Prince Edward Island Snow Crab, Chionoecetes opilio Fishery Stock Assessment - 1989

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 additional permits in 1986. The 16 original permits were reissued as licenses in 1987. The fishery has operated under no quota limitations since its inception.

In 1989, the fishing season opened on April 9th but as for the midshore fishery, the season closed on May 29th (of the ten weeks proposed under the management plan) because of high percentage of newly molted crab in the catches. Total landings of 747 t were recorded during that period.

Biological information was obtained from sea sampling while catch, effort and distribution of fishing effort were obtained from fishermen's logbooks and processor's sales slips. Eleven stations within the P.E.I. fishery were surveyed and analysed for biomass estimation within the framework of the S.W. Gulf post season trawl survey.

Logbook records for the season represented 45% of the total catch of 747 t. Abnormally high catch per unit effort (CPUE's) observed in the northern boundary of the zone were not observed for any of the S.W. Gulf of St. Lawrence fleet fishing in adjacent region. The mean CPUE in 1989 calculated from logbooks for the season was similar to the 1988 fall season (47 kg/trap haul). Fishing locations were concentrated at the edge and outside of the zone.

The trawl survey data suggests a good recruitment into the fishery is expected in the coming seasons. However, this recruitment should be protected by avoiding the catch of newly molted crab. The result of the biomass estimation, together with the uncertainty of catch data obtained from the logbooks, suggest that direct biomass estimations should be made using trawls and more precise estimates can be achieved by increasing the surface to be covered.

RÉSUMÉ

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.

En 1989, le plan de gestion proposait une saison de pêche de dix semaines avec une ouverture prévue pour le 9 avril. Telle que la pêcherie semi-hauturière, la saison a été fermée le 29 mai due à un taux élevé de crabe récemment mué dans les prises. Des débarquements de 747 t ont été enregistrés durant cette période.

Les caractéristiques biologiques pertinentes ont été obtenues lors de l'échantillonage en mer. La prise, l'effort et la distribution d'effort ont été obtenus des carnets de bord des pêcheurs et des bordereaux d'achat. Onze stations à l'intérieur de la zone de l'I.-P.-E. ont été échantillonnées et analysées pour l'estimation de la biomasse lors de la croisière d'après-saison du S.O. du Golfe .

Les prises rapportées des carnets de bord représentaient 45% de la capture totale de 747 t. Des P.U.E. anormalement hautes observées à la limite nord de la zone n'ont pas été observées dans la flotille du N.-B. ni parmi la flotille du Québec qui pêchent dans les régions adjacentes du S.O. du Golfe du Saint-Laurent. La prise par unité d'effort moyenne (P.U.E.) en 1989 calculée à partir des carnets de bord était similaire à 1988 (47 kg/casier levé). La pêcherie a été toujours concentrée à la frontière ou à l'extérieur de la zone de pêche.

Les données de chalutage suggèrent un bon recrutement dans la pêcherie pour les prochaines saisons. Cependant, ce recrutement devrait être protégé en évitant la capture du crabe récemment mué. Le résultat d'estimation de biomasse et le doute sur la validité des données de carnet de bord suggèrent que des estimations directes de biomasse soient obtenues à partir du chalutage tout en augmentant la surface couverte afin d'obtenir des estimations plus précises.

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 was increased from 16 in 1985 to 30 in 1986 (Davidson et al, 1986; Comeau and Davidson, 1987). The initial 16 exploratory permits were issued as licenses for the 1987 snow crab fishing season. The fishermen are allowed to fish 30 traps, and most use 6' x 6' standard rectangular traps. The S.W.Gulf snow crab fishery,however, uses pyramidal and large conical traps while only five fishermen used large conical traps in the I988 PEI fall season.

From 1985 to 1987, the PEI snow crab fishery was under no quota limitation and the fishing season officially opened April 1st and closed November 30th. In I988, the snow crab fishery 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 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 the PEI crab resource was 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 zone.

Despite CAFSAC's advice against a fall fishery for 1988, an opening was supported by the Province of P.E.I., processors from Eastern P.E.I. and 13 of the 30 fishermen; a 4 week fall fishery was officially announced by the Fishery's Parliamentary Secretary on October 1st. The first landings were recorded on October 3rd and the last landings on October 31st.

In 1989, the crab fishing season was the same as southwestern Gulf with an opening date on April 9th and a closure on May 29th because of high percentage of newly molted crab in the catches.

MATERIAL AND METHODS

SEA SAMPLING

Location of capture, size in mm (carapace width and chela height), sex and shell condition (soft,medium and old) was noted for all crabs sampled during the 1989 fishing season. Chela height was measured for males to determine morphometric maturity using the method decribed by Conan and Comeau (1986).

Sea samples were obtained from Area 26 (Fig. 1) during weeks 4 and 6 (starting on April 16th). Weekly percentages of undersized males, immature males, soft shelled crabs and mean size distributions and cumulative summary statistics were calculated for the males.

LOGBOOK DATA

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 and contained 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 catch reported in the logbooks, which represented only 45% of the total catch, was extrapolated to the total catch in order to calculate the weekly landings. The weekly data summaries were used in Leslie analysis (Ricker, 1975). The geographical fishing positions were plotted to identify the major fishing effort concentrations.

POST SEASON TRAWL SURVEY

A post season trawl survey was conducted in the Southern Gulf of St. Lawrence between August 15th and October 29th, 1989 and included 11 stations within the PEI fishery (sampled between September 4th and September 7th,1989 (Fig.2) .

A standard 20m Nephrops trawl equipped with a 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 started when the predetermined amount of cable (usually three times the depth) was let out and the winch drums locked. The catch was 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 were used to estimate biomass 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 swept area method (Pennington and Grosslein, 1978) with these two biomass estimation methods and concluded that the swept area method of biomass estimation used for the 1987 snow crab survey was 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 to the final estimate but this procedure does not appear to be adequate since it implied that there was 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). Numbers of crab were converted to weight by using the size-weight relationship of samples collected during the survey. The catch in number of newly molted

crabs (molt stage A-C3: larger than 95 mm C.W. (Moriyasu and Mallet, 1986) was used for estimating recruitment biomass for the 1990 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 the SCANMAR electronic net sensor.

