Assessment of the 1986 fishery for snow crab, Chionoecetes opilio, off the Atlantic coast of Cape Breton Island

by

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Abstract

Biological monitoring data (based upon fishermen's logbooks, sales slip statistics and commercial catch sampling) were examined for the Cape Breton Island (Atlantic coast, areas 2-6) snow crab fishery in 1986. Assessments for each stock were made by comparison of the monitoring data against historical patterns. Since 1978 the snow crab fisheries in areas 2-6 have been based on a resource with low or sporadic recruitment. The accumulated virgin biomass has been drastically reduced by fishing. Management dropped catch controls for the fishery in 1982 to allow fishermen to take advantage of whatever productivity occurs from time to time on an opportunistic basis. The minimum legal size of 95 mm, carapace width was thought to confine exploitation to males that had been mature for 1-3 years. Thus, the reproductive potential of the resource has been believed to be protected. However, up to approximately 50% of the commercial-sized males sampled in areas 3, 5, and 6 during 1986 were morphometrically immature; the biological implications of this situation are unclear.

The overall status of stocks 2-6 in 1986 appears to be improving over the collapsed state noted in previous years. As evidenced from shell condition and size frequency data, a pulse of immature, sub-legal males first detected in 1985, partly recruited into the commercial stocks before the 1986 fishing season. A strong market demand for snow crab increased fishing effort and relatively stable mean catch rates resulted in a rise in 1986 landings. Thirty-two of 120 licenced vessels were active and their recorded catch (104.2 mt) was 124% of the 1985 value (25 vessels: 84.0 mt) but still only 74% of the 1984 value (51 vessels: 140.9 mt). For the first time in several years, stock dynamics and logbook returns permitted estimates of biomass and exploitation rate for all areas by Leslie analyses.

Little fishing activity was reported in area 2 (1 vessel: 56 kg). Landings of 5.6 mt were recorded from sales slips for the 12 active vessels in area 3. The 7 vessels in area 4 recorded total landings of 16.7 mt, by sales slips. Sales slips from the single area 4 vessel that fished offshore showed landings of 8.7 m.t.; the remaining area 4 vessels were active inshore. Utilizing the 11 available logbooks for vessels fishing in the combined area 2,3, 4 (inshore), mean CPUE was 3.33 kg. trap haul^{-1}, close to the mean of 3.94 kg. trap haul^{-1} recorded in 1985. Total available biomass for the combined inshore area was estimated at 20.2 mt and the exploitation rate at 51%.

In area 5, sales slips indicated landings of 44.0 mt, and increase from 29.2 mt in 1985. Logbooks from 6 of the 7 active vessels reported landings of 40.2 mt. The mean CPUE of 14.15 kg. trap haul^{-1} was slightly under that for 1985 (14.22 kg. trap haul^{-1}) and the lowest ever experienced in this area. Leslie estimates gave total available biomass for the season as 72.9 mt and exploitation rate as 55%.

Logbooks documenting catches of 49.0 mt were received from all 5 active vessels in area 6; landings of 37.8 mt were recorded through sales slips. Mean CPUE was 11.9 kg. trap haul^{-1}, an increase over the 1985 mean value of 10.21 kg. trap haul^{-1}. Total available biomass and exploitation rate were estimated at 69.2 and 71%, respectively.

The 1986 assessment for areas 2-6 does not appear to justify changes in current management strategy. Given the erratic production dynamics of these stocks, and notwithstanding an influx of recruitment that is likely to continue into 1987, there appears no rationale for reintroducing catch controls in the 1987 season. However, in the future, if significant and stable production levels develop, the management strategy should be reconsidered.

Résumé

Des données de contrôle biologiques relatives à la pêche du crabe des neiges à l'Île du Cap-Breton (côte Atlantique, zones 2-6) en 1986 ont été examinées. Ces données étaient basées sur des journaux de bord de pêcheurs, sur des statistiques faites à partir de bordereaux de vente et sur l'échantillonnage de prises commerciales. Les évaluations de chaque stock ont été effectuées en comparant les données de contrôle aux données recueillies par le passé. Depuis 1978, la pêche du crabe des neiges dans les zones 2-6 se fait aux dépens d'une ressource dont le recrutement est faible ou irrégulier. La biomasse accumulée en l'absence d'exploitation a été presque complètement récoltée. Le contrôle des prises a été abondonné en 1982 dans le but de permettre aux pêcheurs de profiter de tout sursaut de productivité susceptible de se présenter de temps à autre. En imposant une taille légale minimale de 95 mm de largeur de carapace, on croyait limiter l'exploitation aux mâles ayant atteint la maturité depuis 1 à 3 ans et, par conséquent, protéger le potentiel reproducteur des stocks. Toutefois, en 1986, jusqu'à environ 50 % des mâles échantillonnés parmi les prises commerciales dans les zones 3, 5 et 6 étaient immatures sur le plan morphométrique. On ignore quelle est la signification biologique de cette situation.

En 1986, l'état global des stocks dans les zones 2-6 semble s'améliorer par rapport aux dernières années. Comme le montrent des données concernant l'état de la carapace et la taille des prises, le nombre de mâles immatures, de taille inférieure au minimum légal, semble avoir brusquement augmenté. Cet accroissement a d'abord été décelé en 1985, quand un certain nombre de ces mâles sont apparus dans les stocks commerciaux, avant la saison de pêche de 1986. La forte demande de crabe des neiges sur le marché a conduit à un accroissement de l'effort de pêche et à cause de la stabilité relative du taux de capture moyen, les débarquements ont augmenté en 1986. Trente-deux des 120 bateaux détenteurs de permis ont été actifs et ont enregistré des captures atteignant 124 % (104,2 tm) de la valeur obtenue en 1985 (25 bateaux : 84,0 tm mais seulement 74 % de la valeur obtenue en 1984 (51 bateaux : 140,9 tm). Pour la première fois depuis plusieurs années, la dynamique des stocks de crabes et le retour des journaux de bord ont permis d'estimer la biomasse et le taux d'exploitation pour toutes les zones, par la méthode d'analyse de Leslie.

Une faible activité halieutique a été rapportée dans la zone 2 (1 bateau : 56 kg). Des débarquements de 5,6 tm ont été enregistrés d'après les bordereaux de vente des 12 bateaux actifs dans la zone 3. Les 7 bateaux de la zone 4 ont enregistré des débarquements totaux de 16,7 tm, selon les bordereaux de vente. Les bordereaux de vente de l'unique bateau ayant pêché au large de la zone 4 indiquent que ses débarquements ont atteint 8,7 tm; les 4 autres bateaux de la zone 4 ont pêché sur la côte. En combinant les données des 11 journaux de bord fournis par les bateaux côtiers des zones 2, 3 et 4, on obtient un PUE moyen de 3,33 kg/mise à l'eau de casier^{-1}, valeur qui s'approche du PUE de 3,94 kg/mise à l'eau de casier^{-1} enregistré en 1985. La biomasse totale de la région côtière des zones 2, 3 et 4 a été estimée à 20,2 tm et le taux d'exploitation à 51 %.

Dans la zone 5, les bordereaux de vente indiquent que les débarquements ont été de 44,0 tm, ce qui dépasse les 29,2 tm obtenues en 1985. Selon les journaux de bord de 6 des 7 bateaux actifs dans cette zone, les débarquements ont atteint 40,2 tm. Le PUE moyen est de 14,15 kg/mise à l'eau de casier^{-1}, soit une valeur légèrement inférieure à celle qui a été obtenue en 1985 (14,22 kg/mise à l'eau de casier^{-1}). A ce jour, il s'agit du PUE le plus bas que l'on ait noté dans cette zone. En analysant les données selon la méthode de Leslie, on obtient une biomasse totale pour la saison de 72,9 tm et un taux d'exploitation de 55 %.

Les cinq bateaux actifs de la zone 6 ont fourni des journaux de bord indiquant des captures de 49,0 tm; des débarquements de 37,8 tm ont été enregistrés sur les bordereaux de vente. Le PUE moyen était de 11,9 kg/mise à l'eau de casier^{-1}, ce qui représente une augmentation par rapport à la valeur moyenne de 10,21 kg/mise à l'eau de casier^{-1} obtenue en 1985. La biomasse totale et le taux d'exploitation ont été estimés à 69,2 et 71 %, respectivement.

Les résultats de l'évaluation des stocks des zones 2-6 en 1986 ne semblent pas indiquer qu'on doive modifier la stratégie de gestion actuelle. Etant donné la productivité irrégulière des stocks, il n'apparaît pas nécessaire de remettre en vigueur le contrôle des prises pour la saison de pêche 1987, en dépit de l'augmentation du recrutement qui se poursuivra probablement au cours de cette année. Toutefois, si la productivité devait se stabiliser à des niveaux plus élevés au cours des prochaines années, il faudrait revoir la stratégie de gestion.

Introduction

The directed inshore fishery for snow crab, Chionoecetes opilio, off Cape Breton Island was started in 1966 off the northwest coast. Between 1976 and 1978, six inshore areas were defined around Cape Breton Island (Fig. 1) for exclusive exploitation by inshore boats under 45 ft (13.7m) in length. Between 1977 and 1979, landings rose markedly in phase with effort and the expansion of the fishery to approximately 180 inshore vessels operating around most of the Island (Elner 1982b). However, by 1982 it became apparent that the snow crab fishery on the Atlantic coast of Cape Breton Island (areas 2-6, Scotia-Fundy Region) was based on a resource with low productivity and that the accumulated virgin biomass had been drastically reduced by fishing. In contrast, on the Gulf of St. Lawrence coast of the Island (areas 1 and 7, 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 minimum legal size regulation of 95 mm carapace width, CW, was thought to confine exploitation to males mature for 1-3 yr and thus, theoretically protected the reproductive potential of the resource (Elner and Robichaud 1983a; Elner and Gass 1984).

