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Canadian Atlantic Fisheries
Scientific Advisory Committee

CAFSAC Research Document 92/118

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Comité scientifique consultatif
des pêches canadiennes dans
l'Atlantique

CSCPCA Document de recherche 92/118

Snow crab (Chionoecetes opilio) fishery assessment for Western Cape Breton in 1992

by

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ABSTRACT

Assessment of the western coast of Cape Breton, Areas 18 and 19 snow crab fishery for 1992 were based on port sampling, sea sampling aboard commercial vessels, fisher's logbooks, processor's sales slips and trawl surveys after the 1992 fishing seasons.

Area 19:

Total landings of 1678 t were recorded for the 1992 season. The mean CPUE increased from 79.5 kg/trap haul in 1991 to 97.9 kg/trap haul in 1992. The calculated effort increased from 16733 trap hauls in 1991 to 17140 trap hauls in 1992.

According to the trawl survey data, the projected biomass of large claw legal size crab (5226 t) for 1993 represents a slight decrease from 5459 t in 1992.

Although the CPUE level increased in 1992, a decrease in the recruitment to the fishery is predicted in that zone in coming years. It is therefore important to decrease the exploitation rate in order to exploit the accumulated biomass over several years in order to compensate for the years of low recruitment to the fishery in the zone.

Area 18:

Ninety five percent (715 t) of the fall 1992-spring 1993 quota (749 t) was caught in the fall 1992. The mean CPUE for the fall season decreased from 73.1 kg/trap haul in 1991 to 49.3 kg/trap haul in 1992. The spring CPUE increased from 30.7 kg/trap haul in 1991 to 65.6 kg/trap haul in 1992.

After an exploitation rate of about 27.3% was applied to this fishery in 1992, the projected estimated biomass of large claw legal size crab decreased by half. Also, due to a decrease in the CPUE in the fall 92, and a predicted decrease in the future recruitment to the fishery in that zone, it is recommended that the exploitation rate be reduced in that zone.

RÉSUMÉ

Les populations de crabe des neiges exploitées sur la côte ouest du Cap-Breton, zones 18 et 19, ont été évaluées en se basant sur l'échantillonnage au port et en mer, les carnets de bord des pêcheurs, les récipissés d'achat des usines de transformation ainsi que des campagnes de chalutage après les saisons de pêche.

Zone 19:

Les débarquements pour la saison de pêche de 1992 ont été de 1678 t. La PUE moyenne a augmenté de 79,5 kg/casier levé en 1991 à 97,9 kg/casier levé en 1992. L'effort calculée a augmenté de 16733 casiers levés en 1991 à 17140 casiers levés en 1992.

D'après la campagne de chalutage, la biomasse de crabe à grosses pinces de taille légale projetée pour 1993 (5226 t) représente une légère diminution comparé à 5459 t en 1992.

Même si le niveau de PUE a augmenté en 1992, une diminution du recrutement à la pêcherie est à prévoir dans cette zone dans les prochaines années. Il est alors important de diminuer le taux d'exploitation afin d'exploiter la biomasse accumulée sur une période de plusieurs années. Cette mesure pourrait compenser pour les années de faible recrutement à la pêcherie dans cette zone pour les prochaines années.

Zone 18:

Quatre vingt quinze pourcent du contingent pour l'automne 1992-printemps 1993 (749 t) a été capturé à l'automne 1992. La PUE moyenne automnale a diminué de 73,1 kg/casier levé en 1991 à 49,3 kg/casier levé en 1992. La PUE printanière a augmenté de 30,7 kg/casier en 1991 à 65,6 kg/casier en 1992.

Suite à un taux d'exploitation de 27,3% pour cette pêcherie en 1992, la biomasse de crabe à grosses pinces de taille légale estimée pour 1993 a diminué de moitié. De plus, une diminution du taux de capture à l'automne 1992 a été observée, et une possibilité d'un recrutement à la pêcherie plus faible dans le futur, il est donc recommandé de réduire le taux d'exploitation dans cette zone.

INTRODUCTION

In 1978, an inshore fishing area (Area 19) was established on the western coast of the Cape Breton Island to be used exclusively by inshore vessels of under 13.7m (45ft) in length. At the time, 14 inshore boats were licensed for the area with a maximum of 40 traps per license. An additional 13 licenses were issued in 1979 and the maximum number of traps per license was reduced to 30. Since 1979, the catches in this fishery have been regulated by a TAC and by boat quotas. Another 34 licenses were issued in 1984 for a total of 61, at which time the maximum number of traps per license was set to 20 and the quota per boat reduced from 37,195 kg (82,000 lbs) to 22,680 kg (50,000 lbs). This change resulted in an increase of the TAC from 1004 t in 1983 to 1385 t in 1984. In 1986, the number of licenses was reduced to 59 for a total TAC of 1338 t. In 1987, the quota per boat was lowered to 19,505 kg (43,000 lbs). The subsequent decrease of 14% in the TAC had been proposed by CAFSAC in order to decrease the fishing pressure and stabilize the catch rates (Davidson and Comeau 1987). In 1988, good catch rates resulted in the implementation of an increased quota per boat to 22,680 kg (50,000 lbs) which had been in place from 1984 to 1986 for a TAC of 1338 t. The same management regime remained from 1989 to 1991. In 1992, the number of participants to this fishery increased to 74 and the overall quota set at 1686 t. A summary of information on seasons, TAC's, catches, licenses and trap limits is presented in Table 1.

Area 18 had first been exploited in 1979 by 14 inshore vessels which were given exploratory permits allowing them to fish a maximum of 30 traps per permit. These permits were upgraded to licenses the following year and 9 additional licenses were issued to explore an area further from shore. In 1981, all 23 entrants were issued licenses and allowed to fish anywhere in Area 18. Larger mobile vessels from New Brunswick and Québec were allowed to fish in Area 18 from 1980 to 1982. In 1983, the mobile fleet did not participate in this fishery as their season closed before the opening date for the inshore area. In 1984, the offshore vessels were excluded from the zone as northwestern and southwestern boundaries were established (Figure 1). A boat quota of 36,288 kg (80,000 lbs) was put in place for Area 18 in 1981 and retained through 1985. The corresponding TAC of 835 t was a preliminary figure which was used for management purposes as biological estimates were not available because of the unknown level of participation in the area by the mobile vessels. Declining catch rates, high exploitation levels and low production estimates resulted in a decrease in the boat quotas to 27,216 kg (60,000) in 1986 for an overall TAC of 626 t. In 1988, four new licenses were issued for a total of 27 fishers and the TAC was set at 674 t, which allowed boat quotas of 24,948 kg (55,000 lbs). The same management regime remained for 1989. Throughout the history of the fishery, white (soft shell) crabs have been a problem in Area 18. In 1981, an early spring season in addition to the fall season was attempted to avoid poor quality crabs. This experiment was not a success as the animals caught in the spring and early summer were soft shelled and had a low meat yield. Since 1982, the season has been set for late summer and early fall with the opening date being determined by the results of meat yield tests which are done on animals caught during pre-season sampling. In 1990, the fishery opened on April 23rd and closed on April 27th following an agreement with the groundfish fishers. The crab fishers were to remove their gear when the cod migrated into the zone. The fishery was re-opened on May 29th and closed on June 13th when the percentage of soft crab reached 20%. The catch for the spring seasons reached 139 t. The fishery was re-opened from September 3rd to November 13th. Total catch of 523 t were recorded for the fall season. In 1991, a 200 t quota was allocated for the spring season. Total catch of 187 t were recorded. The fall 1991-spring 1992 quota was set at 674 t. A total of 531 t was caught in the fall-1991 and 137 t in the spring-1992. The fall 1992-spring 1993 quota was increased to 749 t and the number of participants increased from 27 to 30 fishers. Further information on catches, TAC's, seasons and licenses are presented in Table 2.

This document presents a review of biological characteristics and catch trends for Areas 18 and 19 snow crab fisheries for 1992 and gives advice for the 1993 fishing season for Area 19 and for the 1993-94 season in Area 18.

MATERIAL AND METHODS

Port sampling and sea sampling

In Area 19, sea sampling and port sampling data were collected during weeks 2 and 3. In Area 18, sea samples and port samples were carried out in weeks 2 to 4 in the spring 1992. Weekly percentages of soft shelled males calculated (using a carapace hardness gauge: durometer; Foyle *et al.* 1989), juveniles (Comeau and Conan 1992) and undersize males were calculated from the sea sampling data. In the present document, at the request of the Steering Committee in order to standardize the terminology between the regions, the juveniles and mature crab will be called small and large claw crab respectively. The small claw (S) and the large claw (L) are the crabs falling in the lower and the upper cloud, respectively, of a plot of chela height versus carapace width (Conan and Comeau 1986). A soft crab is a crab with a durometer reading of less than 68 and a white crab is a crab that molted the same year. Weekly percentages of soft shelled males and small claw males were obtained from the port and sea samples. Weekly and overall size distributions were generated and the overall size distributions of both sea and port samples were generated and plotted according to their morphometric maturity.

Logbook/sales slip data

The logbook and sales slip data were acquired and compiled on computer by the Statistics and EDP Systems Division of the Department of Fisheries and Oceans. The weekly and cumulative catch statistics for use in the Leslie analysis (Ricker 1980) and the CPUE (catch in kg for a trip/number of traps hauled during the same trip) were calculated directly from the logbook data. The calculated CPUE's were summarized into weekly intervals for both areas (Tables 3, 4 and 5).

The overall distribution of fishing effort calculated from the logbooks was plotted by sub areas of 3 min. of latitude x 3 min. of longitude for Area 19 and by sub areas of 2 min. of latitude x 2 min. of longitude for Area 18.

Trawl survey

A post season trawl survey was conducted in the Southern Gulf of St. Lawrence between July 13 and October 21, 1992 and included 29 stations within the Area 19 fishery and 19 stations within the Area 18 fishery (Figure 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, carapace condition and the presence/absence of the external eggs for females.

A geostatistical technique, Kriging (Conan 1985; Conan *et al.* 1988) was used to estimate the biomass in this study. Biomass for the two fisheries were estimated by the Kriging method based on a variogram calculated from samples collected over the whole S.W.Gulf.

A size frequency distribution standardized to the same swept surface (0.8 km²) in numbers was produced for the males captured during the survey. Percentages of soft (reading of less than 68 on the durometer) and white (molted in 1992) male crab were calculated for sub-legal and commercial size crab. The totals do not add up to 100% because some claws were missing and measurements of claw height were unavailable. The catch in number of large claw male crab ≥ 95 mm carapace width (C.W.) from the 1992 trawl survey was used for estimating the commercially exploitable biomass at the beginning of the 1993 fishing season. Numbers of

crab were converted to weight by using the size-weight relationships of crab sampled in the Cape Breton zones according to the molt stage, morphometric maturity and the sampling season. The catch in number of small claw crab larger than 56 mm C.W. from the survey was used for estimating the biomass of newly molted crab larger than 70 mm C.W. for the 1993 spring season using the global growth rate independantly from the morphometric maturity and using the same size-weight relationship as the Southwestern Gulf fishery (zone 12). The fishable area in the Cape Breton crab fishery was estimated from the contours of variance from the trawl survey over the whole sampling area. The swept surface by trawl net was estimated from the data on net opening width measured by the SCANMAR electronic net sensor and the length of the tow measured by a Loran C.