RESULTS AND DISCUSSION

LOGBOOK DATA

The logbook records from 17 of the 30 fishermen who returned log information in the fishery accounted for 336.7 t or 45.1% of the total catch according to the quota report (747t).

FISHING EFFORT AND CATCH PER UNIT OF EFFORT

Total fishing effort decreased from 16478 trap hauls in 1988 to 15726 trap hauls in 1989 (Table 1). The duration of the season decreased from 1985 to 1988, both in the spring and the fall, and decreased again in 1989. The CPUE calculated for the 1989 season (47.5 kg/trap haul) was almost identical to the 1988(47.6 kg/trap haul) fall fishery (Table 1).

The distribution of fishing effort (Fig.3) showed two concentrations : one in the central Area 26; and one at the northeastern corner of the Area 25. Seventy one percent of total logbook records were reported in central Area 26 but in both areas several positions were reported outside the PEI boundaries.

Highest CPUE 's were observed in several 10' X 10' grids during the first two weeks of the season (Fig. 4) with the highest overall CPUE's on the northern limit of Area 26. These abnormally high CPUE's were not observed in any of the logbook records for the New Brunswick or Québec fleet fishing in adjacent region of the S.W. Gulf of St. Lawrence. A significant decrease in CPUE was observed for the last three weeks of the season. Fishing locations were consistently concentrated at the edge and sometimes outside of the fishing zone.

BIOLOGICAL INFORMATION FROM TRAWL SURVEY

The overall size frequency distribution for the 1989 trawl survey (Fig.5) showed an average size of 78.7 mm C.W. for males and 58.9 mm C.W. for females. The distribution of sizes were symetrical for females showing a mode at 62 mm C.W. For males, two modes were observed at 71 mm C.W. and 89 mm C.W.. The percentage of morphometrically immature males was 85.5% , a decrease from 90.6% in 1988. All mature females carried external eggs. The percentage of newly molted crabs was 96.7%. The PEI stock consisted mainly of newly molted crabs which means that the fishery is highly dependant upon the recruitment to the fishery i.e. newly molted crab.

Biological information from sea sampling

The overall size frequency distribution for 1989 (Fig. 6) showed an average size of 101.5 mm C.W. One mode was observed at 102 mm. The seasonal percentage of morphometrically immature males in the samples fluctuated from 17.1% in 1986 , 50.9% in 1987 , 45.1% in 1988 (Moriyasu et al., 1988) and to 12.0% in 1989 .

The percentage of newly molted crab (molted during the previous season) showed a continuous increase from 17.3% in 1986, 54.9% in 1987, 62.0% in 1988 (Moriyasu et al., 1988) to 97% in 1989 for the spring season .

PEI ZONES AND SOUTHERN GULF FISHERY

Analysis and mapping of the trawl survey results with point Kriging showed that there was continuity between the Southern Gulf and PEI fishing grounds (Moriyasu et al., 1988).

BIOMASS ESTIMATION

(1) LESLIE ANALYSIS

The results of the Leslie analysis (Fig. 7) and their corresponding estimates of initial biomass (B_o) and exploitation rate (E.R.), assuming a total catch of 747 t (Table 2) are as follows:

$CPUE = 88.07 - 0.09K_t$ ($r = -0.98$), B_o = 989 t (887t to 1148 t) ER= 75.5%

This exploitation rate is similar to the 1988 spring season (75.4%, Moriyasu et al., 1988)

(2) KRIGING AND ARITHMETHIC MEAN

Total fishable surface estimated for the PEI fishery, based on the commercial fishing effort distribution, was 2442.51 km^2 (Moriyasu et al., 1989). The average swept area calculated, based on SCANMAR data, was 2617.33 x 10^{-6} km^2.

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. showed a range of approximately 13.7 km beyond which no more spatial covariance effects were detected.

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 was located at the border of the zone applicable for biomass estimation by Kriging for male crab larger than 95 mm C.W. resulted in large confidence intervals for estimated biomass.

By using the Kriging techniques, the average density of male crab larger than 95 mm C.W. was 935.2 individuals per km^2 . Total biomass for male crab was estimated at 1319.9 t ($\pm$1295.5 t) for the PEI fishery after the fishing season.

The average density for male crabs estimated by the arithmetic mean method was 350 crabs per km^2. Total biomass for male crabs larger than 95 mm CW was 493.9 t ($\pm$1259 t) for the PEI fishery after the spring season. The exploitation rate was estimated to be 75.6% by Leslie analysis, 151% by the arithmetic mean method; and 56.6% by Kriging for the 1989 season.

RECOMMENDATION

Comeau and Davidson (1987), Comeau et al., (1988), Moriyasu et al. (1988), and Moriyasu et al. (1989) all reported low level of fishable biomass of the snow crab stock for 1986, 1987 and 1988 respectively. From 1987 to 1989, exploitation rates (over 75%) have always been higher than the CAFSAC reference level of 50-60 % except for the 1988 fall season (52%). We reiterate our advice of last year that effort levels will need to be reduced. In addition, the disappearence of old large males from the fishery indicate a depressed stock condition. The threat of a decrease in reproductive potential still remains. A high percentage of morphometrically juvenile males were found during the trawl survey in 1988 (Moriyasu et al.,1988) and 1989 and may indicate a positive sign for good recruitment into the fishery in the coming seasons. An effective management of the annual renewal of the stock (recruitment of newly molted crabs) is of utmost importance to this fishery. The recruitment should be protected by closing the fishery as soon as the newly molted crab enter the fishery to allow the participation of the mature crabs in the reproduction cycle during early spring of the following year. Biomass estimation for the P.E.I. fishery together with the uncertainty of catch data obtained from logbook records, suggested the need to use an alternative biomass estimation technique, namely kriging. In addition, increasing the surface covered by the post-season trawl survey in the P.E.I. zone would provide more precise biomass estimation.

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Table 1. Fishing effort, duration of season, CPUE and total catch for the P.E.I. snow crab fishery from 1985 to 1989.

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
1989	15726 (06)	-	47.5	-	747	-

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 extrapolated using quota report for the 1989 P.E.I. snow crab fishery.

