalutage après la saison de pêche du Sud-Ouest du Golfe du Saint-Laurent, dix-neuf quadrilatères à l'intérieur de la pêcherie de l'I.-P.-E. ont été échantillonnés et analysés afin d'estimer la biomasse.

La distribution de l'effort de pêche durant la saison d'automne 1988 révèle la présence d'une concentration de pêche à la limite nord-est de la zone 25. La prise par unité d'effort (PUE) moyenne pour la saison d'automne a diminué de 38,2 kg/casier levé en 1985 à 29,5 kg/casier levé en 1987 puis a augmenté à 47,6 kg/casier levé en 1988. Durant les deux dernières années, la PUE moyenne était plus élevée en automne qu'au printemps. La prise totale pour l'automne est passée de 168,7 t en 1987 à 229,1 t en 1988. Même si la relation entre les pêcheries des régions adjacentes du Cap-Breton et de la zone 25 est incertaine, les caractéristiques biologiques et celles de la pêcherie lors de la saison d'automne semblent être semblables. Un projet expérimental de marquage des crabes récemment mués a été mené en 1988 dans la zone 18 du Cap-Breton. Nous attendons les retours d'étiquettes et nous espérons recueillir de l'information sur la relation entre les deux pêcheries.

Même si l'exactitude des estimations de biomasse est incertaine, le taux d'exploitation (64-73%) calculé selon la méthode de Leslie recommandée par le CSCPCA pourrait avoir dépassé le taux de référence de 50-60% utilisé par le CSCPCA. De plus, la disparition de mâles à vieille carapace de la pêcherie et une baisse continue de la taille moyenne pour trois saisons de printemps consécutives (de 1986 à 1988) suggère une mauvaise condition du stock. Une très grande proportion de crabes récemment mués dans les prises (70%) indique que la pêcherie dépend largement du recrutement annuel. La fermeture de la saison pourrait être bénéfique pour la pêcherie puisqu'une amélioration du rendement en chair et de la qualité commerciale durant les mois d'hiver permettrait d'éviter les rejets en mer et les crabes récemment mués pourraient participer au moins une fois à la reproduction. Une gestion efficace de l'exploitation de ce recrutement annuel est donc très importante pour cette pêcherie.

INTRODUCTION

An exploratory snow crab fishery was initiated off the coast of Prince Edward Island (PEI) in 1985 and is composed of management Areas 25 and 26 (Fig.1). The number of exploratory permits were increased from 16 in 1985 to 30 in 1986 (Davidson et al, 1986; Comeau and Davidson, 1987). The initial 14 exploratory permits were issued as licenses for the 1987 snow crab fishing season. The fishermen are allowed to use 30 traps, which are mainly 6' x 6' standard rectangular traps. Contrary to the S.W.Gulf snow crab fishery, new types of trap such as pyramidal and large conical traps are not commonly used in this fishery; only five fishermen started to use large conical traps in the I988 fall season.

From 1985 to 1987, the PEI snow crab fishery was under no quota limitation and was officially opened April 1st and closed November 30th. In I988, the management plan proposed a 10 week season with no fall fishery. The 1988 spring fishery opened April 28th and ended July 5th which coincided to the midshore southwestern Gulf crab fishing season.

The DFO News Release (NR-HQ-88-022E) did indicate, however, that a fall season could be reconsidered "if there was evidence during the spring fishery that harvests and catch rates had changed for the better". Following the closure of the 1988 fishery on July 5, 1988, an ad hoc CAFSAC meeting for the PEI fishery was called (Moriyasu et al.,1988) and CAFSAC provided advice concerning a fall fishery. CAFSAC concluded that PEI crab resource has been significantly

reduced and the level of exploitation remained very high. CAFSAC also cautioned that catches during the period from the fall 1988 to the summer of 1989 would depend largely on the recruitment (molting) during the summer of 1988. Consequently, CAFSAC warned that a fishery in the fall 1988 would result in an exploitation rate likely well above the target level and reduce the spawning potential in the area.

Despite of CAFSAC advice not to open a fall fishery for 1988, an opening was supported by the Province of P.E.I., processors from Eastern P.E.I. and 13 fishermen out of 30; it was officially announced by the Fishery's Parliamentary Secretary on October 1st. to be four weeks during the month of October. The first landings were recorded on October 3rd and the last landings on October 31st.

MATERIAL AND METHODS

LOGBOOK DATA

No sea sampling was conducted for the fall fishery. Therefore, only logbook data have been analyzed. Catch/effort data for the PEI fishery was obtained from fishermen' logbooks by the Department of Fisheries and Oceans Electronic Data processing and Statistics Branch. The resulting data set was comprised of entries containing the following information:

a) Canadian Fisheries Vessel number (CFV)
b) date fished
c) date landed
d) fishing position (Loran C or latitude/longitude)
e) number of traps hauled
f) catch estimated in pounds by the fishermen

From these data, catch (converted to kg) and CPUE (daily catch/ number of trap hauls per day) were calculated and summarized into weekly intervals. The weekly data summaries were used in Leslie analysis (Ricker, 1975). The geographical fishing positions were plotted to identify the major fishing effort concentrations. Only logbooks received by the DFO/EDPS Branch by December 31st, 1988 have been analyzed.

POST SEASON TRAWL SURVEY

A post season trawl survey was conducted on the Southern Gulf of St. Lawrence between August 5th and October 3rd, 1988. Although this survey was not planned for the PEI fishery, 19 stations within the PEI fishery area were sampled (Fig.4) between September 4th and October 17th,1988. Three of these were excluded because of trawl damage.

A standard 20m Nephrops trawl with SCANMAR electronic net sensor was used on a chartered vessel for the research survey. Stations were sampled on a twelve hour basis during daylight. The duration of the tows varied from 4 to 8 minutes at a speed of 2.0-3.5 knots. A standard trawl haul starts when the predetermined amount of cable (usually three times the depth) is let out and the winch drums are locked. The catch is sorted out by sex,size,

morphometric maturity, molt stages and the presence/absence of the external eggs for females . This year's survey was planned in order to cover as large an area as possible. Therefore the number of tows per 10'x10' grid was limited to one.

Two methods for biomass estimation were used in this study: a geostatistical technique, Kriging (Conan, 1985; Conan et al., 1988), and an arithmetic mean (Conan et al., 1988).

Conan et al. (1988) compared the area swept method (Pennington and Grosslein, 1978) with these two methods for biomass estimation purpose and concluded that the swept area method used for biomass estimation of snow crab for the 1987 survey is not really a "stratified" method because the strata were not based on a previous knowledge of the spatial structure of the data. Furthermore the swept area method in the present instance was considered to increase bias rather than reduce it; it produced the largest estimate for average density and biomass. Stratified averages reduce the estimated variance attributed the final estimate but this procedure does not appear to be adequate, it implies that there is no covariance between sub-areas (Conan et al., 1988).