The present paper assesses the status of the snow crab fishery in areas 2, 3, 4, 5, and 6* for 1986. Such annual assessments form the biological basis for management of the various Canadian fisheries for snow crab.

Methods

Cape Breton Island snow crab fishermen have been required to maintain logbooks for each fishing season since 1978. The logbooks from the 1986 season provided catch, effort and CPUE data for each area (Area 2-6) over time. In contrast to previous years, exploitation rates and biomass could be estimated by Leslie analysis for all areas in 1986. Sales slips provided supplementary landing statistics and also served to check logbook coverage. 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 more detailed accounts of snow crab logbook format and Leslie analysis see Elner (1982b) and Mohn and Elner (1987).

Port and at-sea sampling were carried out on an opportunistic basis throughout the fishing season in areas 3, 5 and 6 to monitor the size-frequency distribution and shell-hardness profile of commercial catches. Snow crab size was determined by measurement of carapace width (CW) across the

*Cape Breton Management Areas: 20, 21, 22, 23 and 24 respectively.

widest part of the carapace. Shell hardness was assessed subjectively as "hard", "intermediate" or "soft" by applying thumb pressure across a chela. Personnel and resource shortages precluded sampling in areas 2 and 4.

Frequently, 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 maturity. In summary, when logarthms of chela height are plotted against the logarithms of carapace width, morphometrically mature crabs form a swarm of data points distinct from morphometrically immature crabs. The major axes of the swarms are parallel and the cutting line:

$$\text{Ln chela height} = -4.1637 + 1.587 \text{ Ln CW}$$

effectively separates the two swarms; data points for mature crabs appear above the cutting line and points for immature crabs fall underneath. Close monitoring of the proportions of immature-crab-at-size in at-sea commercial catches could help develop a valuable, new technique for forcasting commercial biomass levels. Essentially, relative maturity proportion profiles' for a given year are likely to be related to growth and recruitment in the subsequent year; hence, coupled with existing data on growth, such proportion profiles might provide a predictive index. Given dramatic inter- and intra-stock variations in snow crab recruitment patterns, the present assessment approach of projecting from trends in biomass levels for previous years has proven not to be particularly useful.

Eight tagged male snow crabs were recovered from area 5 during 1986. These crabs were marked and released in 1983 as part of longer term studies into snow crab movement, growth and reproductive biology.

The status of snow crab stocks in area 2, 3, 4, 5 and 6 for 1986 was assessed on the basis of fishermen's logbooks, sales slips, commercial catch sampling as well as historical monitoring data.

Results

The 1986 fishing season extended between July 22-September 15 for areas 2,3,4, and 5, and August 1-September 31 for area 6. A summary of snow crab landings, effort statistics, biomass and exploitation rates for each area since 1978 is presented in Tables 1 and 2.

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

Port and at-sea sampling:

Due to personnel shortages, catch samples were taken only in area 3. Large quantities of pre-recruit males were discarded at-sea during the 1986 season as a pulse of crabs approached the catchable size range. Mirroring the phenomenum, size frequency profiles (Fig. 3) of male snow crab from port (mean CW: 101.3 mm) and at-sea (mean CW: 83.9 mm) samples in August, 1986 show considerable shifts towards the left as compared to previous years. [The mean CW. for an in-port sample in area 3 in August, 1985 was 109.4 mm (Elner and Robichaud 1986)]. However, all crabs sampled were in a hard-shelled condition, despite the fact that many had 'new' shells. The industry gave no indication of a 'white' crab problem.

Maturity

Chela height versus CW data for males in the 1986 at-sea sample (data plot not presented here) indicated that a large proportion of the sublegal crabs (<95 mm CW), and some legal-sized crabs, on the grounds were immature. Similarly, 12 (44%) out of 27 legal-sized crabs sampled in-port were immature (Fig. 4). The immature crabs can be expected to moult and contribute to commercial biomass for the 1987 season.

Females

All 112 mature female crabs sampled at-sea during August, 1986 were ovigerous and most were primiparous (Fig. 5).

Logbooks:

One fisherman was active in area 2, twelve were active in area 3 and seven in area 4. Log records were received from the single fisherman in area 2, eight in area 3 and two in area 4 (Table 1). With one exception, all of the fishermen were active on inshore grounds in or adjacent to area 3 (Fig. 1). Thus, for assessment purposes (as in previous years) they are considered to have exploited a single stock. The known exception was a fisherman from area 4 (Table 2) who failed to return a logbook and trapped in area 4 offshore (Fig. 1). The same offshore area has been exploited in previous years (Elner and Robichaud 1985). Landings, as recorded from sales slips and logbooks for inshore area 2/3/4 were 22.4 mt and 10.2 mt, respectively. Catches of 8.7 mt were recorded by the vessel fishing offshore (Table 2).

Catch and effort data from the logbooks demonstrated a declining trend in CPUE through the fishing season (Table 3). Leslie analysis (Fig. 6) indicates

that the total available commercial biomass (Bo) for the fishing season was 20,177 kg (95% Confidence Limits (C.L.): 15,090 kg and 37,113 kg). Hence, given logbook - derived catches of 10,194 kg, 9,983 kg would have been left on the grounds at the end of the fishing season (95% C.L.: 4,896 kg and 26,919 kg) after an exploitation rate of 51% (95% C.L.: 68% and 27%). The total available biomass estimated for 1986 is below all previous historical levels (Table 2).

Area 5 (southeast Cape Breton)

Port and at-sea sampling:

Size-frequency histograms for port sampling during July and August and at-sea sampling in August are shown in Fig. 7. Comparison between port sampling histograms for 1985 (Elner and Robichaud, 1986: mean CW, July = 109.7 mm; August = 109.1) and 1986 (mean CW, July = 104.0 mm; August = 105.5 mm) reveal shifts in size-frequency distributions commensurate with a recruitment pulse, as observed in area 2/3/4. However, a comparison of the sea sample for July 1985 (Elner and Robichaud, 1986: mean CW = 101.4 mm) with that for August 1986 (mean CW = 100.3 mm) reveals little change.

Most crabs landed and sampled at-sea (Fig. 8) during the 1986 season were in hard-shelled condition; no soft-shelled crabs were captured. No in-season growth and recruitment has been recorded in area 5 since 1978 (Elner 1982b; Elner and Robichaud 1983b, 1984, 1985, 1986).

Maturity

Plots of chela height versus CW for male snow crabs sampled at-sea (Fig. 9) and in-port (Fig. 10) during the 1986 season indicate that a large proportion of both the sublegal crabs ($<$95 mm CW) and the legal crabs ($\geq$95 mm CW) were morphometrically immature. The actual distribution of the data points in Figs. 9 and 10 appears remarkably similar to the pattern observed in 1985 (Elner and Robichaud 1986).

Females

Of the 207 mature females sampled at-sea in August 1986, 203 (98%) were ovigerous and most were 'new', primiparous individuals (Fig. 11). The high proportion of ovigerous females appears a reversal of the declining trend noted in previous years (Elner and Robichaud 1986) and is probably a reflection of the same recruitment pulse detected for the male crabs. Previously, a lack of recruitment had led to a 'senility' phenomenum with most of the female population being comprised of either barren individuals or individuals with reduced egg clutches.

Tagging (growth and reproduction studies)

With the collapse of the Atlantic coast of Cape Breton snow crab stocks we have shifted emphasis from annual stock monitoring and assessment programs to longer-term , basic research into the biological basis of stock/recruitment dynamics. Hence, mark-recapture techniques are being utilized to elucidate growth and reproduction biology rather than provide biomass estimates. Table 4 summarizes aspects of the longer-term tagging data series from 1982 to 1986.

Eight male snow crabs marked with t-bar tags and releasd in 1983 were recaptured during the 1986 fishing season in area 5. Of the 5 crabs measured (range 95 mm - 136 mm CW) only one had grown: the individual was 95 mm CW on tagging and 116 mm CW on recapture.

Logbooks:

Logbooks were received from six of the seven area 5 fishermen who set traps in 1986. Total landings derived from logbooks were 40,155 kg, as compared to 43,972 kg from sales slips statistics. Landings in 1986, according to sales slips, were 151% above the record low for the area documented in 1985 (29,171 kg) and close to the level achieved in 1984 (45,215 kg); however, catches are still considerably below historical levels (Tables 1, 2). Actual recorded effort in 1986 (2,837 trap hauls) was 194% of the 1985 value and 128% of the 1984 value (Table 2).

The overall mean CPUE value for the 1986 season (14.5 kg. trap haul^{-1}) dropped below mean values estimated for previous years (Table 2). Mean weekly CPUE values fluctuated through the fishing season but, overall, demonstrated a declining trend that was amenable to resolution by Leslie analysis (Table 5, Fig. 12). Based on Leslie analysis, the total available biomass (Bo) for the season was 72,906 kg (95% C.L.: 54,384 kg and 130,599 kg). Logbook-derived catches of 40,155 kg would have resulted in an exploitation rate of 55% (95% C.L.: 74% and 31%) and left 32,751 kg (95% C.L. 14,229 kg and 90,444 kg) on the area 5 grounds after the fishing season. The Bo level estimated for 1986 is above that for 1984 (55.3 mt) but remains below previous historic levels (Table 2).

Area 6 (south Cape Breton)

In terms of landings (logbook-derived), area 6 eclipsed area 5 for the third year in succession to become the major snow crab producing area on the Atlantic coast of Cape Breton Island. Nevertheless, CPUE indices and Leslie estimates indicate that area 5 still retains a larger population of commercial sized snow crab than area 6.