Week	CPUE	Trap hauls	C_t	$C_t/2$	K_t
1April16-22	73.1	883	210456	105228	105.2
2April23-29	66.1	855	175341	87671	298.1
3April30-May06	52.8	1225	173686	86843	472.6
4May07-13	33.4	885	84019	42010	601.5
5May14-20	25.9	780	56667	28334	671.8
6May21-27	24.9	593	25556	12778	712.9
7May28-June02	20.6	90	4160	2080	727.8
Mean	47.6	Tot. 5311	747000		

Ct : weekly catch, Kt: cumulative catch

Table 3. Catch(t), estimation of initial biomass(B_o.),final biomass(B_f.) and exploitation rate for the P.E.I. 1989 snow crab fishery.

Method	C_t (t)	B_o(t)		B_f (t)	E.R. (%)
Leslie	747	989	(887-1148)	242	75.5
Arithmetic mean	747	494	(-769-1756)	-	151.2
Kriging	747	1320	(24-2616)	573	56.6

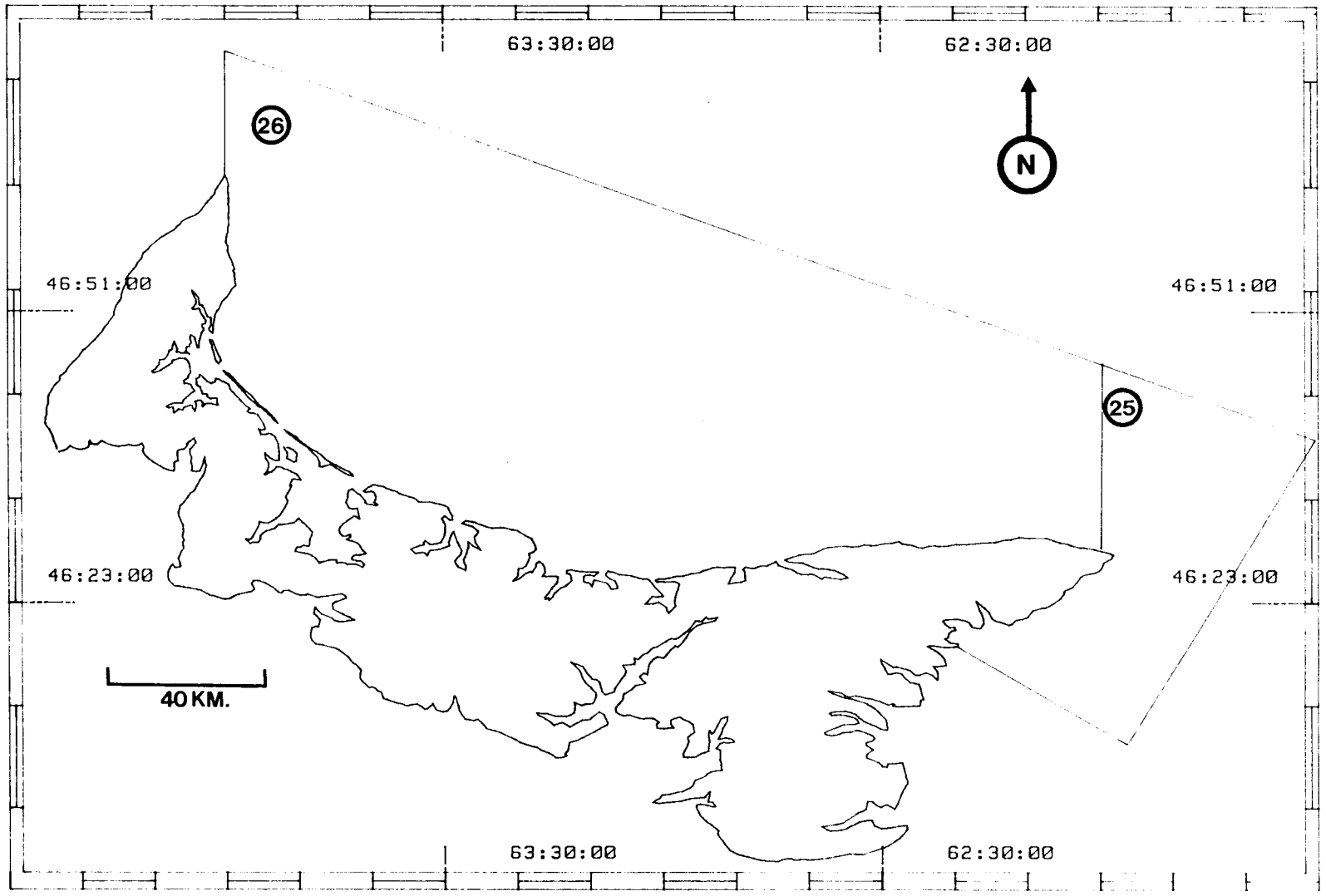


Figure 1. Prince Edward Island fishing Area 25 and 26.