The catch in number of male crabs larger than 95 mm carapace width (C.W.) was used for estimating the commercially exploitable biomass at the end of the spring season (or at the beginning of the fall season). The catch in number of newly molted crabs (molt stage A-C3: Moriyasu and Mallet, 1986) larger than 95 mm C.W. was used for estimating recruitment biomass for the 1989 spring season. The fishable area in the PEI crab fishery was estimated from the historical fishing effort distribution. The swept surface by trawl net was estimated from the data on net wing width measured by SCANMAR electronic net sensor.

RESULTS AND DISCUSSION

LOGBOOK DATA

The logbook records from all 16 fishermen who participated in the fall fishery accounted for 207.1 t which represents 90.4% of the total catch according to the quota report (229.1 t). Unusable logbook records for CPUE calculations for the 1988 fall fishery accounted for 18% (38 t) of all logbooks. For this season, five fishermen used 30 large conical traps for the first time in the PEI fishery. However, no distinction was made between traditional square trap and large conical traps on the logbook record.

FISHING EFFORT AND CATCH PER UNIT OF EFFORT

Total fishing effort increased in 1986 relative to 1985 for both spring (11756 to 30824 trap hauls) and fall (3404 to 7182 trap hauls) seasons (Table 1). Total fishing effort decreased considerably in 1987 for both seasons (19069 trap hauls for the spring and 5919 trap hauls for the fall). Total fishing effort was further decreased in 1988 with 16478 trap hauls in the spring and 4813 trap hauls in the fall. The total duration of the season constantly decreased from 1985 to 1988 both in the spring and the fall. However, the fishing effort per week for the fall season showed a constant increase from 475 trap hauls per week in 1985 to 1200 trap hauls per week in 1988, which shows that the fall season becomes more and more a short-term fishery. CPUE for the spring season decreased constantly from 57.2 kg per trap

haul in 1985 to 15.1 kg per trap haul in 1987 (Table 1). Although the same trend in CPUE was observed for the fall fishery, the decrease was less evident. CPUE in 1988 showed an increase by 61 to 75% respectively for the spring and fall seasons compared to the 1987 season. The 1988 fall season showed the second highest CPUE since the beginning of the PEI fishery in 1985. For two consecutive years (1987 and 1988), CPUE in the fall season has been higher than CPUE in the spring season.

FISHING EFFORT AND CPUE DISTRIBUTIONS

The distribution of fishing effort for the fall season (Fig.2) showed one main concentration (73% of total logbook records) at the northeastern corner of the Area 25. Twenty one percent of total logbook records indicated the eastern end of the Area 26 as the fishing ground.

During the first week of the fall season, fishermen started to fish in two 10' x 10' grids then expanded to six grids in the third week and the highest CPUE was observed in one grid between the Area 25 and 26 showing 112.8 kg/trap haul (Fig. 3). During the fourth week, the total trap haul and CPUE decreased slightly, but the fishing effort was distributed in five grids. A considerable decrease in effort (distributed in three grids) accompanied by a significative decrease in CPUE was observed during the last week (Fig.3). Fishing locations are consistently concentrated at the edge and sometimes outsides of the fishing zones.

BIOLOGICAL INFORMATION FROM TRAWL SURVEY

The overall size frequency distribution for the 1988 trawl survey (Fig.5) showed an average size of 64.9 mm C.W. for males and 55.1 mm C.W. for females. The sizes were relatively symetrically distributed for females showing a mode at 56-58 mm C.W. For males, at least four distinct modes were observed at 56-58 mm C.W., 65-67 mm C.W., 77-79 mm C.W. and 89-94 mm C.W. The percentage of morphometrically immature crabs was 90.6% for males and 15.9% for females. All mature females carried external eggs but 7.1% showed 10-20% egg loss. The percentage of newly molted crabs was 93.6 %. A disappearance of old large males from the fishery is conspicuous. The fall stock mainly consists of newly molted crabs (70-96% of the initial biomass at the beginning of the fall season) which means that the PEI fishery highly depends on the recruitment to the fishery i.e. newly molted crabs. The percentage of newly molted crabs (molted during the previous season) showed a continuous increase from 17.3% in 1986, 54.9% in 1987 to 62.0% in 1988 for the spring season. The percentage of newly molted crabs (molted during the previous year and between the spring and fall season)also increased from 34.1% in 1986 to 81.2% in 1987 for the fall season (Moriyasu et al., 1988).

PEI ZONE 25 AND CAPE BRETON FISHERY

Although the relationship between PEI Zone 25 and the adjacent area of the Cape Breton fisheries is uncertain, the fisheries and biological characteristics in the fall season seem to be similar (Chiasson et al., 1988). An experimental tagging project on newly molted crabs was conducted in 1988 in Cape Breton Area 18. Tag returns are anticipated and some information on the relationship between these two areas should be forthcoming.

PEI ZONES AND SOUTHERN GULF FISHERY

The trawl survey results analysed and mapped by point Kriging show that there is no discontinuity between the Southern Gulf fishery and PEI areas harvestable grounds.

BIOMASS ESTIMATION

(1) LESLIE ANALYSIS

The weekly CPUE and cumulative catch data for the fall season (Table 2) as is, are not amenable for Leslie analysis due to considerably low CPUE values during the first two weeks.

Fishermen report that they were not very active during the first two weeks due to bad weather and to the opening of the fall fishery on short notice. They finally found good fishing spots during the third week. When eliminating the CPUE's for the first two weeks, the results of the Leslie analysis and the corresponding estimates of B_0 (Fig.6) and ER assuming a total catch of 229 t are as follows:

CPUE = 67.12 - 0.14 K_t (r = -0.99), B_0 = 477.42 t (254.3 t to -158 .8 t) ER= 48.0%

The recruitment between the spring and the fall seasons is estimated at 334 t by substracting the final biomass at the end of the spring season from the initial biomass at the beginning of the fall season. The recruitment ratio (biomass of recruitment/total fishable biomass) was estimated at 70%.

(2) KRIGING AND ARITHMETHIC MEAN

The locations of the trawl sampling stations inside of the PEI zone are shown in Figure 4. Total fishable surface estimated for the PEI fishery based on the commercial fishing effort distribution was 2442.51 km^2. The average swept area calculated based on SCANMAR net sensor records of wing width was 3950.52 x 10^{-6} km^2. The results provided by the various methods used for assessing the initial biomass (B_0.s) before the spring fishery, final biomass (B_f.s) after the spring fishery and final biomass (B_f.f) after the fall fishery are presented on Table 3. Numbers of crab were converted to weight at 535 g per male crabs larger than 95 mm C.W. calculated from the size frequency distributions and size-weight relationship of samples collected during the survey.

Since the crabs that molted during the early spring are the main part of the recruitment for the forthcoming season, the amount of recruitment can be roughly predicted by estimating the biomass of newly molted crab at the end of the spring season and assuming no natural mortality until the next fishing season(Rnm). The biomass of newly molted crabs was calculated by Kriging and the arithmetic mean (Table 3). The conversion of numbers to weight was based on the size frequency distribution and size-weight relationship of newly molted crabs collected during the survey i.e. 495 g per newly molted crab larger than 95 mm C.W.