Port and at-sea sampling

For the first time since the fishery began, in-port and at-sea catch sampling was carried out in area 6 (Fig. 13). The at-sea sample (mean CW = 84.5 mm) was comprised almost entirely of sub-legal (<95 mm CW) crabs while, in dramatic contrast, the port sample (mean CW = 115.1 mm) was considerably displaced to the right.

Maturity

Plots of chela height versus carapace width for male snow crabs sampled at-sea (Fig. 14) and in-port (Fig. 15) during the 1986 season indicate that a large proportion of both the subleqal crabs (<95 mm CW) and the legal crabs (≥ 95 mm CW) were morphometrically immature.

Females

All of the 383 mature female snow crabs sampled at-sea in August 1986 were ovigerous and most were primiparous (Fig. 16).

Logbooks:

The total landings from five logbooks received from the area 6 fishermen in 1986 amounted to 49,027 kg, as opposed to the 37,770 kg recorded through the sales slips statistics system (Tables 1,2). Total landings and effort were above 1985 levels but below those values for 1984; however, mean CPUE was the highest since 1981 and likely a reflection of the recruitment pulse noted in other Atlantic-coast areas around Cape Breton Island in 1986.

For the first time since 1983, CPUE declined through the season and the resultant pattern was amenable to resolution by Leslie analysis (Table 6, Fig. 17). Total available biomass (Bo) for the 1986 season was estimated at 69,227 kg (95% C.L.: 63,021 kg and 77,982 kg) and given logbook-derived landings of 49,027 kg, exploitation rate was 71% (95% C.L.: 78% and 63%). By subtraction, 20,200 kg (95% C.L.: 13,994 kg and 28,955 kg) of commercial-sized crab remained on the area 6 grounds at the end of the fishing season. The Bo level estimated for 1986 is close to that of the first assessment in 1979 (69.44 mt) but below subsequent assessment levels, with exception of 1981 (35.8 mt) (Table 2). Overall, area 6 has shown greater stability in commercial biomass and catch rate than any other crab stock around 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. Essentially, a moderately large influx of snow crab recruited into the fisheries in areas 2-6, the first significant production noted in the system since assessments began in 1978. Previously, the lack of production in the face of continued fishing pressure had resulted in rapidly declining commercial biomass levels, excessive exploitation rates and marginal catch rates. Consequently, annual effort and landings fell progressively between 1979 and 1985.

The recruiting males in 1986 were characterized by their 'new' shell condition and a size-distribution straddling the minimum legal size (95 mm CW). Female recruitment reversed a trend for 'reproductive senility'; whereas, in 1985, most of the mature females sampled were old, multiparous individuals (Elner and Robichaud 1986) the majority of females caught in 1986 were new-shelled and primiparous. It is probable that the upcoming recruitment pulse was detected as by-catch to a Danish seiner operating in grid #383 (area 5) in July, 1985. Size-frequency histograms of the by-catch

show immature males and females at a modal size of approximately 57 mm CW. Given the large numbers of immature, pre-recruit males sampled in 1986, the improved production trend seems likely to continue into the 1987 season with concommittant increases in commercial biomass and catch rates. However, the longer-term prognosis for snow crab in Cape Breton is uncertain; the fundamental biological basis to snow crab management is now acknowledged to be weak and until 'break-throughs' in research occur managers and biologists must continue to react to system changes as they occur rather than plan for predicted commercial biomass levels.

Overall, the 1986 Cape Breton recruitment pulse shifts our understanding of the system dynamics from one in which growth and recruitment is low to a system in which production is intermittent. Nevertheless, the 1986 assessments for areas 2-6 do not appear cause for changes in current management strategy: the erratic nature of production precludes a biomass stabilization strategy, as advocated for other Atlantic snow crab stocks, and for the present, the existing fishermen would seem best served in being allowed to continue taking advantage of whatever productivity occurs from time to time on an opportunistic basis.

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Table 1. Snow crab statistics for the Atlantic coast of Cape Breton Island, 1978-86.

Area	Year	No. of boats licensed	No. of active boats	No. of logbooks received	Landings Statistics Area Managers (kg)	Landings Statistics logbooks (kg)	Actual effort in traps hauled (from 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
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
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
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
6	1979	8	4	4	24,868	27,351	1,880
	1980	11	10	9	58,586	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	12	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
TOTAL	1978	89	42	42	-	646,270	25,296
	1979	119	98	83	1,621,507	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

Table 2. Comparison of assessment data for Cape Breton Island snow crab (Areas 2-6), 1978-86.

Area	Year	No. of active boats	No. of logbooks received	Landings Statistics: Area Managers (kg)	Landings 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	-	-	(1.2x0.9x0.8 m, 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	-	-	(1.5x1.5x0.5 m, steel)
	1982	41	28	252,209	100,161	13,971	7.17	153.0	65	(1.2x0.9x0.8 m, 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	3,065	3.33	20.2	51	"
4	1978		4	-	203,966	4,916	41.49	-	-	(1.5x1.5x0.5 m, steel)
(offshore)	1979		16		507,569	10,546	48.13	790.0	64	"
	1980		4		39,800	827	48.13	-	-	"
	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	-	-	-	-	-	"
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	"
6	1979	4	4	24,868	27,351	1,880	14.55	69.44	39	(1.5x1.5x0.5 m, 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	"
TOTAL	1978	42	42	-	646,270	26,705	24.20			All trap types combined
	1979	98	83	1,621,507	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			"

Table 3. Catch and effort statistics from logbook data for the snow crab fishery in area 3 plus part of areas 2 and 4 adjacent to area 3 in 1986.

Week Period	Trap hauls (conical and wooden traps combined)	Catch (kg)	CPUE (kg/trap haul)
22/7-28/7	535	2580	4.8
29/7-4/8	275	990	3.6
5/8-11/8	879	2699	3.1
12/8-18/8	593	1966	3.3
19/8-25/8	169	501	3.0
26/8-1/9	298	808	2.7
2/9-8/9	316	650	2.1
TOTAL	3065	10194	3.3

Table. 4 Summary of mark-recapture data for male snow crabs tagged in area 5 with t-bar tags. 1982-86.

Date	1982 (Study)	1983 (Study)	Total
No. male crabs tagged	1958	1288	3246
1982 - No. recaptured	924 (47.2%)	-	924
No. measured	364	-	364
No. grown	13 (3.6%)	-	13 (3.6%)
1983 - No. recaptured	158	624 (48.4%)	782
No. measured	121	566	687
No. grown	5 (4.1%)	7 (1.2%)	12 (1.7%)
1984 - No. recaptured	17	94	111
No. measured	1	7	8
No. grown	0	1 (14.3%)	1 (12.5%)
1985 - No. recaptured	4	13	17
No. measured	4	9	13
No. grown	0	0	0
1986 - No. recaptured	0	8	8
No. measured	0	5	5
No. grown	0	1 (20%)	1 (20)%

Table 5. Catch and effort statistics from logbook data for the snow crab fishery in area 5, 1986.

Week Period	Trap hauls	Catch (kg)	CPUE (kg/trap haul)
22/7-28/7	150	2954	19.7
29/7-4/8	166	2665	16.1
5/8-11/8	633	11376	18.0
12/8-18/8	653	10032	15.4
19/8-25/8	277	3180	11.5
26/8-1/9	391	5672	14.5
2/9-8/9	335	2585	7.7
9/9-15/9	232	1691	7.3
TOTAL	2837	40155	14.2

*Steel Traps (1.5 x 1.5 x 0.5 m) combined with Japanese conical traps.

Table. 6 Catch and effort statistics from logbook data for the snow crab fishery in area 6, 1986.

Week Period	Steel traps (1.5x1.5x0.5 m)	Catch (kg)	CPUE (kg/trap haul)
1/8-7/8	622	11308	18.2
8/8-14/8	671	10404	15.5
15/8-21/8	538	7760	14.4
22/8-28/8	350	4018	11.5
29/8-4/9	662	5989	9.1
5/9-11/9	732	6038	8.3
12/9-18/9	-	-	-
19/9-25/9	380	2697	7.1
26/9-30/9	164	813	5.0
TOTAL	4119	49027	11.9