RESULTS AND DISCUSSIONS

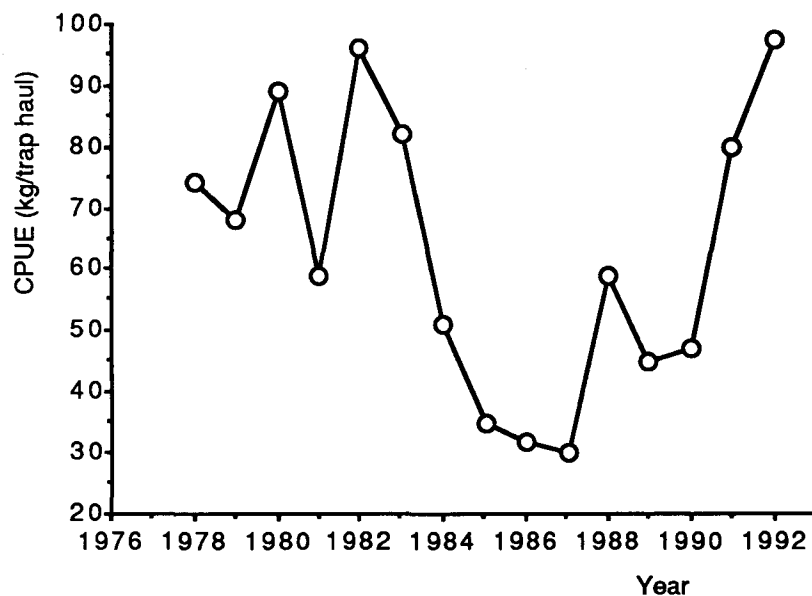
Area 19

The spatial distribution pattern of the fishing effort showed a concentration on the southern end of the zone (Figure 3). The effort was distributed uniformly throughout the season.

The overall quota, total catch, fishing effort and catch rate from 1986 to 1992 are summarized as follows:

Year	Overall quota	total catch	fishing effort	catch rate
1986	1338	1235	38594	32.0
1987	1150	1151	37987	30.3
1988	1338	1337	22794	58.7
1989	1338	1334	29978	44.5
1990	1338	1333	28422	46.9
1991	1338	1337	16733	79.9
1992	1686	1678	17140	97.9

The weekly CPUE decreased from 117.7 kg/trap haul in week 1 to 52.3 kg/trap haul in week 5 (Table 3). The total effort calculated for the season was 17140 trap hauls; an increase of 2% over 1991 (16733 trap hauls). The seasonal CPUE (97.9 kg/trap haul) represents an increase of 22% over 1991 (79.9 kg/trap haul) and is the highest CPUE ever recorded for that zone (Table 6).



Biological information from sea samples

The composition in percentage of the sea samples for males (N=580) for the whole season was as follows:

	Soft crab			Hard crab			Total		
	S	L	T	S	L	T	S	L	T
Legal	3.6	2.4	6.0	4.7	85.7	90.3	8.3	88.1	96.6
Non legal	0.5	0.0	0.5	0.9	2.1	2.9	1.4	2.1	3.4
Total	4.1	2.4	6.6	5.5	87.8	93.3	9.6	90.2	100.0

The seasonal mean carapace size was 115.3 mm C.W. (Figure 4) and the mean percentage of undersized male crabs was 3.4%. The percentage of soft crab was 6.6% for the season. The seasonal percentage of berried females in the sea samples was 98.4% (N=435). The mean percentage of small claw males for the season was 9.6%.

Biological information from port samples

The seasonal mean size was 118.3 mm C.W.. The seasonal percentage of small claw crab was 2% (Figure 4).

Biological information from the trawl survey

The catch from the trawl survey data comprised 51.0% of white crab of which 38.5% had small claws. 44.1% of the total catch had small claws. The mean carapace size of males from the survey was 80.5 mm C.W. (Figure 5) and the composition (in percentage) of the catch was as follows:

	White crab			Hard crab			Total		
	S	L	T	S	L	T	S	L	T
Legal	3.2	10.6	14.1	1.5	35.2	36.7	4.7	45.8	50.8
Non legal	35.3	0.8	36.8	4.1	7.8	7.8	39.4	8.6	49.2
Total	38.5	11.3	51.0	5.6	42.9	48.8	44.1	54.2	100.0

The mode of small claw crab smaller than 29 mm C.W. present in 1990 and 1991 is still found in 1992. The pre-recruit group (small claw <95 mm C.W.) present in 1990 and 1991 seems to have diminished considerably in 1992. Recruitment to the legal size could therefore be considerably reduced in 1993.

A total of 301 immature females and 2511 mature females were caught. 99% (2481) of the mature females were bearing eggs.

Biomass estimationSurvey:

The total fishable surface estimated for Area 19, based on the contours of variance was 3419 km². The variogram plots for the large claw male crabs ≥ 95 mm C.W. and the small claw male crabs ≥ 56 mm C.W. showed a range of approximately 10.0 km and 19.3 km respectively beyond which no more spatial covariance effects were detected (Figure 6). By using the kriging techniques, the concentrations of male crab (Figure 7 and 8) according to their biological category are as follows:

Category	Crabs/km ²
Large claw ≥ 95 mm C.W.	2403.9
Small claw ≥ 56 mm C.W.	1790.0

The biomass of large claw hard crab ≥ 95 mm C.W. for 1993 is projected at 5226.2 t (± 2205 t), a decrease of 4% from 1992 (5459 t ± 1942 t).

The biomass of soft shell crab ≥ 70 mm C.W. for 1993 is projected at 1895.9 t (± 2850.8 t), a decrease of 49% from 1992 (3746 t ± 1702 t).

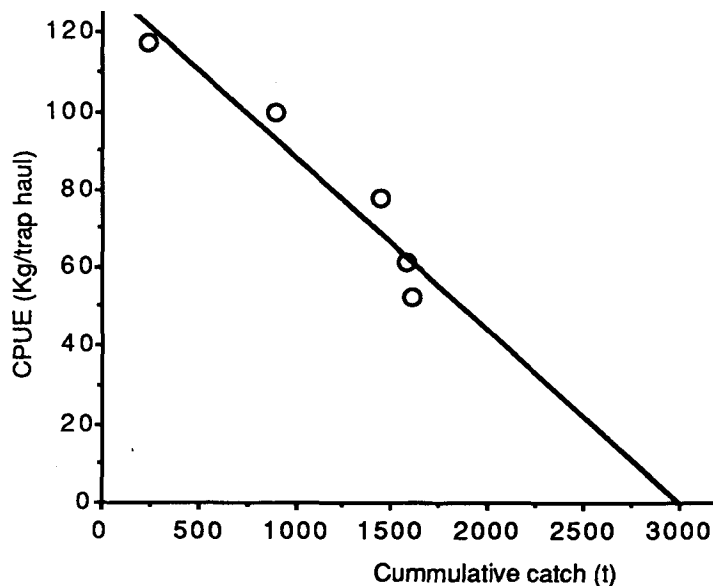
The biomass of large claw hard crab ≥ 95 mm C.W. after the 1992 fishery was estimated at 3351.5 t (± 1216 t). By dividing the catch of 1992 (1678 t) by the biomass of 1992 before the fishery (1678 + 3351.5), the exploitation level is estimated at 33% for the 1992 fishing season.

By using the projections from the 1991 trawl survey, the exploitation level for the 1992 season is estimated at 30.7% (1678 t / 5459 t).

Leslie analysis:

The estimation of initial biomass (B_0) and exploitation level (E.L.) for 1992 according to the logbook data using the Leslie analysis, showed an increase in the initial biomass from 2458 t in 1991 to 3000 t in 1992 and an increased exploitation level from 54.4% in 1991 to 55.9% in 1992 (Table 6). The parameters were as follows:

$$\begin{aligned} \text{CPUE} &= 132.5 - 0.044Kt \\ r &= -0.96 \\ B_0 &= 3000 \text{ t} (2325 \text{ t} - 5077 \text{ t}, p < 0.05) \\ \text{E.L.} &= Tc/B_0 = 55.9\% \end{aligned}$$



Area 18

The fishing effort for the fall 1991-spring 1992 was concentrated on the northern end of the zone (Figure 9). For the fall season, the weekly CPUE fluctuated throughout the season with the highest value (89.4 kg/trap haul) in week 4 (Table 4) and its lowest value (60.5 kg/trap haul) during week 1. For the spring season, the weekly CPUE fluctuated throughout the season with the highest value (83.9 kg/trap haul) in week 3 (Table 4) and its lowest value (42.7 kg/trap haul) during week 9. The CPUE was 73.1 kg/trap haul during the fall 1991 season and 49.7 kg/trap haul in the spring 1992. The combined CPUE for the two seasons was 72.2 kg/trap haul.

The fishing effort for the fall 1992 was also concentrated on the northern end of the zone (Figure 10). For the fall 1992 season, the weekly CPUE fluctuated throughout the season with the highest value (77.1 kg/trap haul) in week 7 (Table 5) and its lowest value (42.7kg/trap haul) during week 4. The CPUE was 49.3 kg/trap haul during the fall 1992 season.



The total calculated effort was 9252 trap hauls for the fall 1991-spring 1992 season and 14503 trap hauls for the fall 1992 season.

The overall quota, total catch, fishing effort and catch rate from 1986 to 1992 are summarized as follows:

Year	Overall quota	total catch	fishing effort	catch rate
1986	626	618	14372	43.0
1987	626	626	9766	64.1
1988	674	669	10790	62.0
1989	674	666	11463	58.1
1990	674	662	15691(5334 S/10357 F)	42.2 (26.1 S/50.5 F)
1991	200	187	6091	30.7
1991-92	674	668	9346(7259 F/2087 S)	72.2 (73.1 F/65.6 S)
1992-93	749	715	14503	49.3

Biological information from sea sampling

Fall 1991 fishery:

The seasonal percentage of soft crabs was 5.7%. The seasonal proportion of small claw males in the sea samples was 7.8% with a mean size of 120.1 mm C.W. (Figure 11). 1.5% of all samples was sub-legal. The composition (in percentage) of the samples (N=1659) for the season was as follows:

	Soft crab			Hard crab			Total		
	S	L	T	S	L	T	S	L	T
Legal	4.9	0.2	5.1	2.5	90.2	92.8	7.4	95.1	98.5
Non legal	0.2	0.4	0.6	0.1	0.8	0.9	0.3	1.2	1.5
Total	5.1	0.7	5.7	2.7	91.0	93.7	7.8	91.7	100.0

Spring 1992 fishery:

The percentage of soft crabs was 1.4% and the percentage of small claw males in the sea samples was 2.8%. The mean size was 115.9 mm C.W. (Figure 11). The composition (in percentage) of the samples (N=1079) for the season was as follows:

	Soft crab			Hard crab			Total		
	S	L	T	S	L	T	S	L	T
Legal	0.6	0.6	1.3	1.9	93.3	95.3	2.7	93.9	97.5
Non legal	0.1	0.0	0.1	0.2	1.9	2.0	0.3	1.9	2.5
Total	0.7	0.6	1.4	2.1	95.2	97.3	2.8	95.8	100.0

Fall 1992 fishery:

The percentage of soft crabs was 5.6% and the percentage of small claw males in the sea samples was 6.4%. The mean size was 116.3 mm C.W. (Figure 12). The composition (in percentage) of the samples (N=1854) for the season was as follows:

	Soft crab			Hard crab			Total		
	S	L	T	S	L	T	S	L	T
Legal	1.2	3.6	4.9	4.0	87.4	91.4	5.2	91.0	96.4
Non legal	0.5	0.2	0.8	0.6	2.0	2.6	1.1	2.2	3.6
Total	1.8	3.8	5.6	4.6	89.4	94.1	6.4	93.2	100.0

Biological information from port samples

Fall 1991-spring 1992 fishery:

The seasonal mean size was 119.0 mm C.W. (N=1394). The seasonal percentage of small claw males was 3% (Figure 11).

Fall 1992 fishery:

The seasonal mean size was 118.3 mm C.W. (N=899). The seasonal percentage of small claw males was 7.6% (Figure 12).

Biological information from the trawl survey

The catch from the trawl survey data was composed of 77.9% of white crab of which 41.7% was small claw crab. 56.2% of the total catch had small claws. The mean carapace size of males from the survey was 94.1 mm C.W. (Figure 5) and the composition (in percentage) of the catch was as follows:

	White crab			Hard crab			Total		
	S	L	T	S	L	T	S	L	T
Legal	13.0	35.5	48.6	10.1	6.9	17.0	23.1	42.4	65.6
Non legal	28.6	0.7	29.3	4.3	0.7	5.1	32.9	1.4	34.4
Total	41.7	36.2	77.9	14.5	7.6	22.1	56.2	43.8	100.0

A large proportion of the modes of small claw crab between 65-100 mm C.W. present in 1990 molted to the large claw legal size group in 1991 and was fished. This group of crab doesn't seem to have been replaced by new recruitment in 1992. Therefore, the pre-recruit group (small claw <95 mm C.W.) present in 1990 and 1991 seems to have diminished considerably in 1992.