Biomass for the PEI fishery was estimated by block Kriging based on a variogram calculated from samples collected over the whole S.W.Gulf. The variogram plots for the male crabs larger than 95 mm C.W. and for the newly molted crabs larger than 95 mm C.W. (Fig.7) show a range of approximately 28 km beyond which no more spatial covariance effects are

detected. Contour of variances and average densities for male crabs and for newly molted crabs both larger than 95 mm C.W. are presented in Fig.8.

The sampling units are well distributed over the S.W. Gulf of St. Lawrence fishery, but the contours of variances show that the PEI fishery located at the border of the zone applicable for biomass estimation by Kriging (Fig.8) for both male crabs and newly molted males resulted in large confidence intervals for estimated biomass.

By using the Kriging techniques, the average density of male crabs and of newly molted crabs both larger than 95 mm C.W. was 363 and 305 individuals per km^2 respectively. Total biomass for male crabs and for newly molted crabs was estimated at 472 t ($\pm$570 t) and at 369 t ($\pm$478 t) respectively for the PEI fishery after the spring season. The recruitment ratio (biomass of recruitment/total fishable biomass) was estimated as 78%.

The average density for male crabs and for newly molted male crabs and biomass estimated by arithmetic mean were 374 crabs per km^2 and 357 crabs per km^2 respectively. Total biomass for male crabs and for newly molted crabs both larger than 95 mm CW were 489 t ($\pm$348 t) and 467 t ($\pm$310 t) respectively for the PEI fishery after the spring season. The recruitment ratio (biomass of recruitment/total fishable biomass) was calculated as 96%. The exploitation rate was estimated at 52.0% by Leslie analysis, at 46.8% by arithmetic mean and at 48.3% by Kriging for the fall season, and at 63.0% by spring and fall Leslie analyses combined, at 62.3% by arithmetic mean and spring Leslie analysis combined and at 63.2% by Kriging and spring Leslie analysis combined for I988 (spring and fall seasons combined).

The substraction of the final biomass at the end of the spring season from the initial biomass at the beginning of the fall season should indicate the recruitment between the two seasons, because neither conspicuous immigration of crabs into the PEI fishery nor molting can be expected before the 1989 spring season. The recruitment level was estimated at 334 t by Leslie analysis, 346-467 t by arithmetic mean and 329-369 t by Kriging, which corresponds to the initial biomass levels at 477 t, 487-610 t and 474-512 t respectively and to the final biomass levels at 248 t, 260-381 t and 245-283 t respectively for the fall season. The estimated exploitation rate for the fall season varied from 37.5-52.0%, which resulted in the total estimated exploitation rate level of 63.6-72.9% for the 1988 season.

RECOMMENDATION

Although, CAFSAC recommended not to open the 1988 fall fishery, the fishery was opened and the estimated total exploitation rate (64-73 %) may have largely exceeded the CAFSAC reference level of 50-60 %. In addition, the disappearence of old large males from the fishery and a continuous decrease in the mean carapace size for three consecutive seasons (no data available for the 1988 fall season) also indicate a depressed stock condition. The threat of a decrease in reproductive potential still remained. However, a high percentage of newly molted crabs in the catch in the 1987 and 1988 seasons and the incidence of large number of morphometrically juveniles in the catch in the I988 spring season (Moriyasu et al.,1988) may indicate a positive sign for good recruitment into the fishery in the coming seasons. Furthermore, CAFSAC has suggested in the past that the closure of a fall season may be beneficial to the fishery, because the growth in weight of newly molted crabs at 15-20% level can be anticipated in the next spring fishing season and this also allows newly molted males to participate at least once in reproduction. An adequate management of the annual renewal of the

stock by recruitment of newly molted crabs is most important to this fishery. A closure of the fall season is recommended.

NOTE : FEEDBACK FROM FISHERMEN AND INDUSTRY (CLIENT MEETING)

A meeting for post fishery/pre-CAFSAC consultations with fishermen and industry was held on December 13, 1988. Fishermen and industry appreciated to have this kind of pre-CAFSAC meeting. During this meeting the following items were the main subjects discussed:

(Fishery)

- In the spring season, the meat quality was good and the average carapace size seemed to be larger than in 1987 but very few old crabs were found in the catch.
- The fishermen were seriously concerned by the drop in CPUE in the midshore fishery.
- Removal of the PEI zone boundaries without a fall season was suggested by fishermen.

(Research)

- An increase in sea sampling activity by DFO was recommended.
- Catchability of white crabs seems to be lower with round traps than rectangular traps.
- The predation on small snow crab by cod seems to be very high.

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Table 1. Fishing effort, duration of season, CPUE and total catch for the spring and fall fishery in P.E.I. fishery from 1985 to 1988.

Year	Trap hauls (#weeks)				CPUE		Total catch	
	S		F		S	F	S	F
1985	11756	(13)	3404	(7)	57.2	37.9	672.6	129.1
1986	30824	(13)	7182	(9)	32.7	32.2	1007.7	231.3
1987	19069	(11)	5919	(6)	15.1	28.5	287.9	168.7
1988	16478	(10)	4813	(4)	26.5	47.6	436.7	229.1

S: spring season, F: fall season

Weeks : duration of the fishing season in week

Table 2. Weekly effort and catch data based on fishermen's logbook records for the fall 1988 PEI fishery.

Week	CPUE	Trap hauls	Ct	Ct/2	Kt
1 Oct.02-08	45.2	529	25057	12529	12.5
2 Oct.09-15	40.8	436	23158	11579	36.6
3 Oct.16-22	54.1	1287	81606	40803	89.0
4 Oct.23-29	45.1	1236	75132	37566	167.4
5 Oct.30-Nov.05	37.0	120	4891	2446	207.1
Mean	47.6	Tot. 3608	209844		

Ct : weekly catch, Kt: cumulative catch

Table 3. Estimation of initial biomass(B_o.s), final biomass(B_f.s) for the spring 1989 season, final biomass (B_f.f) for the fall season 1989, biomass of recruitment between two seasons and exploitation rate.

Method	B_o.s (t)	B_f.s (t)	ERs (%)	Rnm (t)	B_o.f (t)	B_f.f (t)	ERf (%)	ERt (%)
Leslie	580* (398-1614)	143*	75.3*	334	477	248	52.0	72.9
Arithmetic mean	-	-	-	346**	489	260	46.8	71.9
				467	610	381	37.5	63.6
Kriging	-	-	-	329**	474	245	48.3	73.3
				369	512	283	44.7	70.2

B_o.s : initial biomass at the beginning of the spring season.
B_f.s : final biomass at the end of spring season or initial biomass at the beginning of the fall season.
Rnm : biomass of recruitment between the spring and the fall season. **: B_o.f - B_f.s
B_f.f : final biomass at the end of the fall season.
ERs : Exploitation rate for the spring season.
ERf : Exploitation rate for the fall season.
ERt : Total exploitation rate for the season (spring + fall) = total catch / (B_o.s + Rnm)

* Moriyasu et al.(1988).