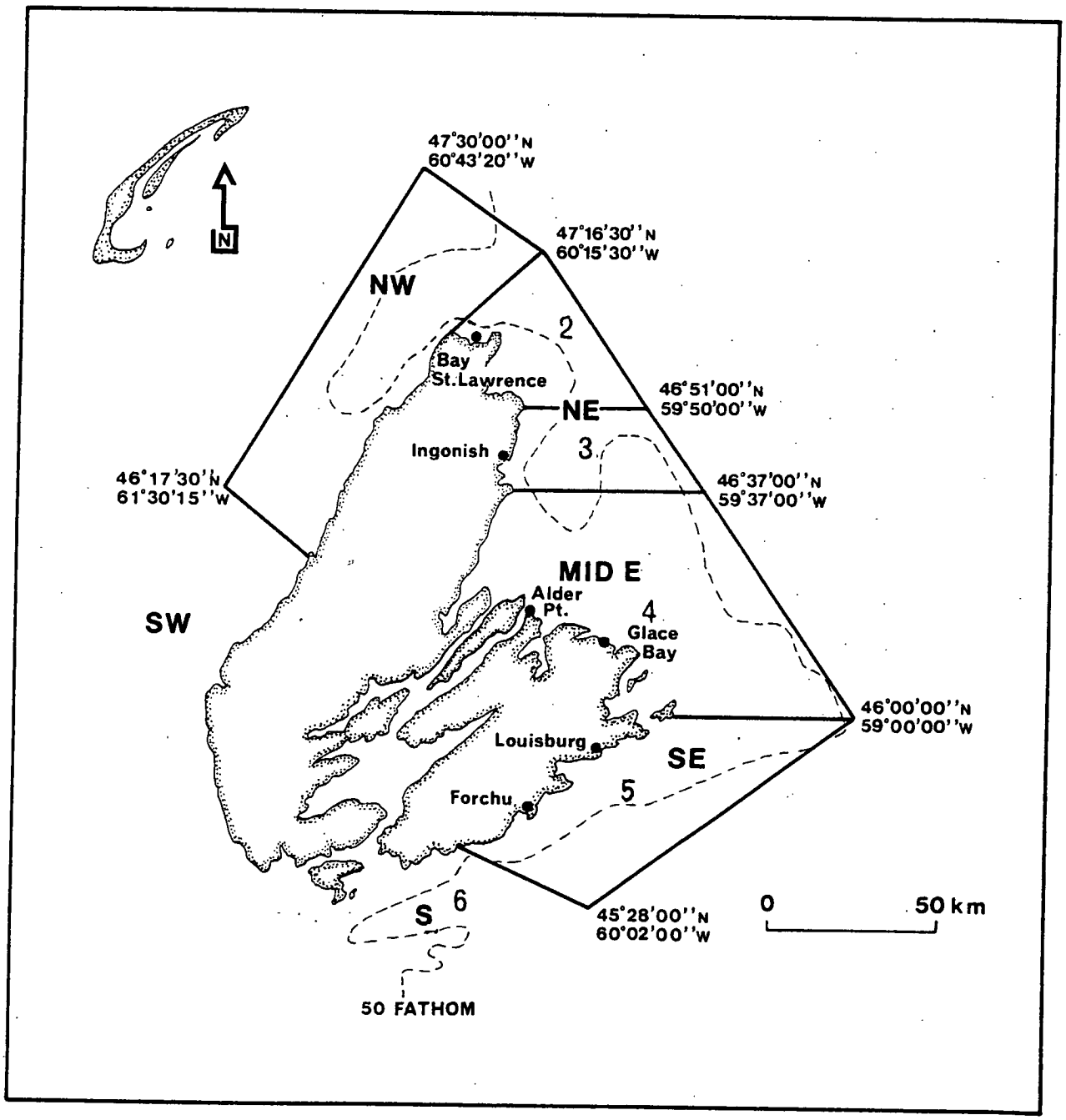
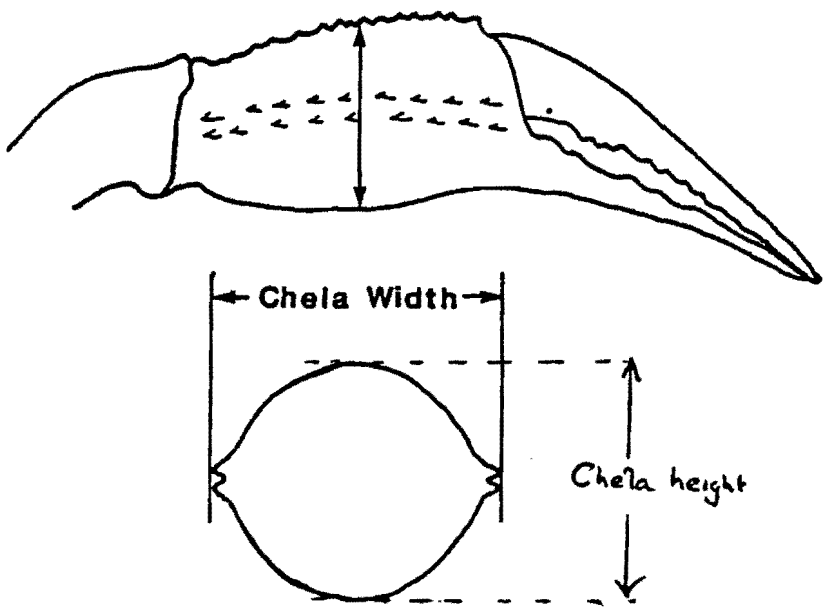


Fig. 1 Cape Breton Island snow crab fishing areas.

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



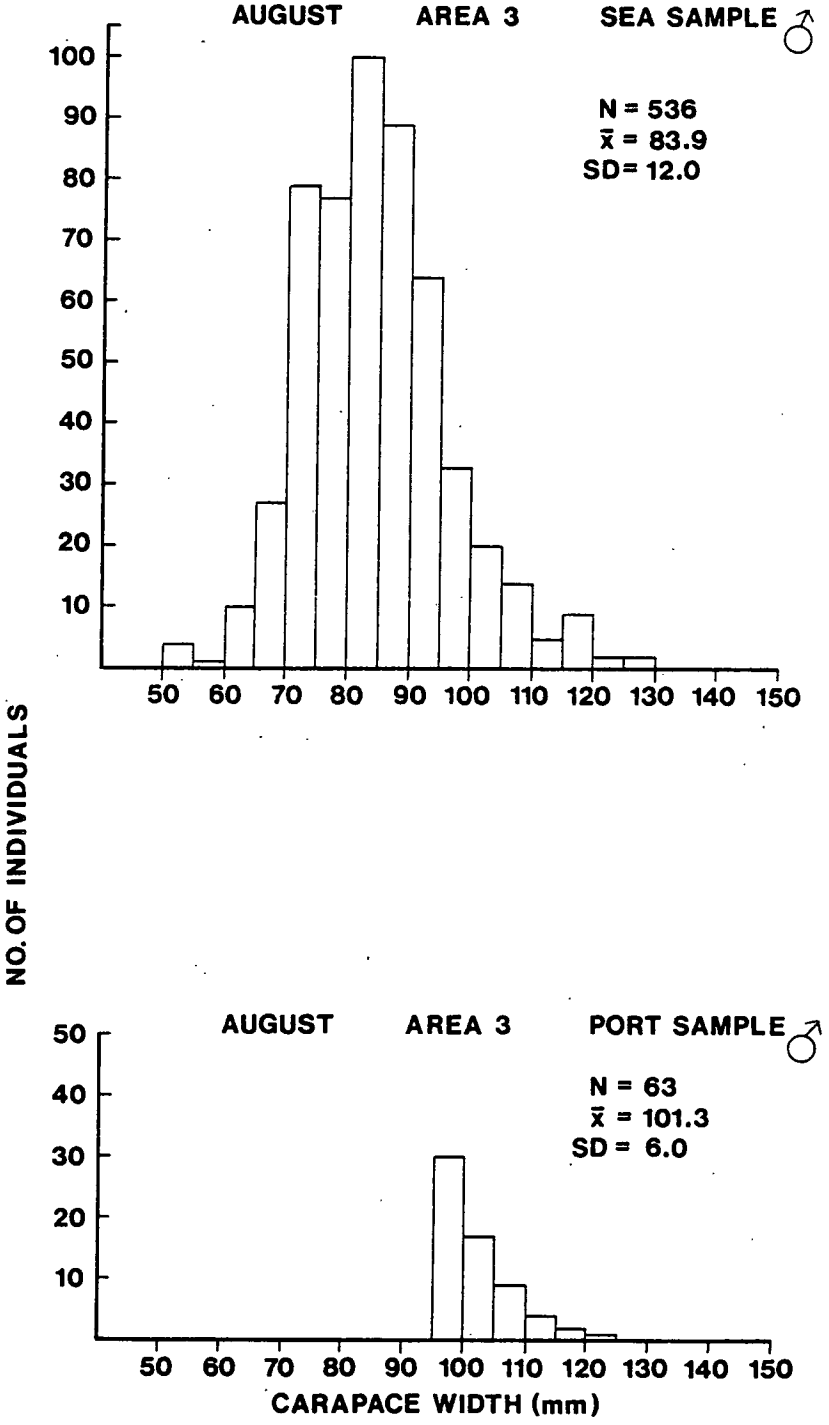


Fig. 3 Size-frequency histograms for male snow crabs sampled at-sea and in-port from commercial vessels in area 3 during the 1986 fishing season.

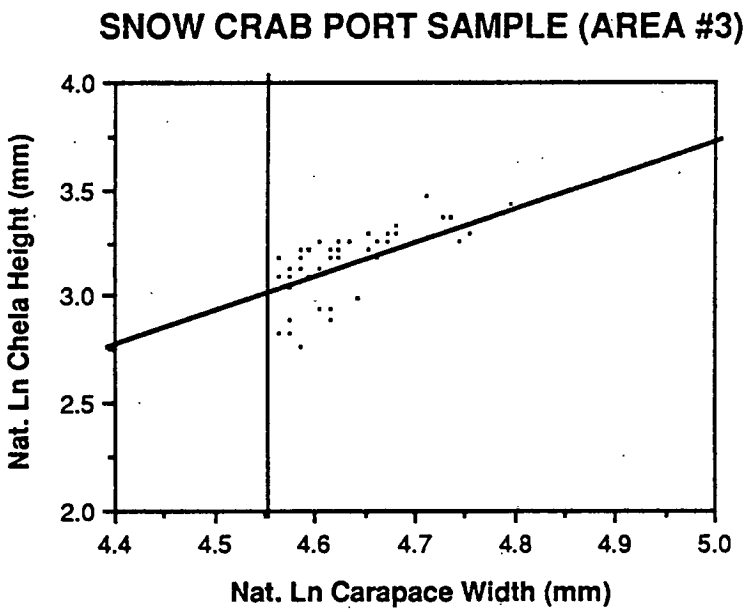


Fig. 4 Graph showing the relationship between the natural logarithm of the chela height and the natural logarthm of the carapace width for male snow crab sampled at-sea in area 3 during the 1986 season. (N.B. Minimum legal size = 95 mm CW = In 4.55)