A total of 60 immature females and 6 mature females were caught. All the mature females were berring eggs.

Biomass estimation

The total fishable surface estimated for Area 18, based on the contours of variance was 1815 km². The variogram plots for the large claw male crabs ≥ 95 mm C.W. and the small claw male crabs larger than 56 mm C.W. showed a range of approximately 24.7 km and 38.2 km respectively beyond which no more spatial covariance effects were detected (Figure 6). By using the kriging techniques, the concentrations of male crab (Figure 9) for different biological categories gave the following results:

Category	Crabs/km ²
Large claw ≥ 95 mm C.W.	1217.4
Small claw ≥ 56 mm C.W.	1990.0

The biomass of large claw hard crab ≥ 95 mm C.W. for 1993 is projected at 1278 t (± 1171 t) (Table 7).

The biomass of soft shell crab ≥ 70 mm C.W. for 1993 is projected at 1260.6 t (± 1877.9 t).

The biomass of legal size large claw hard shell crab after the 1992 fishery was estimated at 335.4 t (± 648.6 t).

The fall 1991-spring 1992 and the fall 1992 data were not amenable to Leslie analysis (Tables 4 and 5).

By dividing the catch of 1992 (715 t) by the biomass left before the 1992 season projected from the 1991 survey (3284-668), the exploitation level is estimated at 27.3% for the 1992 fishing season.

Conclusions and Recommendations

The following conclusions are based on the mid value of biomass estimates from the survey and it is assumed that there is no movement in and out of the two areas between the survey in 1992 and the fishery of 1993.

Area 19

Based on the 1992 trawl survey results, after an exploitation level of 33% estimated for this fishery in 1992, the projected estimated biomass of large claw hard crab ≥ 95 mm decreased slightly. If the same exploitation level is to be applied to the 1993 fishery, an overall catch level of 1604 t should be allocated to this fishery.

Although the CPUE level increased by 22% for the 1992 season, a decrease in the recruitment in that zone in coming years seems inevitable. It is therefore important to decrease the exploitation rate in order to exploit the accumulated biomass over several years in order to compensate for future possible low recruitment in the zone.

Area 18

Based on the 1992 trawl survey results, after an exploitation rate of about 27.3% for this fishery in 1992, the projected estimated biomass decreased by half. If the same exploitation level is to be applied to the 1993-94 fishery, an overall catch level of 349 t should be allocated to this fishery. Also, due to a decrease in the CPUE in the fall 1992, and a decrease in the future recruitment in that zone, it is recommended that the exploitation rate be reduced in that zone. Also, the fishery should be closed when soft crab appear in the catches and remain closed until the spring of the following year. This measure would help reduce mortality of soft crab due to discard at sea.

The annual trawl survey should always be done after the fishery (as it was conducted in 1992) in order to produce more precise estimates and projections for the following year.

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Table 1. Number of participants, trap limits, seasons, TAC regulations and total catch for the Area 19, western Cape Breton Island snow crab, Chionoecetes opilio, fishery: 1978-1992.

Year	# of Licensed boats	# of traps per boat *	Season	TAC (kg/license) (t)	catch (t)
(1) 1978	14	40	May 13 - Sept. 30	-	1941
(1) 1979	27	30	June 16 - Sept. 16	1406 (52164)	1390
(1) 1980	27	30	June 15 - Sept. 15	1225 (45360)	1158
(1) 1981	27	30	July 15 - Sept. 15	1004 (37195)	913
(1) 1982	27	30	July 15 - Sept. 15	1004 (37195)	953
(1) 1983	27	30	July 15 - Sept. 15	1004 (37195)	906
(1) 1984	61	20	July 15 - Sept. 15	1385 (22680)	1315
(1) 1985	61	20	July 15 - Sept. 15	1385 (22680)	1234
(1) 1986	59	20	July 15 - Sept. 15	1338 (22680)	1235
(1) 1987	59	20	July 15 - Sept. 15	1150 (19505)	1151
(1) 1988	59	20	July 15 - Sept. 15	1338 (22680)	** 1337
(1) 1989	59	20	July 15 - Sept. 16	1338 (22680)	1334
(1) 1990	59	20	July 14 - Sept. 15	1338 (22680)	1333
(1) 1991	59	20	July 15 - Sept. 15	1338 (22680)	1337
1992	74	20	July 15 - Sept. 15	1686 (22680)	1678

* Standard box trap 1.5m x 1.5m x 0.6m or 1.8m x 1.8m x 0.6m

** Originally set at 1150 t, the TAC has increased to 1338 t during the season.

(1) Chiasson et al., 1992

Table 2. Number of participants, trap limits, seasons, TAC regulations and total catch for the Area 18, western Cape Breton Island snow crab, Chionoecetes opilio, fishery: 1980-1992.

Year	# of Licensed boats	# of traps per boat *1	Season	TAC (kg/license) (t)	catch (t)
(1) 1980	23	30 *1	July 15 - Sept. 15	-	519
(1) 1981	23	30	April 15 - June 15 Sept. 1 - Nov. 30	835 (36288)	494
(1) 1982	23	30	Aug. 20 - Nov. 30	835 (36288)	824
(1) 1983	23	30	Aug. 15 - Nov. 3	835 (36288)	822
(1) 1984	23	30	Aug. 25 - Nov. 10	835 (36288)	722
(1) 1985	23	30	Aug. 3 - Oct. 31	835 (36288)	537
(1) 1986	23	30	Aug. 4-8 ; 28 - Oct. 28	626 (27216)	618
(1) 1987	23	30	Aug. 16 - Oct. 10	626 (27216)	626
(1) 1988	27	30	Aug. 26 - Oct. 26	674 (24948)	669
(1) 1989	27	30	Sept. 4 - Nov. 4	674 (24948)	666
(1) 1990	27	30	April 23 - April 27 May 29 - June 13 Sept. 3 - Nov. 13	674 (24948)	139 S90 523 F90
1991-92	27	30	May 16 - June 30 Sept 9 - Nov. 28	200 (16300) 674 (24948) *2	187 S91 531 F91
1992-93	30	30	May 18- June 30 July 6- Nov. 3	749 (24948) *3	137 S92 715 F92

(1) Chiasson et al., 1992

*1 9 or 10 new exploratory permit holders were allowed 20 traps.

*2 Combination fall 1991 and spring 1992

*3 Combination fall 1992 and spring 1993

Table 3. The 1992 western Cape Breton Island, Area 19 snow crab, Chionoecetes opilio, fishery CPUE and cumulative catch (K) statistics used in Leslie analysis.

Week	CPUE (kg/trap haul)	# Trap hauls*	Weekly logbook catch. C_{t1} (kg)	$C_{t1}/2$ (kg)	K_t (t)	% of total (C_{t1}/C_{total})
1- July (12-18)	117.74	4007	471804	235902	235.90	29.4
2- July (19-25)	99.60	8385	835149	417574.5	889.38	52.0
3- July (26-01)	77.60	3320	257647	128823.5	1435.78	16.0
4- Aug. (02-08)	61.33	645	39561	19780.5	1584.38	2.5
5- Aug. (09-15)	52.33	45	2355	1177.5	1605.34	0.1
Total	mean=97.9	16402	1606516			

* Reported in the logs

Table 4. The fall 1991-spring 1992 western Cape Breton Island, Area 18 snow crab, Chionoecetes opilio, fishery CPUE and cumulative catch (K) statistics used in Leslie analysis.

Week	CPUE (kg/trap haul)	# Trap hauls*	Weekly logbook catch, C_{t1} (kg)	$C_{t1}/2$ (kg)	K_t (t)	% of total (C_{t1}/C_{total})
1-Sept. (08-14)	60.52	153	9260	4630		
2-Sept. (15-21)	72.77	563	40967	20483.5		
3-Sept. (22-28)	76.77	1113	85449	42724.5		
4-Sept. (29-05)	89.44	768	68690	34345		
5-Oct. (06-12)	68.92	531	36598	18299		
6-Oct. (13-19)	65.79	1596	105000	52500		
7-Oct. (20-26)	73.08	1138	83163	41581.5		
Total fall	mean=73.12	5862	429127			
Week	CPUE (kg/trap haul)	# Trap hauls*	Weekly logbook catch, C_{t1} (kg)	$C_{t1}/2$ (kg)	K_t (t)	% of total (C_{t1}/C_{total})
1-May (17-23)	59.85	60	3591	1795.5		
2-May (24-30)	55.12	240	13229	6614.5		
3-May (31-06)	83.97	150	12596	6298		
4-June (07-14)	72.35	190	13747	6873.5		
5-June (15-21)	57.75	146	8431	4215.5		
Total spring	mean=65.6	786	51594			

* Reported in the logs

Table 5. The fall 1992 western Cape Breton Island, Area 18 snow crab, Chionoecetes opilio, fishery CPUE and cumulative catch (K) statistics used in Leslie analysis.

Week	CPUE (kg/trap haul)	# Trap hauls*	Weekly logbook catch. C_{t1} (kg)	$C_{t1}/2$ (kg)	K_t (t)	% of total (C_{t1}/C_{total})
1- July (05-11)	50.7	3426	173777	86888.5	86.9	23.9
2- July (12-18)	50.4	3693	186195	93097.5	266.9	25.7
3- July (19-25)	50.2	4383	220114	110057.0	470.0	30.4
4- July (26-01)	42.7	2558	109326	54663.0	634.7	15.1
5- Aug. (02-08)	47.4	450	21341	10670.5	700.1	2.9
6- Aug. (09-15)	74.3	100	7427	3713.5	714.5	1.0
7- Aug. (16-22)	77.1	90	6941	3470.5	721.6	0.9
Total	mean=49.3	14700	725121			

* Reported in the logs

Table 6 . Trends in exploitation level, initial (B_0) and final (B_f) biomass estimates, initial ($CPUE_0$), final ($CPUE_f$) and mean ($CPUE$) catch per unit effort for the Area 19 snow crab, Chionoecetes opilio, fishery: 1978-1992.

Year	Exploitation level (%)	B_0 (t)	B_f (t)	Estimated production *	Trap hauls **	$CPUE_0$ (kg/trap haul)	$CPUE_f$ (kg/trap haul)	$CPUE$ (max.-min.) (kg/trap haul)
(1) 1978	64	3016	1075	-	26301	86.4	55.0	73.8 (86.4-51.8)
(1) 1979	62	2239	848	1164	20436	69.3	45.2	68.0 (75.1-45.2)
(1) 1980	60	1838	733	990	12953	112.0	52.6	89.4 (112.0-52.6)
(1) 1981	47	1690	894	957	15396	-	-	59.3
(1) 1982	44.7	2282	1329	1388	9927	114.0	45.0	96.0 (114.0-45.0)
(1) 1983	54.7	1654	748	325	11076	98.5	36.3	81.8 (98.5-32.8)
(1) 1984	67.2	2240	925	1492	26040	93.2	51.5	50.5 (93.2-33.9)
(1) 1985	34.8	3291	2057	2366	35460	47.1	26.3	34.8 (47.1-26.3)
(1) 1986	52.7	2343	1108	286	38594	49.8	22.1	32.0 (49.8-22.1)
(1) 1987	52.5	2126	1010	1018	37987	51.6	29.8	30.3 (134.8-1.7)
(1) 1988	80.4	1662	325	652	22794	101.4	13.3	58.7 (202.5-4.0)
(1) 1989	71.5	1865	531	1540	29978	63.7	22.7	44.5 (142-0)
(1) 1990	55.6 L 42.0 K	2394 L 2971 K	1061 L 1638 K	1863 L 1910 K	28422	61.3	11.7	46.9 (184-0)
(1) 1991	54.4 L 53.1 K	2458 L 4799 K	1397 L 3462 K	1397 L 3161 K	16733	92.6	9.1	79.5 (256.6-2.8)
1992	55.9 L 30.9 K 30.7 K ¹	3000 L 5030 K 5459 K ¹	1322 L 3351 K 3781 K ¹	1890 L 1568 K	17140	117.7	52.3	97.9 (117.7-52.3)
1993		5226 K ¹		1445 K ¹				

(1)- Chiasson *et al.*, 1992

* - $B_0^t - B_f^{t-1}$ where t=year

** - Total catch/mean CPUE

L- From Leslie analysis; K- from kriging; K¹- projections from previous year's survey

Table 7. Trends in exploitation level, initial (B_0) and final (B_f) biomass estimates, and initial ($CPUE_0$), final ($CPUE_f$) and mean ($CPUE$) catch per unit effort for the Area 18 snow crab, *Chionoecetes opilio*, fishery: 1979-1992.