N.B. Total catch for the spring season and for the fall season were 437 t and 229 t respectively.

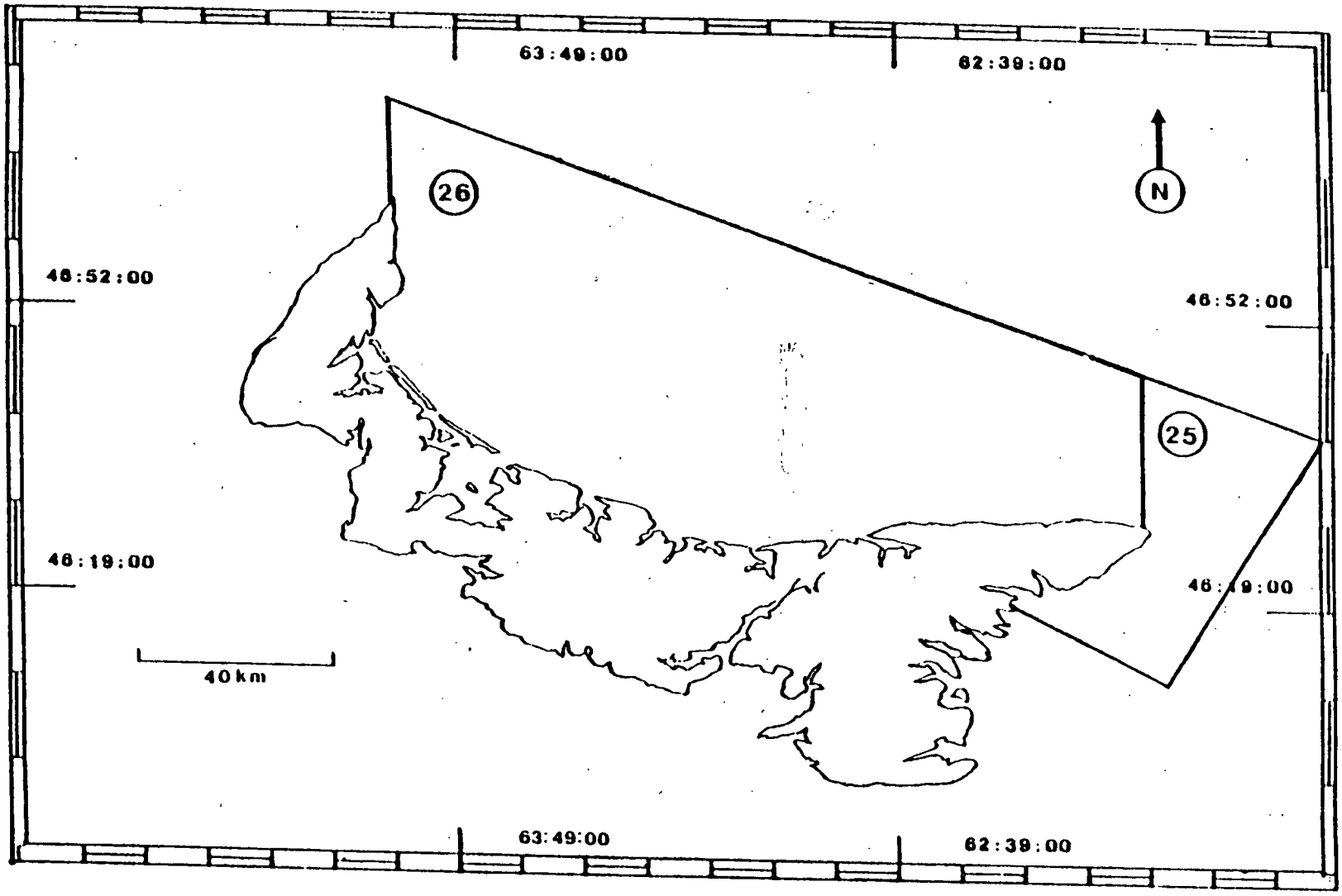


Figure 1. Prince Edward Island fishing Areas 25 and 26.

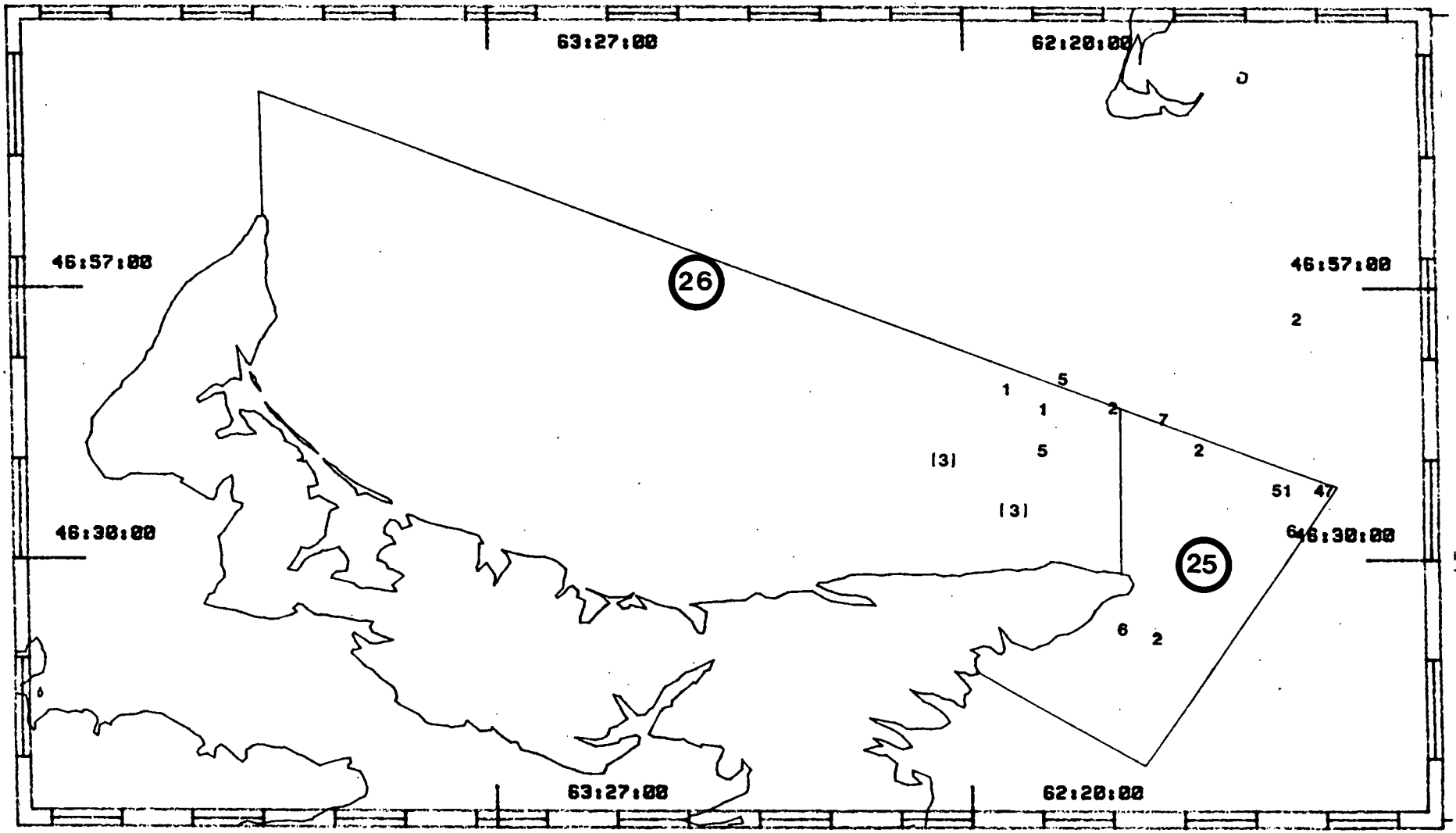
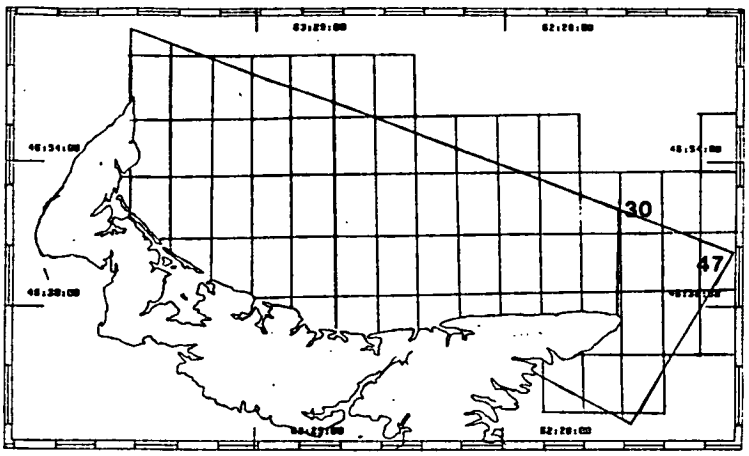