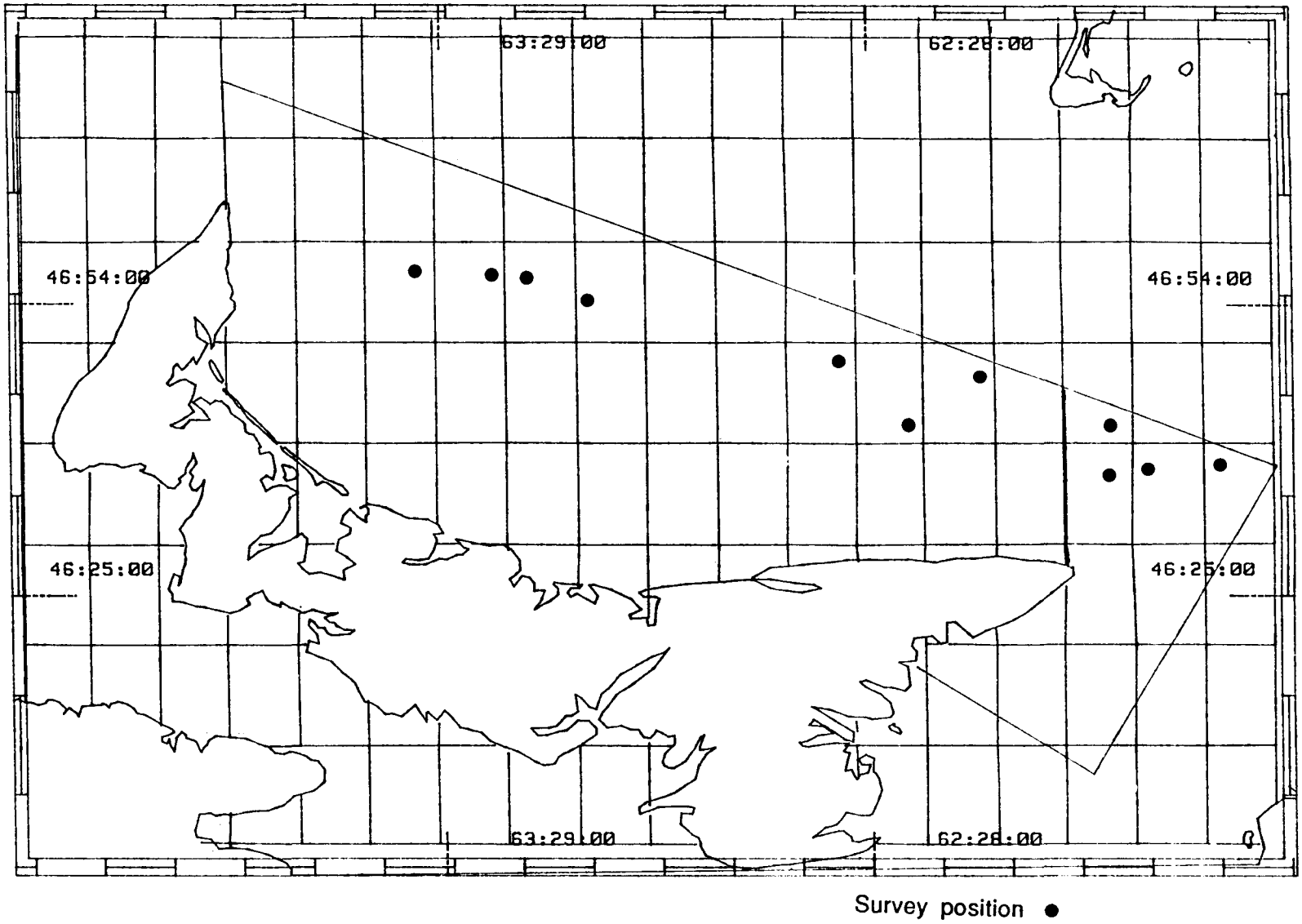


Figure 2. Geographic locations of the post season trawl survey in the P.E.I. snow crab fishery in 1989.

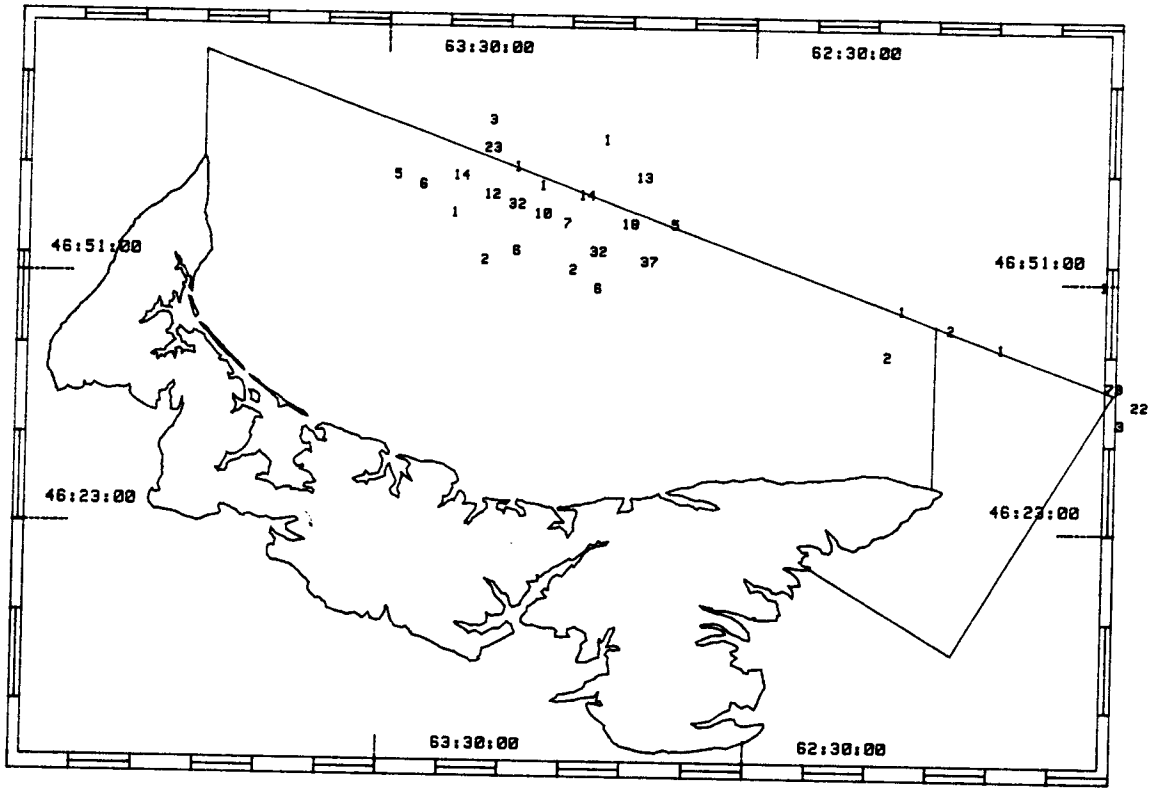


Figure 3. Overall distribution of fishing effort for the P.E. I. snow crab fishery for the 1989 season based on logbook data.

The numbers indicate the number of fishing positions reported in the logbooks.

