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Assessment 1988: Snow crab off the Atlantic Coast of Cape Breton Island

by

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ABSTRACT

Biological monitoring data (based upon fishermens' logbooks, sales slip statistics and commercial sampling) were examined for the Cape Breton Island (Atlantic Coast, areas 2-6) snow crab fishery in 1988. Assessments for each stock were made by comparing the monitoring data against historical patterns. The overall status of stocks in areas 2-6 appears to show a slight improvement over 1987, maintaining the reversal of the collapsed state noted in previous years. A pulse of males first detected in 1985 continued recruiting into the commercial stocks prior to the 1988 fishing season and increased, or maintained, fishable biomass over 1987 levels in all areas. A strong market demand for snow crab resulted in a 50% increase in fishing effort; this, coupled with slightly higher than average catch rates, resulted in a large rise in landings. Eighty-nine of 106 licensed vessels were active and their recorded catch (540.6 t) was 150% of the 1987 value (64 vessels: 360 t) but still only 66% of the 1980 value (99 vessels: 822.3 t). The logbook returns and pattern of CPUE permitted estimates of commercial biomass and exploitation rate for all areas by Leslie analyses.

Fishing activity was minor in area 2 (4 vessels: 16.6 t). Landings of 125.1 t were recorded from sales slips for the 24 active vessles in area 3. The 29 active vessels in area 4 all fished inshore and recorded total landings of 90.5 t, by sales slips. Analyses of logbooks for vessels fishing in the combined area 2,3,4 (inshore) gave a mean CPUE of 9.9 kg/trap haul (compared to the mean of 8.2 kg/trap haul recorded in 1987). Total available biomass for the combined inshore area 2,3,4 was estimated at 292.3 t and exploitation rate at 64%.

Sales slips in area 5 indicated landings of 174.1 t, an increase from the 157.4 t landed in 1987. Logbooks from 16 of the 19 active vessels reported landings of 162.2 t. The mean CPUE of 25.7 kg/trap haul was close to that for 1987 (26.2 kg/trap haul). Leslie estimates gave available commercial biomass and exploitation rate for the season at 284.6 t and 57%, respectively.

Logbooks for area 6 documented catches of 162.6 t for all 13 of the active vessles; landings of 134.2 t were recorded by sales slips. Virgin offshore grounds with a mean CPUE of 29.2 kg/trap haul, were discovered. The mean CPUE for the inshore grounds was 13.5 kg/trap haul, a small increase over the 1986 value of 12.9 kg/trap haul. Total available biomass and exploitation rate on the inshore grounds were estimated at 199.7 t and 59%, respectively.

The 1988 assessment for areas 2-6 does not appear to justify changes in current management strategy. Given the erratic production dynamics of these stocks over the past decade, there is no rationale for re-introducing catch controls for the 1989 season. Nevertheless, the high proportion of morphometrically immature males in the stocks does suggest that the current improved trend in growth and recruitment levels will continue for at least a further fishing season.

RESUME

On a examiné des données de surveillance biologique (fondées sur les journaux de bord, sur les reçus de vente et sur l'échantillonnage commercial) des pêcheries de crabe des neiges du Cap-Breton (côte Atlantique, zones 2-6) en 1988. On a évalué chacun des stocks en comparant les données de surveillance aux tendances antérieures. Dans l'ensemble, les stocks des zones 2-6 semblent s'être légèrement améliorés depuis 1987, confirmant le redressement de situation amorcé ces dernières années après l'effondrement de ces stocks. Un afflux de mâles, détecté pour la première fois en 1985, a continué d'être recruté dans les stocks commerciaux avant la saison de pêche de 1988 et a permis d'augmenter ou de maintenir la biomasse exploitable au-delà de son niveau de 1987. La forte demande des marchés du crabe s'est traduit par un accroissement de 50 % de l'effort de pêche qui, combiné à des prises légèrement supérieures à la moyenne, a abouti à une forte augmentation des débarquements. Il y avait 89 bateaux actifs sur les 106 faisant l'objet d'un permis, et les prises qu'ils ont déclarées (540,6 t) équivalaient à 150 % de celles de 1987 (360 t pour 64 bateaux), mais ne représentaient guère que 66 % des prises de 1980 (822,3 t pour 99 bateaux). Les journaux de bord retournés et l'évolution suivie par les PUE ont permis d'établir des estimations de la biomasse commerciale et du taux d'exploitation dans tous les zones, au moyen d'analyses de Leslie.

L'activité de pêche a été minime dans le zone 2 (quatre bateaux : 16,6 t). Dans le zone 3, 24 bateaux actifs ont obtenu, d'après les reçus de vente, des débarquements de 125,1 t. Les 29 crabiers actifs du zone 4 ont tous pêché dans les eaux côtières et ont obtenu des débarquements totaux de 90,5 t, selon les reçus de vente. Les analyses des journaux de bord des bateaux des zones 2, 3 et 4 combinés (pêches côtière) ont établi la moyenne des PUE à 9,9 kg/casier mis à l'eau (comparativement à 8,2 kg/casier mis à l'eau en 1987). On a chiffré la biomasse commerciale et le taux d'exploitation à 292,3 t et 64 % respectivement pour les trois zones côtiers combinés (2, 3 et 4).

Dans le zone 5, les reçus de vente reflétaient des débarquements de 174,1 t, soit une hausse par rapport aux 157,4 tonnes débarquées en 1987. D'après les journaux de bord de 16 des 19 bateaux actifs, les débarquements étaient de 162,2 t. La moyenne des PUE, soit 25,7 kg/casier mis à l'eau était comparable à celles de 1987 (26,2 kg/casier mis à l'eau). Pour la saison considérée, les estimations obtenues par des analyses de Leslie s'établissaient à 284,6 t pour la biomasse commerciale et à 57 % pour le taux d'exploitation.

En ce qui concerne le zone 6, les prises consignées dans les journaux de bord s'élevaient à 162,6 t pour la totalité des 13 bateaux actifs. Les reçus de vente reflétaient des débarquements de 134,2 t. On a découvert des lieux de pêche hauturière jusqu'ici inexploités, où la moyenne des PUE était de 29,2 kg/casier mis à l'eau. La moyenne des PUE dans les eaux côtières s'établissait à 13,5 kg/casier mis à l'eau, représentant une petite augmentation par rapport à 1986 (12,9 kg/casier mis à l'eau). Selon les estimations, la biomasse disponible et le taux d'exploitation dans les eaux côtières étaient respectivement de 199,7 t et 59 %.

Les évaluations réalisées en 1988 pour les zones 2 à 6 ne semblent pas justifier un changement de stratégie de gestion. Etant donné la production irrégulière des stocks au cours de la dernière décennie, il n'y a pas de raison de limiter à nouveau les prises pendant la saison 1989. La présence dans les stocks d'une forte proportion de mâles n'ayant pas atteint la maturité morphométrique laisse croire que l'amélioration actuelle de la croissance et du recrutement se poursuivra pendant au moins une autre saison de pêche.

INTRODUCTION

A directed inshore fishery for snow crab, Chionoecetes opilio, off Cape Breton Island was started in 1966 on the northwestern coast. Between 1976 and 1978, seven areas were defined around Cape Breton Island (Fig. 1) for exclusive exploitation by inshore boats under 45 ft (13.7 m) in length. Between 1977 and 1979, landings rose markedly in phase with effort (Tables 1, 2) and the expansion of the fishery to approximately 180 inshore vessels operating around most of the Island (Elner 1982a). However, by 1982 it became apparent that the snow crab stocks along the Atlantic coast of Cape Breton Island (Areas 2 to 6, Scotia-Fundy Region) had only low, or sporadic, recruitment and that the accumulated virgin biomass had been largely removed by fishing. In contrast, on the Gulf of St. Lawrence coast of the Island (Areas 1 [19] and 7 [18], Gulf Region) larger production levels conferred relative stability to the commercial biomass and landings (Elner 1982a; Davidson et al. 1985). As the productivity of the Atlantic coast resource appeared too low and erratic to allow for a strategy of biomass stabilization, management dropped catch controls for the fishery in 1982 to allow existing fishermen to take advantage of whatever productivity occurs from time to time on an opportunistic basis. The regulatory measures remaining include strict licensing controls, a 30 trap/vessel limit, a relatively short fishing season (10 wk, July-September), and a minimum legal size of 95 mm carapace width (CW).

The minimum legal size regulation of 95 mm CW was thought to confine exploitation to males mature for 1 to 3 yr and thus theoretically protect the reproductive potential of the resource (Elner and Robichaud 1983a; Elner and Gass 1984). However, up to approximately 50% of the commercial-sized males sampled in Areas 3, 5, and 6 during 1986 were morphometrically immature (Elner and Robichaud 1987). Furthermore, both male and female snow crabs in eastern Canada are now considered to have a terminal molt to morphometric maturity (O'Halloran 1985; Conan and Comeau 1986). The size, and presumably age, at which this may occur is variable. Factors influencing when an individual crab undergoes its terminal molt are unknown; but for males, the size of terminal molt can be 50-150 mm CW. The implications of this new knowledge on snow crab management are still unclear (see Bailey and Elner 1989, for discussion of the issue).

The present paper assesses the status of he snow cab fishery in Areas 2, 3, 4 5, and 6* for 1988. Such annual assessments form the biological basis for management of the various Canadian fisheries for snow crab.

MATERIALS AND METHODS

Cape Breton Island snow crab fishermen have been required to maintain logbooks for each fishing season since 1978. The logbooks from the 1988 season provided catch, effort, and CPUE data for each area over time. In contrast to many previous years, exploitation rates

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* Revised Management Areas: 20, 21, 22, 21, and 24, respectively.

and biomass could be estimated by Leslie analysis for all areas in 1988. Sales slips provided supplementary landing statistics and also served to check logbook coverage (see also Appendix I). To improve trap location information given in logbooks, fishermen have been provided large-scale grid charts since 1983 and requested to indicate the grid number(s) corresponding to their fishing area(s). For detailed accounts of snow crab logbook format and Leslie analysis see Elner (1982b) and Mohn and Elner (1988).

Port and at-sea sampling were carried out throughout the fishing season in Areas 2, 3, 4, 5, and 6, to monitor the size-frequency distribution and shell hardness profile of commercial catches (see Appendix II for sampling sheet). Snow crab size was determined by measurement of carapace width (CW) across the widest part of the carapace. Shell flexibility was assessed subjectively as "hard", "intermediate", or "soft" by applying thumb pressure across a chela. Shells were also subjectively classified as either "new" or "dark" according to colour.

Chela height (Fig. 2) was measured for male snow crabs to continue research into morphometrics and size at maturity. Conan and Comeau (1986) and O'Halloran (1985) detail the relationship between chela allometry and morphometric maturity. In summary, when logarithms of chela height are plotted against the logarithms of carapace width, morphometrically immature crabs form a swarm of data points distinct from morphometrically mature crabs. The major axes of the swarms are parallel, and area-specific cutting lines effectively separate the two swarms; data points for mature crabs appear above the cutting line and points for immature crabs fall underneath. Details of the discriminant function analyses and cutting line equations (produced by M. Comeau, DFO, Gulf Region) are given in Elner et al. (1988).

The status of snow crab stocks in Areas 2, 3, 4, 5, and 6 for 1988 was assessed on the basis of fishermen's logbooks, sales slips, commercial catch sampling, as well as historical monitoring data.

RESULTS

Areas 2, 3, and 4 (Northeastern Cape Breton - inshore).

Port and at-Sea Sampling

Size - frequency histograms for port and at-sea sampling in Areas 2, 3, and 4 (inshore) during July, August and September 1988 are shown in Figures 3-6. Comparisons against size - frequency profiles taken in 1987 in the same areas (Elner et al. 1988) reveals some shifts in mean sizes but the pattern is not constant and remains enigmatic.

Port samples taken in Areas 2 and 4 in July and August, 1988 had mean carapace widths close to those observed in equivalent 1987 samples. However, port samples taken in Areas 3 during July (mean CW = 108.4 mm) August (mean CW = 107.3 mm) were shifted to the right

compared to July 1987 (mean CW = 102.6 mm) and August 1987 (mean CW = 102.5 mm). Sea samples taken in Areas 2 and 3 during August 1988 both had mean sizes notably smaller than the equivalent 1987 samples (Area 2: July 1987 - 110.0 mm CW, July 1988 - 92.4 mm CW; Area 3: July 1987 - 101.9 mm CW, July 1988 - 93.1 mm CW). In contrast, the sea sample taken in Area 4 during September 1988 (mean CW = 105.4) was markedly larger in mean size than for September 1987 (mean CW = 94.6 mm).

No newly molted, soft-shelled, male or female snow crab were detected in port and at-sea samples from Areas 2, 3, and 4 in 1988. However, between 21.6 and 35.6% of the samples in a given Area were classed as 'medium' in the shell flexibility scale (Table 3). Such medium-shelled crabs could be comprised of either recently molted individuals and/or individuals that have been in terminal molt status for several years. To help resolve the dichotomy, males were also classified according to shell colour ('new' or 'dark'). Thus, it can be expected that dark shelled males with medium shell flexibility have been several years without molting and 'new' shelled males with medium shell flexibility have only recently molted. In terms of relative age since last molt the following classification (from shortest to longest time interval) is probably applicable:

- Medium flexibility/new shell
- Hard flexibility/new shell
- Hard flexibility/dark shell
- Medium flexibility/dark shell

Some buyers independently classified males as 'light' or 'dark', according to colour, and give a lower price for 'light' crab on account of purported lower meat yield at processing.

Maturity

Chela height versus CW data for males in August/September at-sea samples for Areas 2, 3, and 4 (Figures 10-12) indicate that up to 27.4% of the catch, including many legal-sized crabs were morphometrically immature. Similarly, up to 28% of the landed crabs sampled in port in Areas 2, 3, and 4 in July and August 1988 were morphometrically immature (Figures 10-12). While the morphometrically immature crabs with molt and further contribute to production in the 1989 season, the morphometrically mature individuals, including a large proportion below the legal minimum size cannot be expected to grow again. For all samples taken in Areas 2, 3, and 4 during the 1988 season there were a greater proportion of morphometrically immature males present than for the corresponding 1987 sample (Table 4).