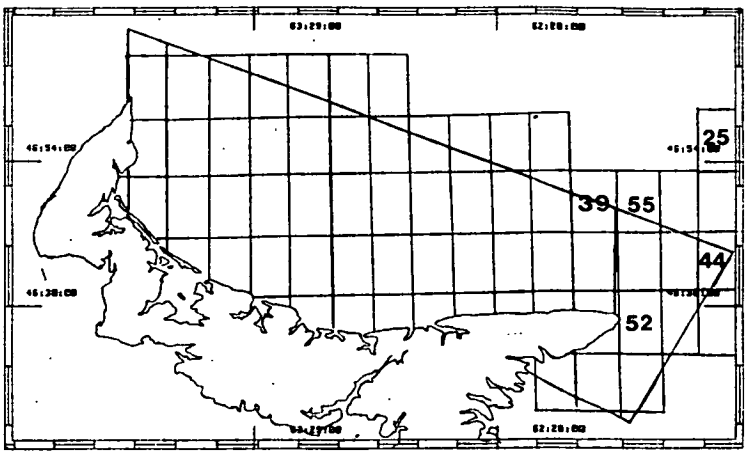
Figure 2. Overall distribution of fishing effort for the Prince Edward Island snow crab fishery for the fall 1988 season based on logbook data.

The numbers indicate the number of fishing position reported in logbook.
( ) :Fishing effort data are not available.

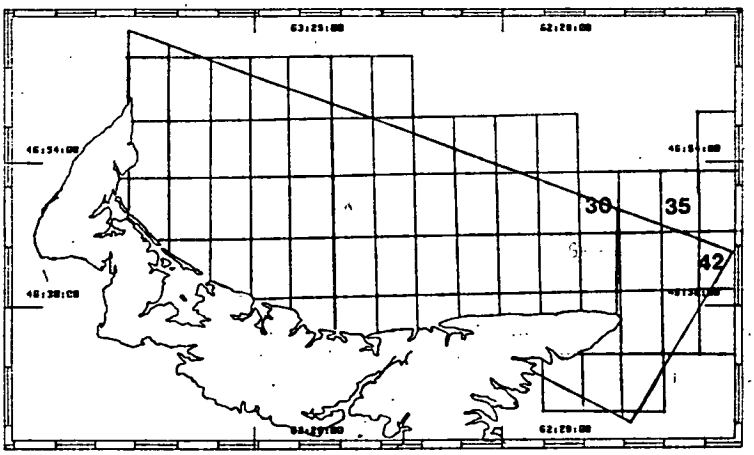
Week 1 :Oct.02-08



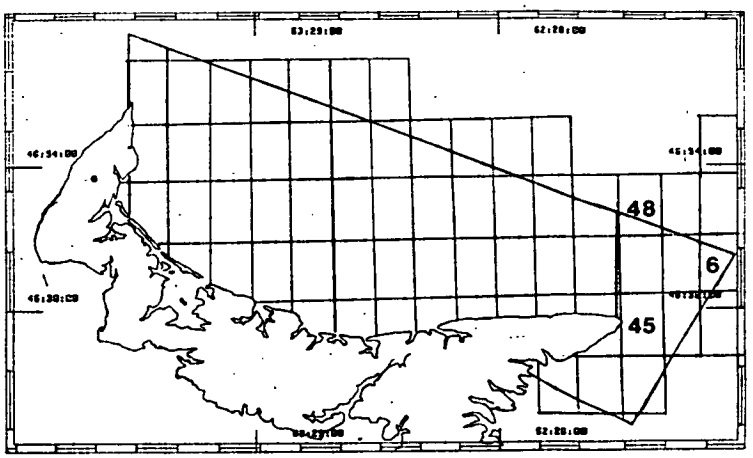
Week 4 :Oct.23-29.



Week 2 :Oct.09-15



Week 5 :Oct.30-Nov.05



Week 3:Oct.16-22

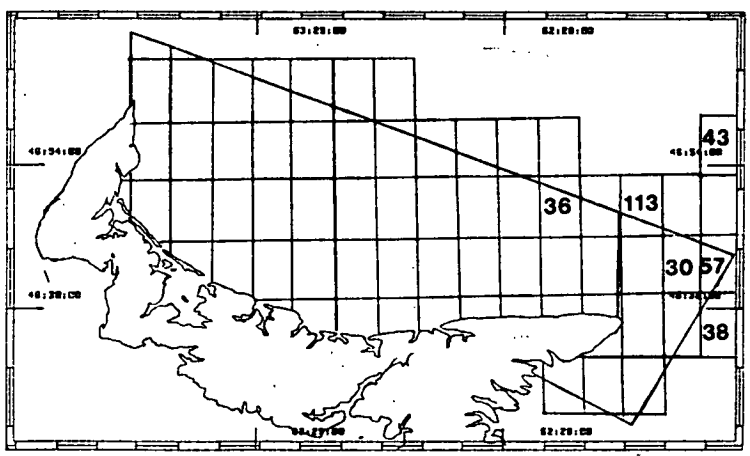


Figure 3 . Weekly distribution of catch per unit effort for the Prince Edward Island snow crab fishery based on the logbook data for the 1988 fall season.

