Canadian Atlantic Fisheries
Scientific Advisory Committee

CAFSAC
Research Document 81/40

Assessment of the Cape Breton inshore fishery for snow crab, 1980

by

Robert W. Elner and David A. Robichaud
Invertebrates and Marine Plants Division
Department of Fisheries and Oceans
Biological Station
St. Andrews, New Brunswick
EOG 2XO

ABSTRACT

Biological assessments are presented for the 1980 Cape Breton snow crab season based on data derived from fishermen's logbooks, tagging studies and in-port and at-sea sampling. Growth of commercial-size stock plus recruitment (sub-legal male crabs moulting into legal size) during the fishing season and inter-season growth and recruitment have been used to estimate the available commercial biomass and TAC's for the 1981 season for 5 of the 7 snow crab management areas around Cape Breton.

A marked decline of most Cape Breton stocks over the past 3 years indicates that the accumulated virgin biomass is being rapidly depleted and that the future fishery will depend increasingly on new recruits. Annual biomass additions due to growth and recruitment appear to be variable in magnitude.

RESUME

Les évaluations biologiques contenues dans le présent document pour la saison 1980 de pêche au crabe des neiges au Cap-Breton sont fondées sur les journaux de bord des pêcheurs, le marquage et l'échantillonnage au port et en mer. La croissance du stock de taille commerciale et le recrutement (nombre de crabes mâles de taille sublégale atteignant la taille légale après la mue) pendant la saison de pêche, ainsi que la croissance et le recrutement d'entre-saisons ont servi à estimer la biomasse disponible et les TPA de 1981 dans 5 des 7 régions de gestion du Cap-Breton.

A en juger par le déclin marqué de la plupart des stocks du Cap-Breton ces 3 dernières années, la biomasse vierge accumulée s'épuise rapidement et la pêche dépendra à l'avenir de plus en plus des nouvelles recrues. Les additions annuelles à la biomasse par croissance et recrutement semblent variables.

INTRODUCTION

The directed fishery for snow crab around Cape Breton Island was started in 1967 by inshore boats from Cheticamp operating in the 'gully' region of NW Cape Breton; New Brunswick and Quebec-based offshore snow crab boats began to fish in the same area soon after. Cape Breton snow crab landings and fishing effort, in terms of numbers of participating boats, has risen steadily with the expansion of the fishery around almost the whole coastline of the Island (Table 1a and b). Table 2 gives an historical comparison of Cape Breton (Nova Scotia) snow crab landings against those of other Provinces. Management of the Cape Breton crab fishery is by the Area Manager in consultation with the Cape Breton Subcommittee of the Gulf of St. Lawrence Snow Crab Advisory Committee.

Between 1976 and 1978 inshore areas were defined around most of Cape Breton (Fig. 1) for exclusive exploitation by inshore snow crab boats of less than 45 ft (14 m) length. One hundred and sixty-two snow crab licenses were issued to Cape Breton boats in 1980. Additionally, 14 and 5 licenses were allotted for mainland Nova Scotia and Prince Edward Island boats, respectively, to set traps in the S.W. and S. Cape Breton areas (however, only 10 licenses issued to the Nova Scotia mainland (Antigonish) boats were actually utilized; the S.W. area is also fished by the New Brunswick and Quebec offshore snow crab fleets. The offshore fleet also fishes up to the western boundary line abutting the 'gully'.

Cape Breton snow crab boats are generally 30-45 feet (9-14 m) in length and of the "Cape Islander" type. Traps are usually inspected daily, and are set singly on soft mud bottoms at depths ranging from 26-140 fathoms. The most commonly used traps are 5 x 5 x 1.6 feet (1.5 x 1.5 x 0.5 m) metal frames covered in 3-4 inch (7-10 cm) mesh, with two fishing heads. However, Japanese-type conical and wooden crab traps predominate in N.E. Cape Breton. Regulations limit the maximum number of traps per license to 30. In 1980 the Cape Breton snow crab season was approximately 9 weeks in duration, extending from July 15 to September 15. This relatively short season is in accord with the policy of developing this particular fishery as a supplementary fishery with as many participants as possible; the fishery is not intended to provide fishermen with their total or even a substantial part of their annual income.

The major concentration of Cape Breton snow crab appears in the 'gully' region of the N.W. area; 46% of the 1980 Cape Breton landings were reported from these grounds. In 1980, fishermen from N.E. and mid-E. Cape Breton were largely confined to exploiting scattered pockets of snow crab on infrequently occurring patches of mud bottom, while some Cape Breton boats from the mid-E. and S.E. areas ventured over 30 miles offshore in search of deep holes containing commercial concentrations of snow crabs. Fisheries have recently developed for snow crab in the S.W. area, north of St. Georges Bay, and the S. area, east of Chedabucto Bay.

For the 1979 season the total biomass of commercial size snow crabs (males above 95 mm carapace width) available around Cape Breton was estimated at 5,137 MT; landings of 3,225 MT indicated that the exploitation rate for the whole Island was approximately 63% (Elner and Robichaud, 1980). Such high exploitation rates and the fact that catches appeared to have peaked suggested then that most Cape Breton areas had reached or were rapidly approaching full exploitation. Biological TAC's used in area 1, N.W. Cape Breton, in 1979 and 1980 were based on a strategy of attempting to crop the biomass increments so as to maintain a stable stock size; this was recognized as a temporary approach until population parameters could be determined for more detailed modeling. In 1979 and 1980 there was only sufficient biological information available to recommend a TAC for N.W. Cape Breton (Bailey, 1978; Elner and Robichaud, 1980); however, there appears to be adequate biological data forthcoming from the 1980 season for biological advice on 1981 TAC's to be provided for other areas around the Island. The initial TAC imposed for N.W. Cape Breton in 1980 was subsequently raised by 25%, from 80,000 to 100,000 lbs per unit, because the log records from the first two weeks of the season indicated that an unusually large pulse of growth and recruitment had occurred (Appendix I). Apart from in areas 6 and 7, S. and S.W. Cape Breton, respectively, this phenomenum appears not to have been reflected throughout the rest of the Island where 1980 landings were generally reduced and where most fishermen failed to reach a management imposed quota of 80,000 lbs/unit. The 1980 season was also marred by a 'white' (soft-shell) crab problem in the S.W. area and acute marketing problems in all areas, which led to reduced crab prices and some stringent buyer-imposed quotas.

The Cape Breton snow crab fishery is confined to exploiting male crabs of 95 mm carapace width and above. The minimum size limit is well above the 80 mm carapace width size of 100% male maturity (Watson, 1970). Female crabs are effectively excluded from the fishery as they undergo a terminal moult to maturity below the legal size limit. The fact that practically all mature females examined around Cape Breton in 1980 were berried indicates that a high reproductive potential is being maintained in the stocks.

During the 1980 fishing season in-port sampling of landed male snow crabs was carried out for most of the Cape Breton snow crab management areas. In addition, at-sea sampling was carried out from commercial snow crab boats, both before and during the season, by beam trawling from research and charter vessels and by sampling the crab by-catch of danish-seiners. Tagging programs were carried out in areas 1, 2 and 5 between 1978 and 1980. Data from these studies, together with data derived from fishermen's 1980 logbooks, are analyzed in this paper to provide an assessment of the Cape Breton snow crab stocks for management consideration.

MATERIALS AND METHODS

Cape Breton snow crab fishermen are required to maintain logbooks giving details of daily catch weight, effort (in terms of number of trap hauls), trap location* and soak time (Fig. 2). Data from logbooks, together with

*For the 1980 season fishermen were given a grid map (Fig. 2a) and requested to indicate in their logbooks the grid number(s) corresponding to their fishing area(s).

information gathered by in-port and at-sea sampling of snow crabs, before and during the 1980 fishing season, on shell hardness and size-frequencies have been used to assess the biomass, population size structure and exploitation rate of commercial size male snow crabs in each of the 7 Cape Breton Biological/Area Management (B.A.M.) areas (Fig. 1; note differences in B.A.M. area numbering compared to Elner and Robichaud (1980)). Tag return data in 1980 from tagging studies carried out in various areas around Cape Breton in 1978, 1979 and 1980 have enabled additional inputs into this assessment. Two types of tag were used:

1) The spaghetti tag; yellow vinyl tubing tied around the carapace of the crab. Although the spaghetti tag is not retained through ecdysis such tags were still being recovered in 1980 more than 2 years after marking. Spaghetti tags are designed for short-term studies on population size, exploitation rate and movement.

2) The t-bar or anchor tag; a dart-type tag injected into the body of the animal through the edge of the posterior suture line under the carapace or at the base of the fourth walking leg. T-bar tags are designed to be retained by the crab through ecdysis and, hence, give information on growth increments and frequency as well as exploitation rate, population size and long-term movements. However, at the present time, there appears no proven reliable moult-retained tag for snow crabs.

Leslie analysis, based on logbook derived CPUE and catch data, is the principal method used in this report to estimate stock size on the fishing grounds; for some areas tagging studies provide an independent estimate. We acknowledge that Leslie estimates can be biased by the following:

1) Catchability (described by the slope (q) of the Leslie regression) is probably low during premoult, high during postmoult and intermediate during intermoult. Catchability is also affected by temperature (McLeese and Wilder 1958); however, at the depths at which snow crabs are trapped, bottom temperature can be expected to remain fairly constant (catchability should ideally remain constant throughout the fishing season for the application of Leslie analysis).

2) There is pulse recruitment (with moulting) during the fishing season that varies in intensity and date from year to year and place to place.

3) Quality of effort is probably not constant: fishermen are more mobile than the crabs and can move from areas of low CPUE to higher CPUE, but require an increasing CPUE with increasing distance from port. Quality of effort also changes with soak time and as fishermen become more experienced. See Ricker (1975) for detailed account of sources of discrepancy.

RESULTS

Area 1 (northwestern Cape Breton)

The directed fishery for snow crab around Cape Breton Island was started in 1967 by inshore boats from Cheticamp operating in the 'gully' region of area 1; exploitation by offshore boats from Quebec and New Brunswick began in the area soonafter. From 1978 onwards area 1 has been exclusively fished by inshore-based Cape Breton boats. A TAC of 1,406 MT was set for area 1 in 1979 based on an assessment of the 1978 fishery (Bailey, 1978). Similarly, based on the assessment of the 1979 fishery season by Elner and Robichaud (1980), a TAC of 980 MT (80,000 lbs per unit x 27 units) was set for the 1980 season. This latter TAC was subsequently raised to 1,224 MT (100,000 lbs per unit x 27 units) because of an apparently relatively high mean CPUE in the area during the initial weeks of the season, which indicated that a substantial pulse of inter-season recruitment had occurred [see Appendix I for details]. The number of license holders in this fishery has remained constant at 27 since 1979 (Table 1). The 1980 assessment is presented below.

Port and at-sea sampling:

Catch size-frequency histograms for landed male snow crabs were obtained from in-port sampling carried out in July and August, 1980 [Fig. 3]. Histograms of catch size frequencies of male snow crabs from at-sea sampling performed in July and August, 1980 are also shown in Fig. 3. Values for mean carapace width, for both at-sea and in-port samples, indicate a decrease in the average size of crabs caught through the season. Data for frequency of occurrence of hard, intermediate and soft-shelled crabs, as determined from at-sea samples in 1980, may indicate a small moulting peak in the third week of the season, late July [Fig. 4].