Females

Forty-three (97.7%) of 44 mature females sampled in Area 2 and 55 (98.2%) females out of 56 sampled in Area 3 during August 1988 were ovigerous (Fig. 15; Table 3).

Logbooks

Four fishermen were active in Area 2, 24 were active in Area 3, and 29 in Area 4. Two logbooks were forthcoming from the Area 2 fishermen, 19 were received from Area 3 and 23 from Area 4 (Tables 1, 2). Most of the traps were set on inshore grounds, or adjacent to, Area 3 (Fig. 1). Thus, for assessment purposes (as in previous years) fishermen are considered to have exploited a single stock (Areas 2, 3, and 4, inshore). The offshore of Area 4, which has been exploited in previous years (Elner and Robichaud, 1987) does not appear to have been fished in 1988. Landings, as recorded from sales slips and logbooks for the combined inshore area, were 232.2t and 231.2t respectively; these values are approximately double the recorded landings in 1987 and the highest since 1982 (Table 2; Fig. 16).

Analysis of catch and effort data from the combined Areas 2, 3 and 4 logbooks revealed a declining trend in mean weekly CPUE through the fishing season (Table 5). The mean CPUE (9.9 kg trap haul) in 1988 was the highest recorded since 1981 and was approximately triple the rate observed for the 1984-1986 annual assessments (Fig. 16). Leslie analysis (Fig. 19) indicates that the total available commercial biomass (B_0) for the fishing season was 292,309 kg (95% confidence limits [CL] :251,256 kg and 369,203 kg). Hence, given logbook-derived catches of 187,144 kg, 105,165 kg would have been left on the grounds at the end of the fishing season (95% CL:64,112 kg and 182,059 kg) after an exploitation rate of 64% (95% CL:74% and 57%). The total available biomass estimated for 1988 is approximately 63t higher than that assessed for 1986 and the highest recorded since 1979 (Table 2).

Area 5 (Southeastern Cape Breton).

Port and at-sea sampling

Size - frequency histograms for port and at-sea sampling Area 5 during July, August and September 1988 are shown in Fig. 7-8. Port samples in July, August and September 1988 had similar mean carapace widths for July and August 1987. The mean carapace width for sea samples taken in August 1988 was 99.4 mm; above the mean for August 1987 (94.7 mm CW) but close to the mean for August 1986 (100.3 mm CW).

All male and female crabs sampled at-sea and in port during the 1988 fishing season were either in a hard or medium-shelled condition (Table 3). In season growth and recruitment has not been recorded in Area 5 since 1978 (Elner et al. 1988). As for Areas 2, 3, and 4, a large proportion (46.5%) of the males sampled had 'medium' shells; of these individuals 93.8% were classified as 'new' shelled, indicating they had molted relatively recently.

Maturity

Plots of chela height versus CW for male crab sampled at-sea and in port (Fig. 13) during the 1988 season indicate that up to 52.1% were

morphometricaly immature. Again, as in Areas 2, 3, and 4, there appears a large 'sink' of males in terminal molt status below the legal minimum size. Also, as the previous Areas, there appears to be a greater proportion of morphometrically immature males present than in 1987 (Table 4).

Females

If the 83 mature females sampled at-sea in August 1988 all but one was ovigerous (Table 3; Fig. 15). The high proportion of ovigerous females appears to be a further reversal of the declining trend noted in previous years (Elner and Robichaud, 1986) and is probably a reflection of the same recruitment wave detected for the male crabs. Previously, a lack of recruitment had led to a "senility" phenomenon with either barren females or multiparous females with reduced egg clutches becoming increasingly common as the population aged (Bailey and Elner 1989).

Logbooks

Logbooks were received from 16 of the 19 Area 5 fishermen who set traps in 1988. Total landings derived from logbooks were 162,946 kg, as compared to 174,112 kg from sales slips statistics. Landings in 1988, according to sales slips, were slightly above the value for 1987 (157,408 kg) and over five times the level achieved in 1985 (29,171 kg); however, catches are still considerably below historical levels at the start of the fishery (Tables 1 and 2).

The overall mean CPUE value for the 1988 season (25.7 kg trap haul^{-1}) was slightly below the 1987 value (26.24 kg trap haul^{-1}) but markedly above mean values estimated for the previous 4 yr (Table 2; Fig. 17). Mean weekly CPUE values demonstrated a declining trend that was amendable to analysis by the Leslie method (Table 5, Fig. 19). Based on Leslie analysis, the B_0 for the season was 284,571 kg (95% CL: 274,022 kg and 347,608 kg). Logbook-derived catches of 162,187 kg would have resulted in an exploitation rate of 57% (95% CL:66% and 44%) and left 122,384 kg (95% CL:84,835 kg and 185,421 kg) on the Area 5 grounds after the fishing season. The B_0 estimated for 1988 is slightly below that for 1987 (293.4 t) and remains considerably below historical high levels (Table 2).

Area 6 (Southern Cape Breton)

Port and at-Sea Sampling

Port and at-sea sampling was carried out in the area during August and September 1988 (Figures 8-9). The mean carapace widths for the two months were similar in the case of both the port samples (August, mean CW = 120.4 mm; September, mean CW = 117.2 mm) and the sea samples (August, mean CW = 107.8 mm; September, mean CW = 109.1 mm). However, while the mean carapace width for the sea sample in August 1987 (mean CW = 108 mm) was almost identical to the 1988 value, the August 1987

port sample value (mean CW = 110.4 mm) was considerably smaller than that for 1988.

As for the preceding Areas, all male and female snow crabs inspected in Area 6 during 1988 were either 'hard' or 'medium' shelled (Table 3). Most (97.1%) of the 'medium' shelled males were classified as being 'new' and, thus, having molted relatively recently.

Maturity

Plots of chela height versus CW for male crab sampled at-sea and in port for Area 6 during August and September 1988 are shown in Fig. 14. Again, as for Areas 2, 3, 4 and 5, the sea samples show a large 'sink' of terminal males below the minimal legal size. The August 1988 sea sample, as for the other Areas, shows a relatively greater proportion of morphometrically immature males present as compared to the equivalent 1987 sample; however, the August 1988 port sample had relatively fewer immature males than in August 1987 (Table 4).

Females

All but six of the 119 mature female snow crabs sampled at-sea in August and September 1988 were ovigerous (Table 3; Fig. 15).

Logbooks

The total landings from the thirteen logbooks received from the 13 active Area 6 fishermen in 1988 amounted to 162,550 kg, as opposed to 134,216 kg recorded through the sales slips statistics system (Tables 1 and 2). Total landings were approximately double the 1987 values, which were themselves above all historical levels (Fig. 18). However, a proportion of the Area 6 landings were accounted for by fishing on newly discovered offshore grounds (mean CPUE = 29.2 kg trap haul).

The overall mean CPUE value (inshore) estimated for the 1988 season (13.5 kg trap haul^{-1}) was the highest recorded since the peak year of 1981 (15.46 kg trap haul^{-1}). CPUE declined through the season, and the resultant pattern was amenable to analysis by the Leslie method (Table 5; Fig. 19). B_0 for the 1988 season was estimated at 199,699 kg (95% CL:167,848 kg and 259,601 kg); and, given logbook-derived landings of 117,118 kg, exploitation rate was 59% (95% CL:70% and 45%). By subtraction, 82,581 kg (95% CL:50,730 kg and 142,483 kg) of commercial-sized crab remained on the Area 6 inshore grounds at the end of the fishing season. The B_0 level estimated for 1988 is the highest ever estimated for Area 6 and is likely a reflection of the recruitment pulse noted in the other Areas assessed in 1988 (Table 2). Overall, Area 6 continues to show relatively greater stability in commerical biomass and catch rates than any other snow crab ground on the Atlantic coast of Cape Breton Island.

DISCUSSION

A notable change in the dynamics of the snow crab stocks around the Atlantic coast of Cape Breton Island occurred between the end of the 1985 fishing season and commencement of the 1986 season (Elner and Robichaud 1987; Elner et al. 1988). Essentially, a moderately large wave of snow crab recruited into the fisheries in Areas 2 to 6 - the first significant production noted in the system since assessments began in 1978. The present assessment indicates that the wave continued to recruit into the system in 1988. Previously, the lack of production in the face of heavy fishing pressure had resulted in rapidly declining commercial biomass levels, excessive exploitation rates, and marginal catch rates (see also Appendix III). Consequently, annual effort and landings fell progressively between 1979 and 1985 (Elner and Robichaud, 1983b, 1984, 1985). It is probable that the upcoming recruitment wave was detected as by-catch to a Danish seiner operating in Area 5 in July 1985 (Elner and Robichaud 1986). Size-frequency histograms of the by-catch showed immature males and females at a modal size of approximately 58 mm CW. Given the large numbers of morphometrically immature, pre-recruit males sampled in 1986, 1987 and 1988, the improved production trend seems likely to continue into the 1989 season with concommittant increases in commercial biomass and catch rates. Nevertheless, considering the erratic nature of recruitment, there appears to be no biological basis for reintroducing catch controls (TAC's). Restricting effort to the present level should not only extend to the period over which the current recruitment pulse will support the fishery but will, also, help to restrain exploitation close to the target rate of 50-60% (Elner and Bailey 1986). The long-term prognosis for snow crab in Cape Breton remains uncertain; the fundamental biological basis to snow crab management is now acknowledged to be weak; and until "breakthroughs" in research occur, managers and biologists must continue to react to system changes as they occur rather than to plan for predicted commercial biomass levels (Bailey and Elner 1989).

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Table 1. Snow crab statistics for the Atlantic coast of Cape Breton Island, 1978-88.

Area	Year	No. of Possible boats	No. of active boats	No. of logbooks received	Landing Statistics Area Managers (kg)	Landing Statistics logbooks (kg)	Actual effort in traps hauled (logbook data) (all trap types combined)
2	1978	-	-	-	-	-	-
	1979	12	8	3	108,005	14,129	1,739
	1980	12	8	3	46,919	10,240	1,276
	1981	13	6	-	4,695	-	-
	1982	13	-	-	-	-	-
	1983	13	12	2	7,130	248	150
	1984	5	2	-	9,593	-	-
	1985	5	-	-	-	-	-
	1986	5	1	1	56	56	30
	1987	4	3	-	529	-	-
	1988	6	4	2	16,635	7,932	1,005
3	1978	36	16	16	-	91,118	7,863
	1979	36	27	27	185,101	164,110	18,124
	1980	36	31	25	139,686	73,988	13,835
	1981	36	22	1	31,215	816	60
	1982	35	20	18	86,814	75,295	9,388
	1983	35	27	27	40,058	40,172	8,217
	1984	37	19	13	14,649	12,839	4,346
	1985	40	10	10	13,537	12,732	3,220
	1986	40	12	8	5,632	5,805	2,306
	1987	32	21	14	59,756	56,826	8,137
	1988	31	24	19	125,110	105,559	9,920
4	1978	38	11	11	-	305,076	11,268
	1979	38	35	26	624,029	591,580	22,775
	1980	38	26	18	181,241	136,605	7,543
	1981	37	11	3	61,476	6,545	520
	1982	37	21	20	165,395	116,243	6,138
	1983	38	24	18	44,199	31,612	4,341
	1984	37	7	6	17,581	18,141	2,173
	1985	37	4	4	406	568	156
	1986	37	7	2	16,744	4,333	729
	1987	34	15	12	58,671	49,096	4,801
	1988	34	29	23	90,490	117,668	7,982
5	1978	15	15	15	-	250,076	6,165
	1979	25	24	23	679,504	682,731	15,382
	1980	26	24	21	395,855	324,786	9,261
	1981	25	11	10	90,463	81,819	3,135
	1982	25	19	18	300,145	298,469	9,931
	1983	22	21	21	151,296	148,827	8,146
	1984	24	10	6	45,215	41,295	2,220
	1985	24	5	5	29,171	20,833	1,465
	1986	24	7	6	43,972	40,155	2,837
	1987	21	14	11	157,408	119,321	4,547
	1988	21	19	16	174,112	162,946	6,321
6	1979	8	4	4	24,868	27,351	1,880
	1980	11	10	9	58,596	69,136	5,246
	1981	11	5	5	15,896	20,350	1,316
	1982	11	7	7	63,072	63,133	6,462
	1983	14	13	12	64,084	64,461	7,733
	1984	14	13	13	53,889	50,239	5,229
	1985	14	6	5	40,844	32,219	3,157
	1986	14	5	5	37,770	49,027	4,119
	1987	13	11	9	83,931	77,782	6,021
	1988	14	13	13	134,216	162,550	10,115

Area	Year	No. of Possible boats	No. of active boats	No. of logbooks received	Landing Statistics Area Managers (kg)	Landing Statistics logbooks (kg)	Actual effort in traps hauled (logbook data) (all trap types combined)
Total	1978	89	42	42	-	646,270	25,296
	1979	119	98	83	1,621,508	1,479,901	59,900
	1980	123	99	76	822,287	614,755	37,161
	1981	122	55	19	203,745	109,530	5,031
	1982	121	67	63	615,426	553,140	31,919
	1983	122	97	80	306,767	285,320	28,587
	1984	117	51	37	140,927	122,514	13,968
	1985	120	25	24	83,958	66,352	7,998
	1986	120	32	22	104,174	99,376	10,021
	1987	104	64	48	360,295	303,025	23,506
	1988	106	89	73	540,563	556,655	35,343

Table 2. Comparsion of assessment data for Cape Breton Island snow crab (Areas 2-6) 1978-88.