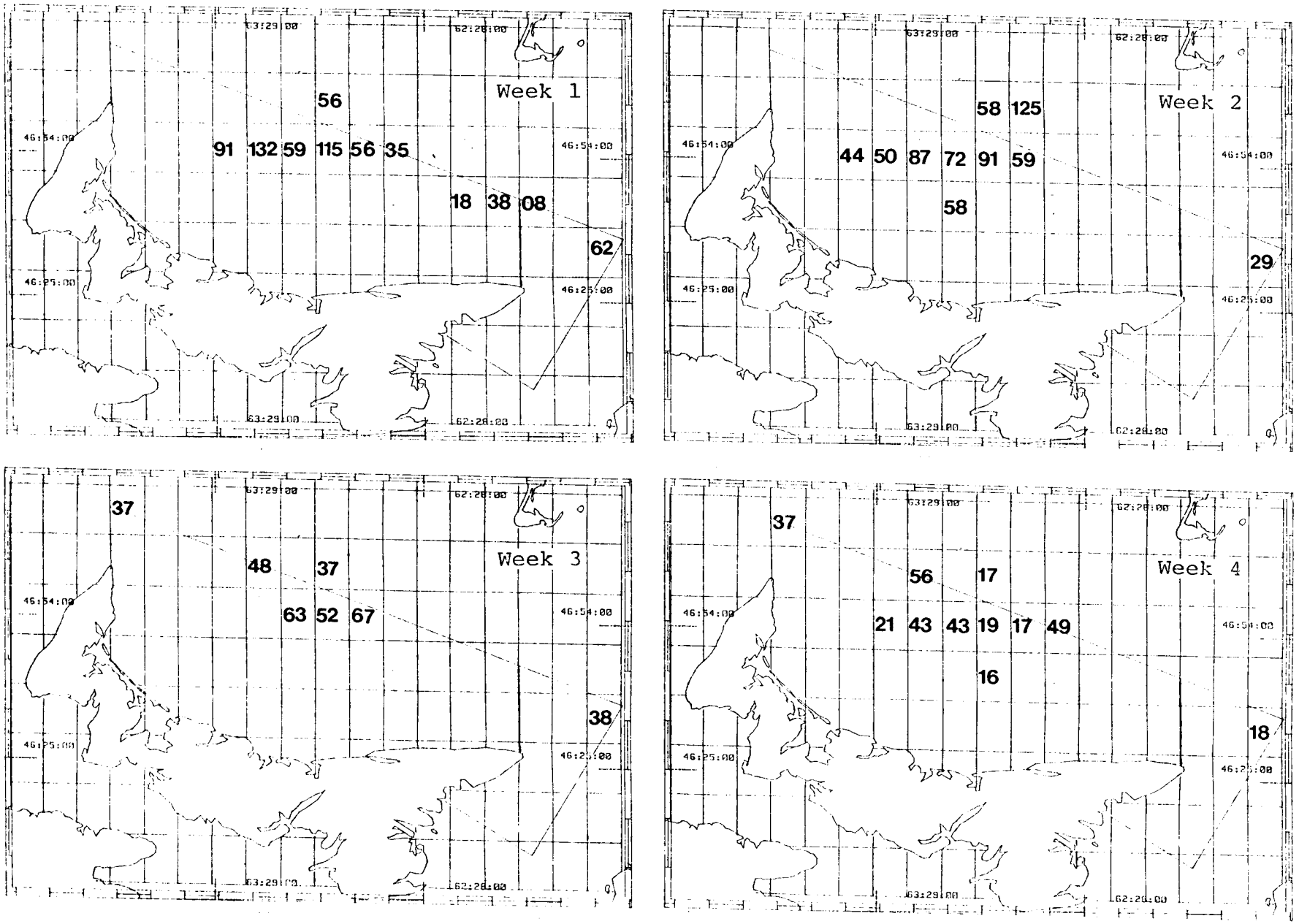
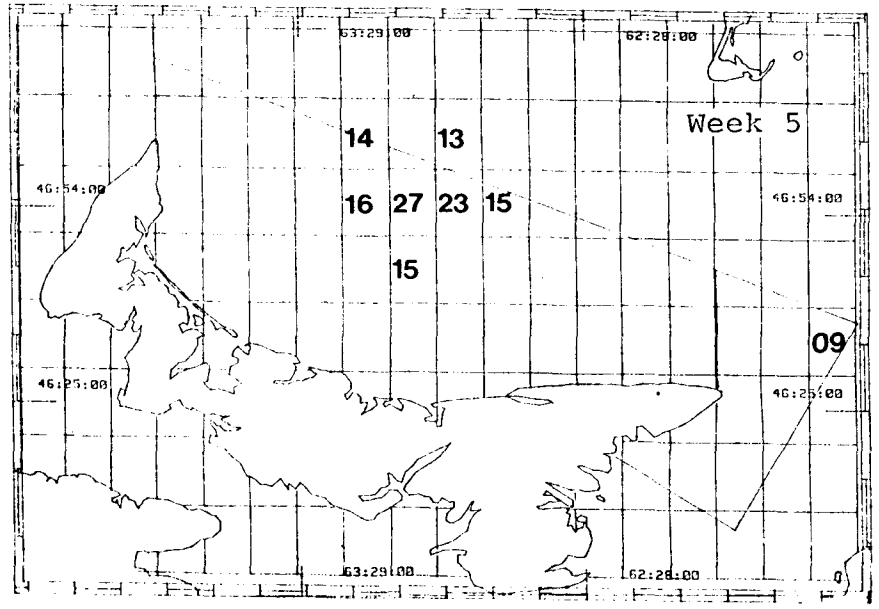
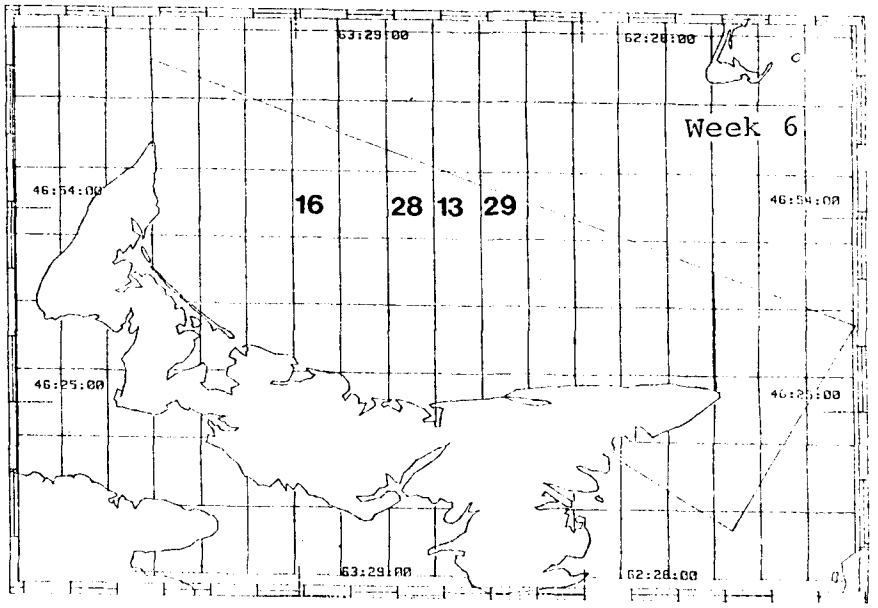
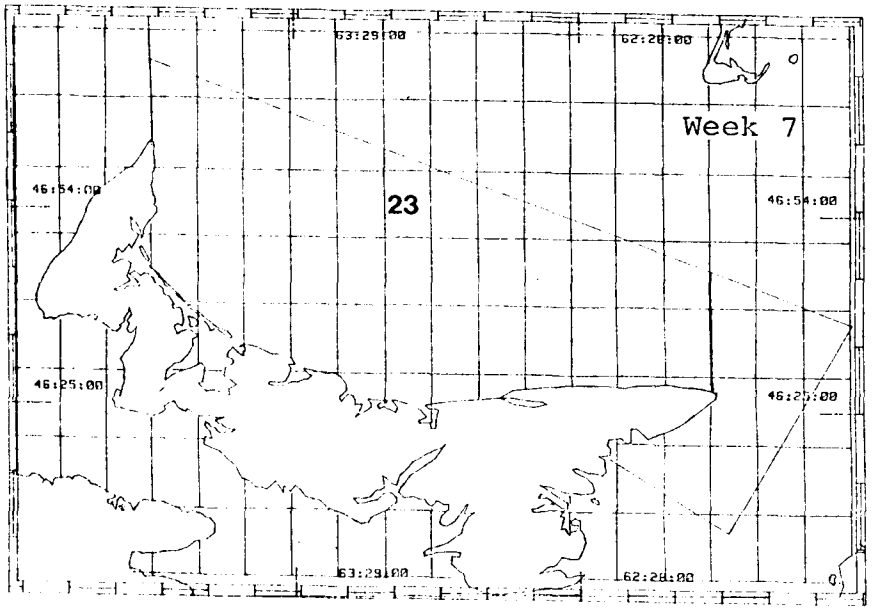
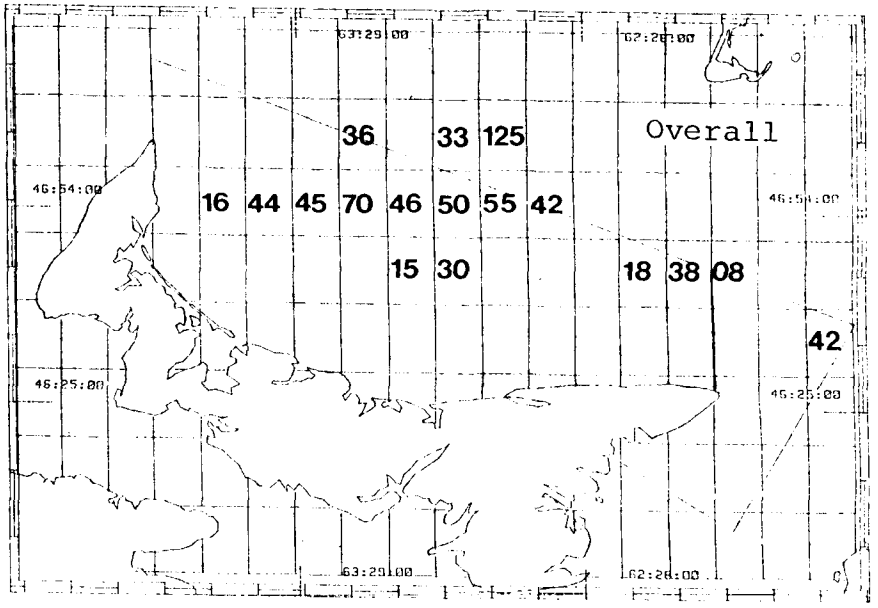