In addition to sampling from commercial crab boats during the fishing season, beam trawling (3-m beam trawl) was carried out in area 1 from a chartered trawler ("G.C. Gorton") during the period July 8-10, 1980. Unfortunately, the beam trawl did not perform as well as anticipated and caught only 182 female and 28 male snow crabs in twenty-three 30-minute tows (6.5 crabs tow^{-1}) at 2-4 knots on proven commercial crab ground. Size frequencies for the male crabs trawled are shown in Fig. 5. Additional pre-season size frequencies of male snow crabs, sampled on May 8, 1980 in a danish seiner's by-catch, are shown in Fig. 6.

Logbooks

Analysis of the 1980 logbooks from all 27 of the licensed area 1 snow crab fishermen was performed by the Leslie method, plotting CPUE (kg trap haul^{-1}) against cumulative catch (kg) for weekly intervals throughout the fishing season (Table 3; Fig. 7). The generally stable CPUE during the initial weeks of the season, despite significant landings may reflect biomass additions into the fishable stock through growth and recruitment. This phenomenon is also evidenced by our data for the frequency of occurrence of soft-shelled crabs in the at-sea samples [Fig. 4]. Similarly, Bailey (1978) and Elner and Robichaud (1980) reported an addition of biomass into the area 1 stock during the same time of year in 1978 and 1979, respectively.

A linear regression through the data for the final 7 weeks of the 1980 season, after the postulated pulse of growth and recruitment, gives an estimate of the total usable stock of commercial size male crabs (B_T) (found by the intercept of the regression line on the x-axis) of 1,838.4 MT

(95% confidence limits: 1,598.5 and 2,300.7 MT)*. By subtraction of the total of the 1980 catch (C) for area 1, (1,104.8 MT, derived from logbooks, Table 3) we estimate that 733.6 MT (95% confidence limits: 493.7 and 1,195.9 MT) were left on the grounds when the fishery closed. If natural mortality is assumed to be not significant during the fishing season (i.e. a Type I fishery, as per Ricker (1975)) this fishery is suffering an exploitation rate (E) [$E = C/B_T$] of 60% (95% confidence limits: 69% and 48%) (F, instantaneous rate of fishing mortality, values: 0.92, 1.17-0.65).

For the initial week of the area 1 fishing season the mean CPUE was 112.05 kg.trap haul^{-1}, giving an estimate for the fishable stock present at this time (B_1) as 1,418.2 MT (from, B_1 = CPUE/q). Given that 1,838.4 MT was the total usable stock (B_T), from the initial fishable stock size at the beginning of the season (B_1) we can estimate a net stock increase of 420.2 MT due to growth and recruitment during the fishing season. This biomass increase represents 29.6% of the initial available biomass (B_1) and 22.9% of the total (B_T). Unfortunately, as the 1980 fishing season opened in mid-July, later than in previous years (Table 1), it is not possible to directly compare the intra-season biomass increase in 1980 with intra-season biomass increases of 1,189 MT and 790 MT in 1978 and 1979, respectively (Bailey, 1978; Elner and Robichaud, 1980).

Elner and Robichaud (1980) calculated that 847.9 MT of usable stock remained on the area 1 grounds at the close of the 1979 fishing season. Thus, a substantial difference of 570.3 MT (67.3% of the stock left at the end of 1979) is estimated to have been added to the grounds, presumably through recruitment and growth, between the end of the 1979 fishing season and the start of the 1980 fishing season. An inter-season biomass increase of 373.7 MT was calculated to have occurred between the 1978 and 1979 fishing seasons.

Tagging

During the pre-season period, June 8, 10 and 11, 1980, in area 1 (grid nos: 173, 193, 212), 2,500 and 251 male snow crabs of legal size (95 mm carapace width) and above were tagged with posterior suture t-tags and spaghetti tags, respectively. Figure 8 shows the size frequency of the tagged crabs and the 369 recaptured crabs. Although the primary objective of the tagging study was to test the ability of the t-tag to be retained through ecdysis a biomass estimate has been performed based on the tag return data.

A Leslie analysis of the tagging data [Fig. 9, Table 4] (excluding an abnormally high set of doubtful tag returns during the final 2 weeks of the season) gives an exploitation rate of 48.1% (95% confidence limits: 65.7% and 25.2%) and a catchability (q) of 5.05123×10^{-5}. A Peterson

---

*Conversely, a linear regression through all data points, assuming that no significant growth or recruitment occurred during the fishing season, gives a value for total initial biomass (B_0) of 2,330 MT (95% confidence limits: 1,899.0 and 3,219.3 MT); values which indicate an exploitation rate of 47% (95% confidence limits: 58% and 34%).

estimate of biomass (B_1) can be obtained for the initial week of the fishery:

$$B_1 = \frac{C_{1-7} \times M_1}{R_{1-7}} = \frac{1041.55 \text{ MT} \times 767}{336} = 2377.59 \text{ MT}$$

where: C_{1-} = Catch in weeks 1-7 of the fishing season

M_1 = Apparent number of animals tagged (from Leslie analysis of tagging data

R_{1-7} = Number of tags returned during weeks 1-7 of the fishing season.

These tagging estimates of exploitation rate, catchability and biomass can be compared with estimates derived from logbook data. The tagging estimates most closely match the logbook estimates that ignore in-season biomass additions; however, it should be taken into account that if significant moulting occurred during the fishing season (as shell hardness data indicates, Fig. 4) biomass calculations from tagging will be overestimates.

All recaptured animals were trapped in the general area of release.

Area 2 and 3 (northeastern Cape Breton [supplemented by area 4])

Northeastern Cape Breton is divided into two relatively small management areas (2 and 3) that, for the purpose of biological assessment, were treated as a single area in studies of the 1978 and 1979 fishing seasons (Elner and Robichaud, 1980); the same approach has been continued in the following assessment for the 1980 fishery. In addition, logbook data from 14 boats licensed to fish in area 4, middle-eastern Cape Breton, are included in the northeastern Cape Breton assessment as they fished in the area immediately adjacent to area 3 due to the paucity of snow crab in the remainder of area 4. The inclusion of area 4 logbooks in the northeastern area assessment is justified by Fig. 10 which indicates that a negligable amount of effort was expended in portions of area 4 not abutting area 3 during the 1980 fishing season.

Catch size-frequency distributions from in-port and at-sea sampling in areas 2 and 3 and in the boundary zone of area 4 during July and August 1980 are shown in Fig. 11. Mean crab size, as determined from in-port and at-sea sampling appeared to remain essentially constant through the fishing season. Figure 12 shows a decrease in the frequency of soft-shelled male crabs in the landed catch as the season progressed. In contrast, Elner and Robichaud (1980) noted a trend for an increase in the frequency of occurrence of soft-shelled crabs towards the end of the 1979 season. Such observations indicate the variable nature of the moulting period for male snow crabs.

Logbooks

Fishermen from northeastern Cape Breton use wooden 4x3x2.5 ft (1.2x0.9x 0.8 m) traps, Japanese conical traps and limited numbers of standard metal rectangular traps (1.5x1.5x0.5 m). Therefore, to standardize the unit of effort for CPUE purposes, all trap data were converted to wooden trap units (Bailey, 1978) as these were the most common trap in the area.

Three logbooks were received from the 13 licensed fishermen in area 2, and 25 logbooks from the 36 licensed fishermen in area 3; in addition, 14 logbooks were analyzed from area 4 boats that fished directly adjacent to area 3. Part of the discrepancy between the number of logbook returns and the number of license holders could be due to the fact that northeastern Cape Breton licensed fishermen sometimes pair-up in one boat for the fishing season to economize on fuel. Total landings for the 1980 season for the northeastern Cape Breton area (including relevant area 4 statistics as indicated from logbooks received) were 181.0 MT, as opposed to 251.7 MT derived by the Cape Breton Area Manager from sales slip returns.

CPUE, plotted against cumulative catch, demonstrates a steady decline throughout the fishing season; indicating that no significant biomass pulse occurred during this period (Fig. 13, Table 5). A linear regression through all the data points gives an initial useable biomass estimate (B_0) of 225.2 MT (95% confidence limits: 200.1 and 267.5 MT) by the Leslie technique. By subtraction of the total 1980 catch for northeastern Cape Breton (181.0 MT derived from logbooks) we calculate that 44.2 MT (95% confidence limits: 19.1 and 86.5 MT) of commercial snow crabs were left on the grounds when the fishery closed.* If natural mortality was not significant during the fishing season this catch is equivalent to an exploitation rate of 80.4% (95% confidence limit: 90.5% and 67.7%) (F values 1.63, 2.35-1.13).

Elner and Robichaud (1980) calculated that 164.0 MT of usable stock remained on the northeastern Cape Breton grounds at the close of the 1979 fishing season; for the same area we estimate that 225.2 MT was the total initial stock for the 1980 fishing season. Thus, 61.2 MT of growth and recruitment (a 37% increase in fishable biomass) can be presumed to have occurred between the two seasons. Elner and Robichaud (1980) reported biomass increases in the commercial stock during the 1978 and 1979 fishing seasons; no such biomass increase appeared in the 1980 season.

Tagging

In area 3 a total of 1,077 male snow crabs were tagged with a non-moult retained vinyl body tag (see Elner and Robidhaud 1980 for details). One hundred and forty-two tags were returned in 1979 and a further 83 tags were returned during the 1980 fishing season. Figure 14 illustrates the size frequency of the recaptured crabs; it is noteworthy that a proportion of smaller crabs tagged had not moulted in the approximate 12 month period subsequent to tagging. Because of the paucity of the tag returns and inherent unreliability no population estimate was attempted from the 1980 tagging data.

---

*Note: these analyses are based on logbook records; underreported catches in the logbooks will produce an underestimate of commercial biomass but exploitation rates will still be realistically reflected.

Area 4 (middle eastern Cape Breton)

The snow crab fishery in area 4 probably began in 1977, although there are no fishery data prior to the assessment of the 1979 fishery season by Elner and Robichaud (1980). Elner and Robichaud (1980) considered area 4 as a single stock in their Leslie biomass estimates for the 1979 season. However, from the map (Fig. 10) showing the distribution of fishing effort, from logbook data, it is apparent that most fishing is concentrated at the boundary to area 3 and that areas 3 and 4 should not be considered to contain separate stocks. Hence, logbooks for 14 area 4 vessels that fished adjacent to the area 3 boundary (out of the 38 licensed vessels in area 4) have been included in the assessment for areas 2 and 3. Limited data from a remainder of four logbooks from vessels which fished well away from the area 3 boundary are presented below.

Generally, there was a severe malaise in the middle-eastern Cape Breton snow crab fishery over the 1980 season caused by the poor marketing situation (which made it difficult for fishermen to sell their crab catch) and a scarcity of crabs on the grounds which prompted many fishermen to leave crabbing for more profitable pursuits.

During the 1980 season area 4 was subject to a management imposed quota of 80,000 lbs/unit to limit effort.

Port and at-sea sampling

During the 1980 fishing season catch size-frequency histograms for male crabs were obtained from in-port sampling in July and August and from at-sea sampling on commercial boats fishing around grid square 316 (Fig. 15). No meaningful changes in mean crab size are apparent. Limited data on shell hardness are shown in Fig. 16 and indicate an increase in the frequency of soft and intermediate shell crabs over the initial 3 weeks of the fishing season (a 'white' crab problem in this area was reported by a newspaper, Appendix II).

Logbooks

Landings by all area 4 boats, as determined from the 18 logbooks received were 62.9 MT, this compares to the 181.2 MT ascertained from sales slips by the Cape Breton Area Manager (507 MT were landed by area 4 boats during the 1979 fishing season).

Analysis of four logbooks from area 4 boats which fished in and around square 316, 317, 331 [Fig. 2a] is presented in Table 6. The boats stopped fishing after 3 weeks because of the uneconomical catches; the limited data precludes the possibility of a meaningful biomass estimate.