Area	Year	No. of active boats	No. of logbooks received	Landing Statistics: Area Managers (kg)	Landing Statistics: logbooks† (kg)	Effort (standardized trap hauls)	Mean CPUE	Available Biomass for Season (mt)	Exploitation rate (%)	Standardized trap type
2,3 & 4	1978	27	23	-	192,228	17,258	11.14	-	-	(1.2X.9X.8m,wood)
(inshore)	1979	70	40	917,136	262,250	25,660	10.22	324.9	81	"
	1980	65	42	367,846	181,033	17,499	10.35	225.2	80	"
	1981	39	4	97,386	7,361	580	12.69	-	-	(1.5X1.5X.5m,steel)
	1982	41	28	252,209	100,161	13,971	7.17	153.0	65	(1.2X.9X.8m,wood)
	1983	63	41	91,387	55,242	11,780	4.69	76.5	72	"
	1984	28	18	41,823	16,423	5,382	3.05	24.2	68	"
	1985	14	14	13,943	13,300	3,376	3.94			"
	1986	19	11	13,712	10,194	3065	3.33	20.2	51	"
	1987	39	26	118,956	105,922	12,938	8.20	229.2	46	-
	1988	57	44	232,235	187,144	18,907	9.9	292.3	64	-
4	1978	*	4	-	203,966	4,916	41.49	-	-	(1.5X1.5X.5m,steel)
(offshore)	1979	*	16	*	507,569	10,546	48.13	-	-	"
	1980	*	4	*	39,800	827	48.13	790.0	64	"
	1981	*	-	*	-	-	-	-	-	"
	1982	*	10	*	91,377	2,875	31.78	-	-	"
	1983	*	6	*	16,790	1,454	11.55	-	-	"
	1984	*	2	*	14,557	1,159	12.56	28.3	51	"
	1985	*	-	*	-	-	-	-	-	"
	1986	1	-	8,720	-	-	-		-	"
	1987	0	0	0	0	0	0	0	0	0
	1988	0	0	0	0	0	0	0	0	0
5	1978	15	15	-	250,076	4,531	55.19	440.0	57	""
	1979	24	23	679,504	682,731	14,747	46.30	1185.0	58	"
	1980	24	21	395,855	324,786	7,341	44.24	543.0	60	"
	1981	11	10	90,463	81,819	2,835	28.86	-	-	"
	1982	19	18	300,145	298,469	8,848	33.73	356.9**	84	"
	1983	21	21	151,296	148,827	7,261	20.50	176.0**	85	"
	1984	10	6	45,215	41,295	2,336	17.68	55.3	75	"
	1985	5	5	29,171	20,833	1,465***	14.22		-	"
	1986	7	6	43,972	40,155	2,837***	14.15	72.9	55	"
	1987	14	11	157,408	119,321	4,547	26.24	293.4	41	"
	1988	19	16	174,112	162,187	6,321	25.70	284.6	57	
6	1979	4	4	24,868	27,351	1,880	14.55	69.4	39	(1.5X1.5X.5m,steel)
	1980	10	9	58,586	69,136	5,246	13.18	177.0	39	"
	1981	5	5	15,896	20,350	1,316	15.46	35.8	57	"
	1982	7	7	63,072	63,133	6,462	9.77	175.0	36	"
	1983	13	12	64,084	64,461	7,614	8.47	102.7	63	"
	1984	13	12	53,889	50,239	5,229	9.61	-	-	"
	1985	6	5	40,844	32,219	3,157	10.21	-	-	"
	1986	5	5	37,770	49,027	4,119	11.90	69.2	71	"
	1987	11	9	83,931	77,782	6,021	12.92	181.7	43	"
	1988	13	13	134,216	162,550	8,649	13.50	199.7	59	
Total	1978	46	42	-	646,270	26,705	24.20			All traps types combined
	1979	98	83	1,621,508	1,479,901	52,833	28.01			"
	1980	99	76	822,287	614,755	30,913	19.89			"
	1981	55	19	203,745	109,530	4,731	23.15			"
	1982	67	63	615,426	553,140	32,156	17.20			"
	1983	97	80	306,767	285,320	28,109	10.15			"
	1984	51	37	140,927	122,514	14,106	8.69			"
	1985	25	24	83,958	66,352	7,998	8.30			"
	1986	32	22	104,174	99,376	10,021	9.92			"
	1987	64	48	360,295	303,025	23,506	12.89			"
	1988	89	73	540,563	466,448	33,877	13.80			

†utilizable

* landings included in Area 3

** from tagging, all other estimates from Leslie analysis of logbook data

*** Japanese conical traps combined with steel trap (1.5 X 1.5 X 0.5m)

Table 3. Compilation of shell hardness and egg presence data for male and female snow crabs sampled in-port and at-sea for Cape Breton (areas 2,3,4,5 and 6) for the 1988 fishing season.

Area	No. of Males	n(%) Hard Shell	n(%) Medium Shell	n(%) Dark Shell	n(%) New Shell
2	559	438(78.4)	121(21.6)	239(42.8)	320(57.2)
3	1964	1265(64.4)	699(35.6)	650(33.1)	314(66.9)
4	1091	738(67.6)	353(32.4)	521(47.8)	570(52.2)
5	2587	1385(53.5)	1202(46.5)	939(36.3)	1648(63.7)
6	1695	1045(61.7)	650(38.3)	642(37.9)	1053(62.1)
Total	7896	4871(61.7)	3025(38.3)	2991(37.9)	4905(62.1)

	Males with Hard Shells			Males with Medium Shells		
Area	No. of Males	n(%) Dark Shell	n(%) New Shell	No. of Males	n(%) Dark Shell	n(%) New Shell
2	438	228(52.1)	210(47.9)	121	11(9.1)	110(90.9)
3	1265	559(44.2)	706(55.8)	699	91(13.0)	608(97.0)
4	738	487(66.0)	251(34.0)	353	34(9.6)	319(90.4)
5	1385	865(62.5)	520(37.5)	1202	74(6.2)	128(93.8)
6	1045	623(59.6)	422(40.4)	650	19(2.9)	631(97.1)
Total	4871	2762(56.7)	2109(43.3)	3025	299(7.6)	2796(92.4)

Area	No.of Females	n(%) Hard Shell	n(%) Medium Shell	n(%) With Egggs	n(%) Without Eggs
2	44	40(90.9)	4(9.1)	43(97.7)	1(2.3)
3	56	53(94.6)	3(5.4)	55(98.2)	1(1.8)
4	0	0	0	0	0
5	83	80(96.4)	3(3.6)	82(98.8)	1(1.2)
6	125	118(94.4)	7(5.6)	119(95.2)	6(4.8)
Total	308	291(94.5)	17(5.5)	299(97.1)	9(2.9)

TABLE 4

Compilation of Morphometric Maturity Data For Male Snow Crabs Sampled In Port and At-Sea For Areas 2, 3, 4, 5 and 6 in 1987 and 1988

		At-Sea		In Port	
AREA	MONTH	% MATURE [+] 1987	% MATURE 1988	% MATURE 1987	% MATURE 1988
2	July	-	-	-	-
	Aug	100	73.9	98	89.1
	Sept	-	-	-	-
3	July	-	-	92	81.5
	Aug	93	72.6	98	72.0
	Sept	-	-	-	-
4	July	-	-	96	83.1
	Aug	91	-	89	84.0
	Sept	-	78.9	-	-
5	July	-	-	83	71.0
	Aug	74	58.8	97	66.9
	Sept	-	-	-	47.9
6	July	-	-	-	-
	Aug	66	52.9	54	75.0
	Sept	-	58.6	-	65.0

[+]: balance will be morphometrically immature

Table 5. Catch and effort statistics from utilizable logbook data for the snow crab fishery in 1988.

Areas 2,3 & 4

Week Period	Trap Hauls	Catch (kg)	CPUE (kg/trap haul)	Cumulative Catch (Kg)
July 22-28	3259	50814	15.6	25407.0
July 29-Aug. 4	4666	53175	11.4	77401.5
Aug. 5-11	3845	32977	8.6	120477.5
Aug. 12-18	2139	17137	8.0	145534.5
Aug. 19-25	2523	14724	5.8	161465.0
Aug. 26-Sept. 1	1395	10966	7.7	174310.0
Sept. 2-8	703	5255	7.4	182420.5
Sept. 9-15+	377	2094	5.5	186095.0
Total	18907	187144*	9.9	

Area 5

Week Period	Trap Hauls	Catch (kg)	CPUE (kg/trap haul)	Cumulative Catch (Kg)
July 22-28	1231	45065	36.6	22532.5
July 29-Aug. 4	1536	43113	28.1	66621.5
Aug. 5-11	677	17617	26.0	96986.5
Aug. 12-18	621	12771	20.1	112180.5
Aug. 19-25	869	17346	20.0	127239.0
Aug. 26-Sept. 1	591	11429	19.3	141626.5
Sept. 2-8	393	7277	18.5	150979.5
Sept. 9-15+	403	7568	18.8	158402.0
Total	6321	162187*	25.7	

Area 6 (Inshore only)

Week Period	Trap Hauls	Catch (kg)	CPUE (kg/trap haul)	Cumulative Catch (Kg)
Aug. 2-7	1126	18863	16.8	9431.5
Aug. 8-14	1285	23304	18.1	30515.0
Aug. 15-21	810	13510	16.7	48922.0
Aug. 22-28	1243	18574	14.9	64964.0
Aug. 29-Sept. 4	1407	17455	12.4	82978.5
Sept. 5-11	709	8138	11.5	95775.0
Sept. 12-18	957	8564	8.9	104126.0
Sept. 19-25	540	4245	7.9	110530.5
Sept. 26-30	572	4465	7.8	114885.5
Total	8649	117118*	13.5	

* Actual logbook catches: Areas 2,3 & 4 = 231,159 kg; Area 5=162,946 kg; Area 6=162,550 kg

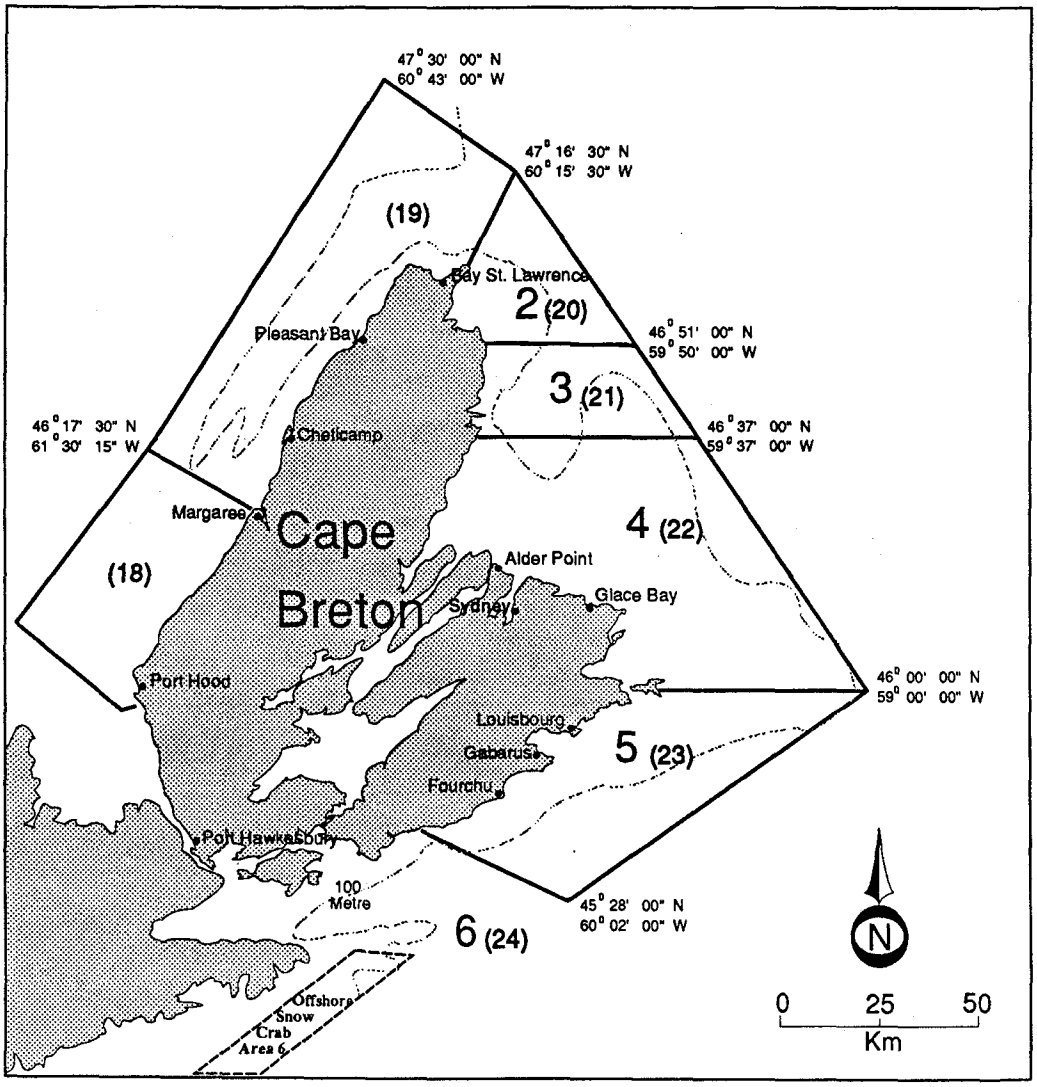


Fig. 1 Cape Breton Island snow crab fishing areas.

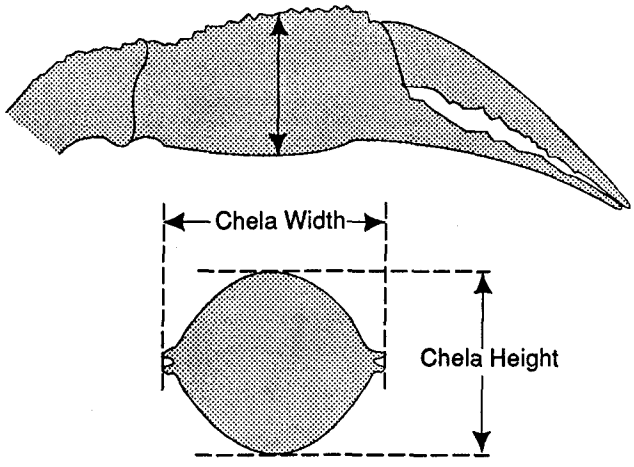


Fig. 2 Diagram of a male snow crab chela. Note: chela width and chela height dimensions.