Year	Exploitation level (%)	B_0 (t)	B_f (t)	Estimated production *	Trap hauls **	$CPUE_0$ (kg/trap haul)	$CPUE_f$ (kg/trap haul)	$CPUE$ (max.-min.) (kg/trap haul)
(1) 1979 L	49.7	428	216	-	4449	37.3	30.7	47.9 (61.0-37.3)
(1) 1980	-	-	-	-	10745	61.2	47.7	48.3 (61.2-39.4)
(1) 1981	-	-	-	-	10207	-	-	48.4
(1) 1982	-	-	-	-	13290	98.0	23.0	62.0 (122.0-23.0)
(1) 1983 L	45.8	1577	854	-	18940	41.4	34.0	43.4 (49.9-33.8)
(1) 1984 L	40.1	1147	687	293	20168	41.9	27.2	35.8 (41.9-27.2)
(1) 1985 L	71.3	753	216	66	17102	49.1	24.1	31.4 (49.1-17.2)
(1) 1986	59.7	1153	465	937	14372	61.8	55.3	43.0 (61.8-26.6)
(1) 1987	47.4	1315	691	850	9766	64.5	26.4	64.1 (140.2-11.0)
(1) 1988	-	-	-	-	10790	64.2	69.2	62.0 (190.0-2.7)
(1) 1989	-	-	-	-	11463	70.1	22.3	56.2 (136.7-3.0)
(1) 1990 S					5334	26.1	26.9	26.1 (69.9-1.4)
(1) 1990 F k	59.8	727	-	-	10357	50.5	41.4	50.5 (116.4-6.4)
1991 S k		681	-		6091	27.3	25.1	30.7 (36.6-23.6)
1991-92 k		-	-		9252	60.5	57.7	72.2 (89.4-55.1)
1992-93 k		-	335		14494	50.7	77.1	49.3 (77.1-42.7)
1993-94 K ¹		1278						

(1) Chiasson *et al.*, 1992

* $B_0^t - B_f^{t-1}$ where t=year

** Total catch/mean CPUE

S=spring; F=fall

L=Leslie; k=kriging; K¹ =Projection from previous year's survey

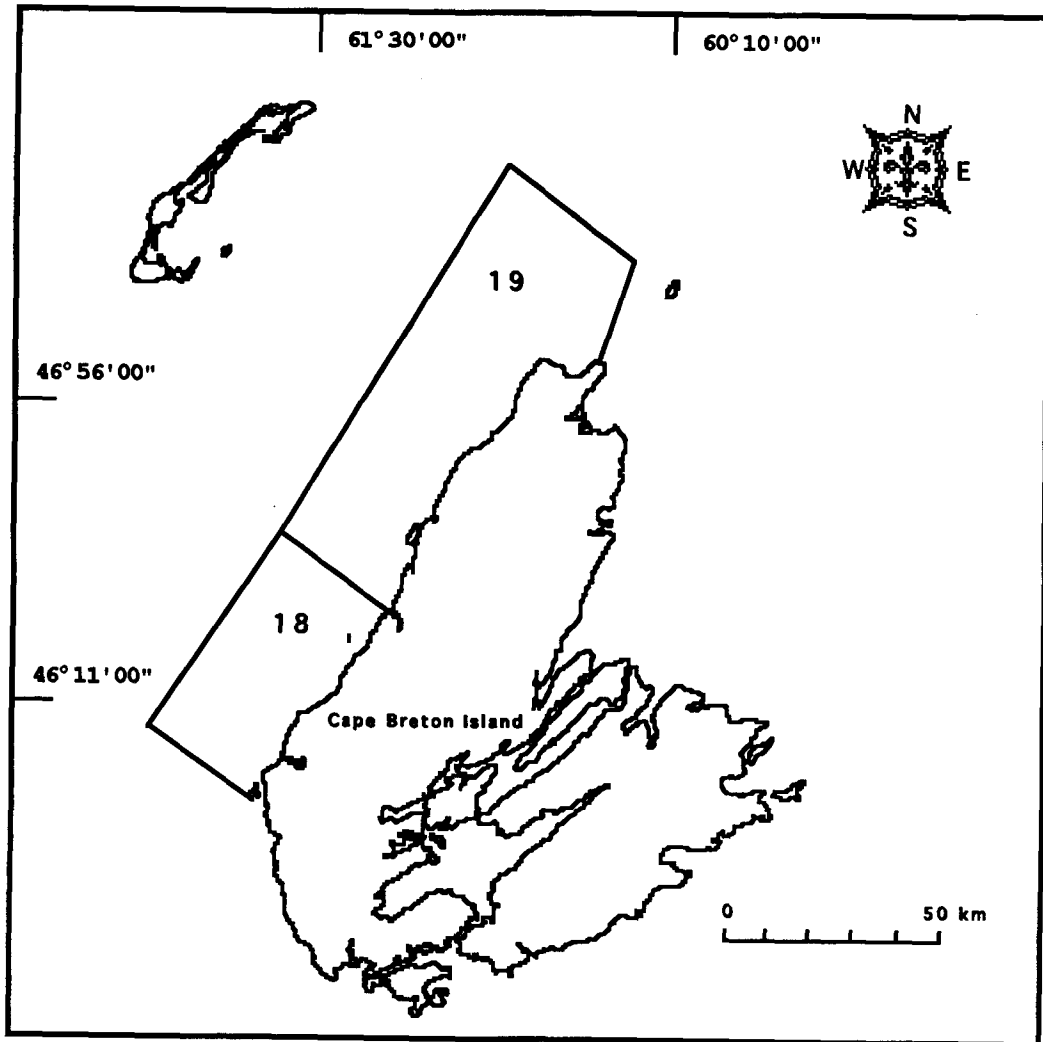


Figure 1. Western Cape Breton Island snow crab management areas.

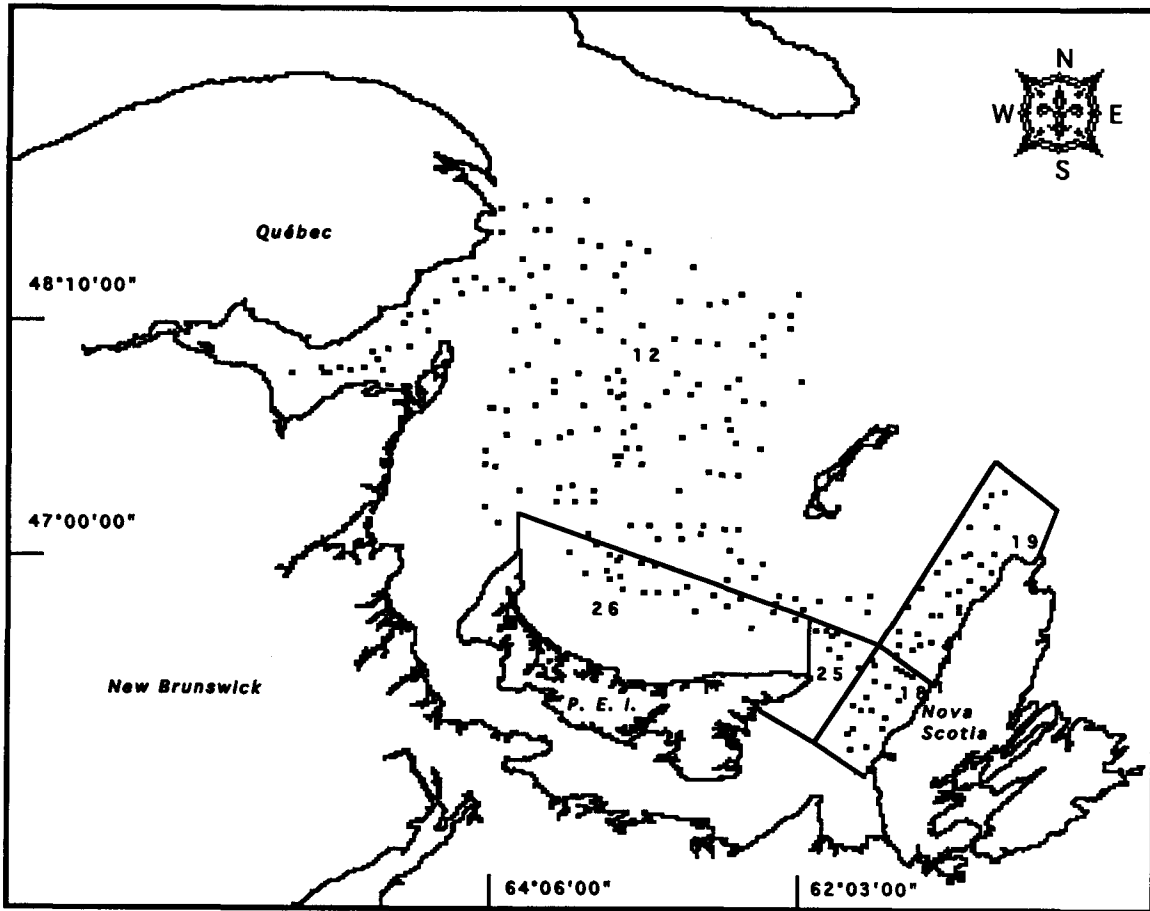


Figure 2. Geographic locations of the post season trawl survey stations in the Southern Gulf of St. Lawrence in 1992. Each dot represents one 4 to 8 minute tow.

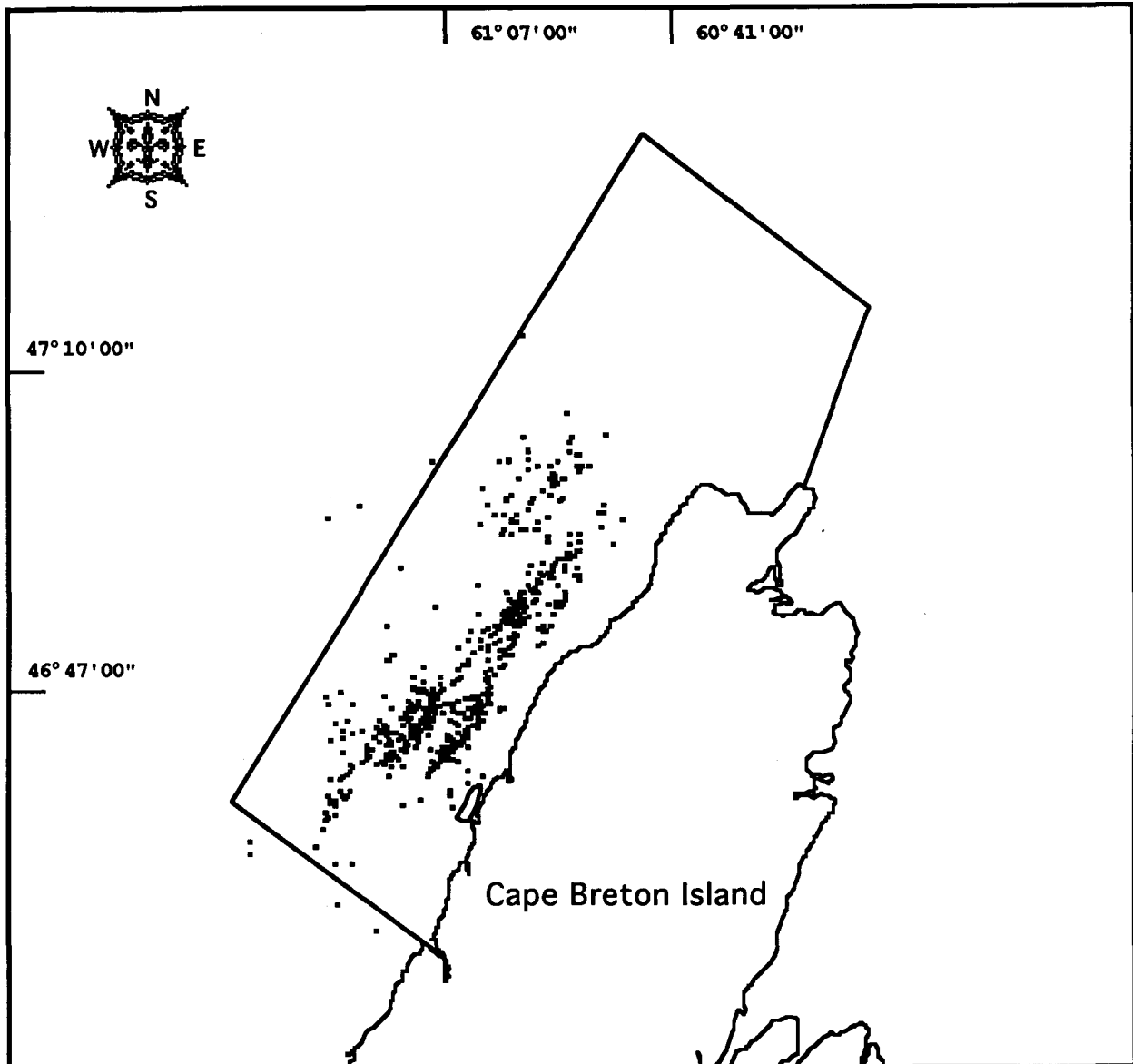


Figure 3. Distribution of fishing effort for the Area 19 Cape Breton Island snow crab, *Chionoecetes opilio*, fishery for 1992. Each dot represents at least one trap haul.