Area 5 (southeastern Cape Breton)

The snow crab fishery in southeastern Cape Breton, area 5, began in 1977. Stock assessments of the area, based on the 1978 and 1979 logbook and sampling data, were made by Elner and Robichaud (1980). A management imposed TAC of 80,000 lbs.unit^{-1} was imposed on area 5 during the 1980 season to limit effort. An assessment of the 1980 fishing season is presented below.

Port and at-sea sampling:

Size-frequency histograms from in-port and at-sea sampling of catches during July and August are shown in Fig. 17. Mean carapace width, as determined from in-port and at-sea sampling, appeared to remain relatively constant between July and August. The frequency of soft-shelled crabs, as determined from in-port sampling, appeared to remain at a low level throughout the fishing season [Fig. 18].

The Nova Scotia Department of Fisheries carried out 12 days of pre-season trapping in area 5 between January 7-February 19, 1980; a size-frequency histogram of the catch is shown in Fig. 19. Eggs on 98.7% (298) of the berried females caught during the study were well developed with prominent eye-spots; 1.3% (4) of the females had recently hatched eggs. In a beam trawl sample from the J.L. Hart on May 25, 1980, in the same area, all of the females caught (6) had new bright orange eggs. Therefore, it would appear that the majority of female crabs in area 5 probably hatched their eggs between February and May, 1980.

Logbooks

Twenty-one logbooks were received from the 26 snow crab fishermen in area 5 in 1980. Total 1980 season landings as indicated by the logbooks were 324.8 MT, as opposed to a value of 395.9 MT derived from the Area Manager's sales slip statistics. A Leslie analysis based on a linear regression through all data points for the season [Table 7; Fig. 20] gives an estimate of total initial usable biomass (B_0) of 542.8 MT (95% confidence limits: 458.0 and 702.3 MT). The rise in CPUE during mid-August may have been due to an addition of biomass through growth and recruitment (a similar rise was noted by Elner and Robichaud (1980) during the latter half of August, 1979) but as this possibility is unsupported by soft-shell frequency data [Fig. 18] the phenomenon is ignored in this assessment. With a total catch during 1980 of 324.8 MT, the area 5 exploitation rate can be calculated at 59.8% (95% confidence limits: 70.9% and 46.3%) (F values: 0.91, a.23-0.62). By subtraction, 218.0 MT were left on the ground at the end of the 1980 fishing season.

The estimate of initial biomass (B_0), 542.8 MT, at the start of the 1980 fishery is only 40.8 MT (8.1%) greater than that calculated to have remained at the end of the 1979 season by Elner and Robichaud (1980). These data suggest that most male snow crabs in area 5 had not moulted in or between the 1979 and 1980 fishing season; a situation that has probably led to a recruitment failure in the area.

Tagging

In area 5, a total of 2,010 male snow crabs were tagged in July, 1979 with non-moult retained vinyl body tags (see Elner and Robichaud, 1980 for details). A total of 1,144 tags were returned during the 1979 season and a further 167 during the 1980 fishing season. Figure 21 shows the size frequency of crabs returned during 1979.

Assuming no moulting occurred from the time the crabs were tagged until the end of the 1980 fishing season, 1980 tag return data can be analyzed: A Leslie analysis using the limited 1980 tag return data [Fig. 22, Table 8] gives an exploitation rate of 48.7% (95% confidence limits: 64.5% and 0%). A Peterson estimate of biomass (B_1) can be obtained for the initial week of the fishery by:

$$B_1 = \frac{C_{1-q} \times M_1}{R_{1-q}} = \frac{319.2 \text{ MT} \times 345}{168} = 653.2 \text{ MT}$$

where: C_{1-q} = Catch in weeks 1-9 of the fishing season.

M_1 = Apparent number of animals tagged (from Leslie analysis of tag data)

R_{1-q} = Number of tags returned during weeks 1-q of the fishing season.

These tagging estimates of exploitation rate and biomass compare favourably with estimates derived from logbook data.

Area 6 (south Cape Breton)

The commercial fishery for snow crab in south Cape Breton, area 6, began in 1979 with inshore permits being issued to 8 boats; 11 licenses were issued in the area for the 1980 fishing season. Elner and Robichaud (1980) assessed landings and logbook data from the 1979 season, an assessment of the 1980 season is presented below.

Port and at-sea sampling

Due to limited numbers of sampling personnel, no catch size-frequency data was collected from area 6 during the 1980 fishing season.

Logbooks

The total catch in area 6 during the 1980 season was 69.2 MT, as determined from logbook returns (as opposed to 58.6 MT recorded through the Area Manager's sales slip system). Leslie analysis of CPUE and cumulative catch data from 9 logbooks [Table 9; Fig. 23] for the final 5 weeks of the fishing season gives an estimate of the total initial commercial biomass (B_1) for the season of 176.5 MT (95% confidence limits: 118.4 and 581.9 MT). CPUE in the initial 4 weeks of the season generally increased and these data have been ignored in the Leslie analysis. The increase in CPUE possibly reflected the increasing skill of the relatively novice crab fishermen in locating crab concentrations rather than any biological phenomena (such as increases in biomass and/or catchability). During the 1979 season a similar erratic trend in area 6 CPUE data was observed (Elner and Robichaud, 1980) and may have been explained by the fishermen being able to move their traps to more productive virgin grounds when their catches decreased.

A total 1980 catch for area 6 of 69.2 MT gives an exploitation rate of 39.2% (95% confidence limits: 58.5% and 11.9%) (F values: 0.50, 0.88-0.12). By subtraction of the total catch from the total biomass (B_0), 107.3 MT (95% confidence limits: 49.2 and 512.7 MT) of commercial crabs remained on the fishing grounds at the end of the 1980 season.

Elner and Robichaud (1980) estimated that 42.0 MT (95% confidence limits: 17.8 and 210.0 MT) of commercial crabs were left on the area 6 grounds at the finish of the 1979 season; hence, a substantial difference of (176.5-42.0) MT = 134.5 MT (320.2% of the end of season stock in 1979) appears to have been added to the area stock between the 1979 and 1980 seasons. However, this evidence of inter-season biomass increase should be viewed with great caution in view of the wide confidence limits inherent in the 1979 and 1980 assessments, as well as the possibility that the fishermen in 1980 trapped over a larger area than in 1979.

Area 7 (southwestern Cape Breton)

Southwestern Cape Breton, area 7, was opened to commercial snow crab fishing by Cape Breton inshore boats for the first time in 1979. However, the area was probably exploited by the New Brunswick- and Quebec-based offshore snow crab fleet for several years previous to 1979 and is presently the only area adjacent to Cape Breton Island that is fished legally by offshore boats. The area 7 fishery is unique in that the grounds are in relatively shallow water compared to other Cape Breton snow crab fishing areas. An assessment for the 1980 season based on in-port and at-sea sampling as well as logbook returns from inshore boats is presented below.

Port and at-sea sampling

At-sea sampling in area 7 was carried out from commercial boats in July, August and September, 1980 [Fig. 24]. Figure 24 also shows in-port sampling data for the same period. Mean carapace widths, for both sampling types, show no meaningful changes during the course of the season.

In-port and at-sea sampling data on shell condition [Fig. 25] show an almost 100% frequency of occurrence of soft and intermediate shelled ("white") male crabs at the start of the season; the frequency gradually declined to approximately 70% by the end of the fishing season. "White" crabs are frail, have a low meat:wet weight ratio and produce a poor quality product when processed; fishermen had problems selling these crabs in an already difficult market situation (Appendix II).

Logbooks

Twenty-two logbooks were received from the 25 licensed inshore fishermen in area 7. The total catch through the 1980 season, as derived from logbook data was 495.1 MT, as opposed to 519.2 MT recorded by the Area Manager's sales slip system (212.8 MT were landed in 1979). CPUE plotted against cumulative catch data [Table 10] derived from the logbooks is shown in Fig. 26. The failure of CPUE to decline over the fishing season probably reflects the large additions of biomass from growth and recruitment into the stocks and precludes the use of a Leslie biomass estimate for the area.

Levels of landings and effort (no. of trap hauls) by area 7 inshore boats in 1980 are more than double the 1979 values while CPUE remained approximately the same as in 1979. (No account has been taken of the probably substantial unrecorded catches by the offshore snow crab fleet in area 7, or of the possibility that some area 7 boats might have set traps on the more productive area 1 grounds).

DISCUSSION AND OVERVIEW

Area 1 (northwestern Cape Breton)

The TAC's for 1979 and 1980 were largely based on the premise of taking the biomass from growth and recruitment without affecting standing stock. A similar strategy for 1981, assuming that inter- and intra-season biomass pulses were the same magnitude as those in 1979/80, would result in a TAC of (581.9+420.2) MT = 1,002 MT.

However, despite a seemingly conservative approach to management, total available stock has apparently declined from 3,016 MT in 1978 (Bailey, 1978), to 2,239 MT in 1979 (Elner and Robichaud, 1980) to 1,838 MT in 1980. Notwithstanding this apparent decline in total available stock, the fishermen insist that the crabs are as plentiful as ever* (a claim reflected by danish-seiners and 'draggers' that report high incidental crab catches in the area) and that declines in CPUE throughout the season, as utilized in the Leslie biomass estimates, are a result of fishermen economizing on fuel and exploiting less productive grounds nearer port as they approached their TAC. Marketing problems that led buyer imposed quotas on catches through the 1980 season may also have influenced fishing patterns and CPUE. In view of such possibly complicating factors and the facts that the Leslie biomass analysis used relies on in-season biomass addition and on even fishing patterns throughout the season a 1981 TAC remaining at the revised 1980 level of 1,224 MT may be argued for.

The possibility that all area 1 boundaries were encroached by crab boats from other areas during the 1981 season (resulting in unrecorded catches would give additional support for a more liberal TAC).

Areas 2 and 3 (plus 4) (northeastern Cape Breton)

CPUE dropped rapidly through the 1980 season and attained values well below those of 1978 and 1979. No in-season biomass pulse, as occurred in 1978 and 1979, was detected for 1980. Total initial stock on the grounds at the start of the 1980 season appeared 61.2 MT greater than that estimated to have been left at the end of the 1979 season.

---

*catchability (q) has increased from 4.73×10^{-5} (1978), to 5.802×10^{-5} (1979) to 7.836×10^{-5} (1980).

Only 40.9 MT of commercial snow crab was estimated to remain on the northeastern area fishing grounds at the end of the 1980 season (in comparison, the total biomass available during the 1979 was assessed at 426.3 MT by Elner and Robichaud, 1980), there was an exploitation rate of approximately 80% during the 1980 season. In summary this stock can be considered collapsed and the rate of recovery will be based largely on future recruitment patterns.

A minimal TAC is recommended for 1981 supplemented by a large decrease in fishing effort.

Area 4 (middle eastern Cape Breton)

The limited data available from area 4 for the 1980 fishing season and the redefinition of stocks for areas 2, 3 and 4 preclude meaningful biomass estimates and comparison with the 1979 season. Shell hardness data (Fig. 16) indicate that some in-season growth and recruitment occurred in area 4 during 1980, although low landings and CPUE data suggest that the stocks are in a collapsed state.

The rapid decline in area 4 snow crab stocks since the inception of the fishery in 1977 suggests that the original fishery was based on a slow growing virgin biomass that had accumulated on marginal grounds*. Now that this accumulated biomass has probably been 'fished out' the fishery in future years will be largely based on unpredictable influxes of new recruits (with a possible consequential escalation of the 'white crab' problem in the area) and on discoveries of pockets of crabs in deep holes over 20 miles from the coast.