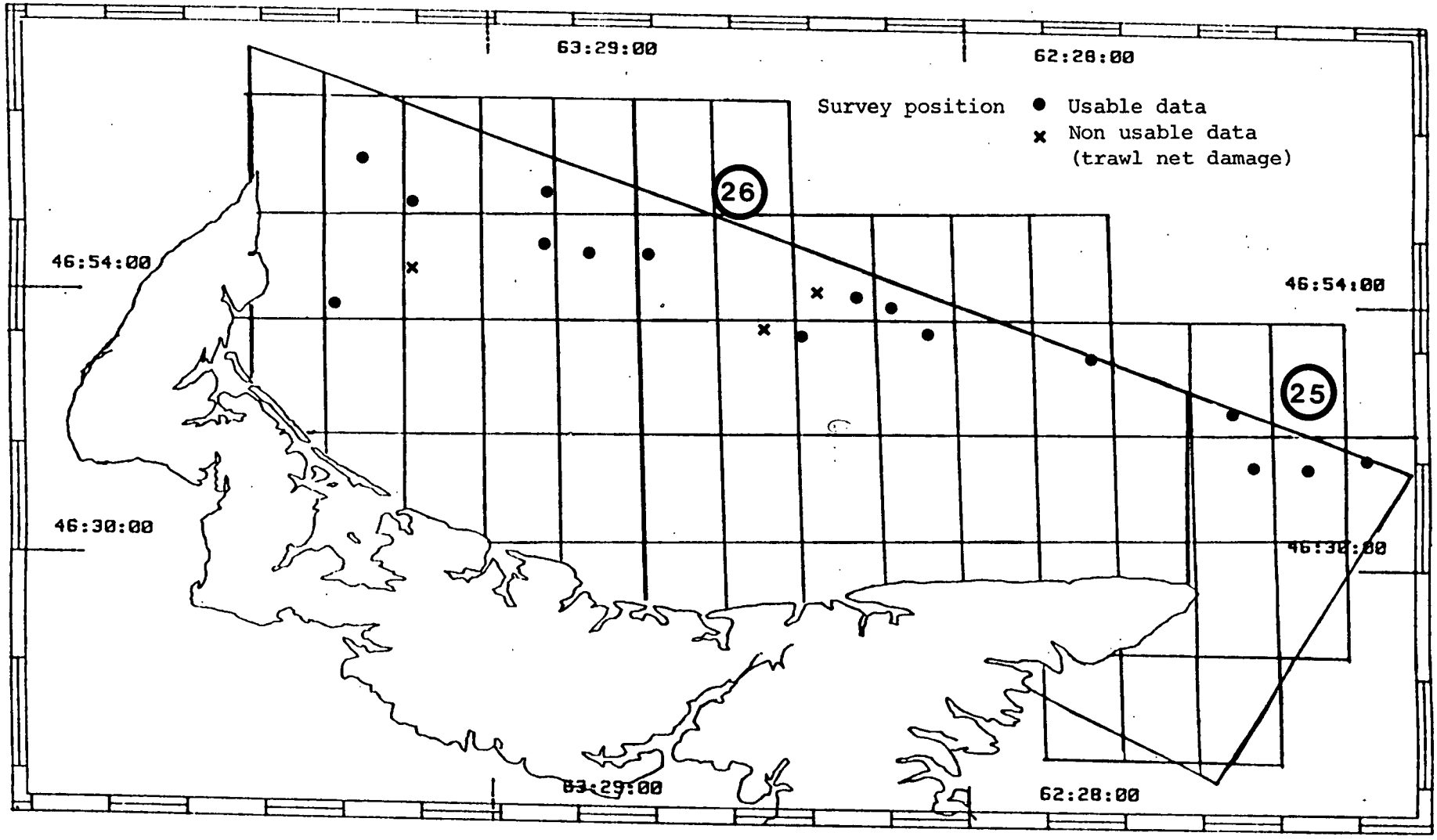


Figure 4. Geographic location of the post season trawl survey in the PEI snow crab fishery in 1988.