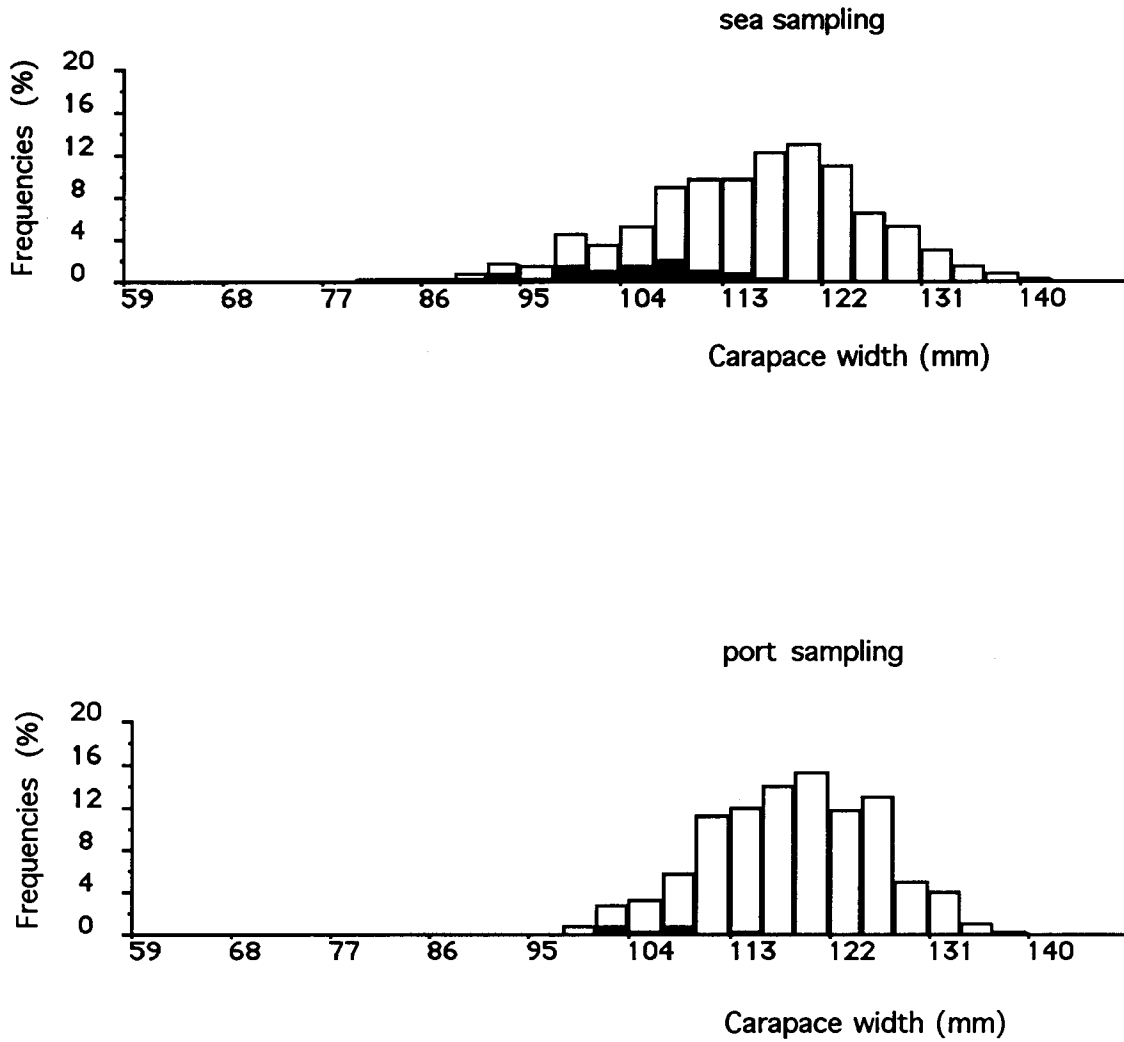


Figure 4. Overall size distributions of male crab, *Chionoecetes opilio*, present in sea and port samples taken during the 1992, Area 19 snow crab fishery.

Percentage of small claw in black, percentage of total in white.

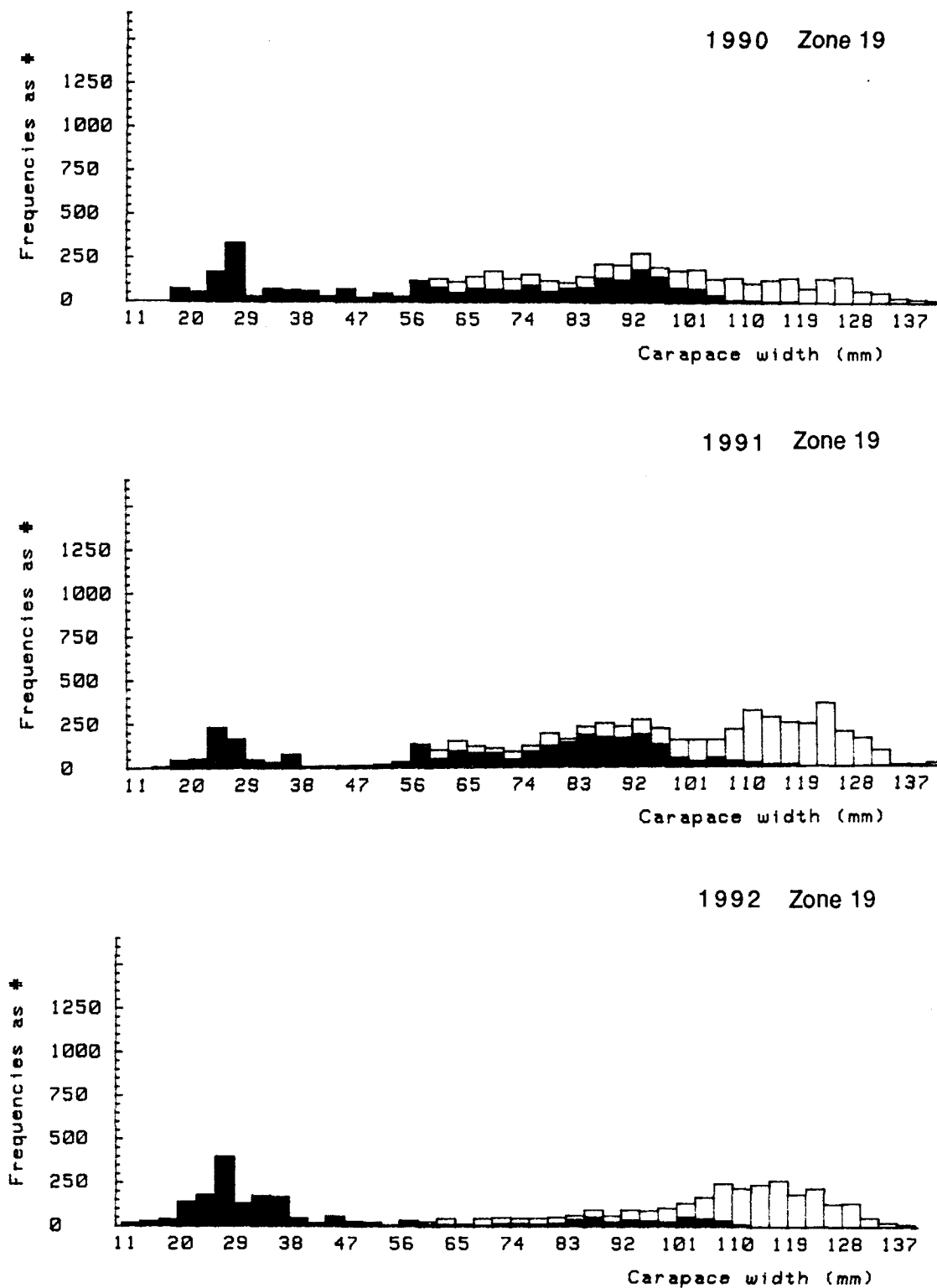


Figure 5. Overall size distributions of male crab, *Chionoecetes opilio*, present in the Cape Breton Area 18 and 19 trawl survey from 1990 to 1992.