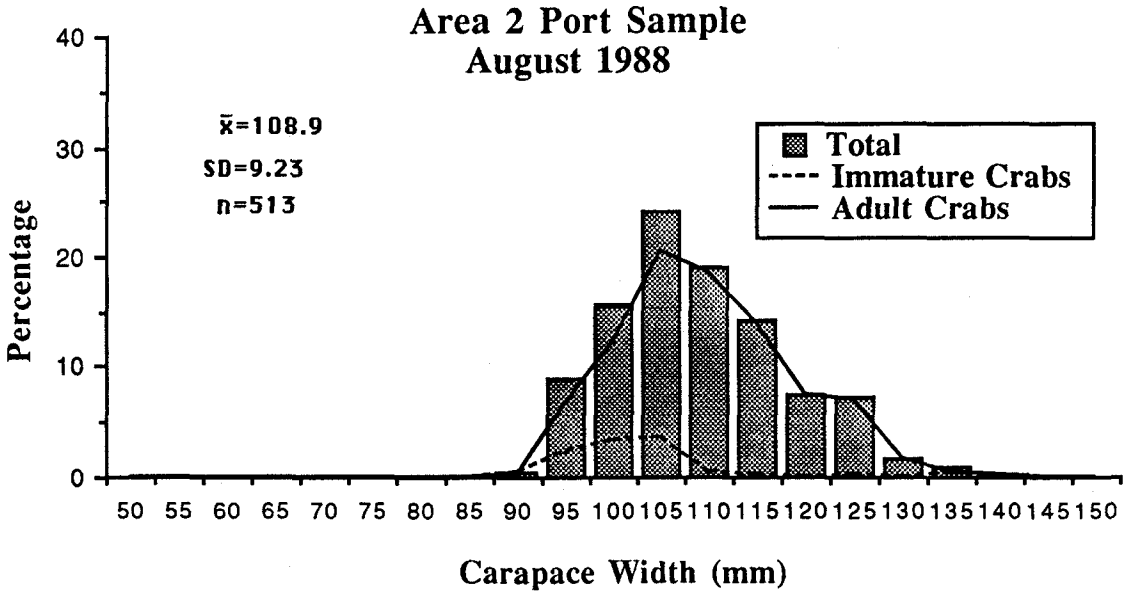
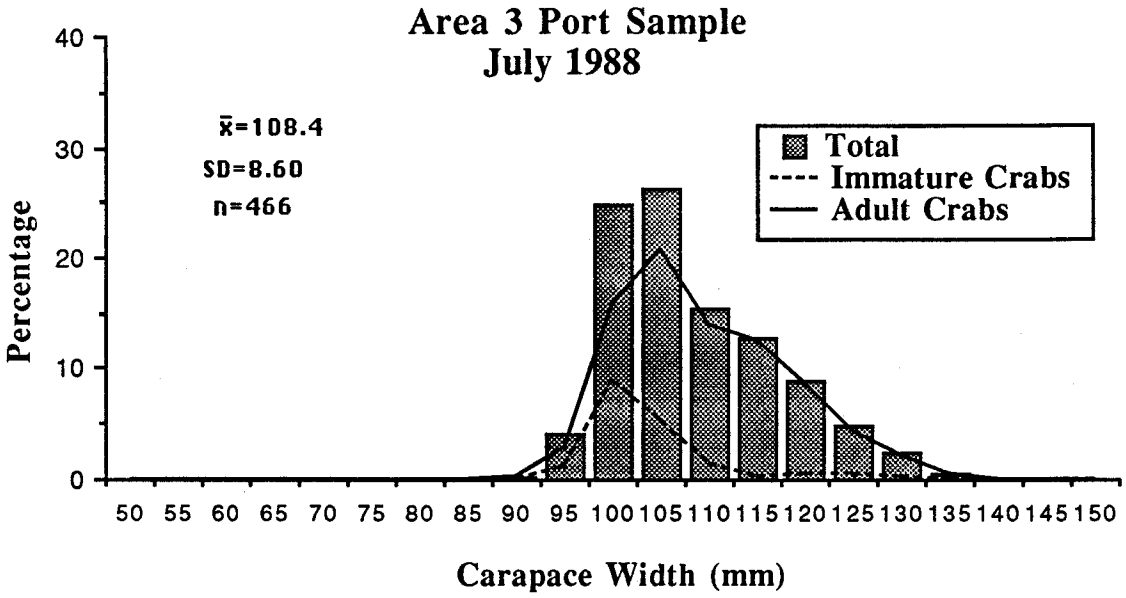


Fig. 3. Size frequency histograms for male snow crabs sampled in-port from commercial vessels in Area 2 during August of the 1988 fishing season.



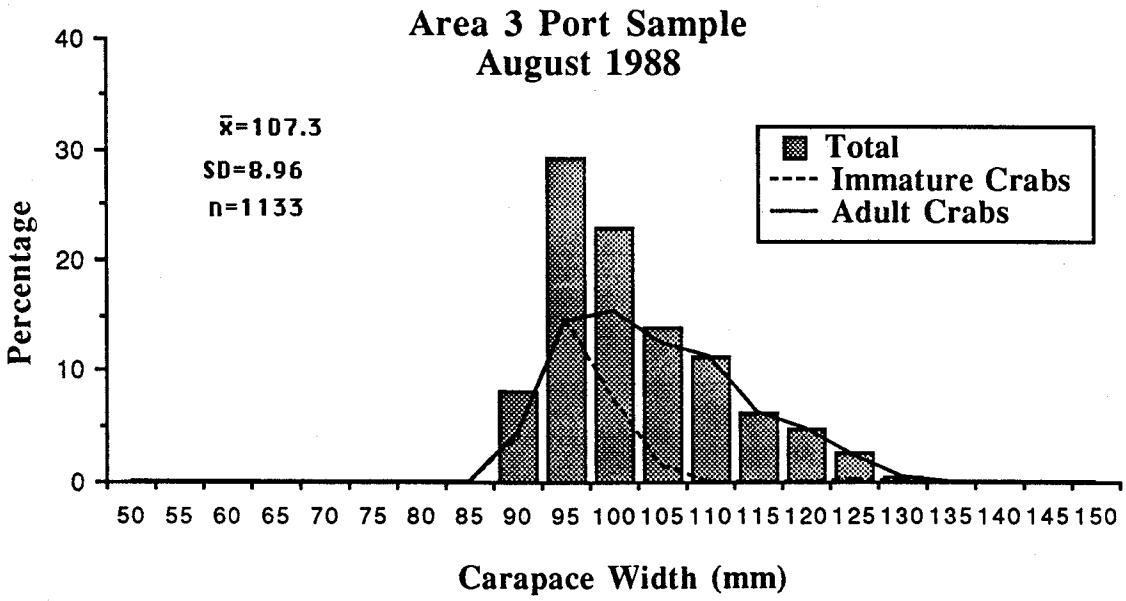
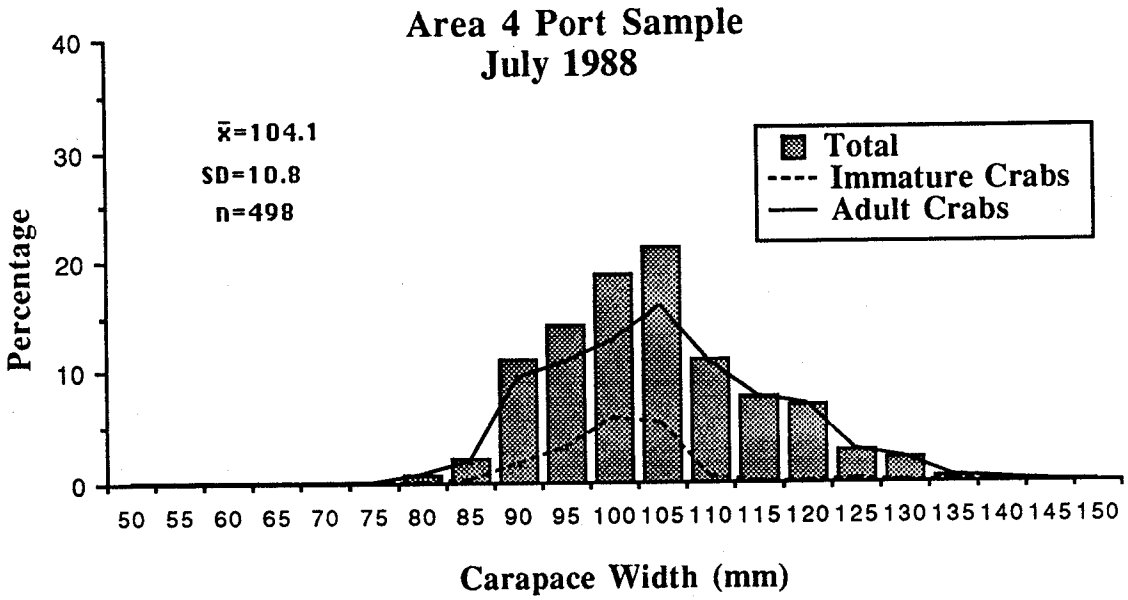


Fig. 4. Size frequency histograms for male snow crabs sampled in-port from commercial vessels in Area 3 during the 1988 fishing season.



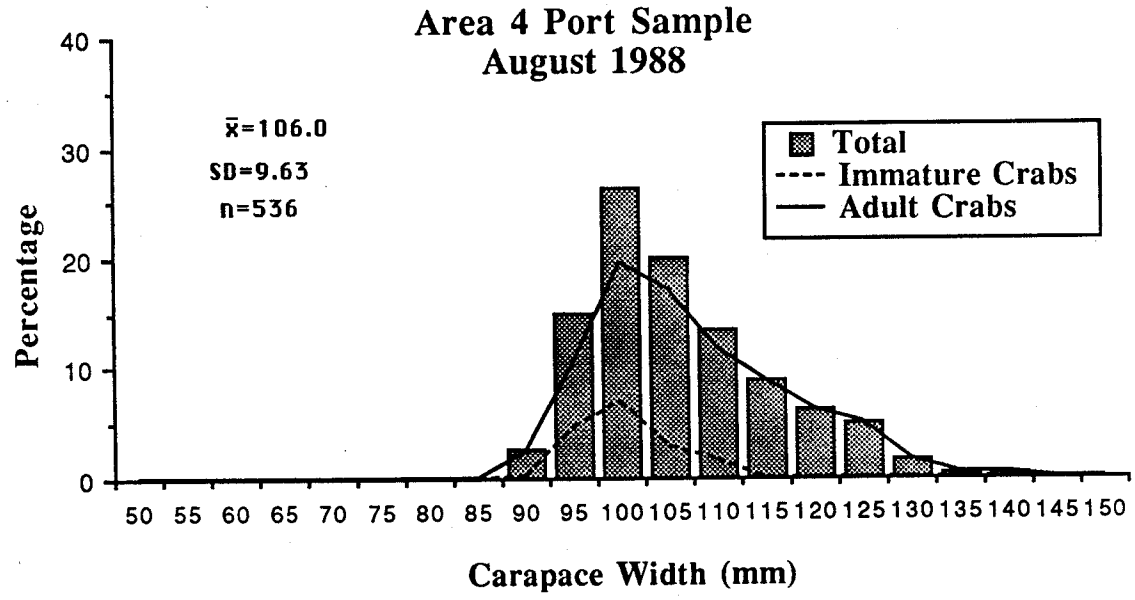


Fig. 5. Size frequency histograms for male snow crabs sampled in-port from commercial vessels in Area 4 during the 1988 fishing season.

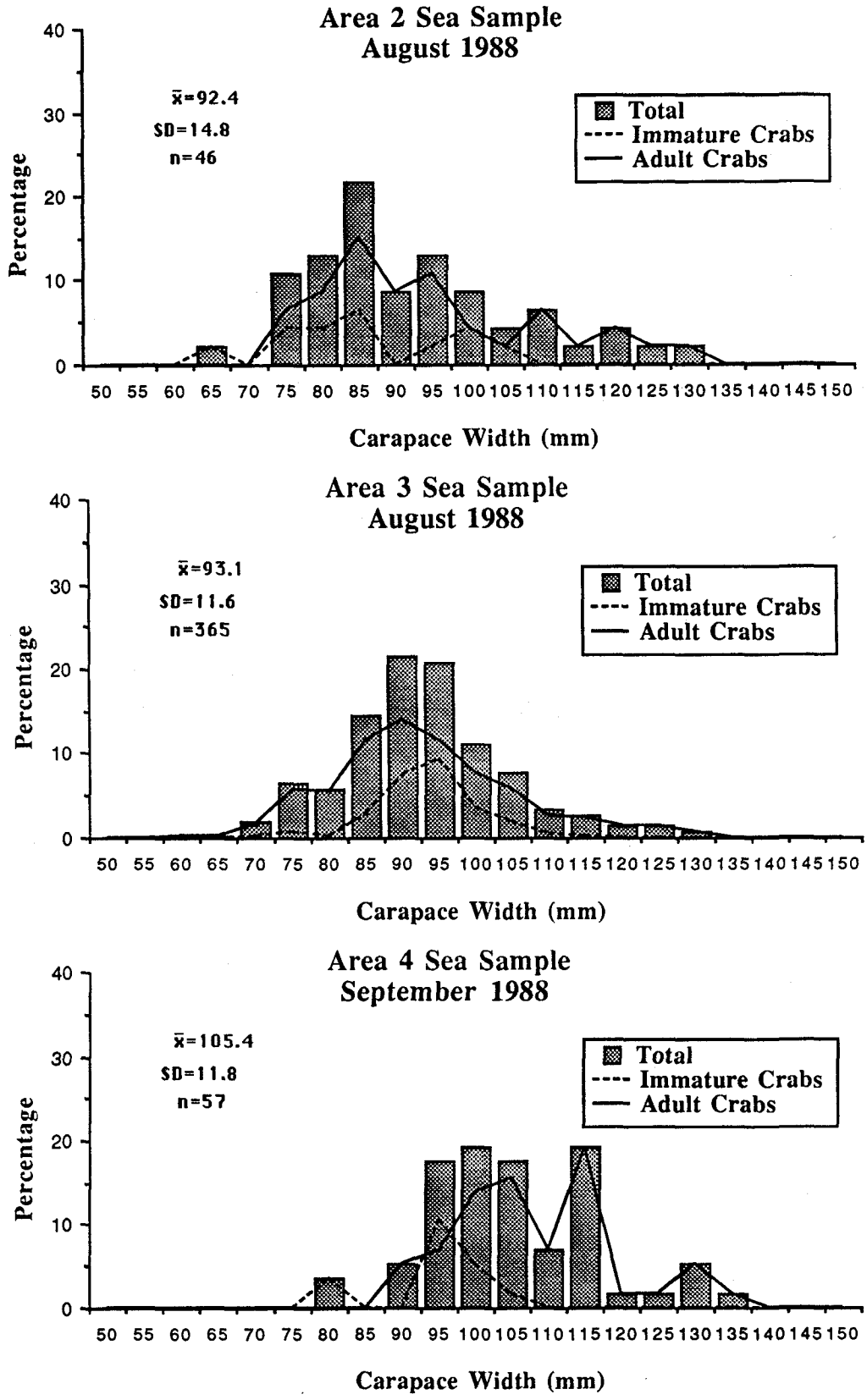


Fig. 6. Size frequency histograms for male snow crabs sampled at-sea from commercial vessels in Areas 2,3 and 4 during the 1988 fishing season.