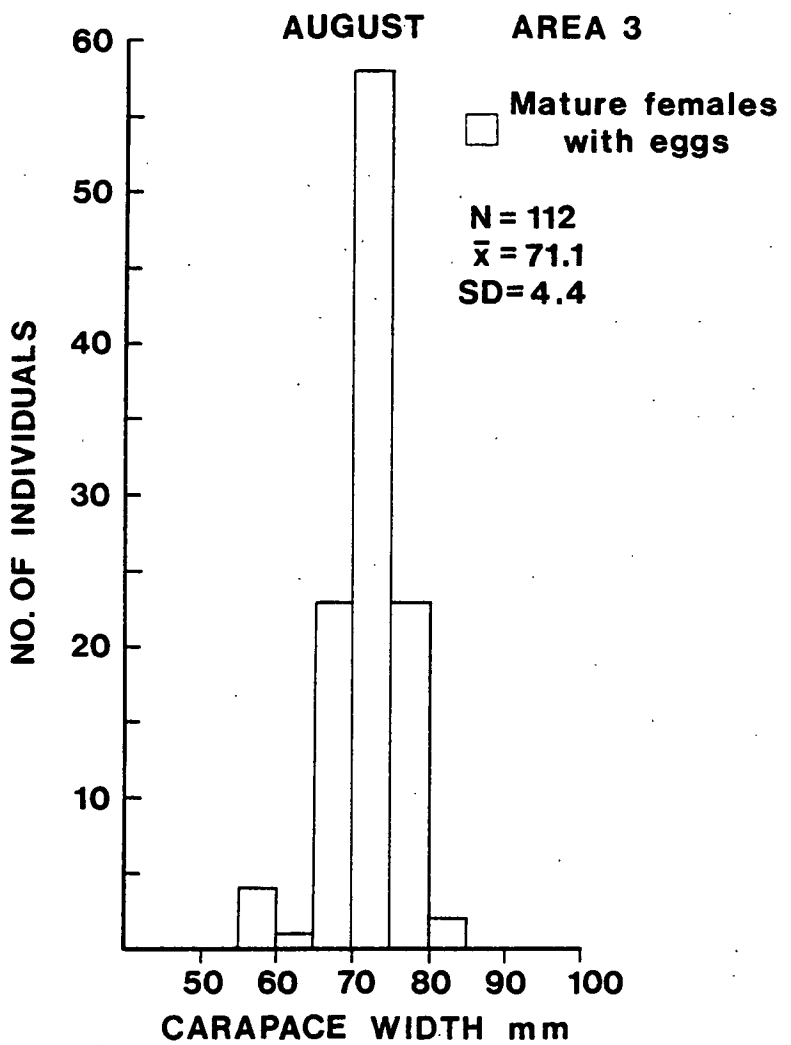


Fig. 5 Size-frequency histograms for mature female snow crabs sampled from a commercial vessel at-sea in area 3 during the 1986 season.

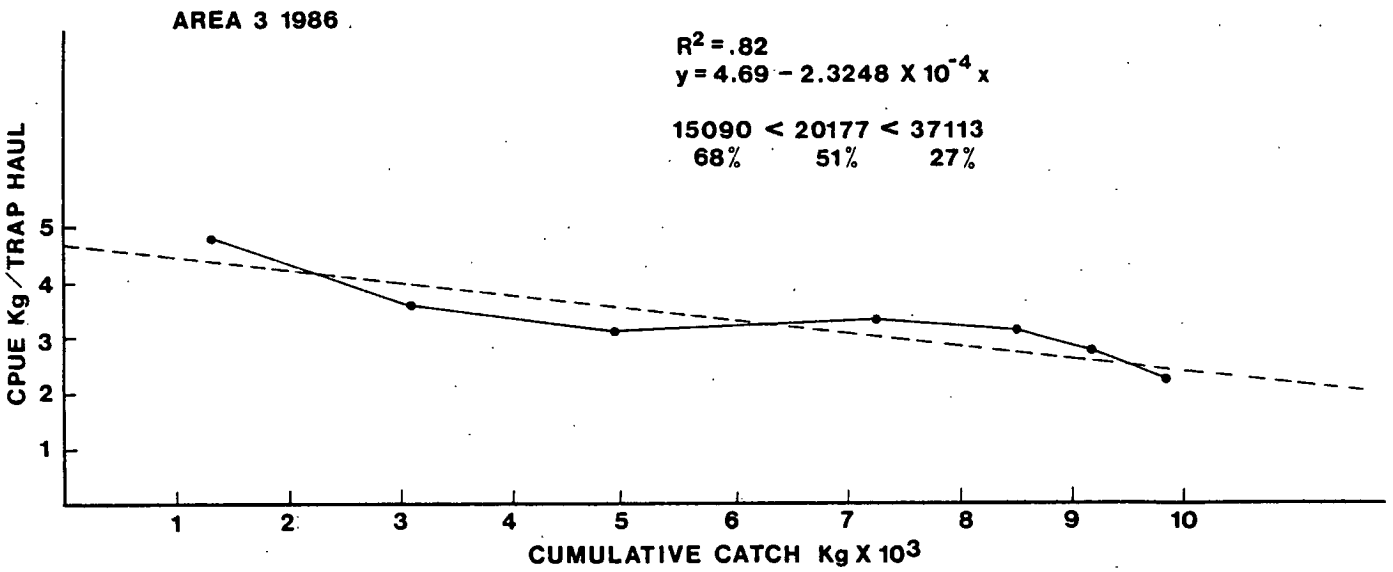


Fig. 6 Graph of cumulative weekly landings against CPUE, from logbook data for area 3 and part of area 4 adjacent to area 3 in 1986.

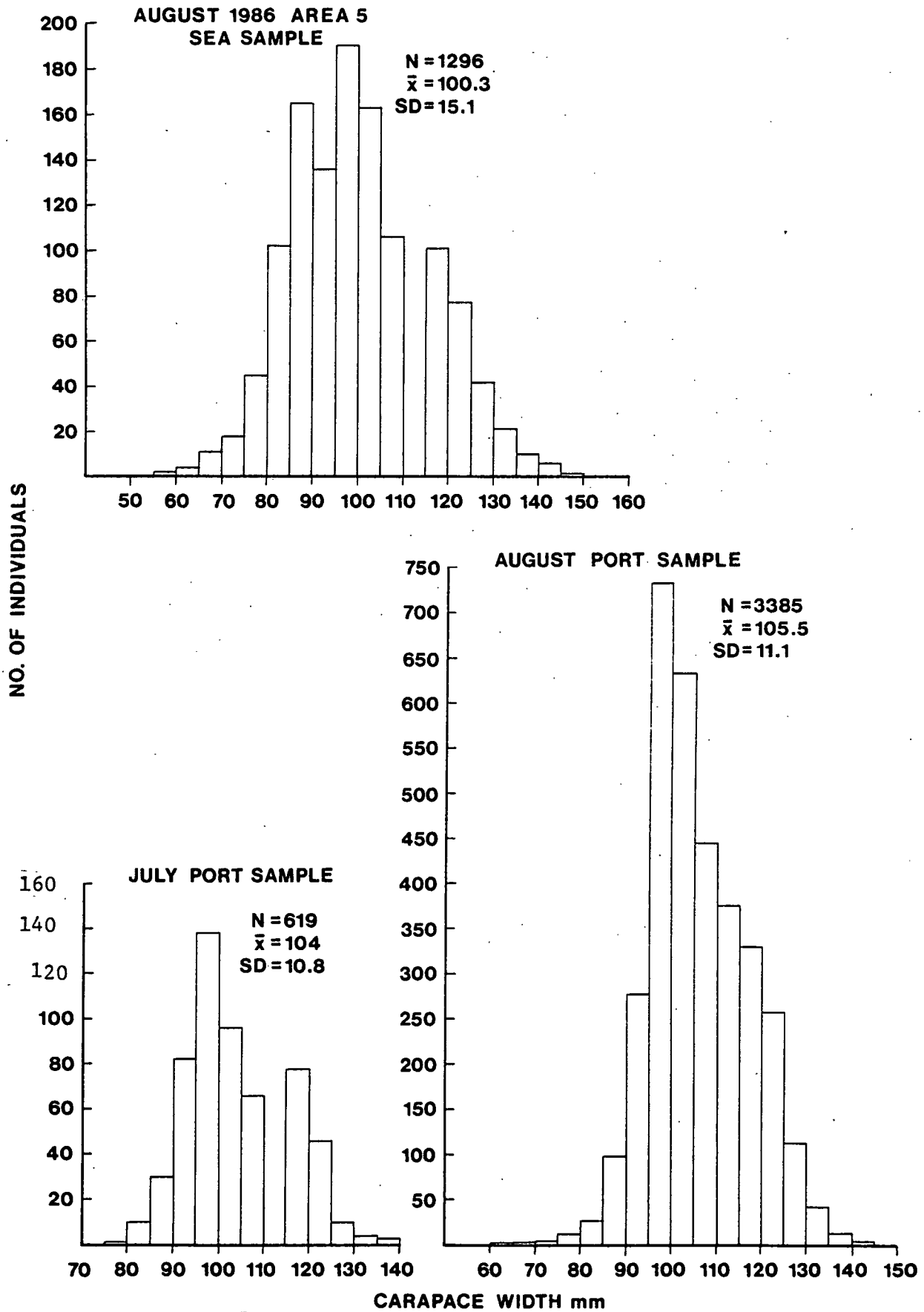


Fig. 7 Size-frequency histograms for male snow crabs sampled at-sea and in-port from commercial vessels in area 5 during the 1986 fishing season.