We can offer no biological advice on management quotas apart from suggesting that the minimum possible TAC's be imposed until the stocks show signs of recovery.

Area 5 (southeastern Cape Breton)

The total initial available biomass in area 5 has declined markedly from 1,185 MT in 1979 to 542.8 MT in 1980. Mean CPUE shows a similar declining trend from 1978 to 1980 (Elner and Robichaud, 1980). Substantial recruitment apparently occurred between the 1978 and 1979 seasons; however, with an apparent growth and recruitment failure between 1979 and 1980 coupled with a high exploitation rate the stocks are now in a critical state. During the 1980 fishing season fishermen were largely dependent on exploiting scattered deep pockets of crabs at considerable distances from port [Fig. 10]. Stock recovery will largely depend on future recruitment pulses. If the fishery is not to become dependent on the vagaries of recruitment patterns fishing effort must be reduced to allow stocks to rebuild.

Biological-based TAC's for Cape Breton have previously been advised on the logic of only cropping the equivalent of the annual biomass increments from growth and recruitment to preserve a large standing stock. On such a basis the 1981 TAC for area 5 would only be 40.8 MT (3,450 lbs unit^{-1}), as opposed to the 1980 TAC which allowed 80,000 lbs unit^{-1} x 26 units.

*A similar situation can be hypothesized for areas 2 and 3.

Area 6 (southern Cape Breton)

Area 6 supports a developing, relatively small-scale fishery. Catches during the 1980 fishing season of 69.2 MT out of a total initial available biomass of 176.5 MT resulted in an exploitation rate of 39.2%. 134.5 MT is estimated to have been added to the area 6 stocks through growth and recruitment between the end of the 1979 fishing season and the start of the 1980 season. Assuming the same rate of recruitment before the 1981 season, the total initial biomass available to the 1981 fishery will be: [(176.5-69.2) + 134.5] MT = 241.8 MT; this compares favourably to the 69.4 MT thought to have been available to the 1979 fishery. However, due to the lack of a long-term, sound information base on this fishery and in view of the rapid stock decline in other areas of Cape Breton a more prudent TAC than the estimated 1979-80 inter-season biomass pulse of 134.5 MT is recommended.

Area 7 (southwestern Cape Breton)

Population assessments in area 7 are normally made difficult due to the unrecorded exploitation of the grounds by the offshore snow crab fleet. Realistic biomass estimates for 1980 and prognoses for 1981, based on logbook data, are made impossible due to the massive biomass influx, from moulting, throughout the 1980 fishing season. Although, assuming that catchability was the same, or less, in 1980 than in 1979, mean CPUE data indicate that the commercial stock was considerably larger in 1980 than in 1979. However, notwithstanding the fact that the area 7 stock may presently be deemed underexploited, our lack of understanding of recruitment patterns for the area should dictate a conservative 1981 management strategy. A substantial change in the dates of the 1981 fishing season should be considered as a method of avoiding the 'white crab' quality problem of 1980.

GENERAL DISCUSSION AND CONCLUSIONS

In view of this assessment of the 1980 Cape Breton snow crab fishery, compared to 1978 and 1979 assessments, it is apparent that:

a) Moulting of sub-legal male crabs through legal size (recruitment) is very variable both in magnitude and in time of occurrence from year to year; and b) Growth is probably much slower than originally thought and a significant proportion of males probably miss annual moult(s) and/or attain a maximum size well below the postulated L_∞. (approximately 170 mm carapace width).

Intuitively, it appears necessary to re-think the Cape Breton management strategy of attempting to maintain a constant of commercial stock biomass whilst reaping only catches equivalent to the annual biomass increment(s), because:

(a) Presently, it is impossible to predict biomass increments, from growth and recruitment, from year to year; and

(b) Significant annual biomass increases do not always occur.

It appears probable with the present effort capability of the Cape Breton snow crab fleet that the standing stock of commercial-size male snow crabs around Cape Breton Island will be extinguished within the next few seasons and the fishery will be reduced to cropping annual biomass pulses of moulting males into the commercial size range (with the associated risk of escalating the 'white crab' problem).

In order to optimize harvesting, immediate pre-season biomass assessments of the commercial stocks in the various Cape Breton areas appear necessary, coupled with a flexible TAC system that can be altered on the basis of initial weeks CPUE data.

Research on factors influencing recruitment strength and growth, so that recruitment patterns can be predicted, is a high priority.

ACKNOWLEDGEMENTS

We are much indebted to Mr. Greg Roach, Nova Scotia Department of Fisheries, for valuable assistance and provision of manpower for sampling. Dr. Robert Miller and Mr. David Taylor critically reviewed earlier drafts of the manuscript.

REFERENCES

Bailey, R. 1978. Analysis of the snow crab population in northwestern Cape Breton, 1978. CAFSAC Res. Doc. 1978/41: 16 p.

Elner, R. W., and D. A. Robichaud. 1980. Analysis of the Cape Breton snow crab fishery, 1979. CAFSAC Res. Doc. 1980/55: 44 p.

McLeese, D. W. and D. G. Wilder. 1958. The activity and catchability of the lobster (*Homarus americanus*) in relation to temperature. J. Fish. Res. Board Can. 15: 1345-1354.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish population. Bull. Fish. Res. Board Can. 191: 382 p.

Watson, J. 1970. Maturity, mating and egg-laying in the spider crab, *Chionoecetes opilio*. J. Fish. Res. Board Can. 27: 1607-1616.

Table 1a). Snow Crab Statistics for Cape Breton 1977, 1978 and 1979.

Area	Year	No. of boats	Kg landed (log books)	Kg landed Area Mgrs' statistics	Effort in trap hauls from log books (trap type)	Quota in M.T.	Exploitation rate (95% confidence limit): log book	Exploitation rate (95% confidence limit): tagging	Commercial biomass (B) estimates from Leslie analysis of CPUE from log books (95% confidence limits): Total available B for the season (M.T.)	Commercial biomass (B) estimates from Leslie analysis of CPUE from log books (95% confidence limits): B at the end of the season (M.T.)	Commercial biomass (B) estimates from Leslie analysis of CPUE from log books (95% confidence limits): Prediction of B for following season (M.T.)	Fishing season
8	1977	8*	-	-	-	-	-	-				June-30/9
northwest	1978	14*	1,941,000	-	26,301 (1.5x1.5x0.5 m)	-	64.4% (55-71)	65.3%	3016 (2722-3555)	1075 (780-1592)	2188 (1863-2759)	22/6-30/9
	1979	27*	1,390,765	1,390,016	20,436 (1.5x1.5x0.5 m)	1,406	62.1% (51-80)	55%	2238.7 (1734-2714)	848 (343-1323)	1769 (-)	1/7-30/9
9	1978	15*	250,076	-	4,531 (1.5x1.5x0.5 m)	-	57% (39-71)	-	440 (352-637)	190 (102-387)	-	July-30/9
9 + offshore southeast	1979	15*+10(?)	682,731	495,435 (no offshore)	14,747 (1.5x1.5x0.5 m)	-	57.5% (50-64)	64.5%	1185 (1060-1367)	502 (377-684)	-	20/7-30/9
10	1977	25 (?)	-	-	-	-	-	-	-	-	-	-
northeast	1978	27 (36)*	192,228	-	17,258 (1.2x0.9x0.8 m)	-	-	-	-	-	-	July-30/9
	1979	40 (48)*	262,250	293,106	25,660 (1.2x0.9x0.8 m)	-	61.5%	71.0%	426 (-)	164 (-)	216.5 (-)	20/7-30/9
11 + offshore middle east	1979	14(38)*+5(?)	507,569	469,600 (no offshore)	10,546 (1.5x1.5x0.5 m)	-	64.2% (70.6-56.9)	-	790 (718-891)	283	-	20/7-30/9
12 southwest	1979	15*	212,800	213,326	4,449 (1.5x1.5x0.5 m)	-	49.7% (67.7-16.4)	-	428 (314.5-130)	215.2	-	1/7-30/9
13 south	1979	8*	27,351	24,868	1,880 (1.5x1.5x0.5 m)	-	39.4% (11.5-60.6)	-	69.44 (45.2-237.4)	42	-	21/7-30/9
offshore	1979	15(27)*	324,048	338,499	6,272 (1.5x1.5x0.5 m)	-	-	-	-	-	-	21/7-30-9

*Actual number of boats
(?) Probably lower than the actual number of boats.

Table 1b). Snow Crab Statistics for Cape Breton 1980.

Area (Equivalent area in 1979)	No. of boats	Kg landed (log books)	Kg landed Area Mgrs' statistics	Effort in trap hauls from log books (trap type)	Quota in M.T.	Exploitation rate (95% confidence limit): log book	Exploitation rate (95% confidence limit): tagging	Commercial biomass (B) estimates from Leslie analysis of CPUE from log books (95% confidence limits): Total available B for the season (M.T.)	Commercial biomass (B) estimates: B at the end of the season (M.T.)	Commercial biomass (B) estimates: Prediction of B for following season (M.T.)	Fishing season
1 (8)	27	1,104,783	1,157,998	12,360 (1.5x1.5x0.5 m)	-	60% (69-47)	48.1% (65.7-25.2)	1848 (2354-1596)	46 (494.6-252.1)	-	15 July-15 Sept.
2 (10)	13	9,365	46,919	-	-	-	-	- -	- -	-	"
3 (10)	36	131,945	139,686	*16,499 (1.2x0.9x0.8 m)	-	*79% (90-64)	-	191.3 (236-167)	40.9 (85.8-16.5)	-	"
4 (11)	38	102,582	181,241	827 (1.5x1.5x0.5 m)	-	-	-	- -	- -	-	"
5 (9)	26	324,786	395,855	7,341 (1.5x1.5x0.5 m)	-	59% (70-45)	48.7% (64.5-)	542.8 (702-458)	218 (133.2-377)	-	"
6 (13)	11	63,510	58,586	5,246 (1.5x1.5x0.5 m)	-	36% (54-11)	-	177 (582-119)	107.9 (512.8-48.9)	-	"
7 (12)	25	494,980	519,248	10,242 (1.5x1.5x0.5 m)	-	-	-	- -	- -	-	"
Total	176	2,23[illegible],951	2,499,533	52,515	-	-	-	- -	- -	-	-

These estimates include boats from areas 2 and 4.

Table 2. Atlantic Canada annual snow crab landings (kg), from Statistics Canada, with Maritimes figures updated at St. Andrews.

Year	New Brunswick	Nova Scotia	Prince Edward Island	Maritimes total	Quebec	Nfld.	Gulf of St. Lawrence (excl. N.S.)	N.S. as % of Maritimes	Atlantic Canada total
1966	15,991	-	-	15,991	14,107	-	30,098	-	30,098
1967	220,620	240,934	28,492	490,046	6,396	-	255,508	49.2	496,442
1968	3,519,793	712,882	334,672	4,567,347	368,725	93,000	4,223,190	15.6	5,029,072
1969	6,318,287	98,120	31,463	6,447,870	1,456,032	319,000	7,805,782	1.5	8,222,902
1970	4,961,382	90,488	-	5,051,870	1,591,157	891,000	6,552,539	1.8	7,534,027
1971	4,578,339	-	-	4,578,339	827,171	1,380,000	5,405,510	-	6,785,510
1972	4,562,304	51,456	-	4,613,760	619,743	1,484,000	5,182,047	1.1	6,717,503
1973	5,907,528	121,881	-	6,029,409	896,888	2,622,370	6,804,416	2.0	9,548,667
1974	5,694,614	216,907	-	5,911,521	1,030,607	3,103,434	6,725,221	3.7	10,045,562
1975	4,049,963	378,883	-	4,428,846	600,466	1,820,099	4,650,429	8.6	6,849,411
1976	6,086,176	489,490	-	6,575,666	1,517,619	2,406,343	7,603,795	7.4	10,499,628
1977	7,329,473	936,297	-	8,265,770	2,082,475	3,750,806	9,411,948	11.3	14,099,051
1978	7,936,609	3,189,061	-	11,125,670	3,382,985	7,427,591	11,319,594	28.7	21,936,246
1979	11,034,315	3,225,000**	452,612*	14,711,927	998,010(?)	11,030,415	12,484,937	21.9	26,740,352
1980		2,499,533**	-	-	-	-	- -	-	-

(?) Probably substantially underreported.
* Landed on P.E.I. by N.B. boats.
** Area Manager's statistics.