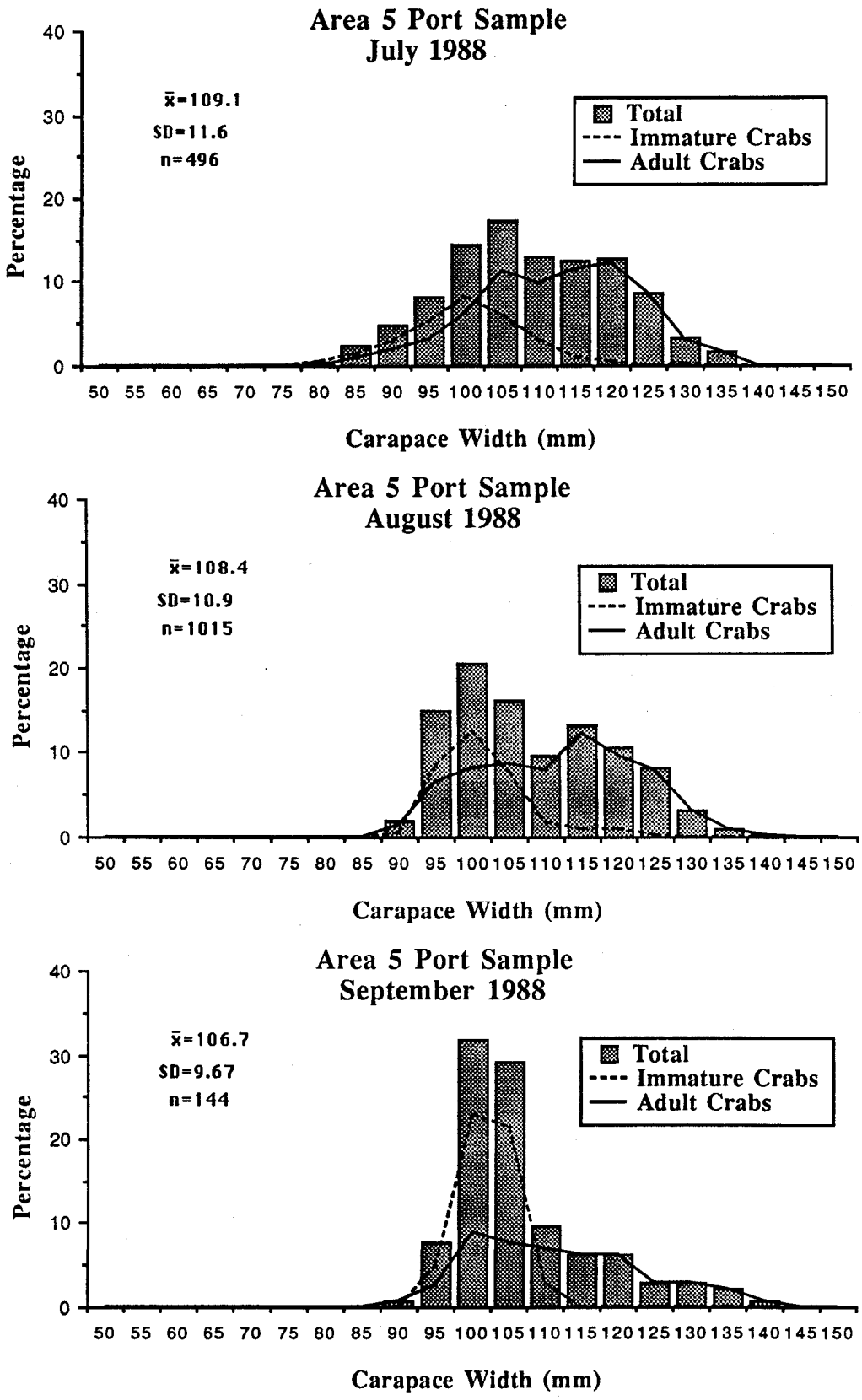


Fig. 7. Size frequency histograms for male snow crabs sampled in-port from commercial vessels in Area 5 during the 1988 fishing season.

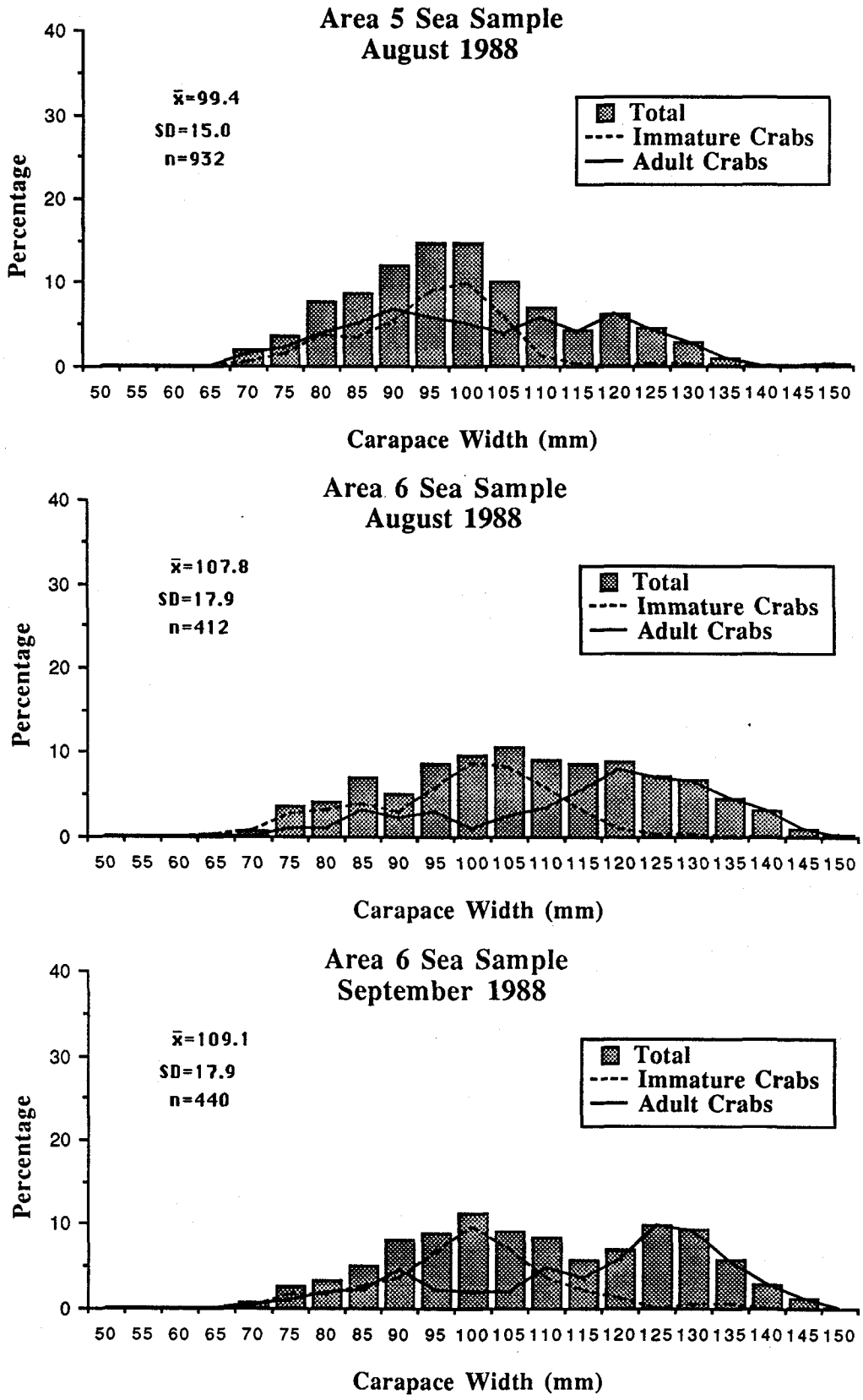


Fig. 8. Size frequency histograms for male snow crabs sampled at-sea from commercial vessels in Areas 5 and 6 during the 1988 fishing season.

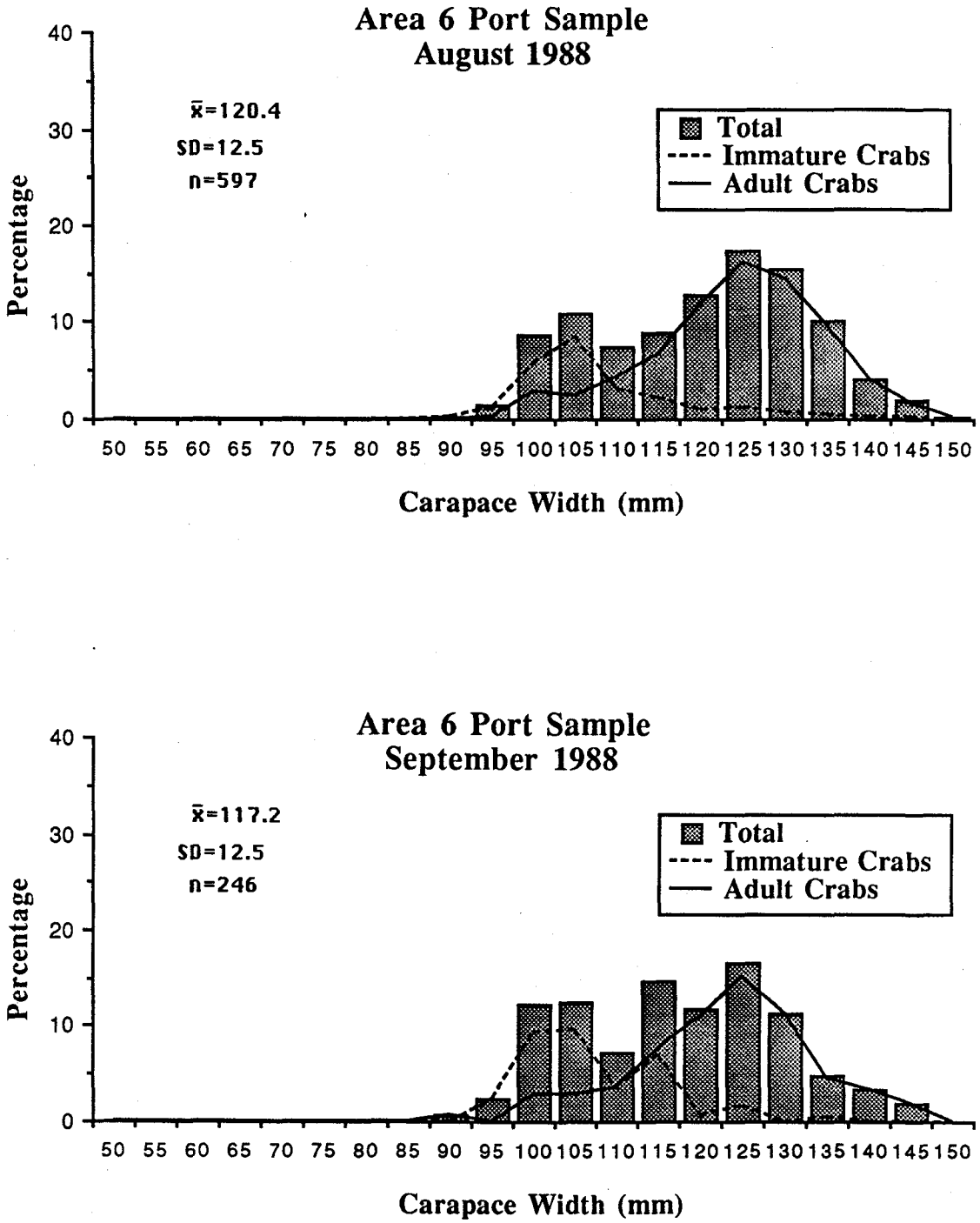


Fig. 9. Size frequency histograms for male snow crabs sampled in-port from commercial vessels in Area 6 during the 1988 fishing season.