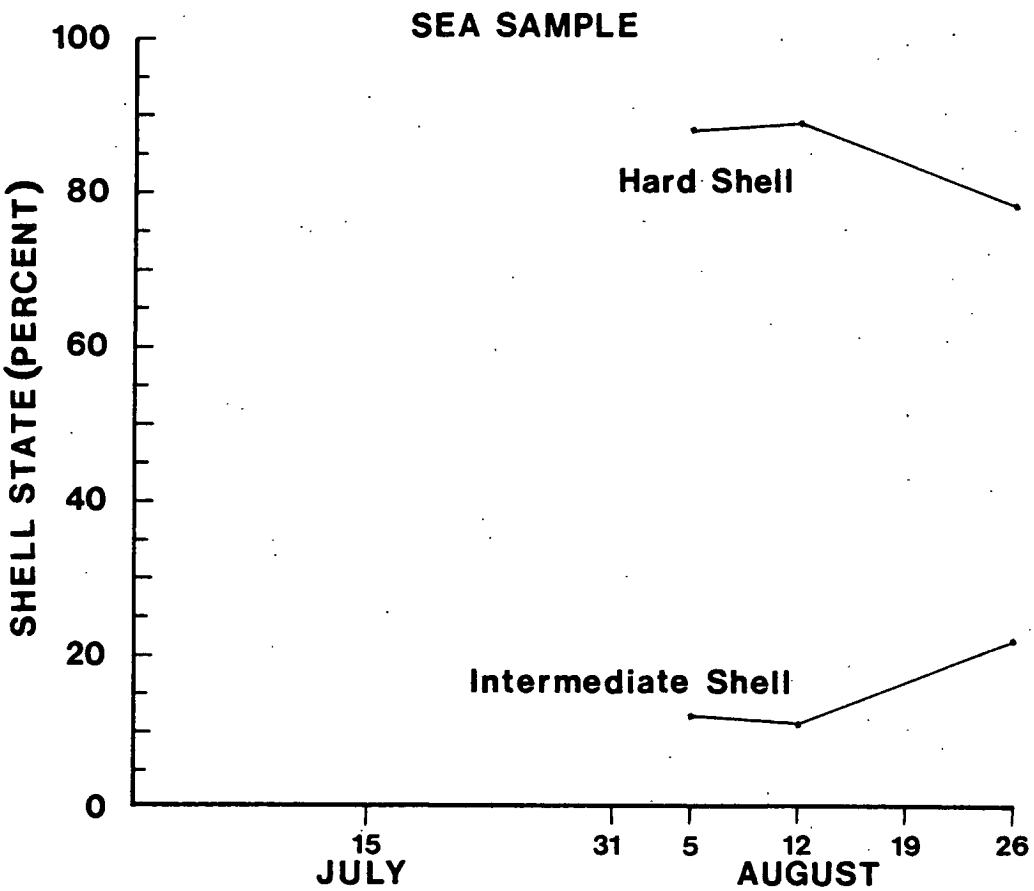


Fig. 8 Percentage frequency of occurrence of shell states for male snow crabs throughout the 1986 fishing season in area 5.

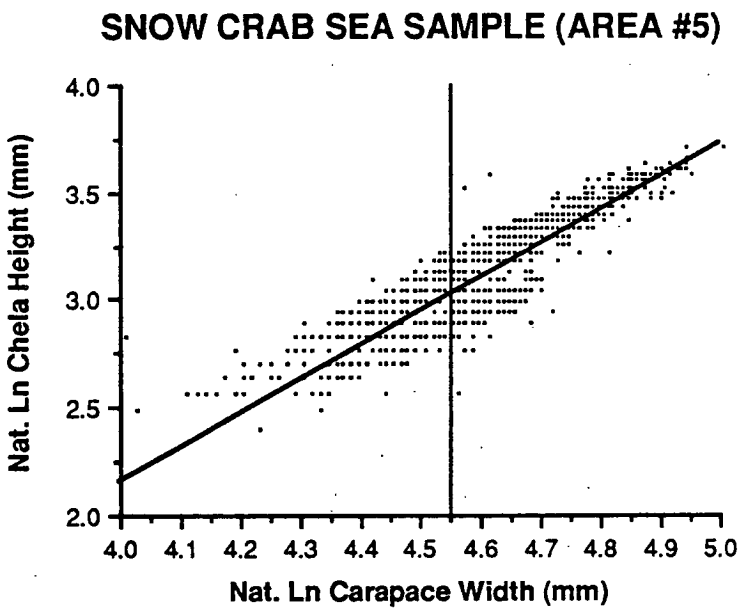
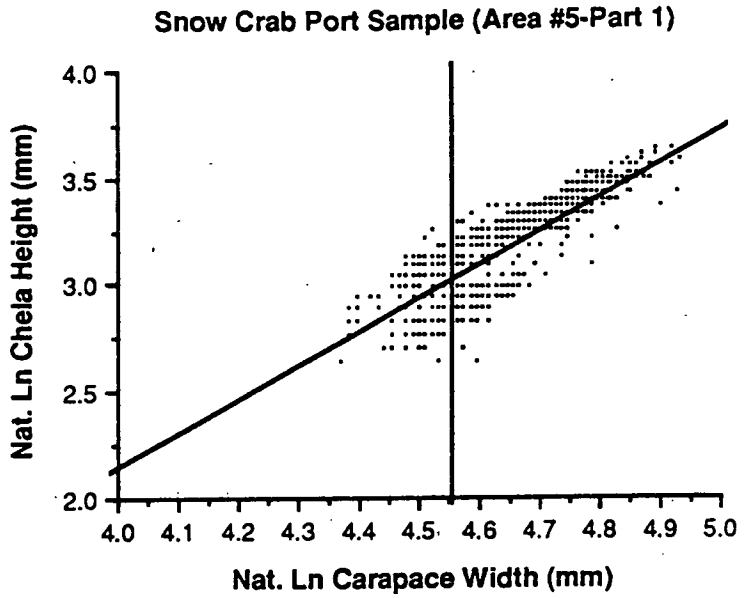
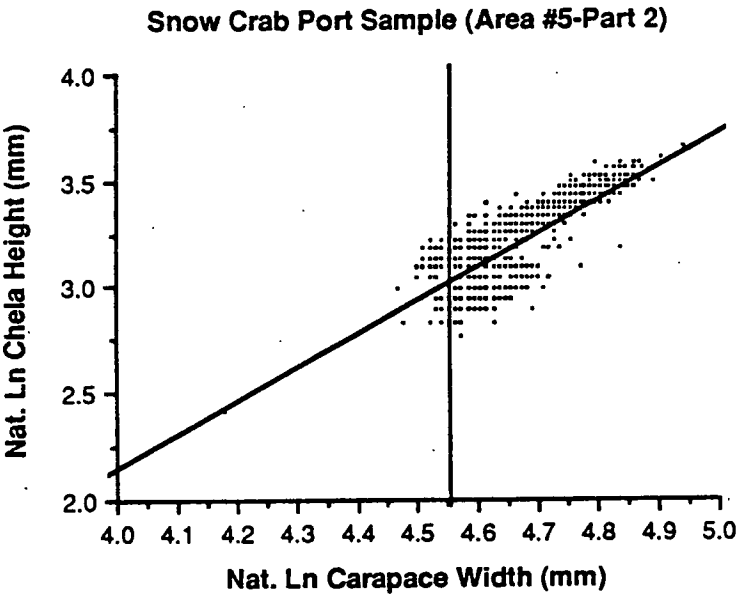
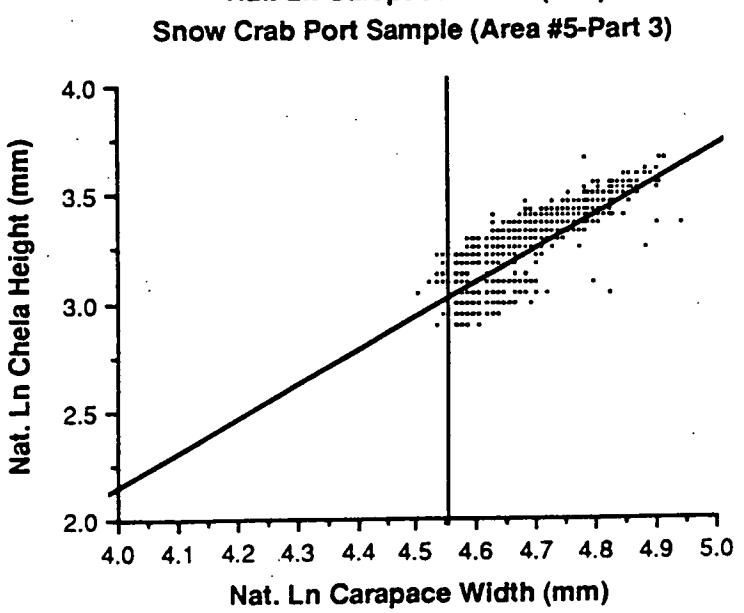


Fig. 9 Graph showing the relationship between the natural logarithm of the chela height and the natural logarithm of the carapace width for male snow crab sampled at-sea in area 5 during the 1986 season.

Fig. 10 Graph showing the relationship between the natural logarithm of the chela height and the natural logarithm of the carapace width for male snow crab sampled in-port in area 5 during the 1986 season.