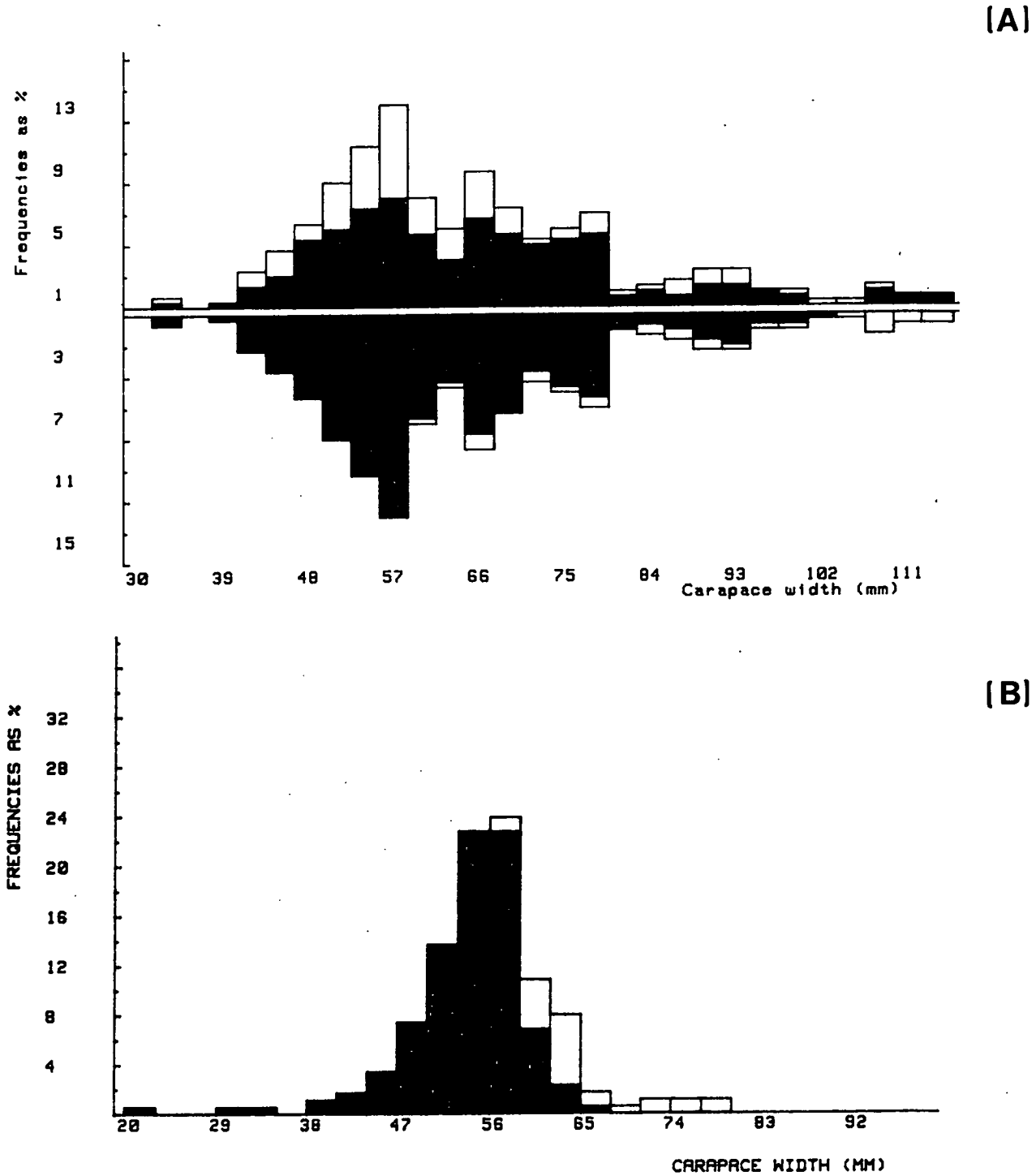


Figure 5. Overall size distribution of male (A) and female (B) snow crab, Chionoecetes opilio, collected during trawl survey in September and October 1988 in the Prince Edward Island crab fishery.

(A) Positive field :Total number of observation in %, percentage of newly molted crab in black
Negative field :Percentage of mature in white, percentage of immature in black.

(B) White :Total number of observation in %.
Black :Percentage of immature females.

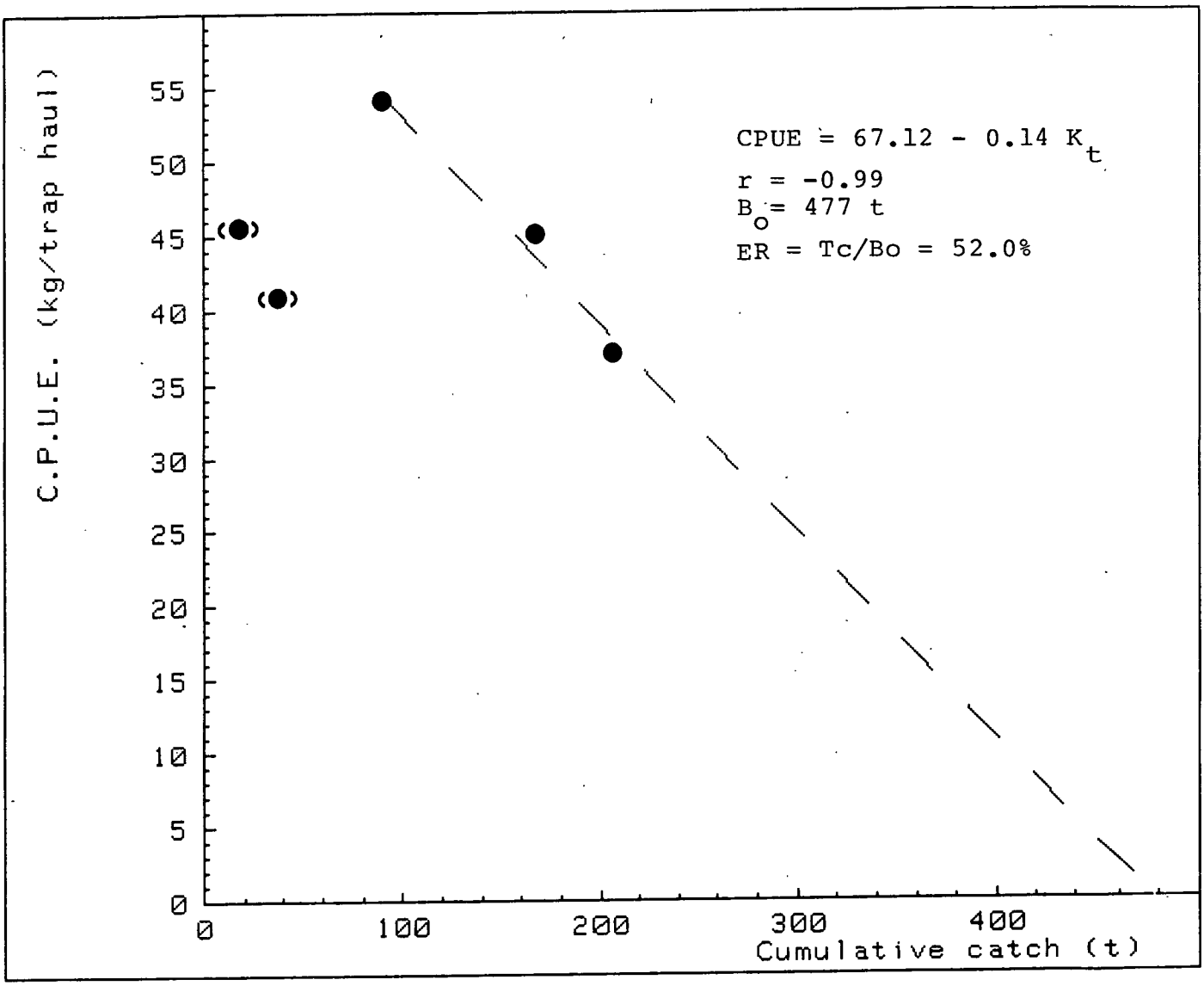
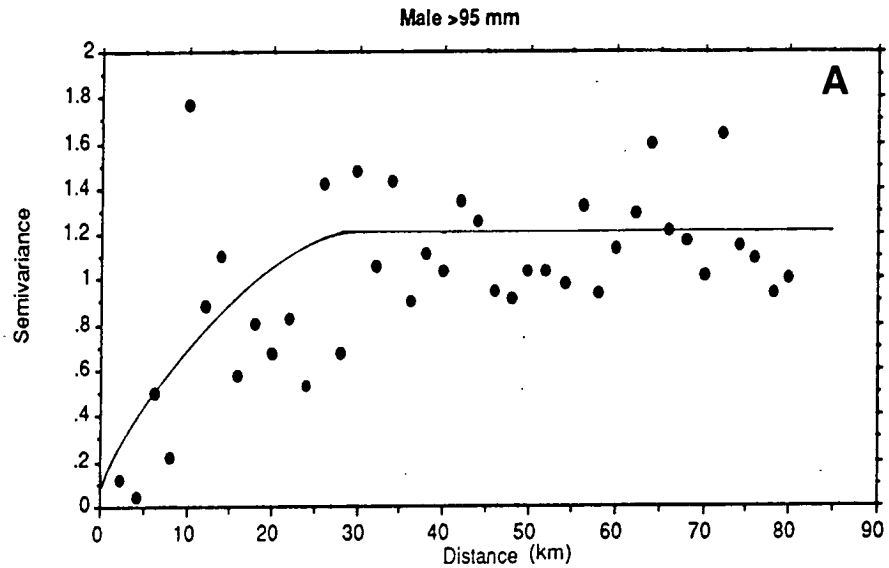


Figure 6. Cumulative catch (t) versus mean weekly catch per unit of effort (CPUE kg/trap haul) for the 3rd to the 5th week in Prince Edward Island crab fishery in the fall season.