Figure 4. Weekly and overall distributions of C.P.U.E. for the P.E.I. snow crab fishery based on logbook data for 1989.









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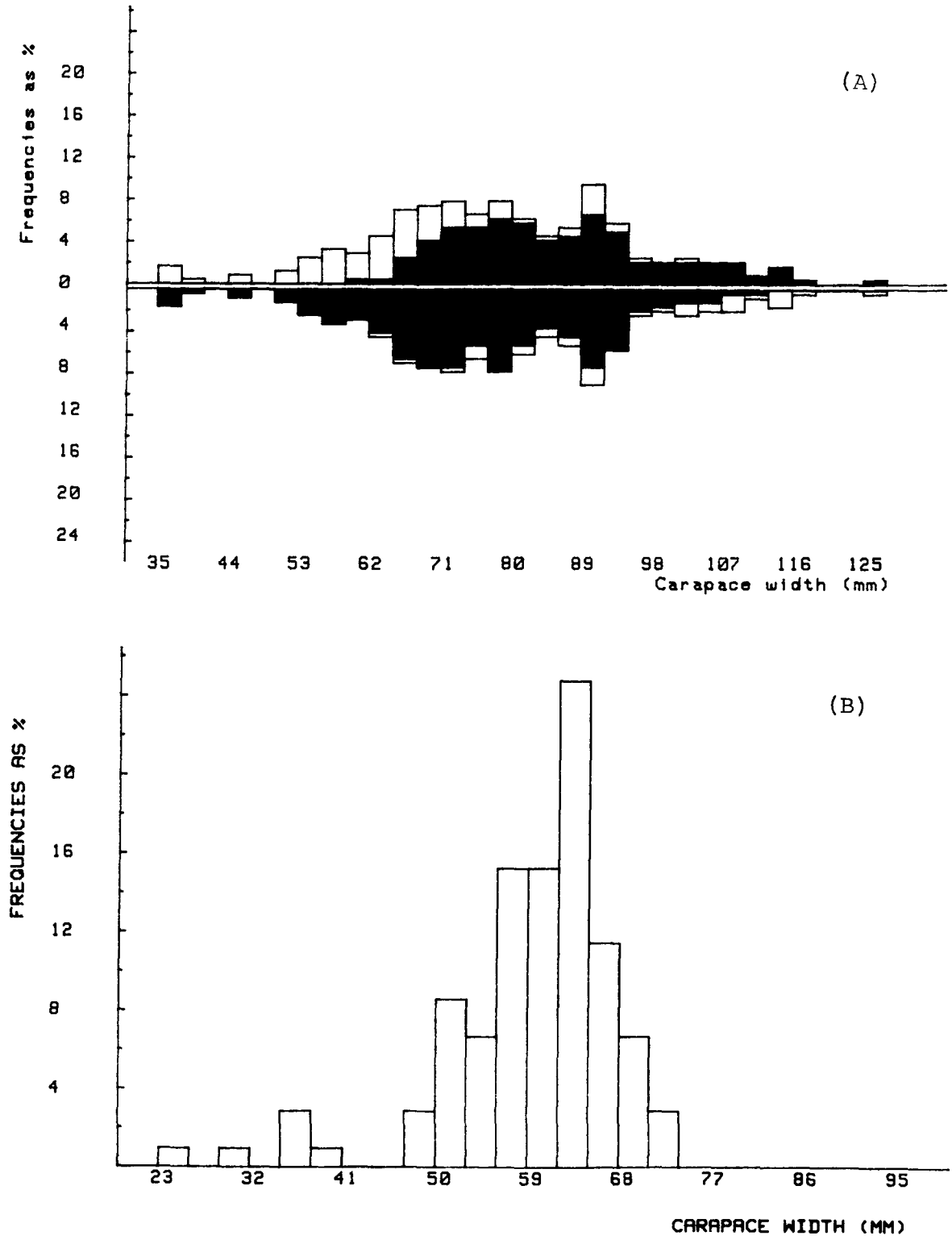