Numbers of small claw in black, numbers of total in white

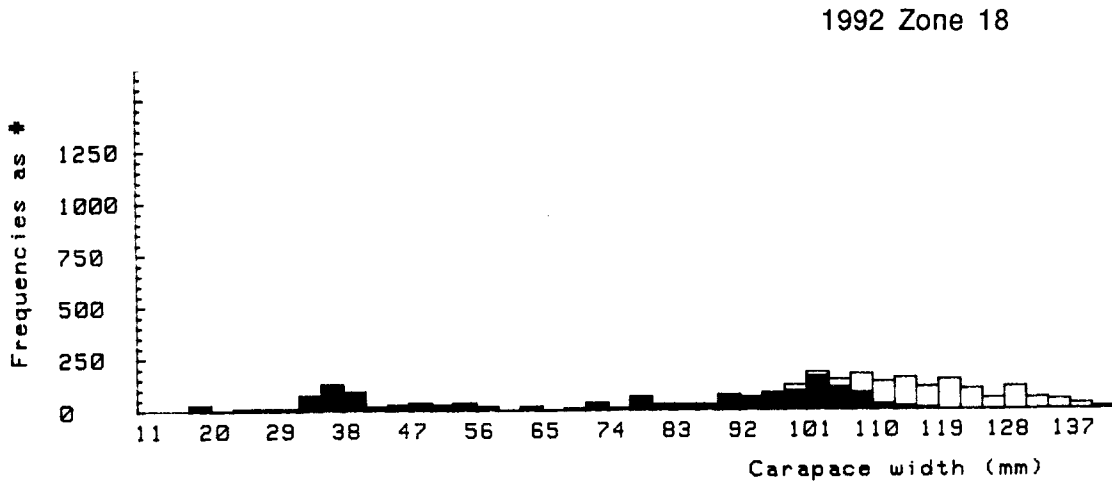
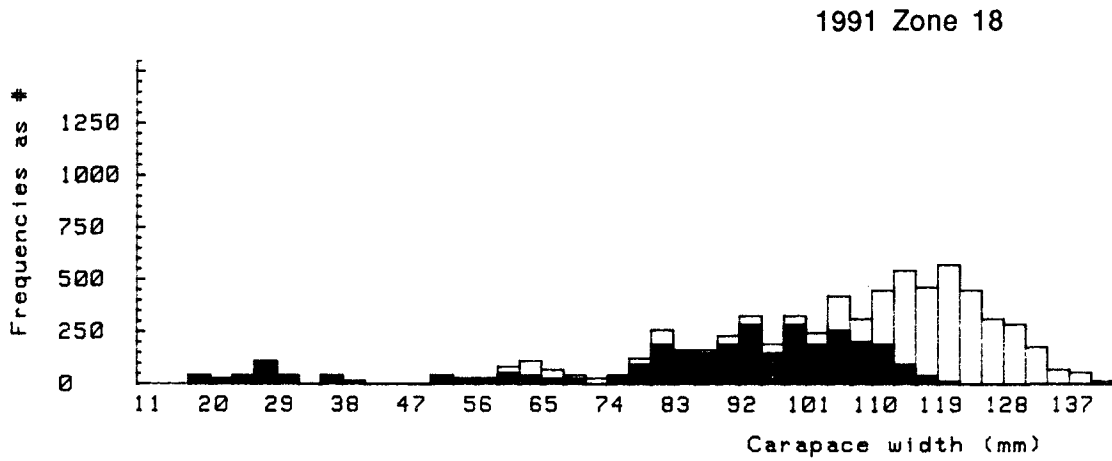
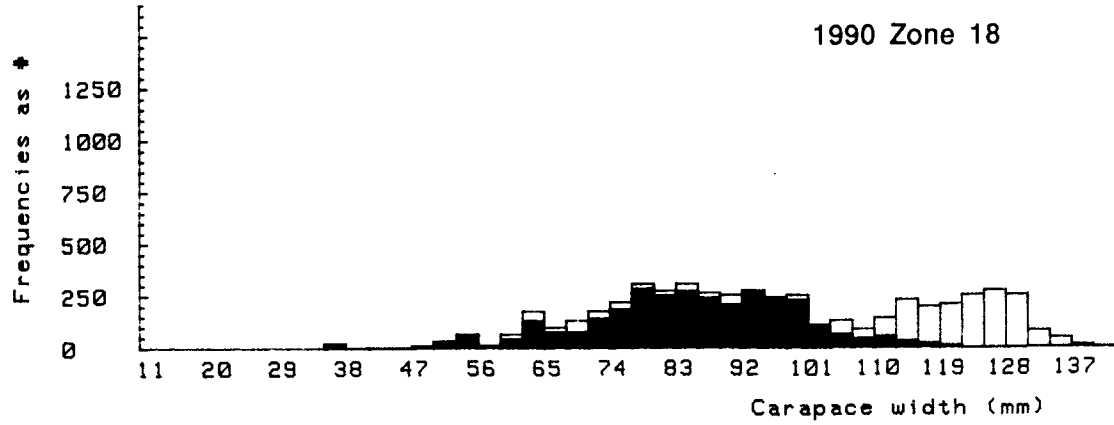


Figure 5. Cont.

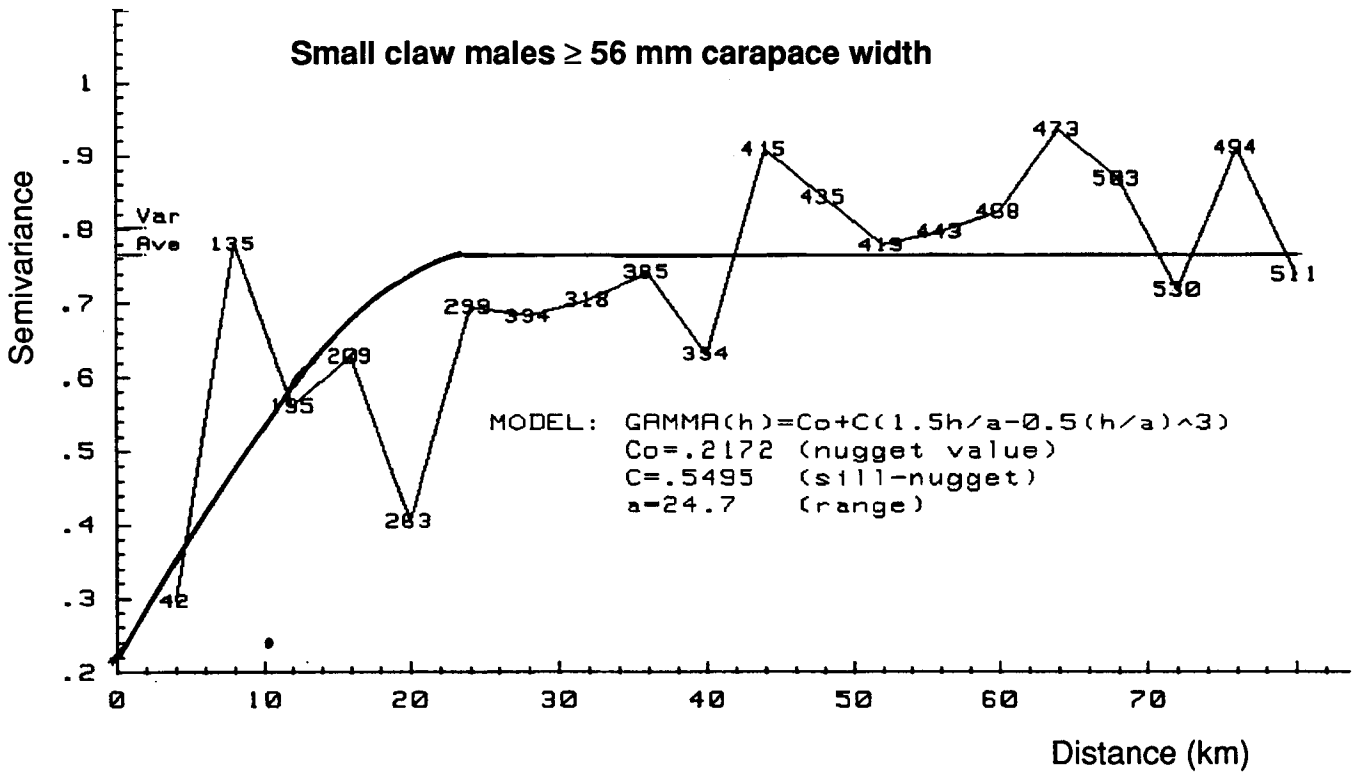
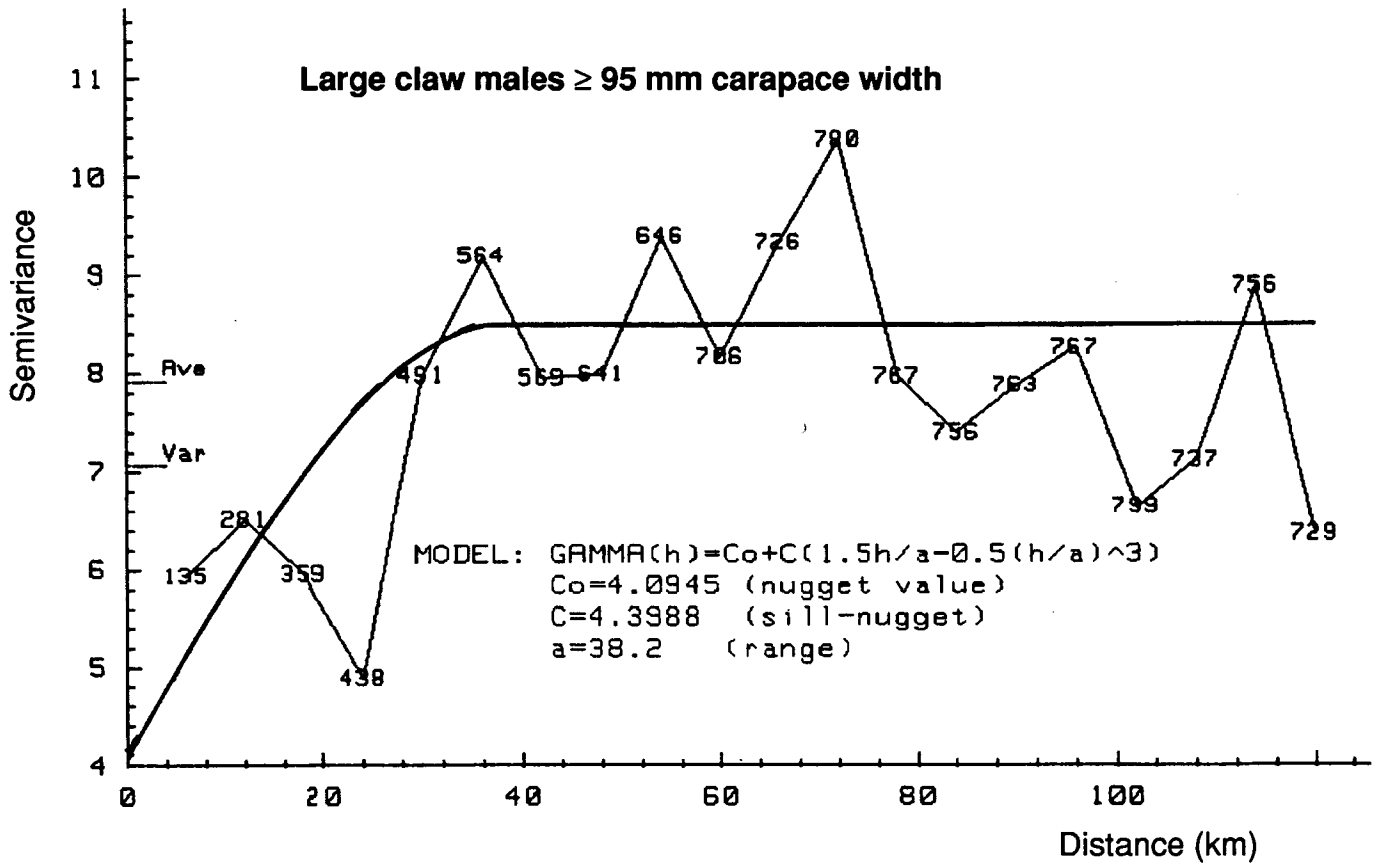
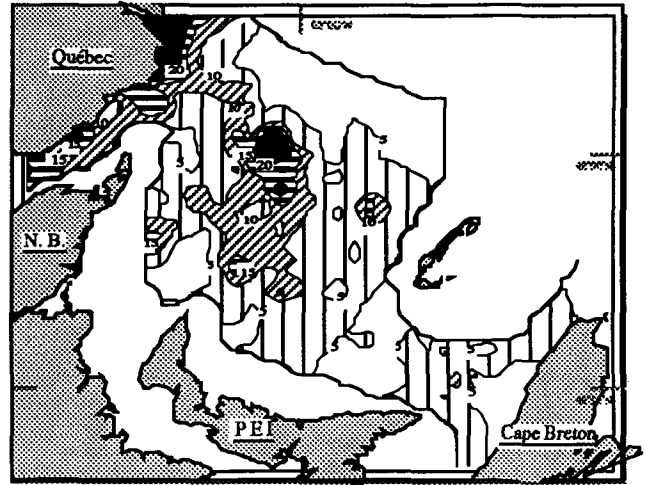
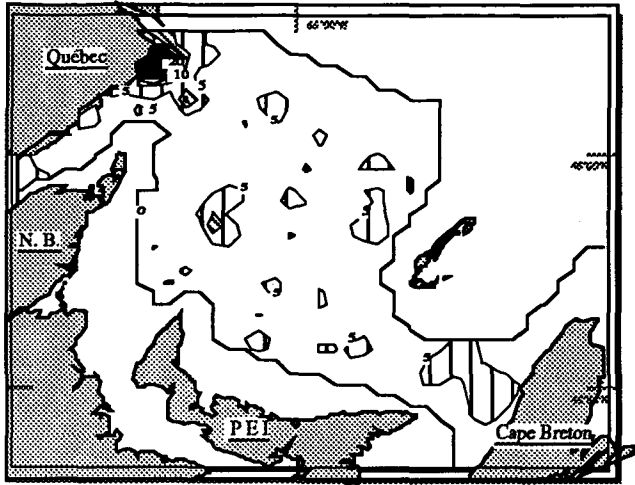


Figure 6. Variograms for the large claw males ≥ 95 mm CW and for small claw males ≥ 56 mm used in the kriging calculations for the 1992 survey.