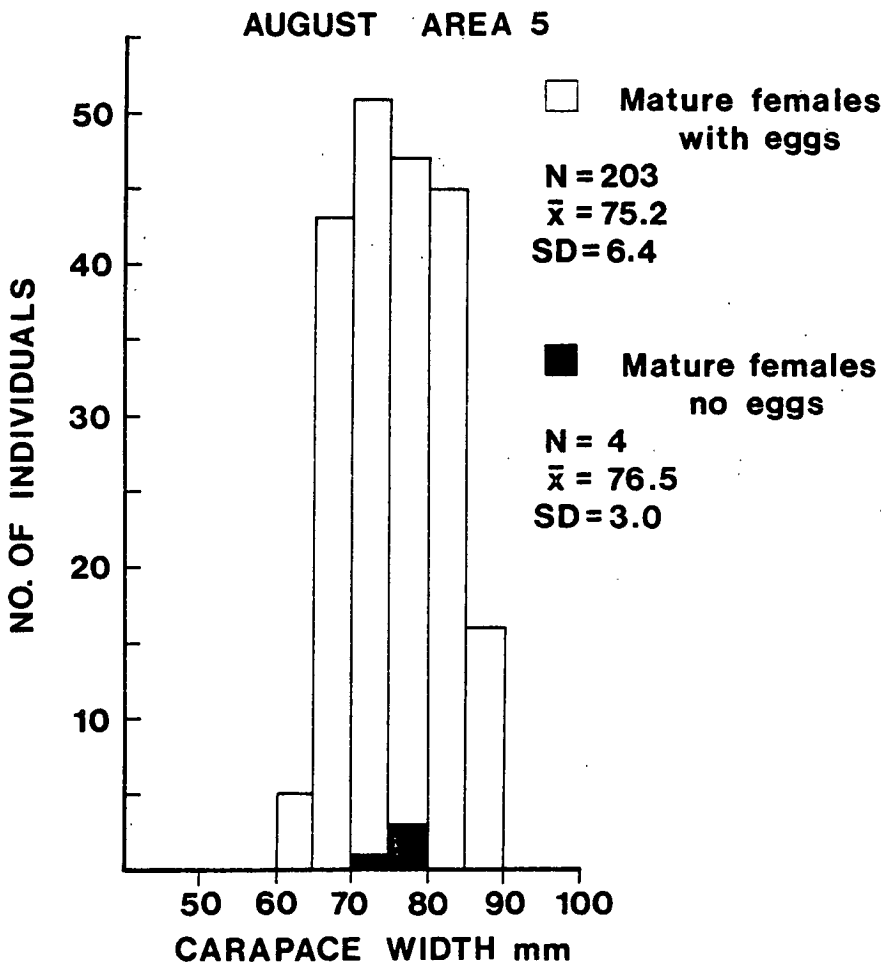


Fig. 11 Size-frequency histograms for mature female snow crabs sampled in area 5 from a commercial vessel at-sea during the 1986 fishing season.

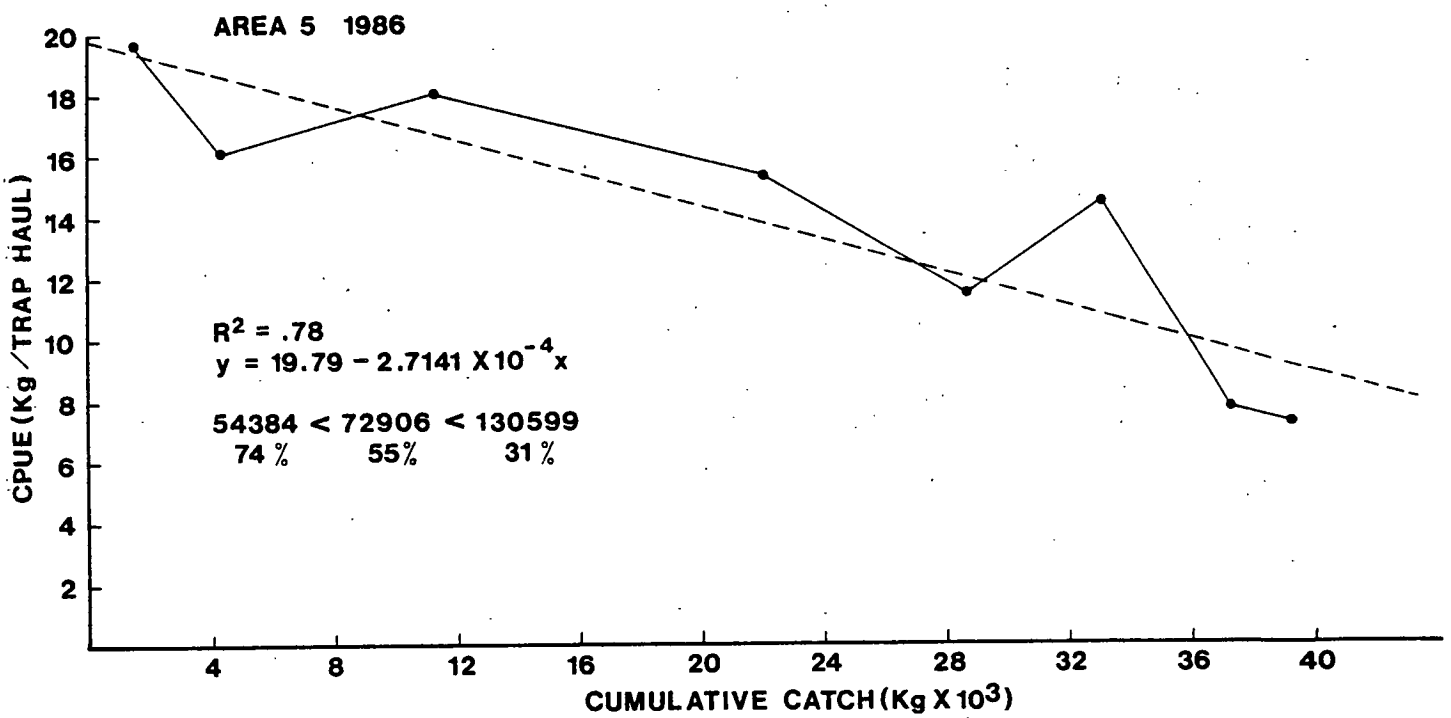


Fig. 12 Graph of cumulative weekly landings against CPUE, from logbook data for area 5 in 1986.

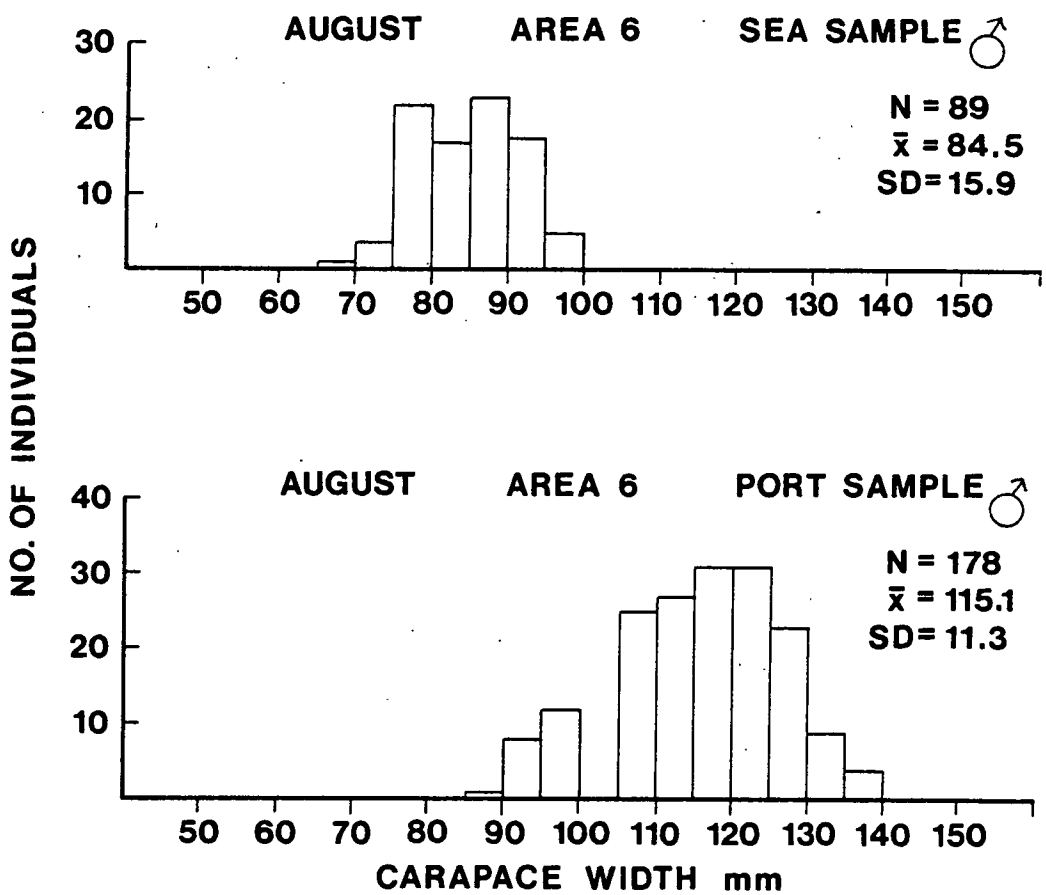


Fig. 13 Size-frequency histograms for male snow crabs sampled at-sea and in-port from commercial vessels in area 6 during the 1986 fishing season.