Figure 5. Overall size distribution of male (A) and female (B) snow crab, Chionoecetes opilio, collected during the September 1989 trawl survey in the P.E.I. snow crab fishery.

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

(B) Total number of observations in %.

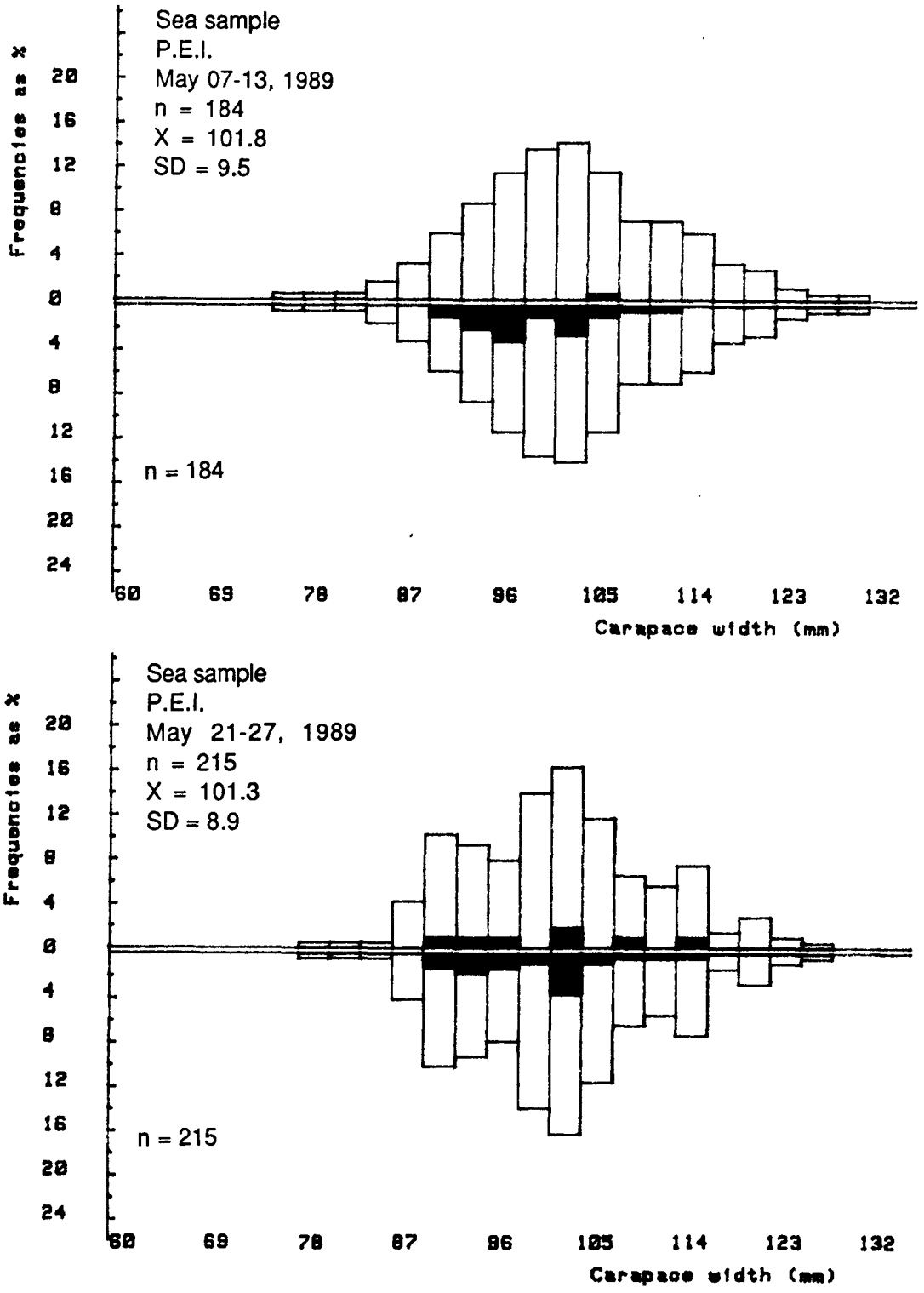
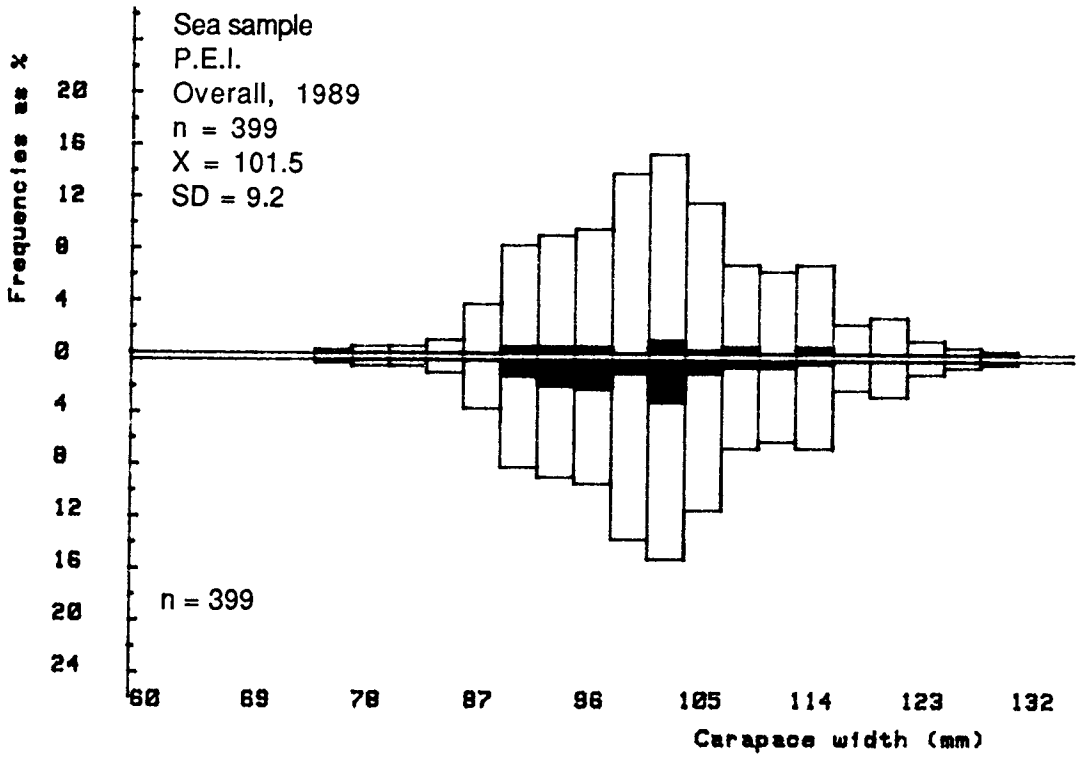