Table 3. Catch and effort statistics for the snow crab fishery in area 1 (northwestern Cape Breton) 1980.

Week period	Effort (trap hauls) steel traps (1.5x1.5x0.5 m)	CPUE (kg/trap haul)	Catch (MT)	Estimated* biomass (MT)
1. 15-21 July	1672	112.05	187.4	1418
2. 22-28 July	2482	95.67	237.4	1212
3. 29 July-4 Aug.	2033	104.74	212.9	1326
4. 5-11 August	1777	86.67	154.0	1097
5. 12-18 August	743	76.07	56.5	963
6. 19-25 August	1673	76.18	127.5	964
7. 26 Aug.-1 Sept.	908	72.51	65.8	918
8. 2-8 September	691	62.49	43.2	791
9. 9-15 September	381	52.62	20.1	666
Total	12360	-	1104.78	-

*Estimated biomass $= \frac{\text{CPUE}}{q}$

q = catchability coefficient from Leslie analysis.

Table 4. Tag returns from the snow crab fishery in area 1 (northwestern Cape Breton) 1980.

Week period	Number of tag returns
1. 15-21 July	58
2. 22-28 July	95
3. 29 July-4 August	55
4. 5-11 August	48
5. 12-18 August	19
6. 19-25 August	42
7. 26 August-1 September	19
8. 2-8 September	26
9. 9-15 September	7
Total	369

Table 5. Catch and effort statistics for the snow crab fishery in areas 2 and 3 (northeastern Cape Breton), supplemented by area 4 (middle-eastern Cape Breton) 1980.

	EFFORT (trap hauls)							
Week period	Large square wooden traps (1.2x0.9x0.8 m)	Conical traps	Large steel traps (1.5x1.5x.5 m)	More than one type fished by same boat	All traps converted into wooden traps	CPUE kg/trap haul (wooden traps)	Catch (MT)	Estimated biomass (MT)
1. 15-21 July	1522	714	512	600	3136	15.6	48.9	184
2. 22-28 July	1688	677	794	570	3752	13.49	50.6	159
3. 29 July-4 Aug.	1518	635	681	487	2156	11.51	36.3	136
4. 5-11 August	1550	420	601	459	3357	6.19	20.8	73
5. 12-18 August	826	110	289	115	1593	5.92	9.4	79
6. 19-25 August	638	168	548	112	1899	5.26	10.0	62
7. 26 Aug.-1 Sept.	406	165	252	-	1135	3.72	4.2	44
8. 2-8 Sept.	86	52	41	-	471	1.71	0.8	20
9. 9-15 Sept.	-	-	-	-	-	-	-	-
Total	8234	2941	3718	2343	17499	-	181.0	-

Table 6. Catch and effort statistics for the snow crab fishery in area 4 (middle-eastern Cape Breton) (excluding statistics for border grounds with area 3) 1980.

Week period	Effort (trap hauls) with steel traps (1.5x1.5x0.5 m)	CPUE (kg/trap haul)	Catch (MT)	Estimated biomass (MT)
1. 15-21 July	147	69.04	10.2	-
2. 22-28 July	277	37.20	10.3	-
3. 29 July-4 Aug.	163	56.40	9.2	-
4. 5-11 August	120	49.01	5.9	-
5. 12-18 August	60	32.20	1.9	-
6. 19-25 August	60	37.85	2.3	-
7. 26 Aug.-1 Sept.	-	-	-	-
8. 2-8 Sept.	-	-	-	-
9. 9-15 Sept.	-	-	-	-
Total	827	-	39.8	-

Table 7. Catch and effort statistics for the snow crab fishery in area 5 (southeastern Cape Breton) 1980.

Week period	EFFORT (trap hauls) Steel traps (1.5x1.5x0.5 m)	Conical traps	All traps converted into steel traps	CPUE kg/trap haul	Catch (MT)	Estimated biomass (MT)
1. 15-21 July	965	165	1034	67.40	69.7	576
2. 22-28 July	1316	176	1394	50.42	70.3	581
3. 29 July-4 Aug.	455	113	522	42.48	22.2	183
4. 5-11 August	951	203	1084	39.02	42.3	350
5. 12-18 August	722	170	778	41.15	32.0	265
6. 19-25 August	888	85	943	33.19	31.3	259
7. 26 Aug.-1 Sept.	489	138	527	34.97	18.4	152
8. 2-8 Sept.	623	111	660	34.43	22.7	188
9. 9-15 Sept.	349	82	399	25.94	10.4	86
Total	6758	1243	7341	-	319.3	-

Table 8. Tag returns from the snow crab fishery in area 5 (northeastern Cape Breton) 1980.

Week period	Number of tag returns
1. 15-21 July	39
2. 22-28 July	30
3. 29 July-4 August	11
4. 5-11 August	23
5. 12-18 August	21
6. 19-25 August	13
7. 26 August-1 September	12
8. 2-8 September	11
9. 9-15 September	8
Total	168

Table 9. Catch and effort statistics for the snow crab fishery in area 6 (southern Cape Breton) 1980.

Week period	Effort (trap hauls) steel traps (1.5x1.5x0.5 m)	CPUE (kg/trap haul)	Catch (MT)	Estimated biomass (MT)
1. 15-21 July	269	11.15	3.0	110
2. 22-28 July	475	13.76	6.5	136
3. 29 July-4 Aug.	342	12.83	4.4	127
4. 5-11 August	186	12.18	2.3	127
5. 12-18 August	574	16.04	9.2	159
6. 19-25 August	879	14.56	12.8	144
7. 26 Aug.-1 Sept.	803	12.47	10.0	123
8. 2-8 September	768	13.37	10.3	132
9. 9-15 September	950	11.23	10.7	111
Total	5246	-	69.2	-

Table 10. Catch and effort statistics for the snow crab fishery in area 7 (southwestern Cape Breton) 1980.

Week period	Effort (trap hauls) steel traps (1.5x1.5x0.5 m)	CPUE (kg/trap haul)	Catch (MT)	Estimated biomass (MT)
1. 15-21 July	851	61.18	52.1	-
2. 22-28 July	1104	45.72	50.5	-
3. 29 July-4 Aug.	892	39.45	35.2	-
4. 5-11 August	1227	40.16	49.3	-
5. 12-18 August	990	45.01	44.6	-
6. 19-25 August	2197	48.59	106.8	-
7. 26 Aug.-1 Sept.	1585	54.11	85.8	-
8. 2-8 September	939	52.37	49.2	-
9. 9-15 September	457	47.74	21.8	-
Total	10242	-	495.3	-

Fig. 1. 1980 Cape Breton snow crab fishing (B.A.M.) areas and landings. [area numbering used previously are shown in ( )].

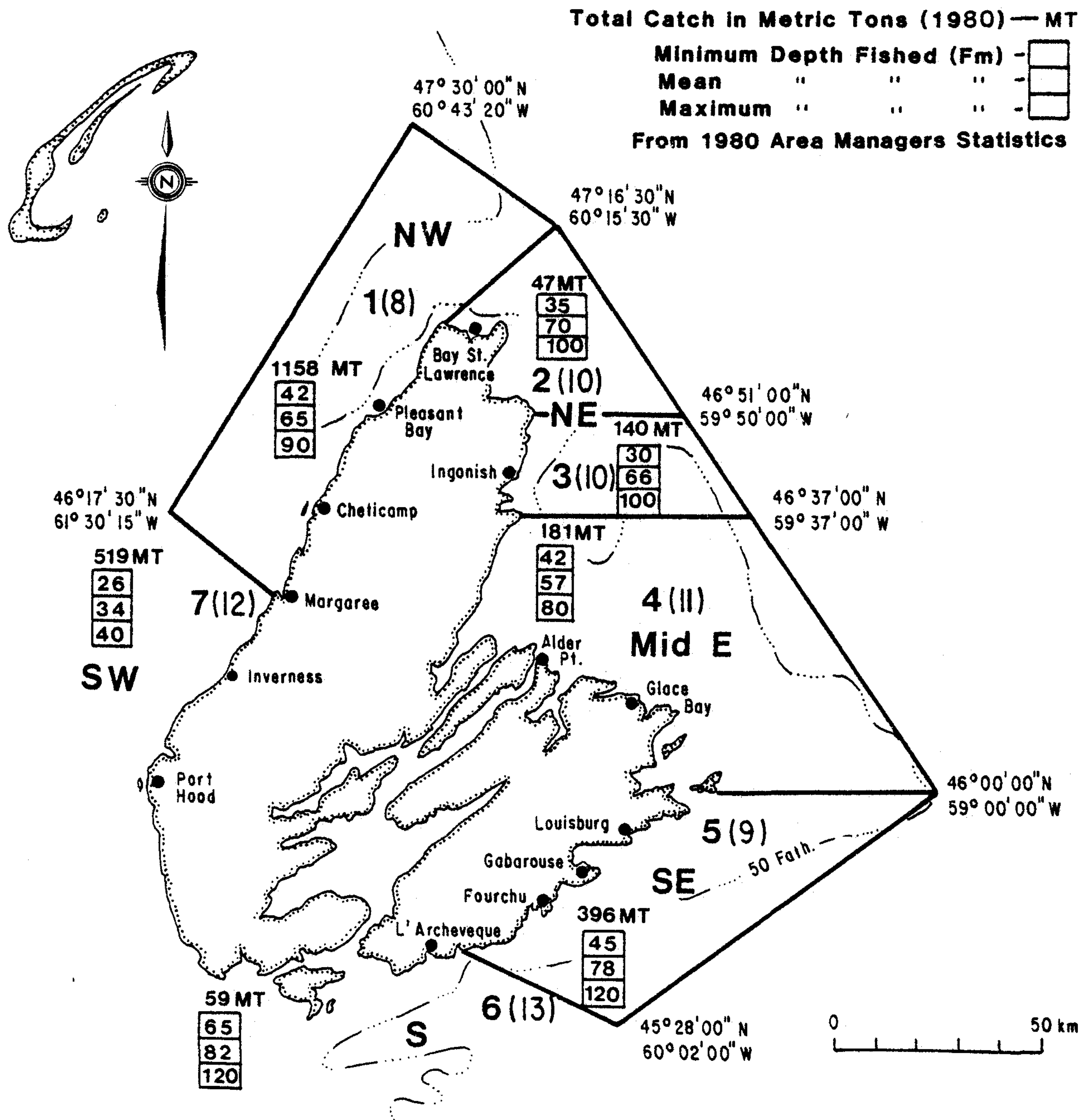


Fig. 2. Logbook page as currently utilized by Cape Breton snow crab fishermen.