1988

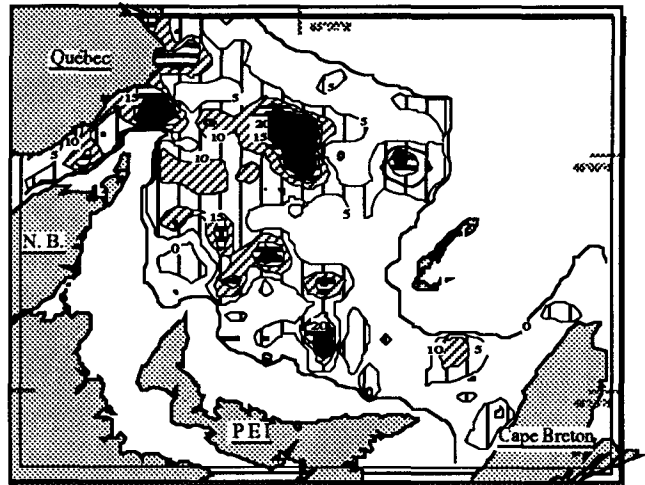
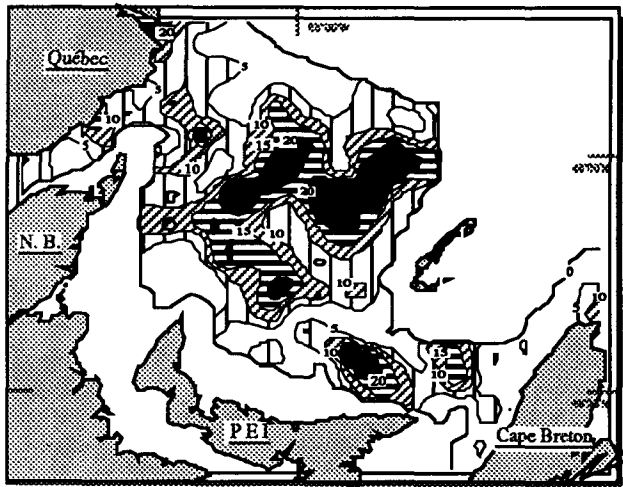
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1989



1990

1991



1992

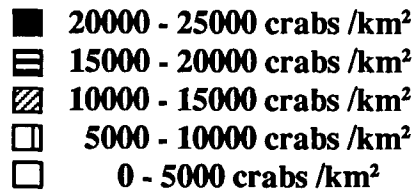
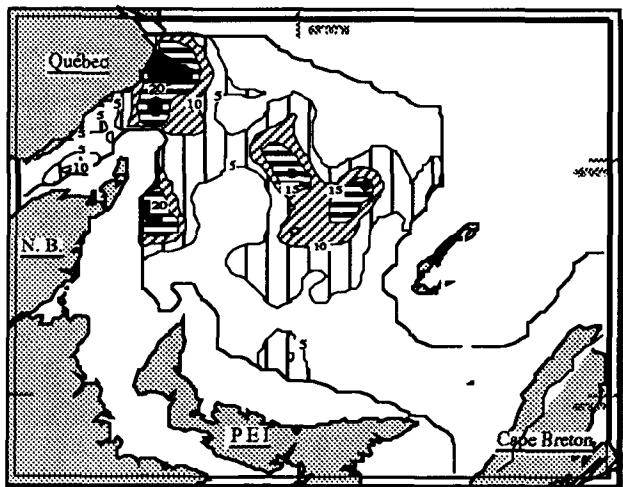
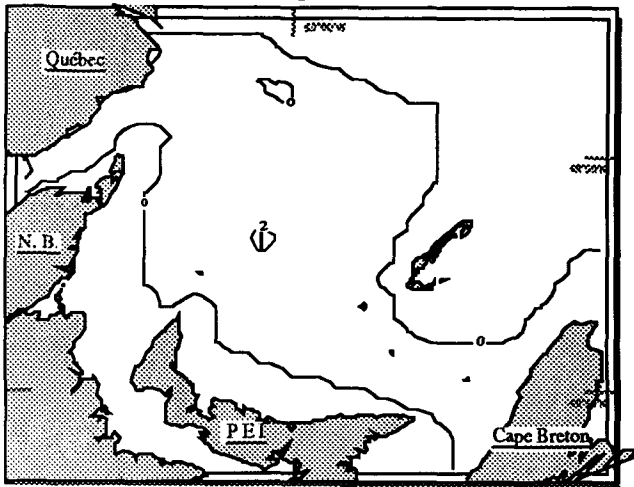


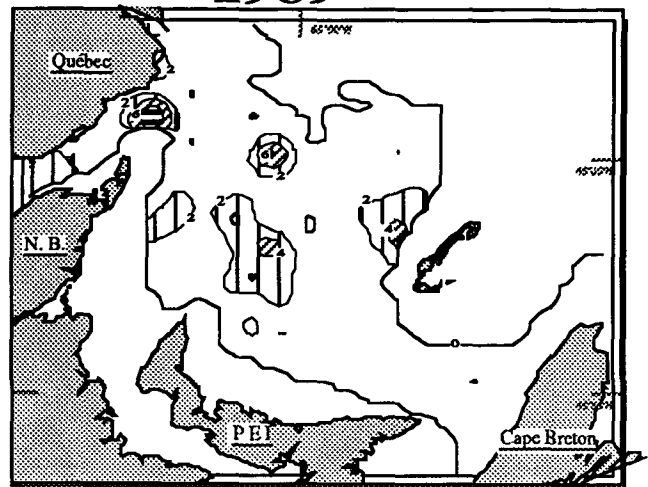
Figure 7. Density contours for small claw crabs ≥ 56 mm calculated by kriging from 1988-1992.

1988

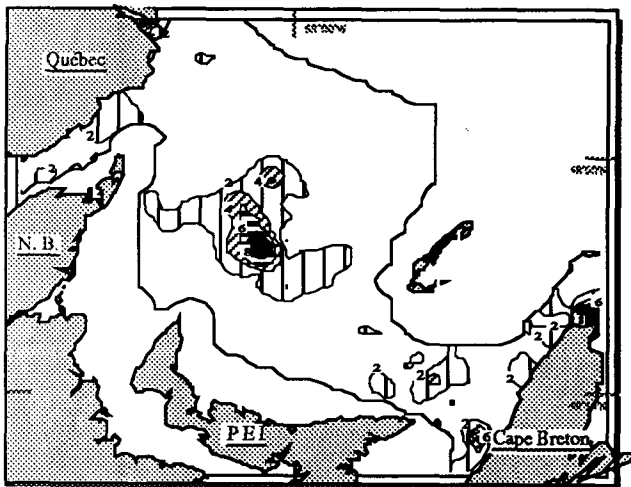
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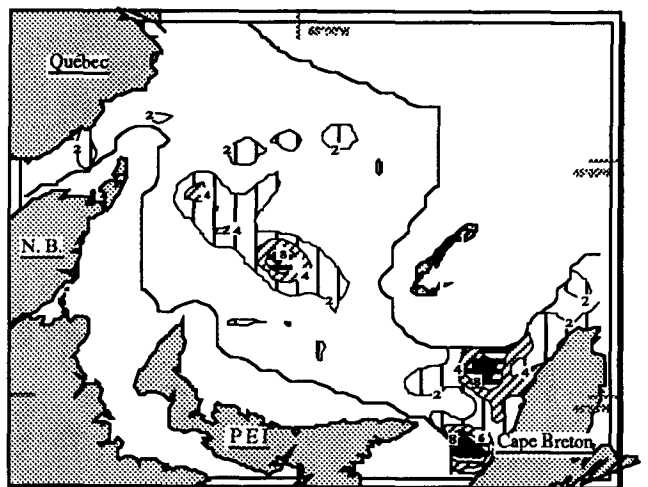
1989



1990



1991



1992

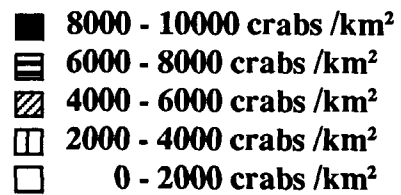
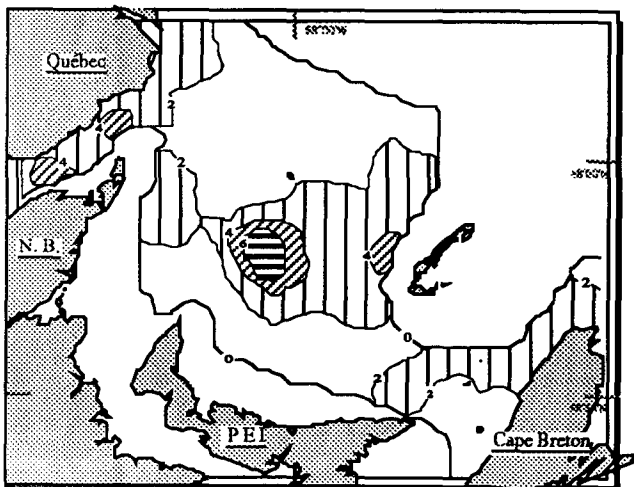


Figure 8. Density contours for large claw crabs ≥ 95 mm calculated by kriging from 1988-1992.

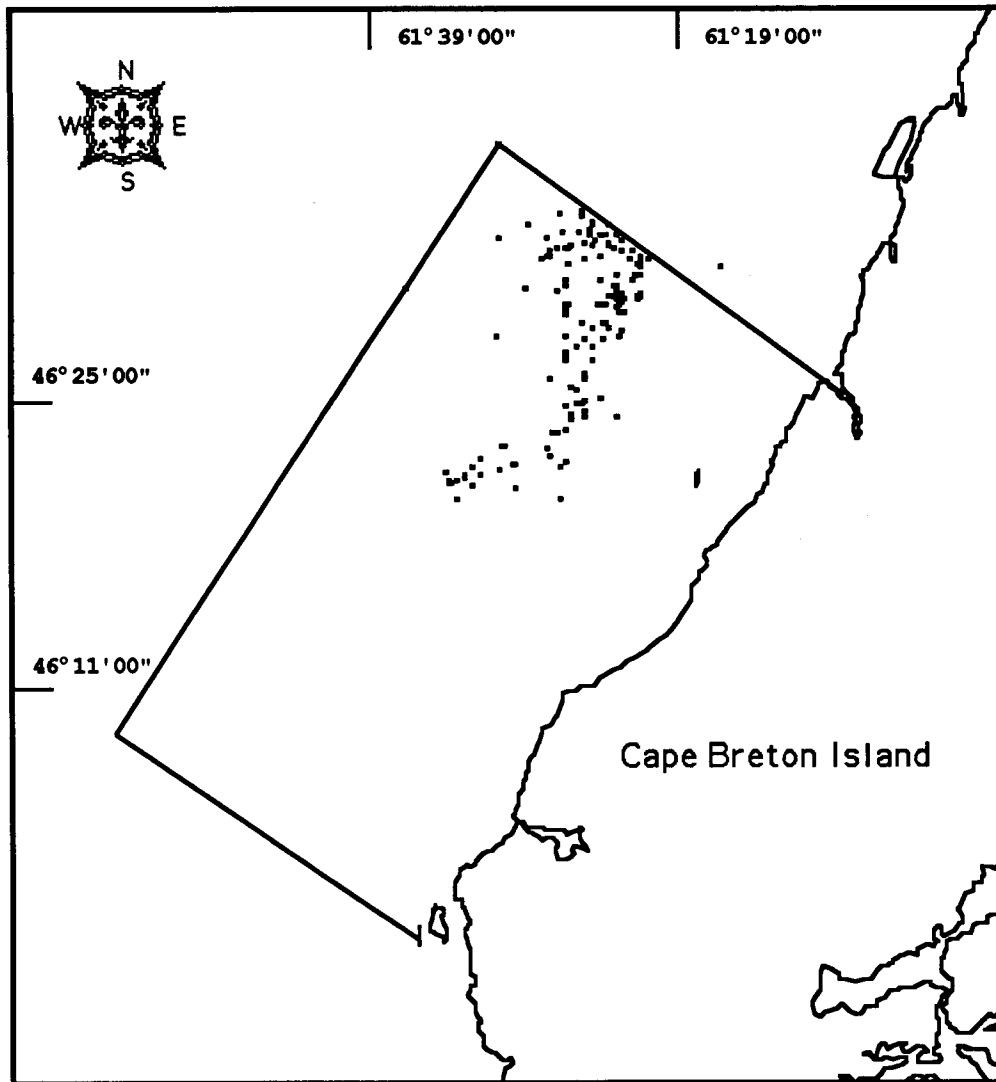


Figure 9. Distribution of fishing effort for the Area 18 Cape Breton Island snow crab, *Chionoecetes opilio*, fishery for the fall 91-Spring 92. Each dot represents at least one trap haul.