Figure 6. Weekly and overall size distributions of male snow crab, Chionoecetes opilio, present in sea samples taken during the P.E.I. snow crab fishery in 1989.

Positive field: Total number of observations in %, percentage of newly molted crab in black.

Negative field: Percentage of mature in white, percentage of immature in black.



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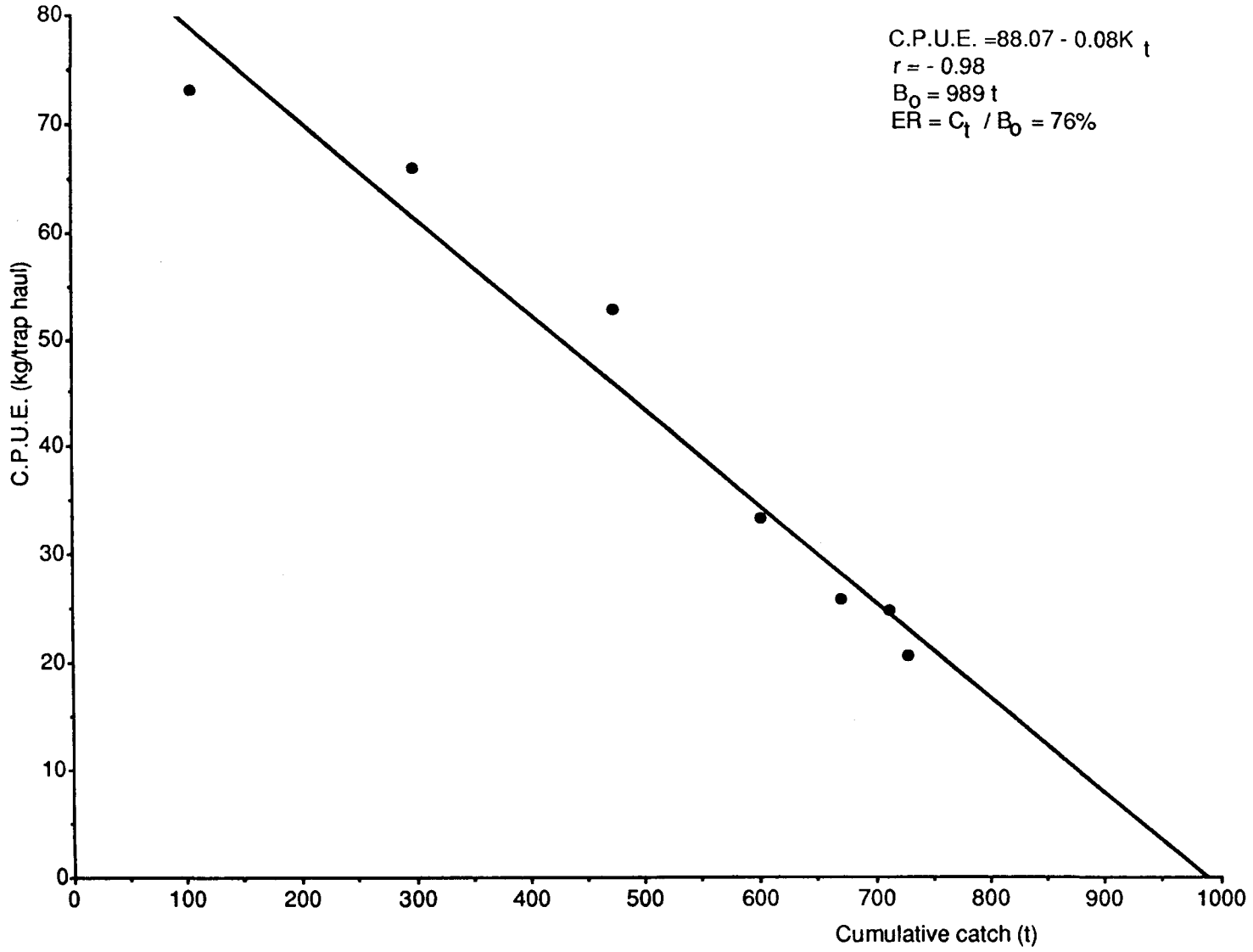

Figure 7. Cumulative catch (t) versus mean weekly C.P.U.E. (kg/trap haul) for the P.E.I. snow crab fishery in 1989.