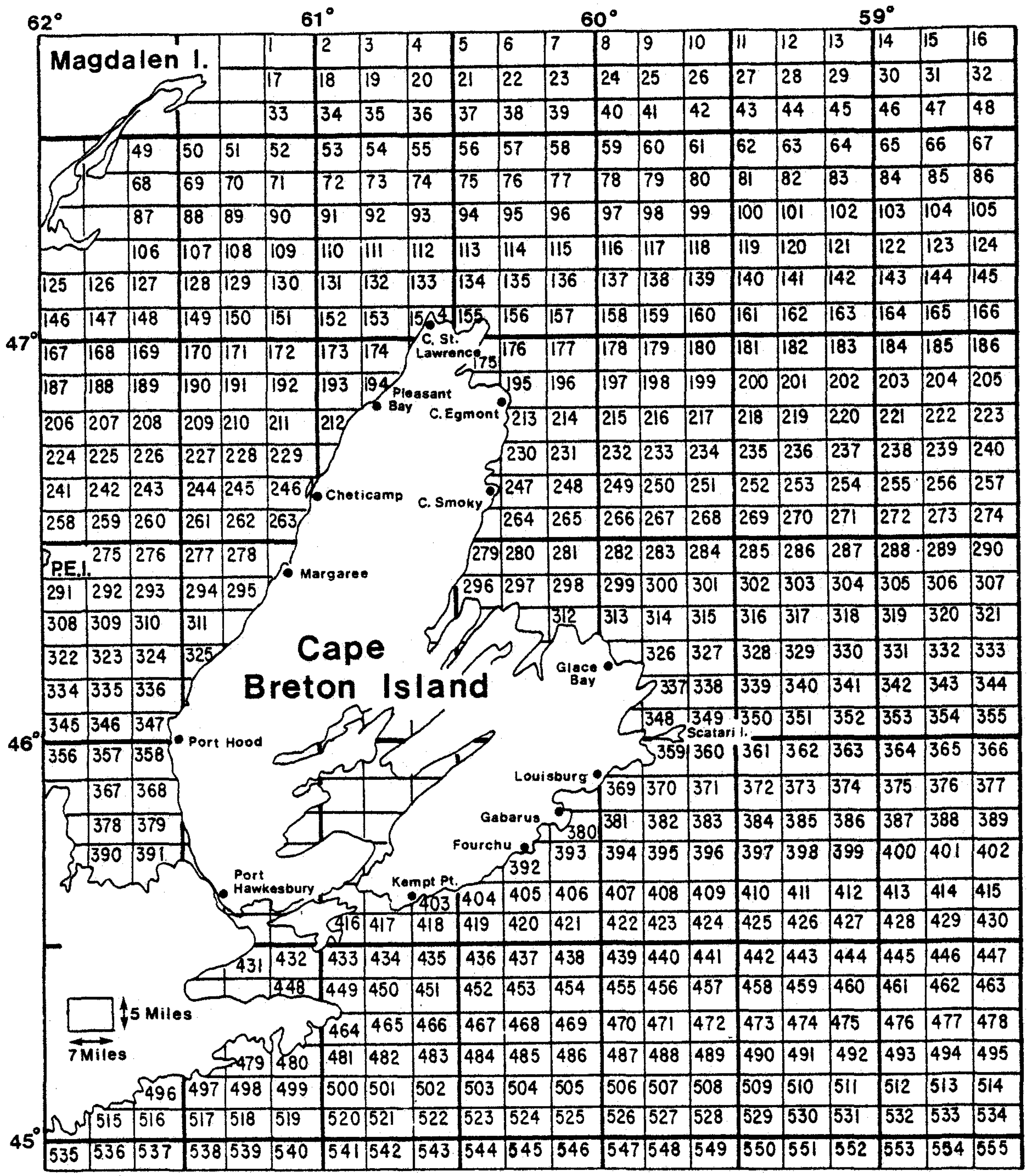
19______ VESSEL ______________ SIZE OF TRAPS ______________ CAPTAIN ____________ TO

DAILY CATCH RECORD								CRABS LANDED			REMARK
		POSITION									
TRIP No.	MONTH AND DATE	LAT.	LONG.	DEPTH (FATH.)	NUMBER HRS. GEAR SET	NUMBER TRAPS HAULED	ESTIMATED CATCH LBS.	MONTH AND DATE CRABS SOLD	BUYER	TOTAL CRABS SOLD LBS.	GEAR LOSSES, TYPES WEATHER, MOVING (
		LORAN OR DECCA READING									

CONFIDENTIAL

Environment Canada Fisheries and Marine
Environnement Canad Pêches et sciences d

Fig. 2a. Grid map utilized by Cape Breton snow crab fishermen to indicate in their logbook where their traps were being set.



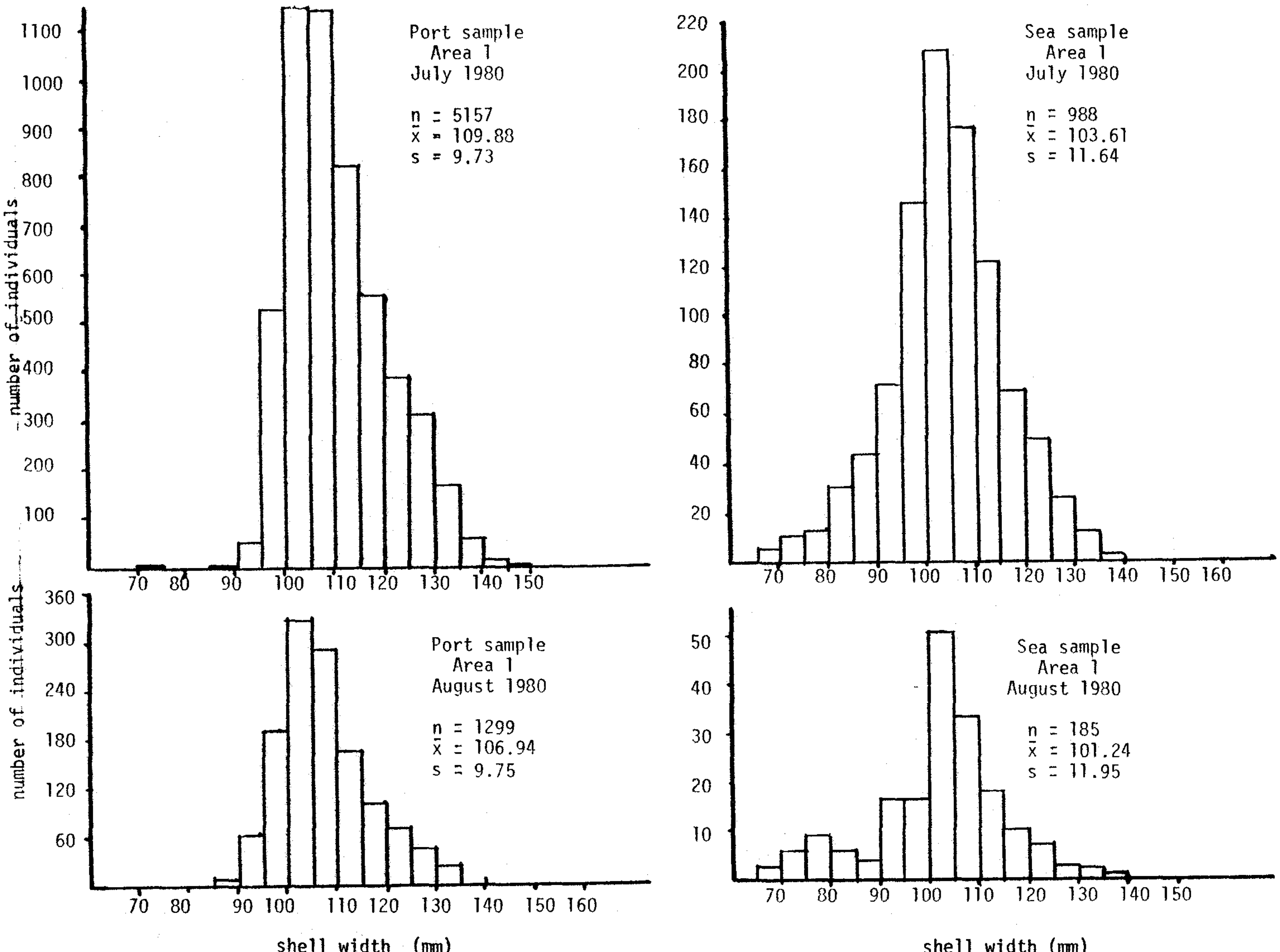


Fig. 3. Size-frequency histogram for male snow crabs for in-port and at-sea sampling from Area 1, northwestern Cape Breton in 1980.

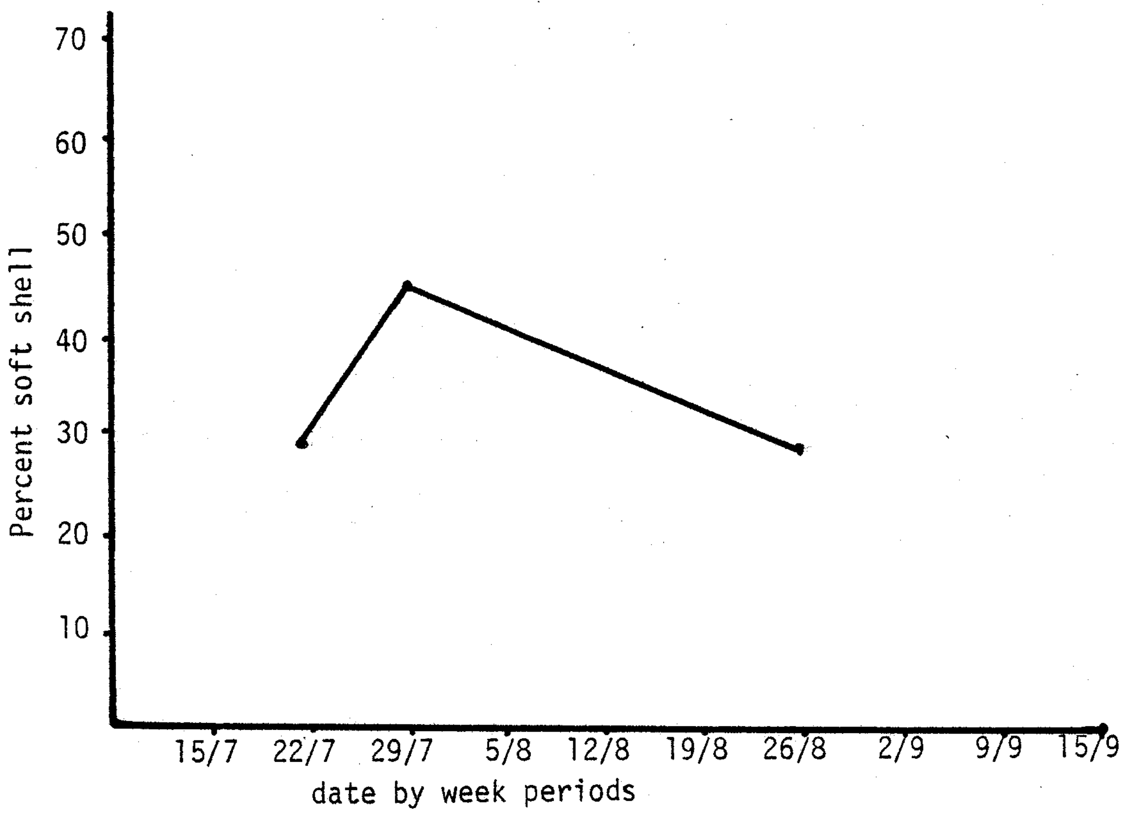


Fig. 4. Percentage frequency of occurrence of shell states for male snow crabs throughout the 1980 fishing season in area 1, northwestern Cape Breton.