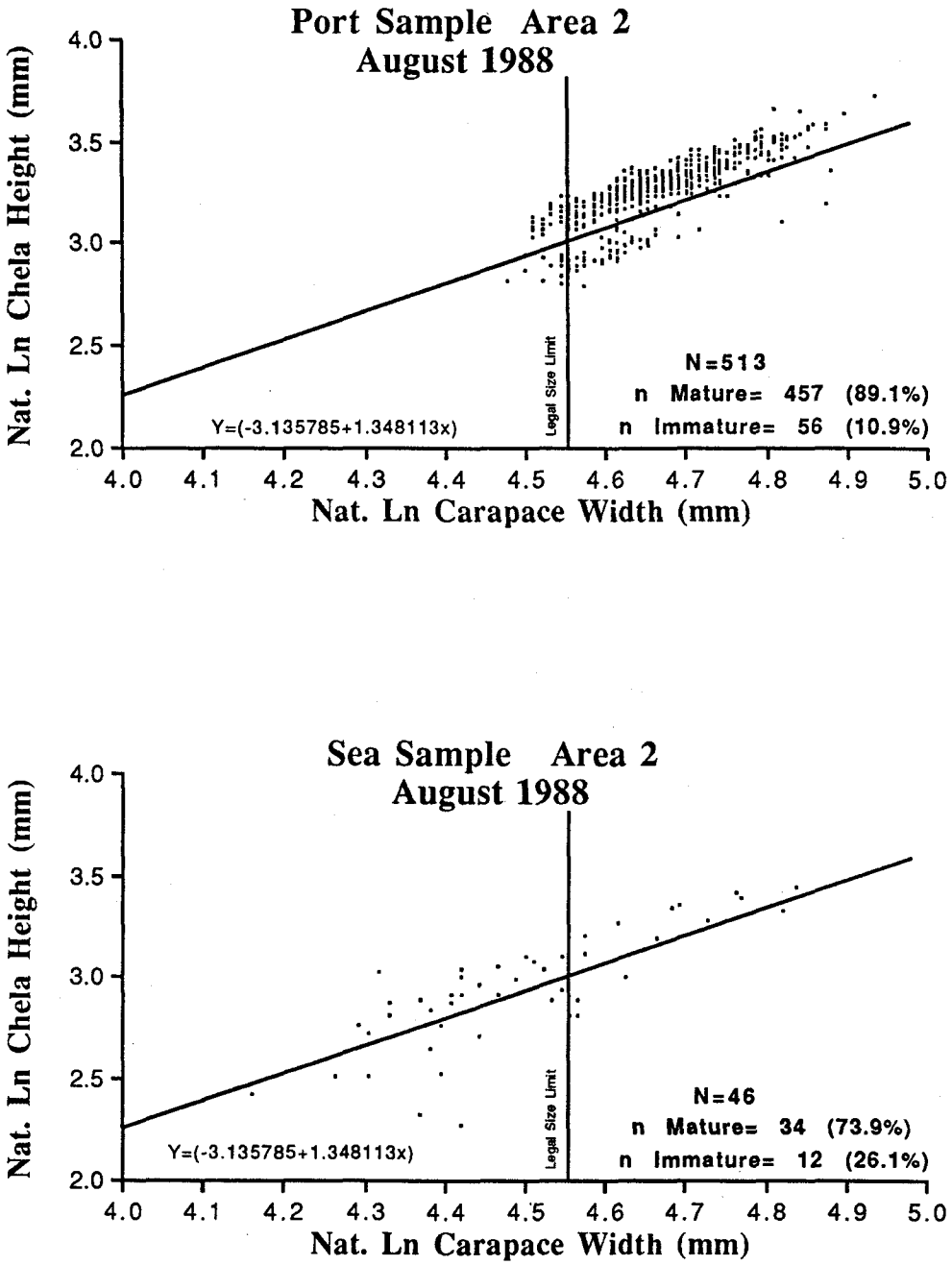


Fig. 10. Graphs showing the relationship between the natural logarithms of the chela height and the natural logarithms of the carapace width for male snow crabs sampled in-port at-sea from commercial vessels in Area 2 during the 1988 fishing season.

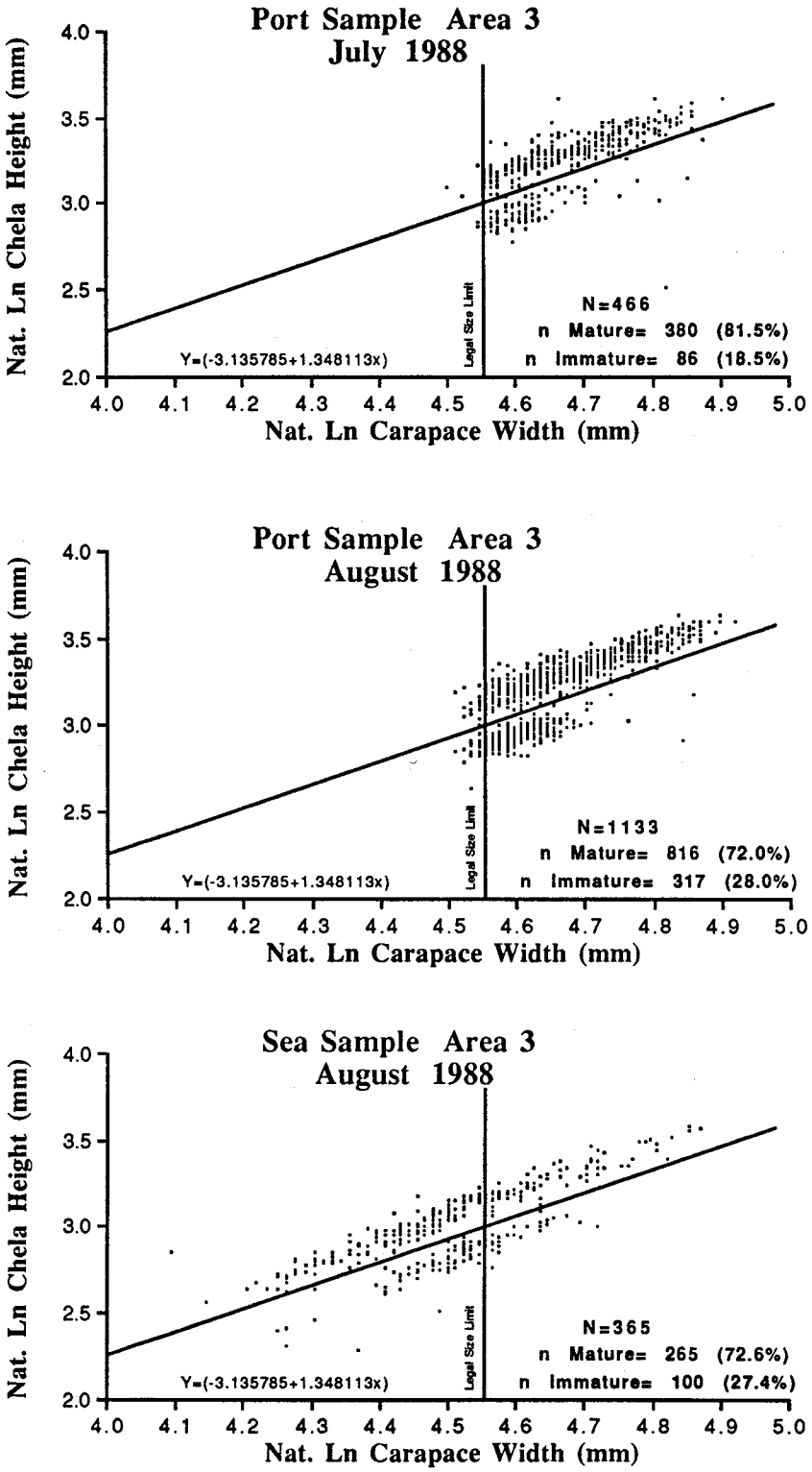


Fig. 11. Graphs showing the relationship between the natural logarithms of the chela height and the natural logarithms of the carapace width for male snow crabs sampled in-port at-sea from commercial vessels in Area 3 during the 1988 fishing season.

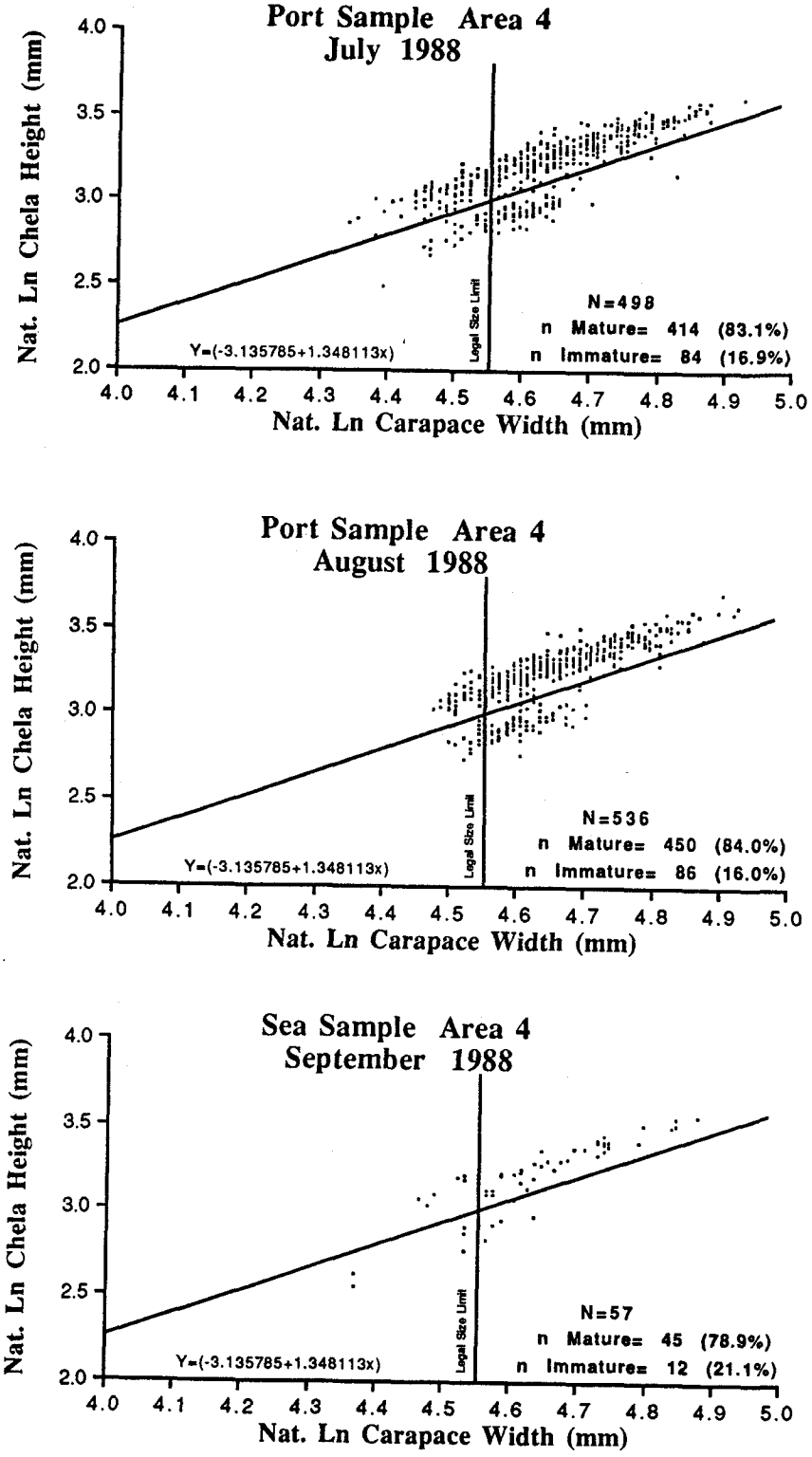


Fig. 12. Graphs showing the relationship between the natural logarithms of the chela height and the natural logarithms of the carapace width for male snow crabs sampled in-port at-sea from commercial vessels in Area 4 during the 1988 fishing season.

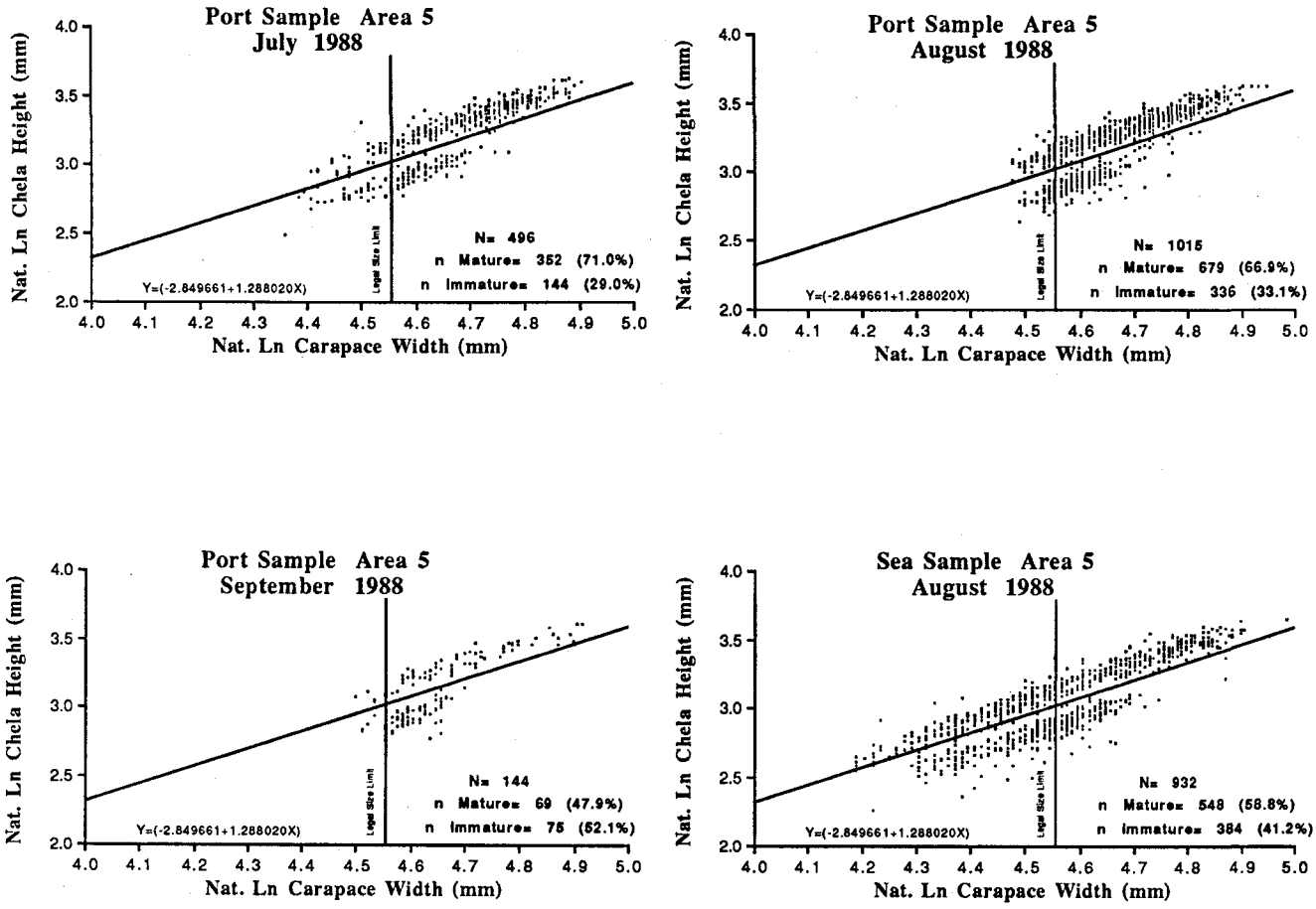


Fig. 13. Graphs showing the relationship between the natural logarithms of the chela height and the natural logarithms of the carapace width for male snow crabs sampled in-port at-sea from commercial vessels in Area 5 during the 1988 fishing season.