(●) : Data not utilized for Leslie analysis



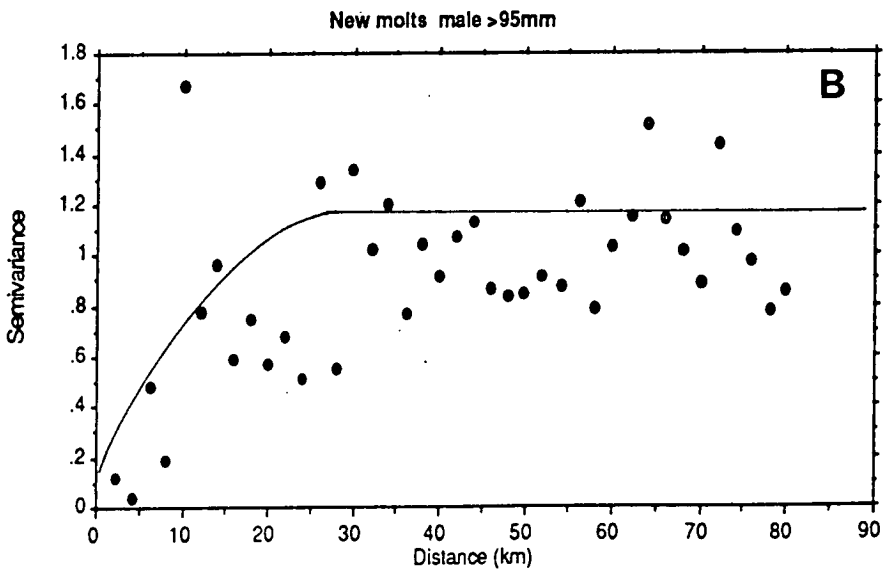


Figure 7. Experimental variogram from male larger than 95mm C.W. (A) and newly molted male larger than 95mm C.W. (B)
The range of spatial covariance effects is approximately 28 km: beyond a distance of 28 km, there is little interaction between sampling units.

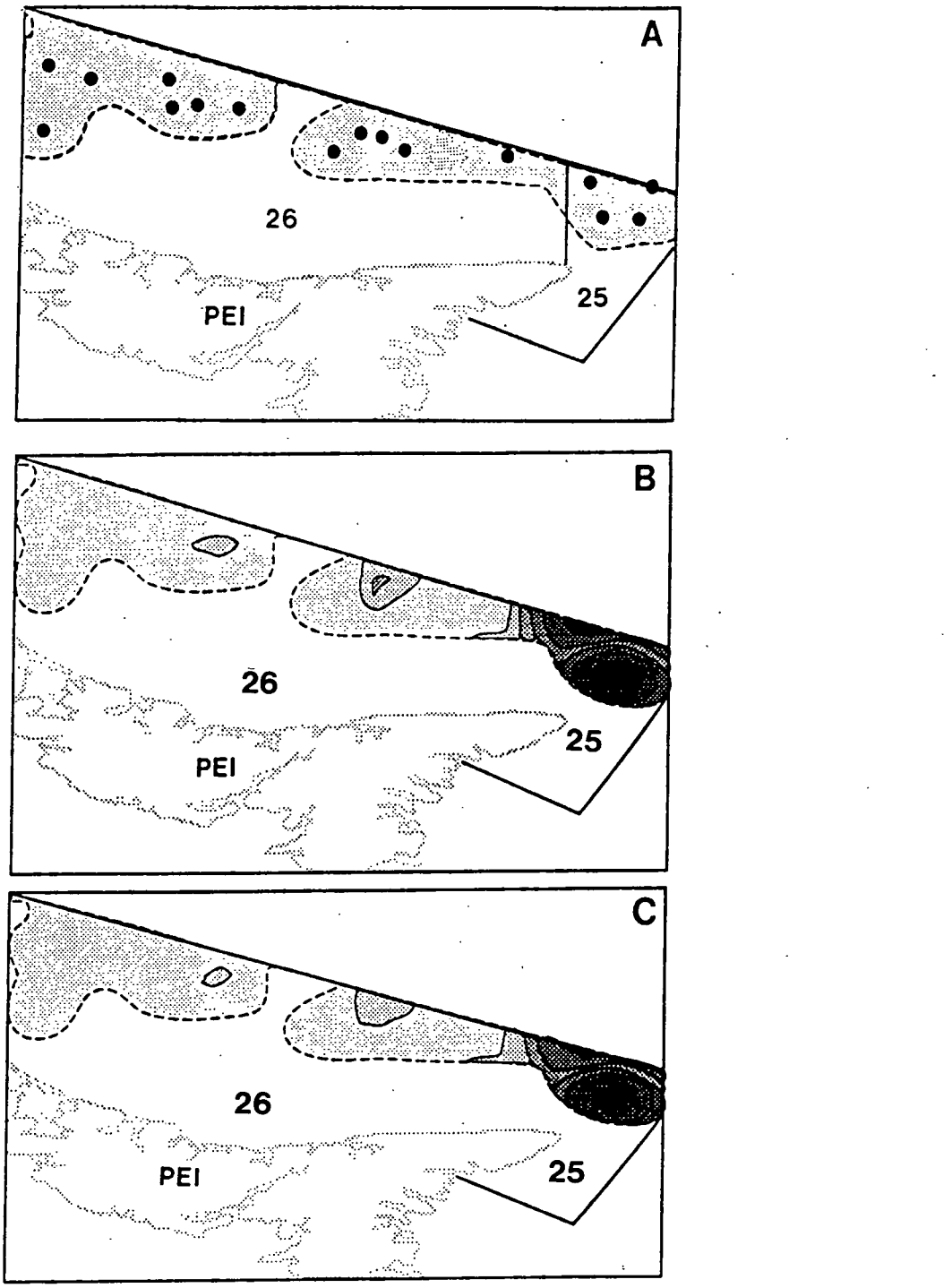


Figure 8. A: Trawl survey stations within the PEI fishery (●) and the limit of zone applicable for biomass estimation by Kriging (-----).

B: Isodensity contours of densities of male snow crabs larger than 95 mm carapace width.

C: Isodensity contours of densities of newly molted male crabs larger than 95 mm carapace width.