Fig. 5. Size-frequency histogram for male snow crabs for at-sea, pre-season beam trawl sampling from area 1, northwestern Cape Breton in 1980.

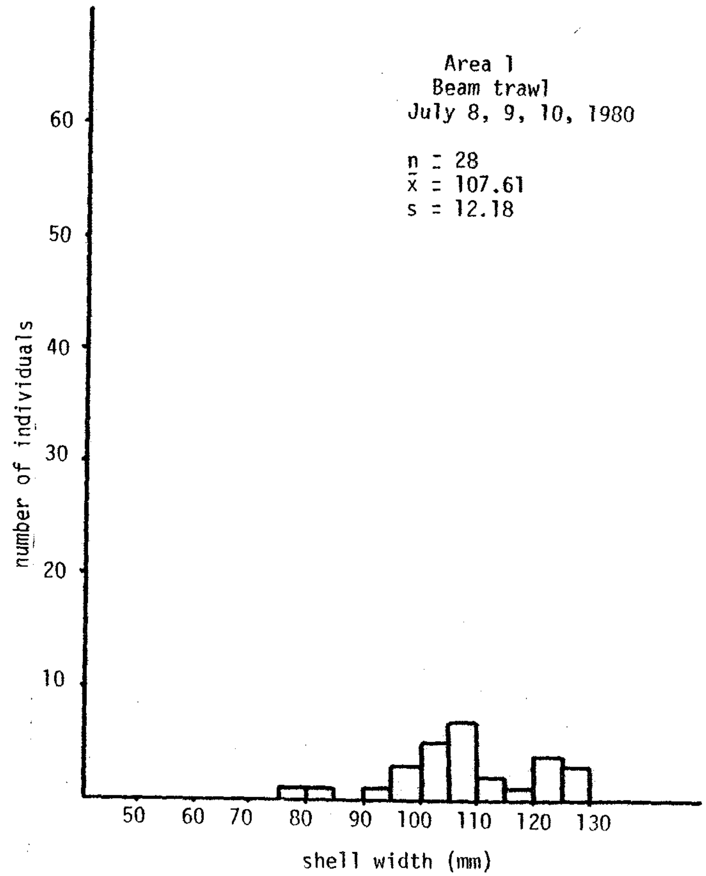


Fig. 6. Size-frequency histogram for male snow crabs for at-sea, pre-season sampling of danish-seiner by-catch from area 1, north north-western Cape Breton, in 1980.

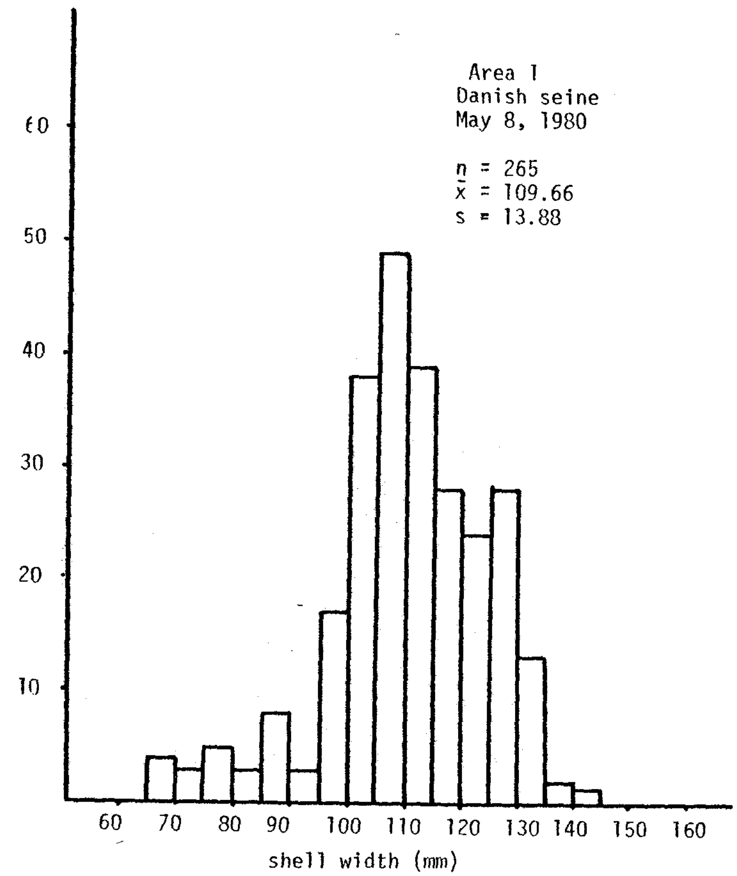


Fig. 7. Leslie graph of cumulative weekly landings of snow crabs against CPUE for area 1, northwestern Cape Breton, in 1980.

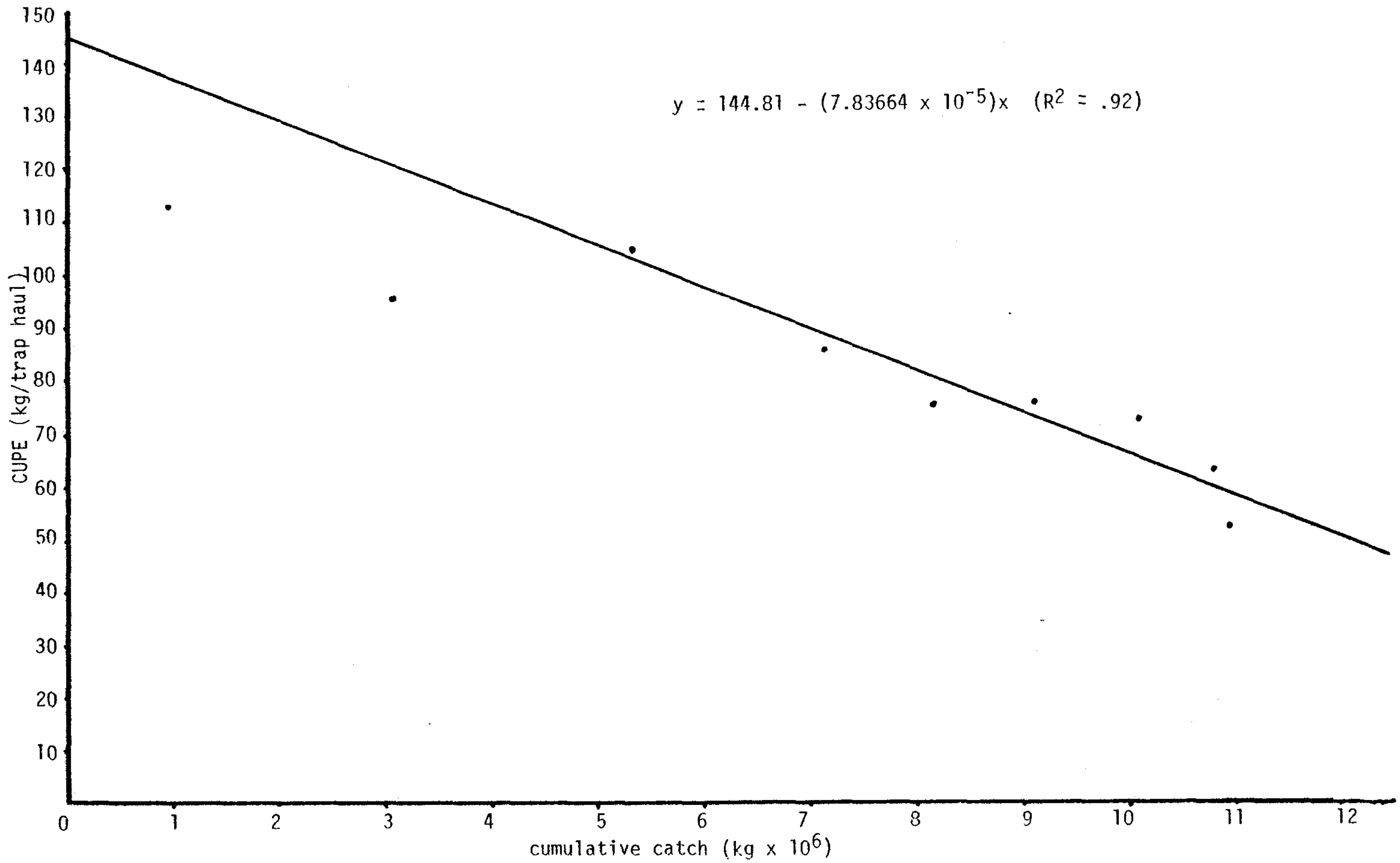


Fig. 8. Size-frequency histogram of male snow crab tagged and recaptured during the 1980 fishing season in area 1, northwestern Cape Breton, in 1980.

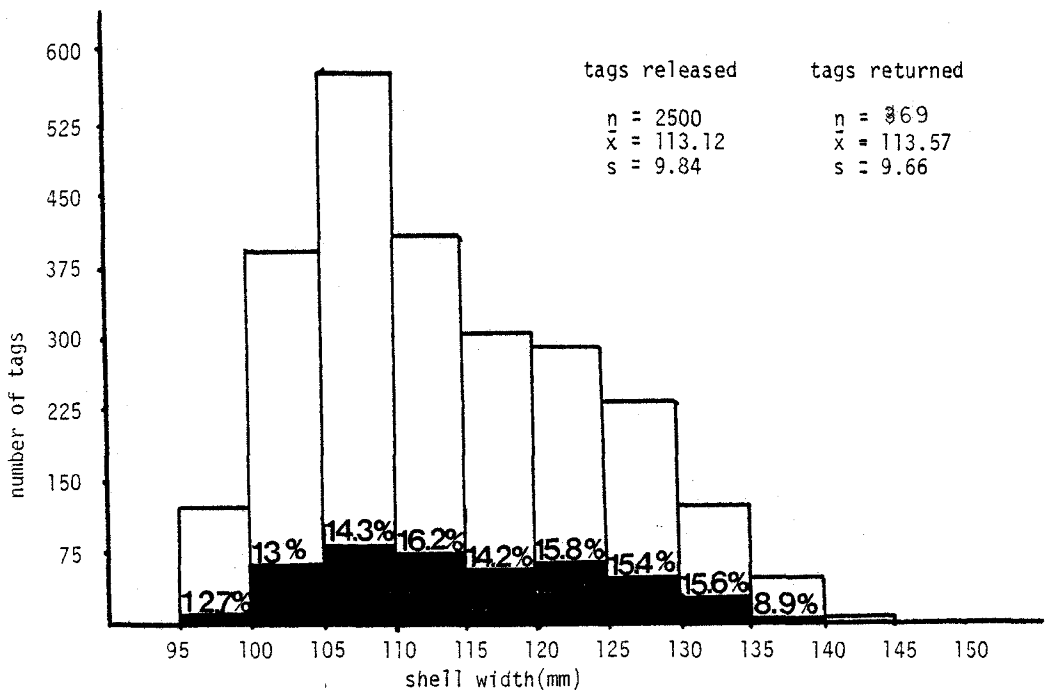


Fig. 9. Leslie graph of weekly tag returns against effort in area 1, northwestern Cape Breton, in 1980.