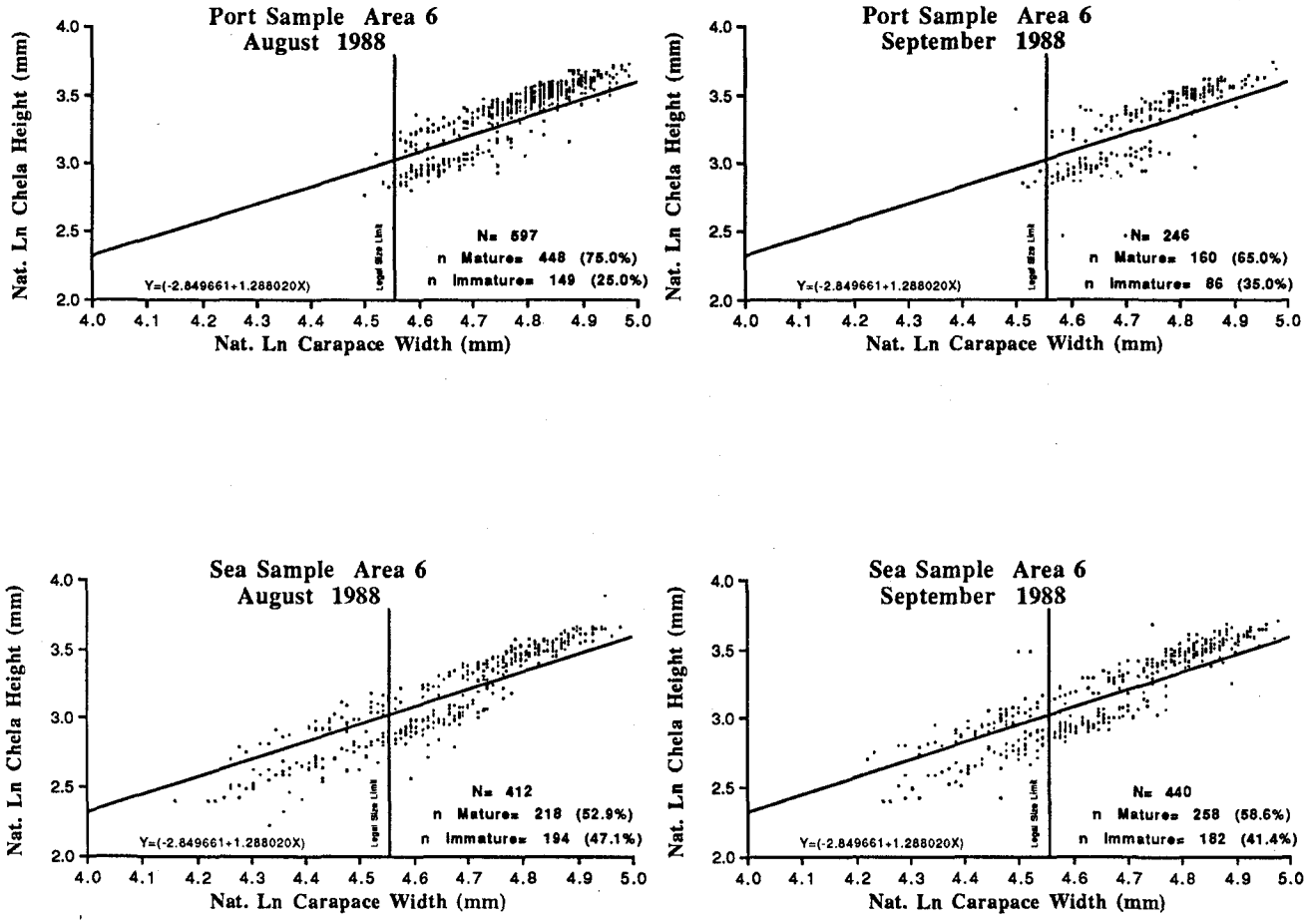


Fig. 14. Graphs showing the relationship between the natural logarithms of the chela height and the natural logarithms of the carapace width for male snow crabs sampled in-port at-sea from commercial vessels in Area 6 during the 1988 fishing season.

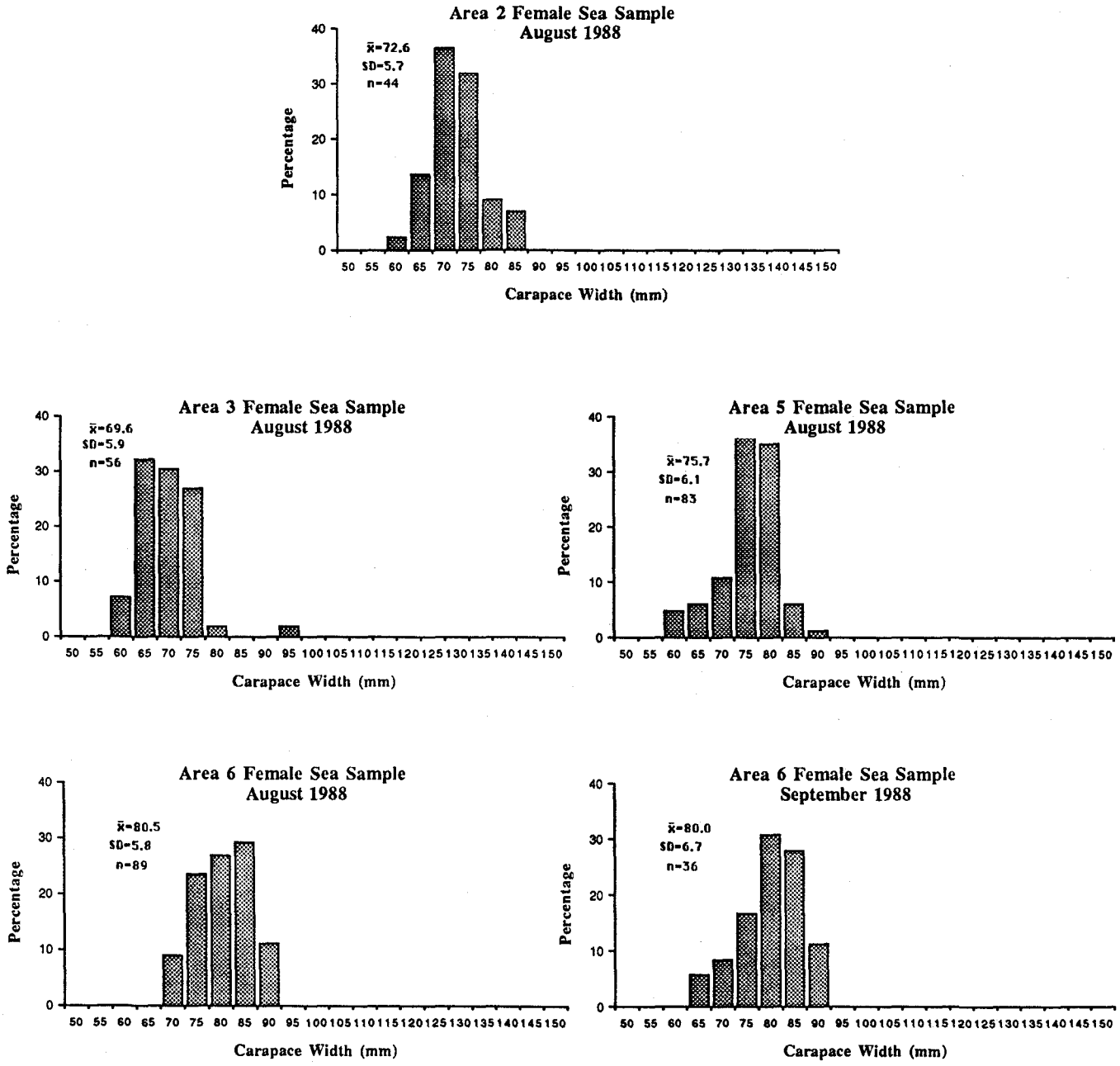


Fig.15. Size frequency histograms of mature female snow crabs sampled at-sea from commercial vessels in Areas 2-6 during the 1988 fishing season.

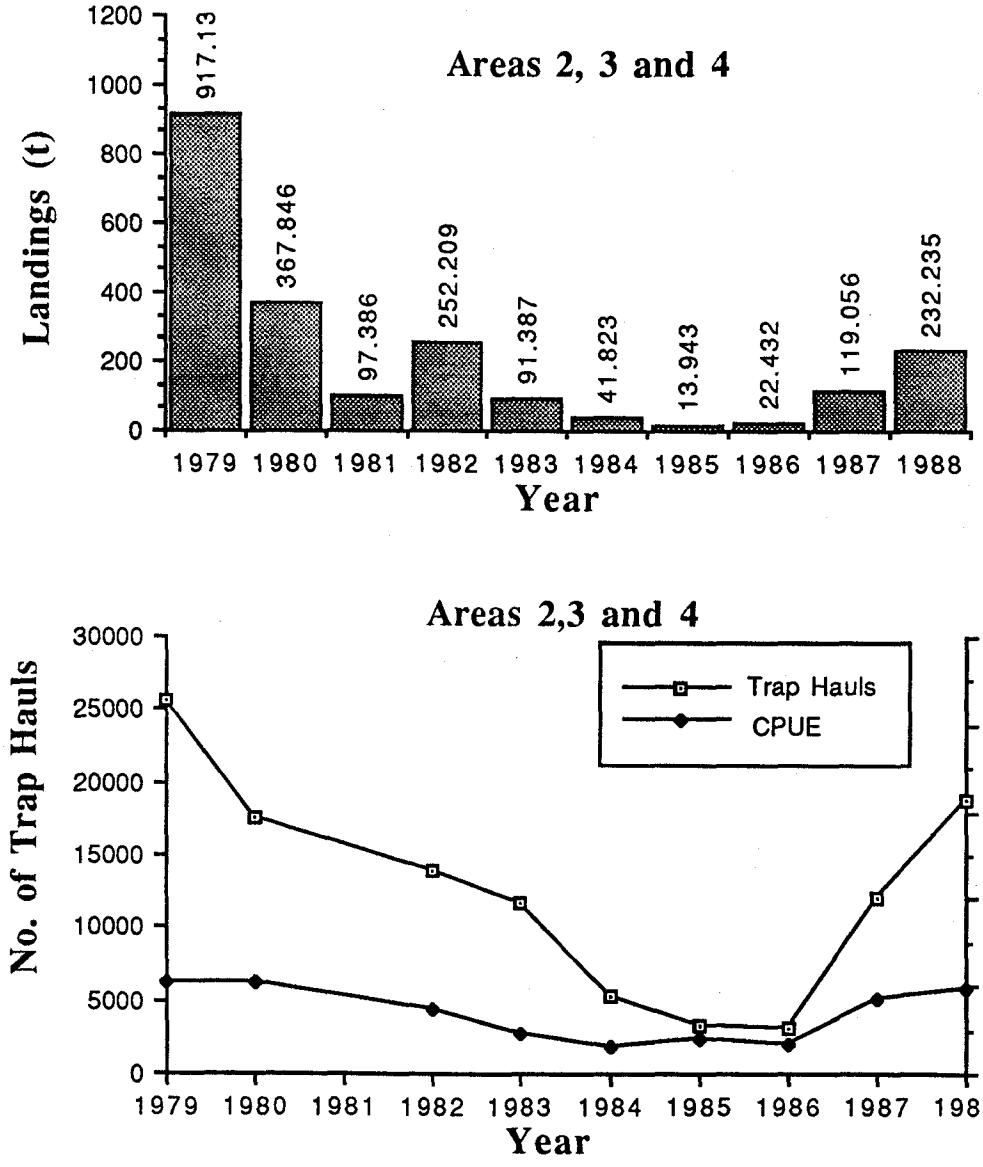


Fig. 16. Historical series (1979-1988) of data on landings, effort and CPUE (kg. trap haul^{-1}) for the snow crab fishery Areas 2,3 and 4 (inshore).

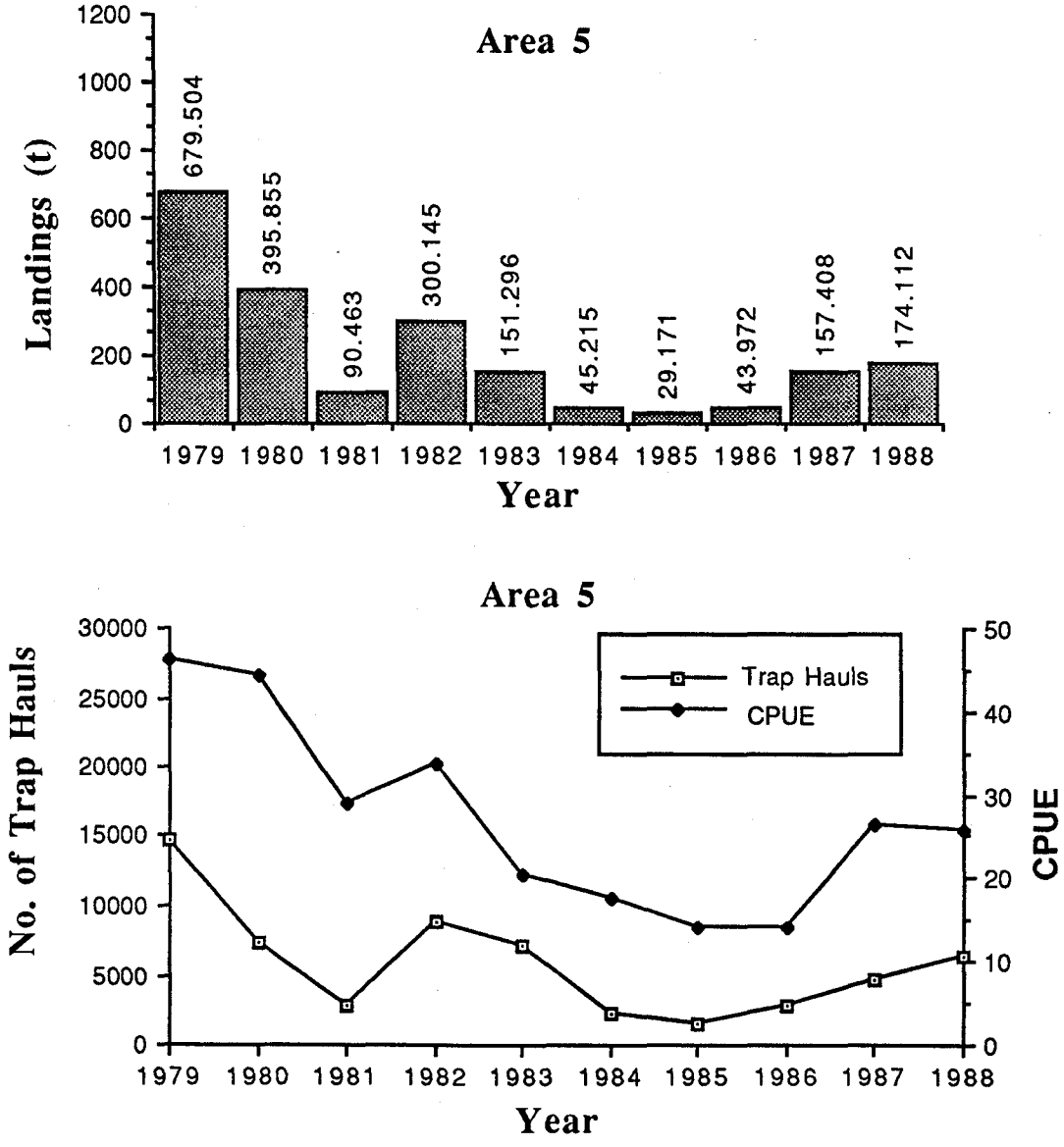


Fig. 17. Historical series (1979-1988) of data on landings, effort and CPUE (kg. trap haul^{-1}) for the snow crab fishery Area 5.