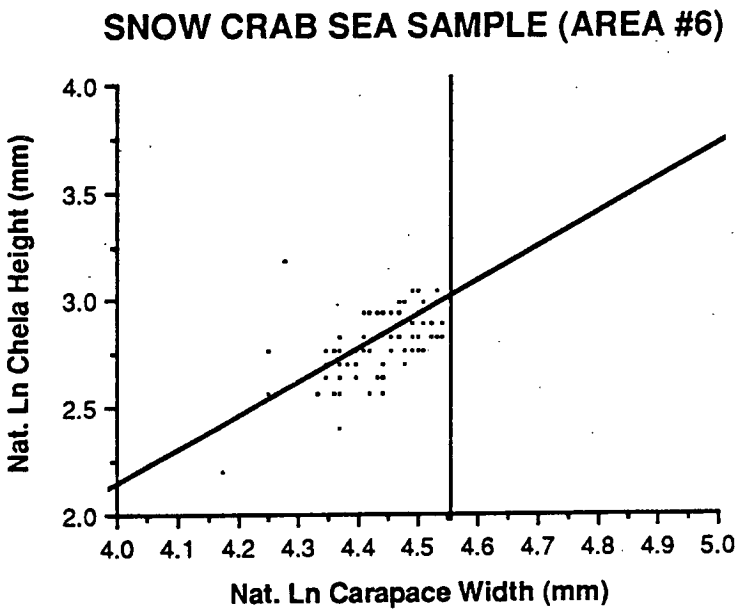


Fig. 14 Graph showing the relationship between the natural logarithm of the chela height and the natural logarithm of the carapace width for male snow crab sampled at-sea in area 6 during the 1986 season.

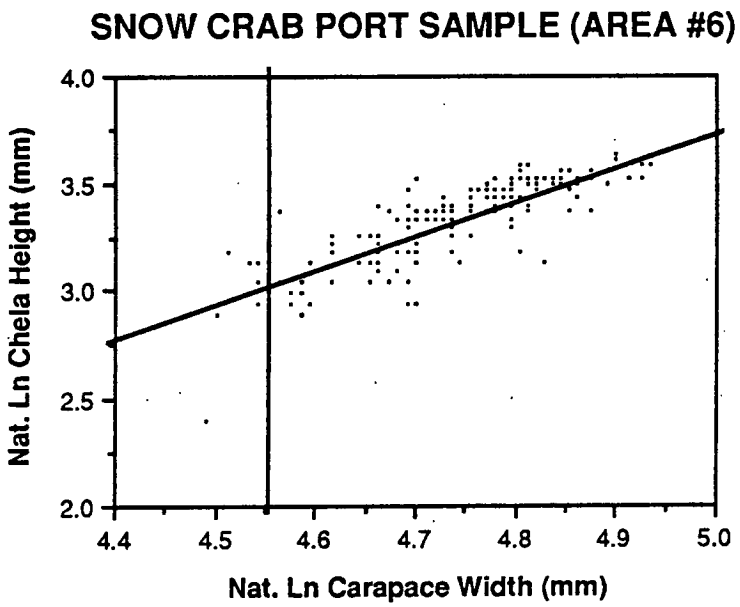


Fig. 15 Graph showing the relationship between the natural logarithm of the chela height and the natural logarithm of the carapace width for male snow crab sampled in-port in area 6 during the 1986 season.

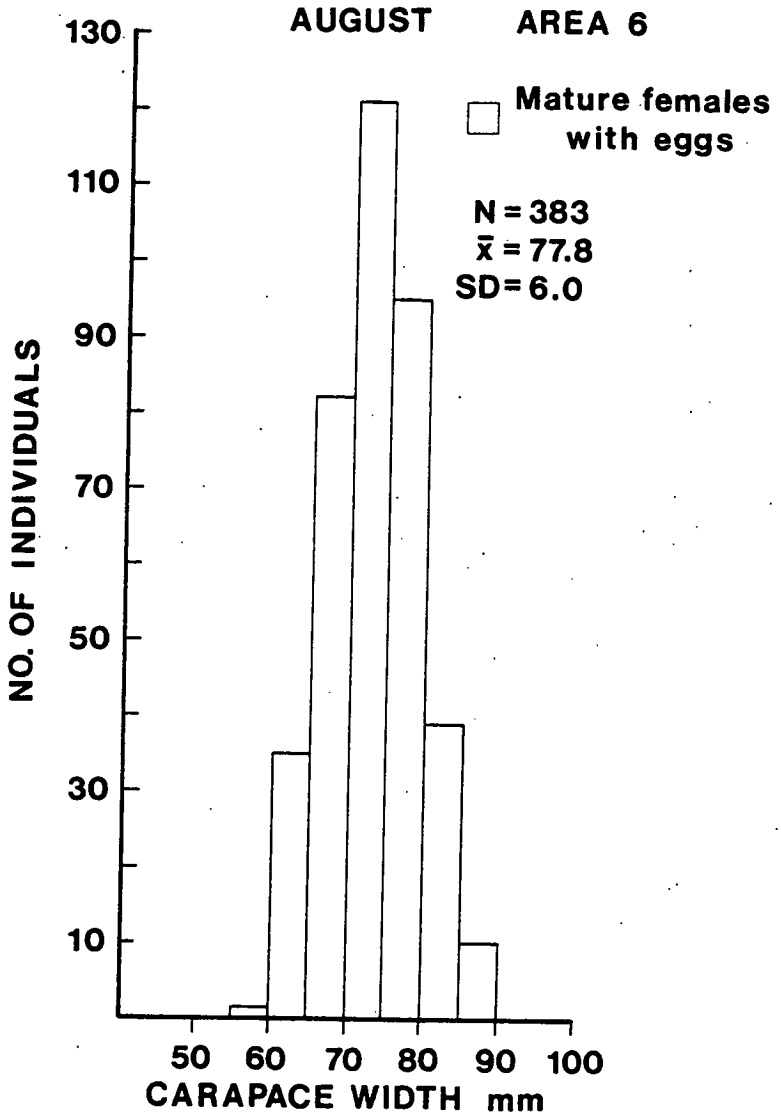


Fig. 16 Size-frequency histograms for mature female snow crabs sampled at-sea from a commercial vessel in area 6 during the 1986 fishing season.

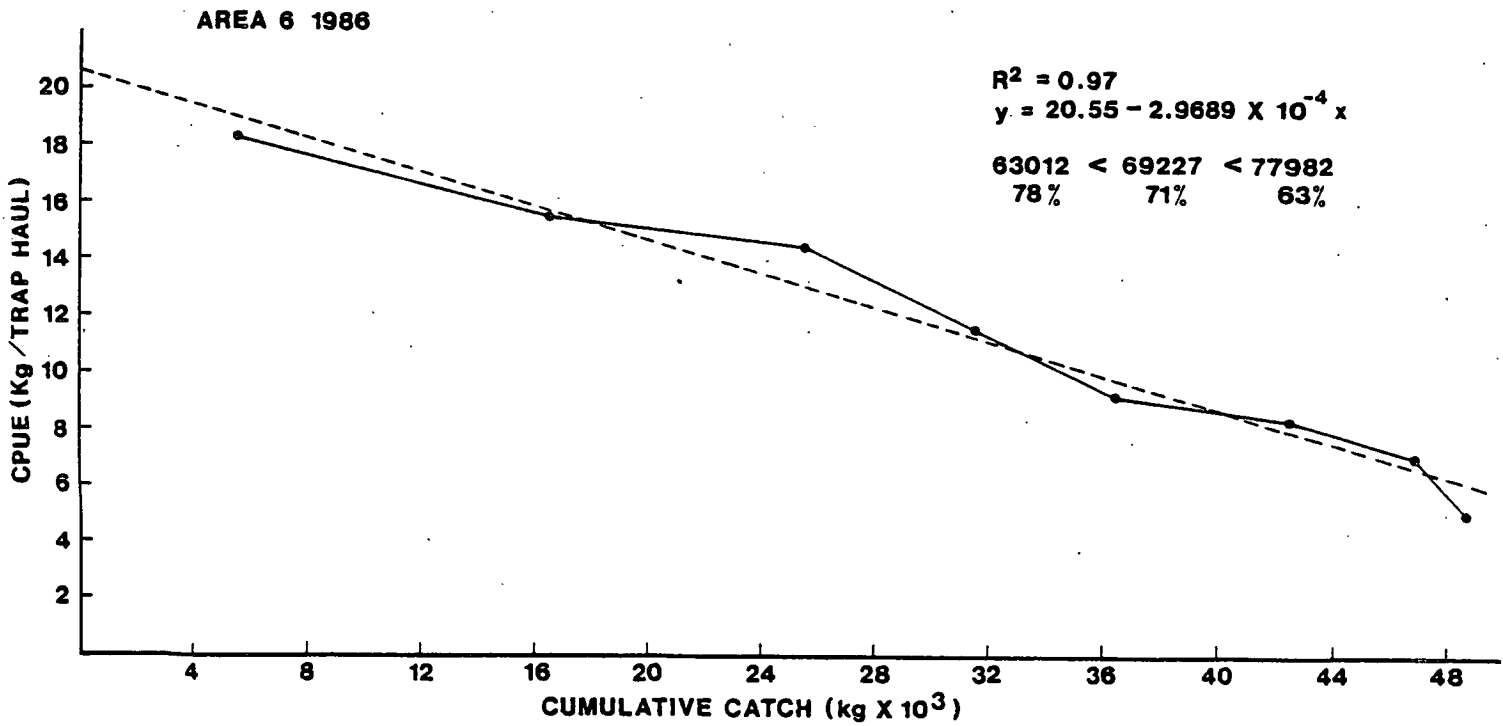


Fig. 17 Graph of cumulative weekly landings against CPUE, from logbook data for area 6 in 1986.