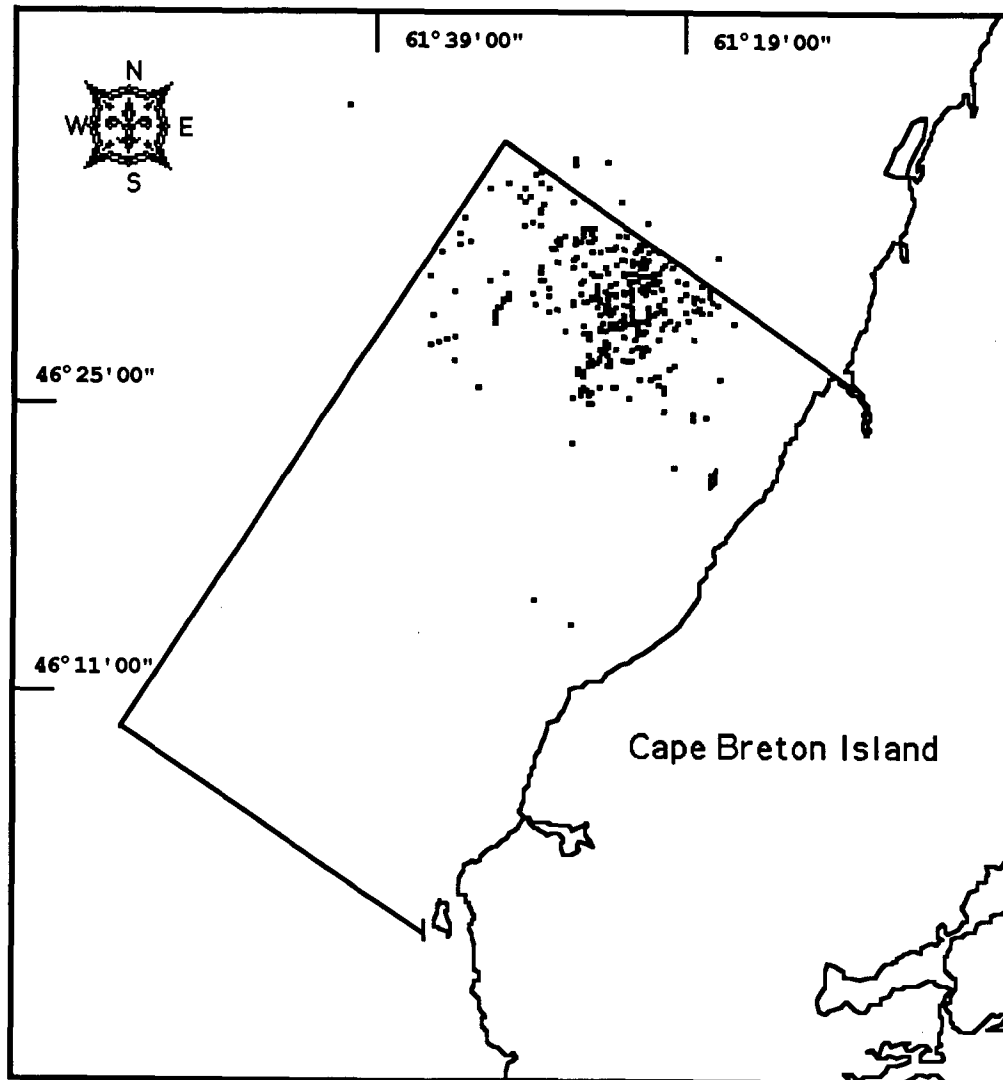


Figure 10. Distribution of fishing effort for the Area 18 Cape Breton Island snow crab, *Chionoecetes opilio*, fishery for the fall 92. Each dot represents at least one trap haul.

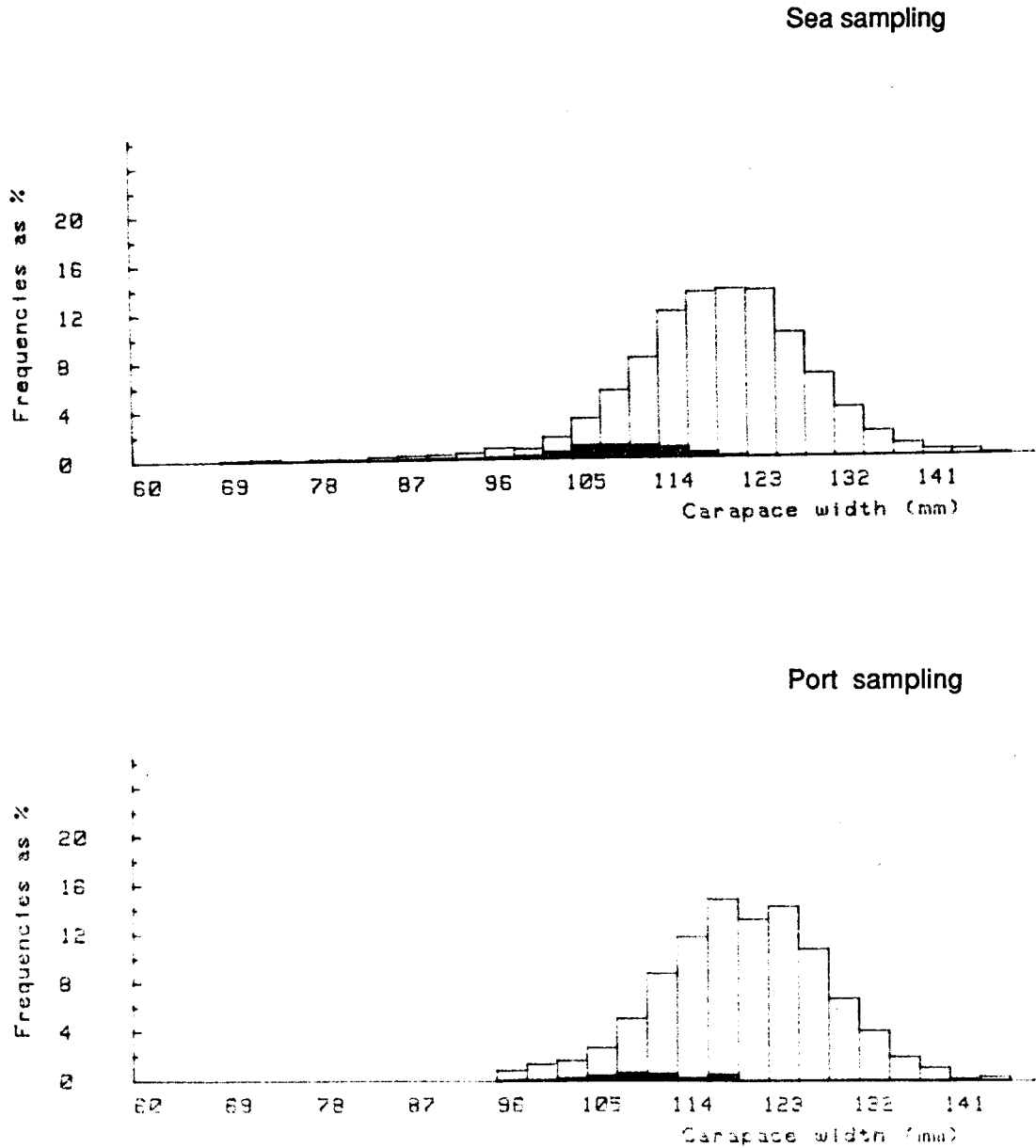


Figure 11. Overall size distributions of male crab, *Chionoecetes opilio*, present in sea and port samples taken during the fall 91- spring 92, Area 18 snow crab fishery.

Percentage of small claw in black, percentage of total in white.

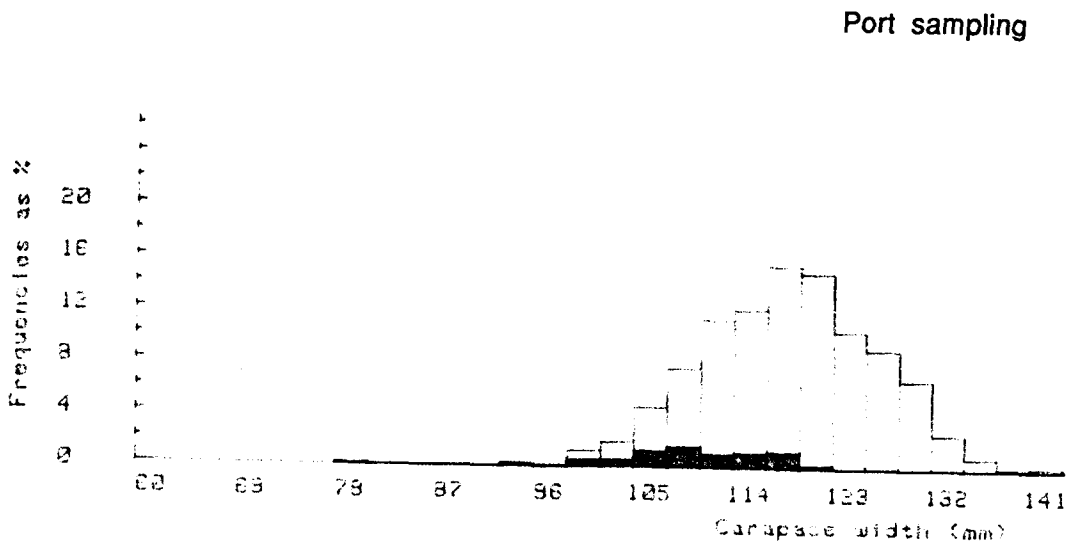
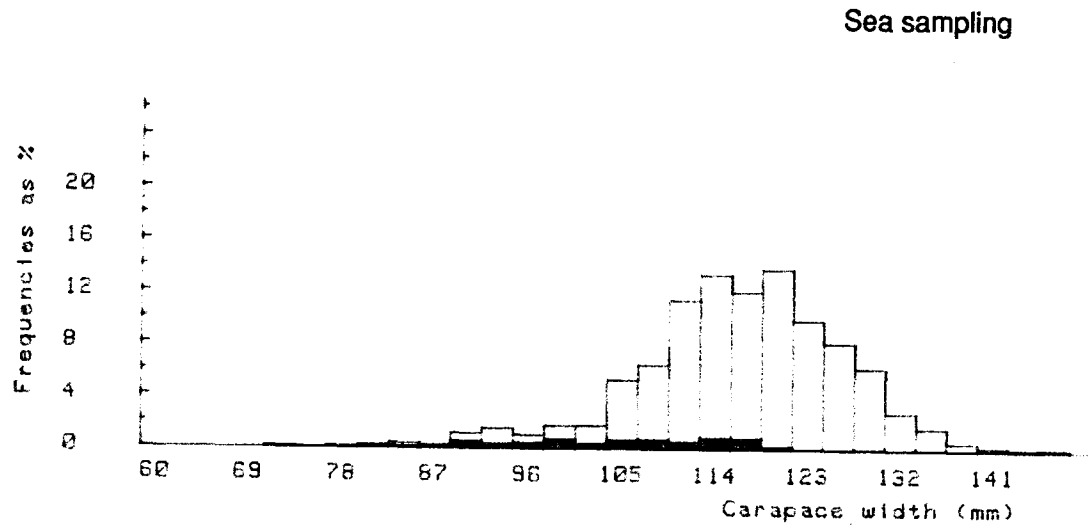


Figure 12. Overall size distributions of male crab, *Chionoecetes opilio*, present in sea and port samples taken during the fall 92, Area 18 snow crab fishery.

Percentage of small claw in black, percentage of total in white.