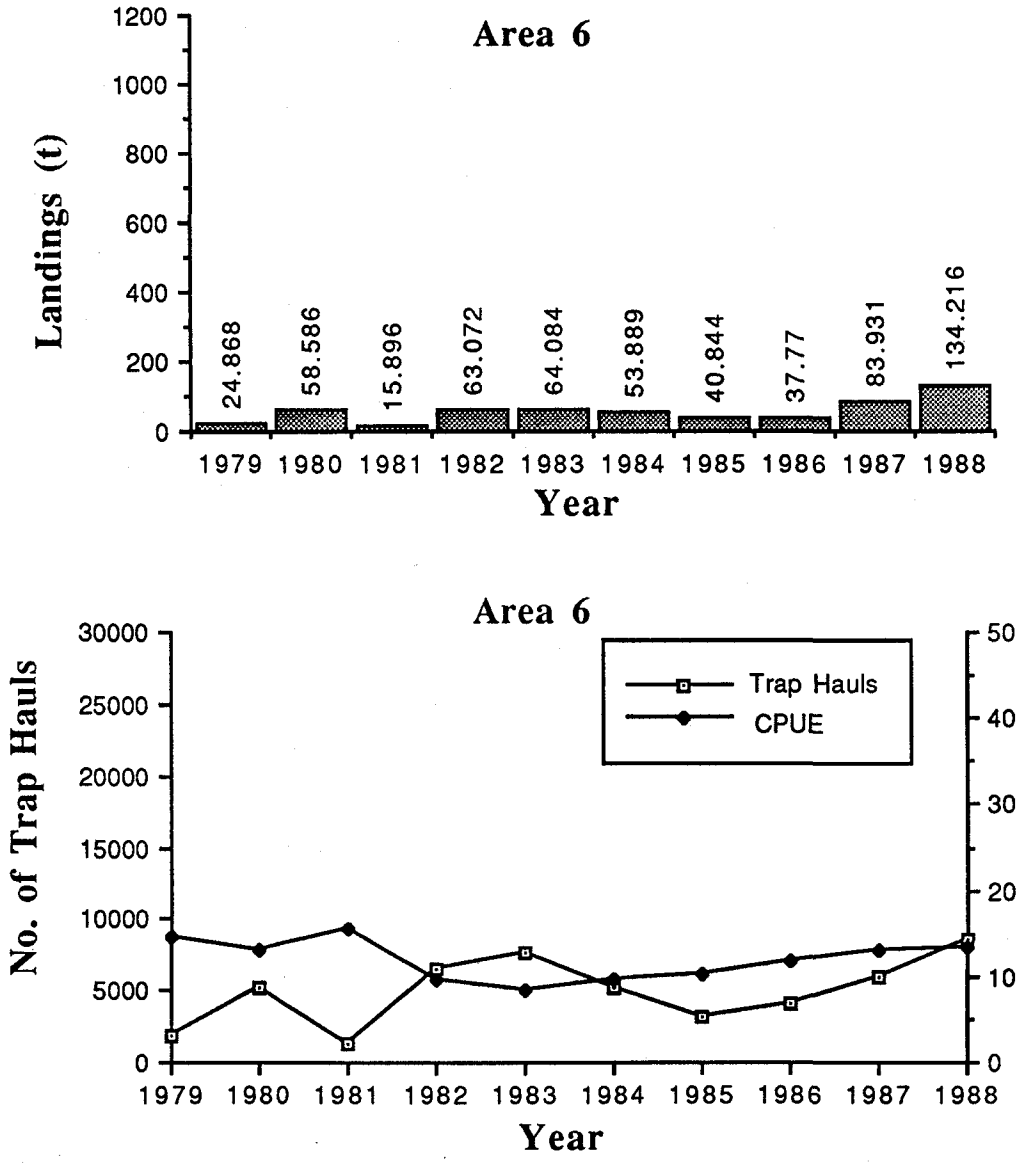


Fig. 18. Historical series (1979-1988) of data on landings, effort and CPUE (kg. trap haul^{-1}) for the snow crab fishery Area 6.

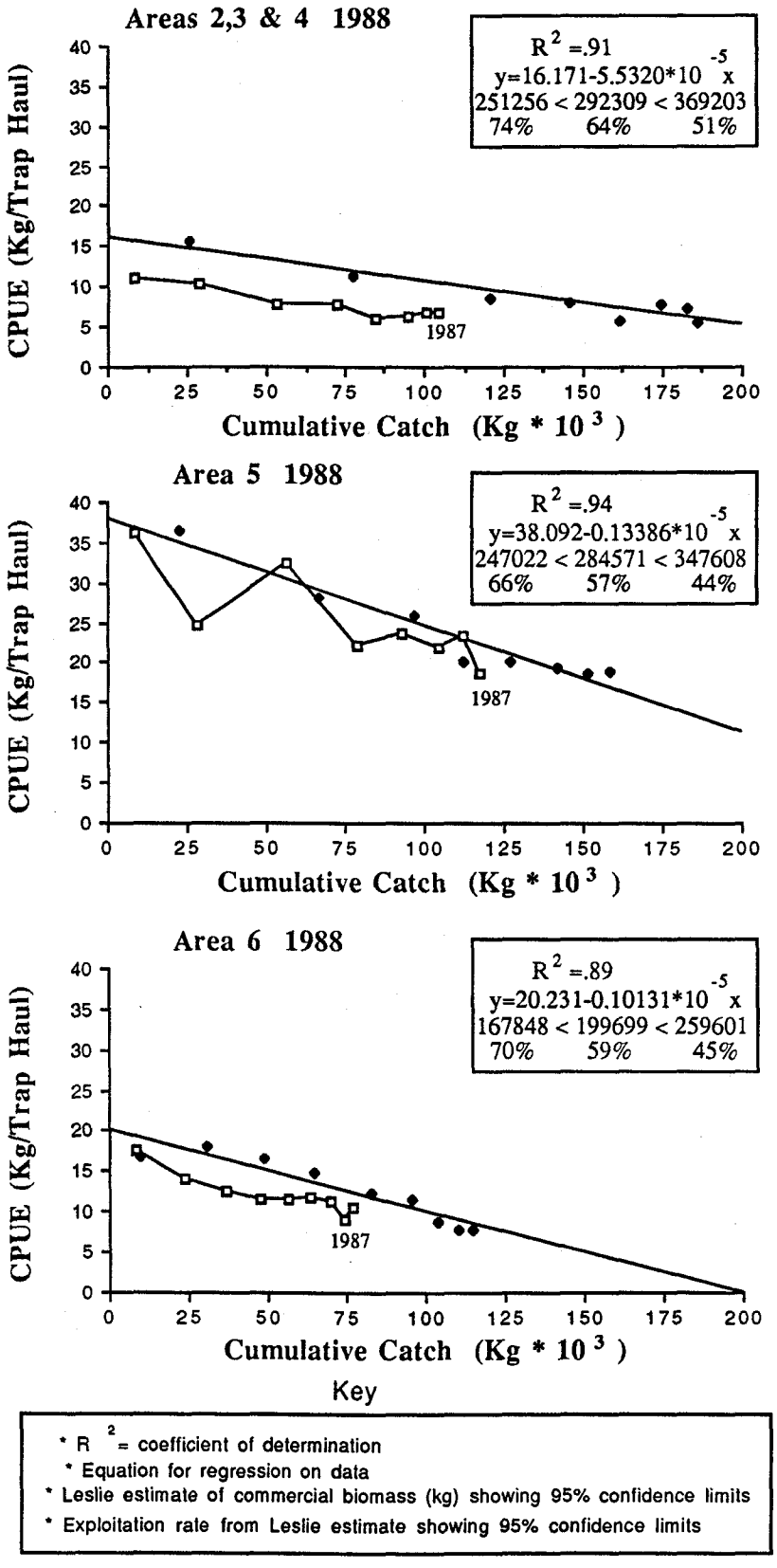
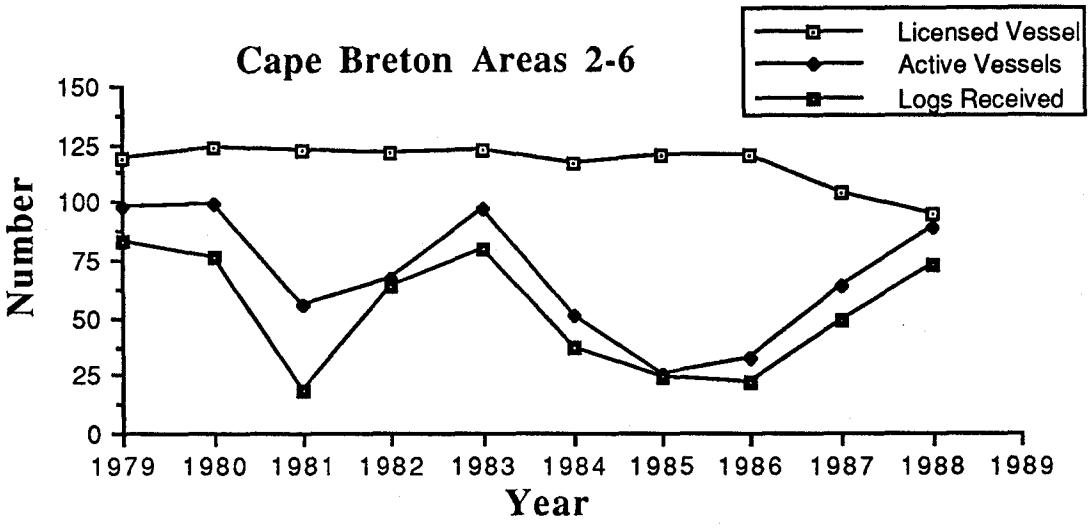


Fig. 19. Graphs of cumulative weekly landings against CPUE, from logbook data for a) Areas 2,3 and 4; b) Area 5; and c) Area 6 in 1988 and Leslie estimates of commercial biomass and exploitation rate.



Appendix I. Statistical display of numbers of snow crab vessels licensed, active and logbooks received for Cape Breton Areas 2-6 for the period 1978 - 1988.

PORT SAMPLE: _____
SEA SAMPLE : _____
__ INSHORE : _____
__ OFFSHORE: _____

DATE: _____

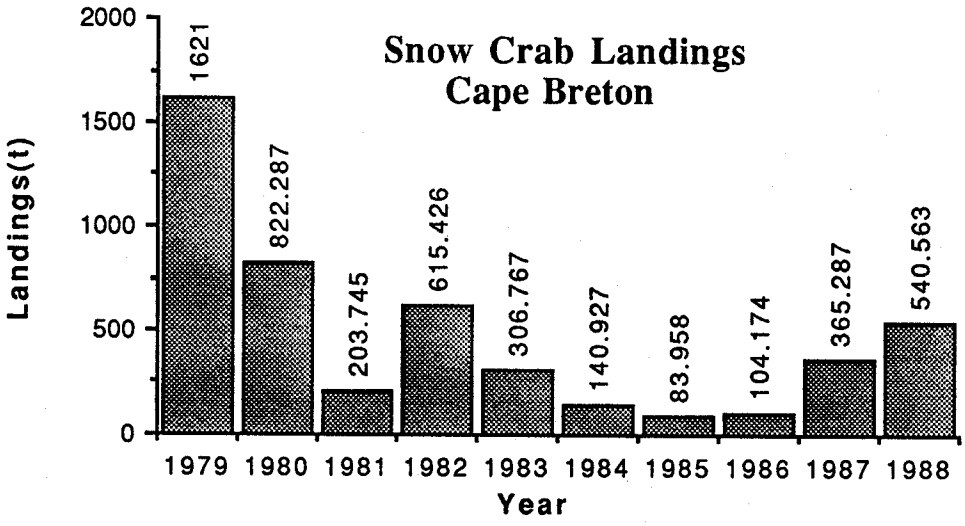
Snow Crab Sampling Sheet

NAME OF VESSEL : _____
NAME OF SKIPPER: _____
PORT LOCATION : _____

AREA FISHED: _____
LOCATION : _____
DEPTH : _____

Carap. width (mm)	Right claw (mm)	Chela height (mm)	Shell hardness H M S	Shell condition New Old	Sex M F	Egg color	Egg clutch size Missing Full	Tag number

Appendix II. Recording sheet as used for at-sea and port sampling of snow crab around Cape Breton (Areas 2-6) in 1988.



Appendix III. Historical series (1979-1988) of data on snow crab landings for Cape Breton Areas 2-6.