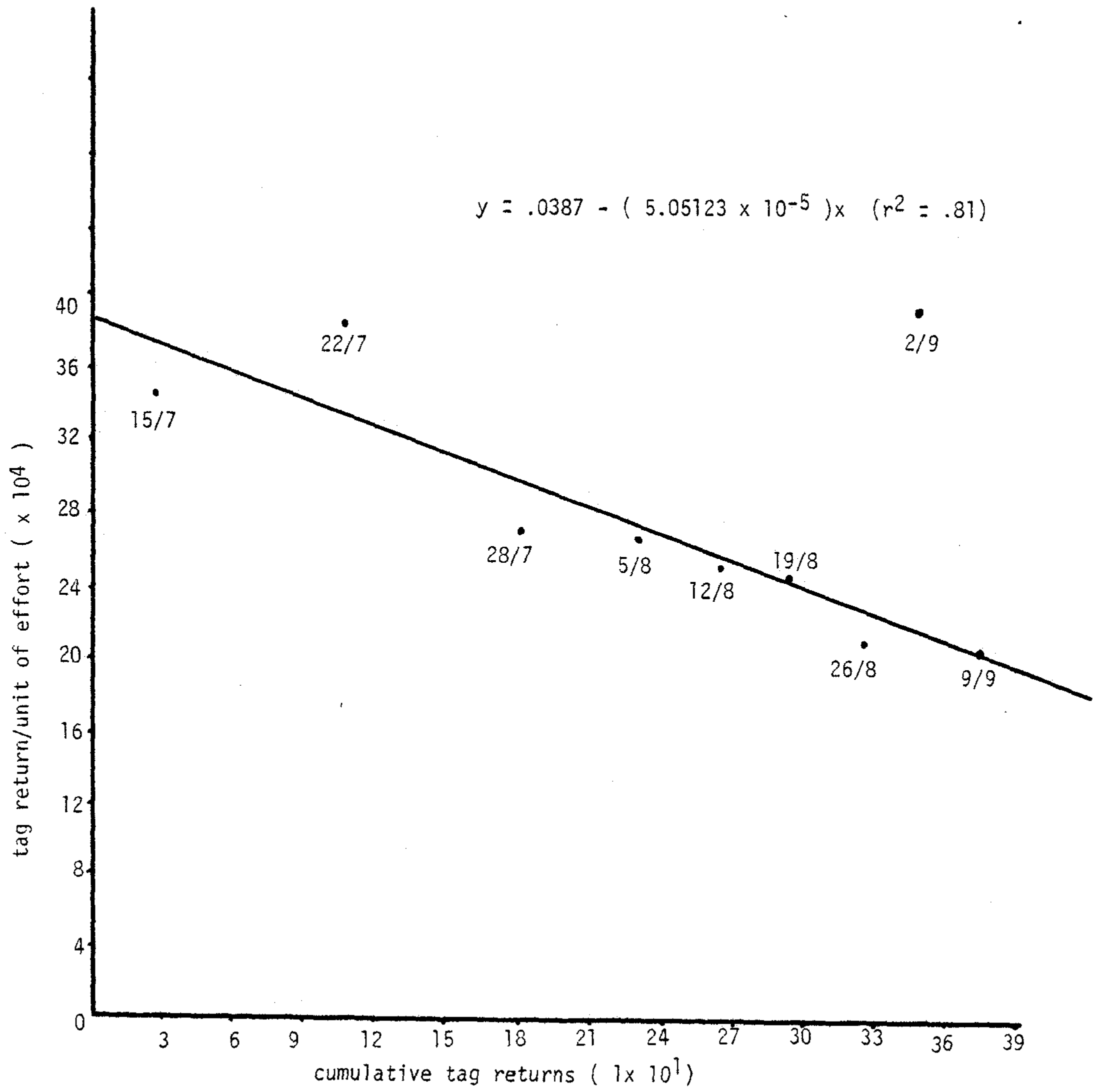
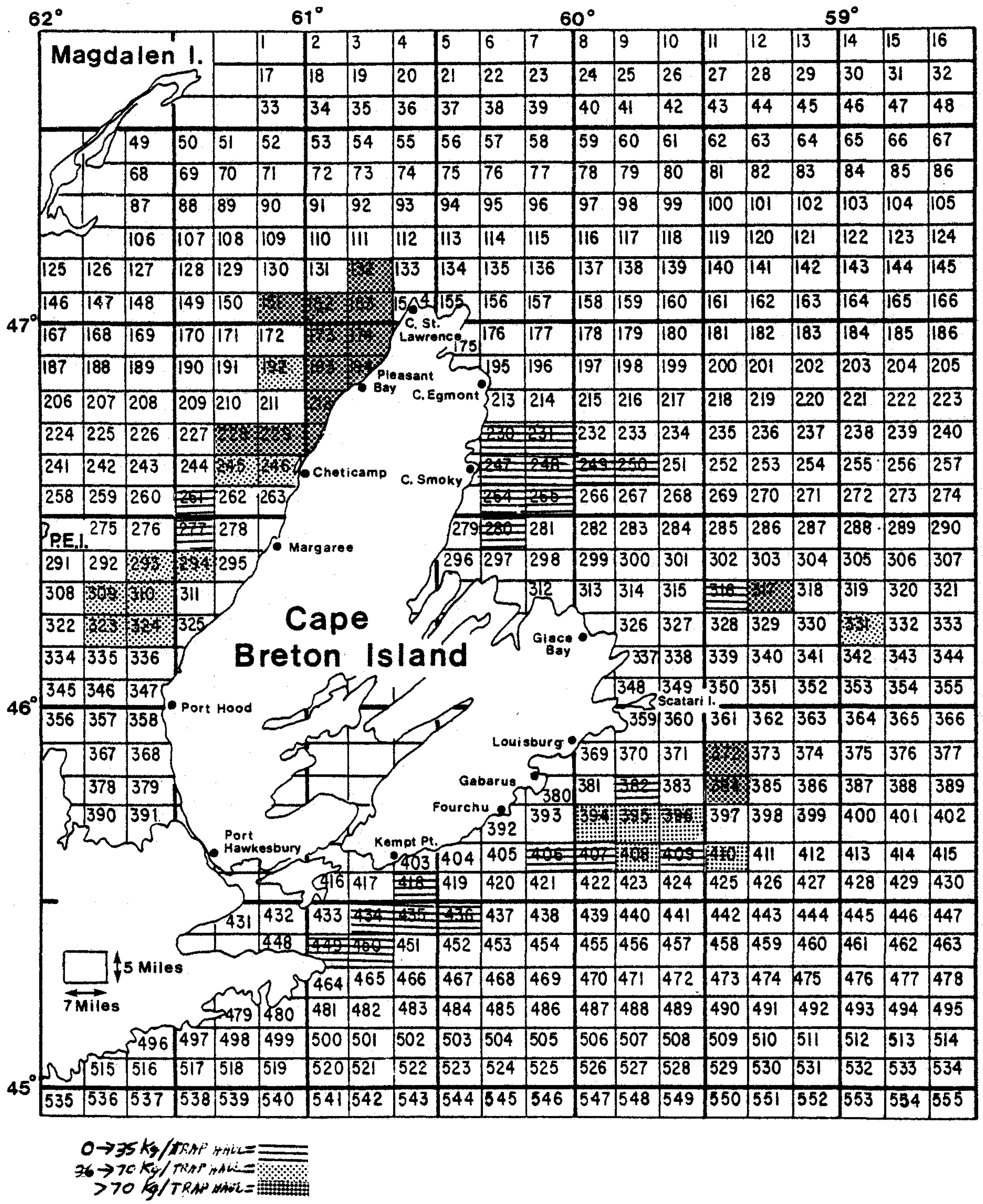


Fig. 10. Distribution of fishing effort around Cape Breton during the 1980 season, as derived from logbook grid map data.



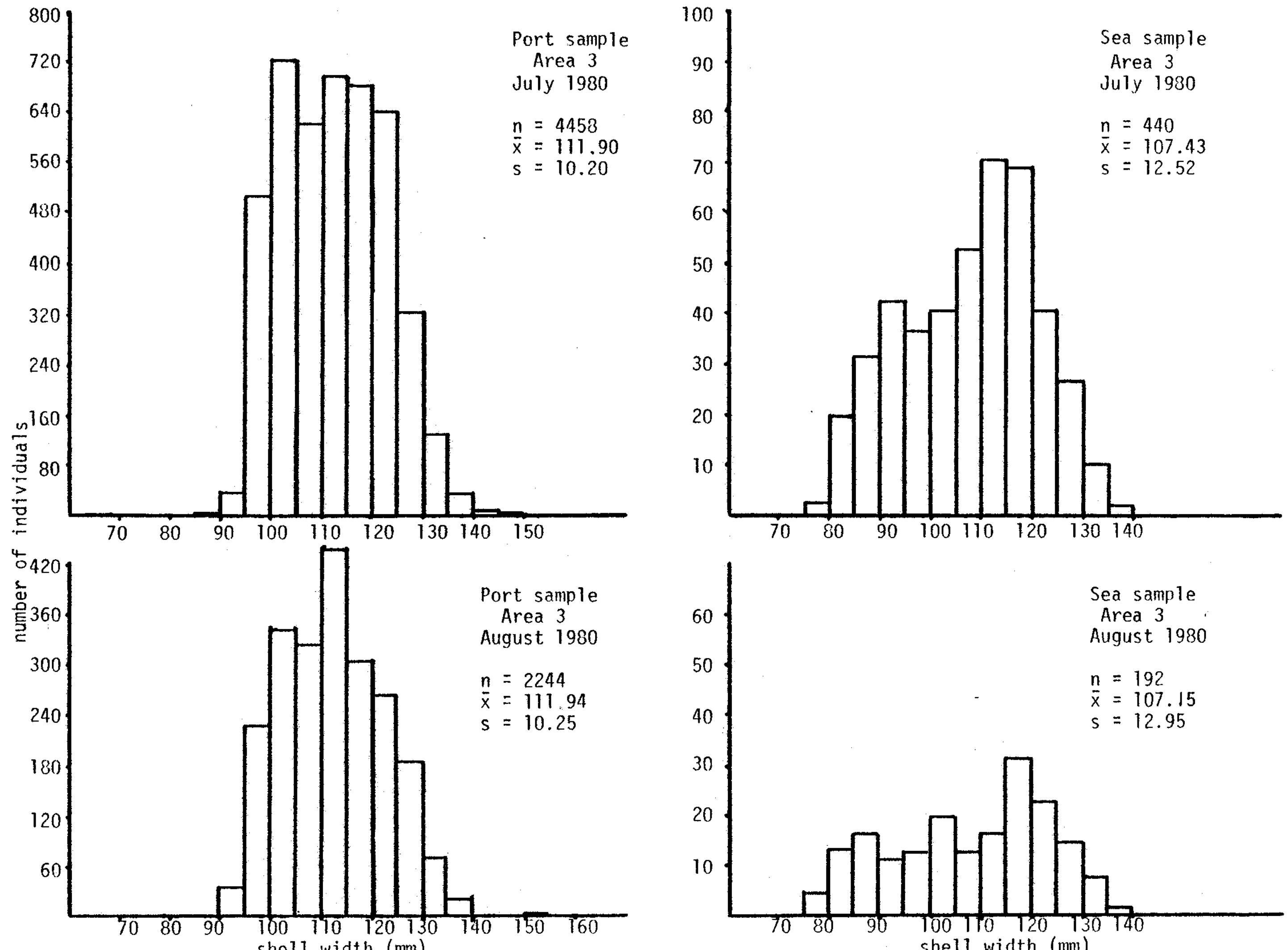


Fig. 11. Size-frequency histogram for male snow crabs sampled from commercial boats in areas 2 and 3 (plus 4 component), northeastern (middle-eastern) Cape Breton during the 1980 fishing season.

Fig. 12. Percentage frequency of occurrence of shell states throughout the the 1980 fishing season in areas 2 and 3 (plus 4 component) north-eastern (middle-eastern) Cape Breton.

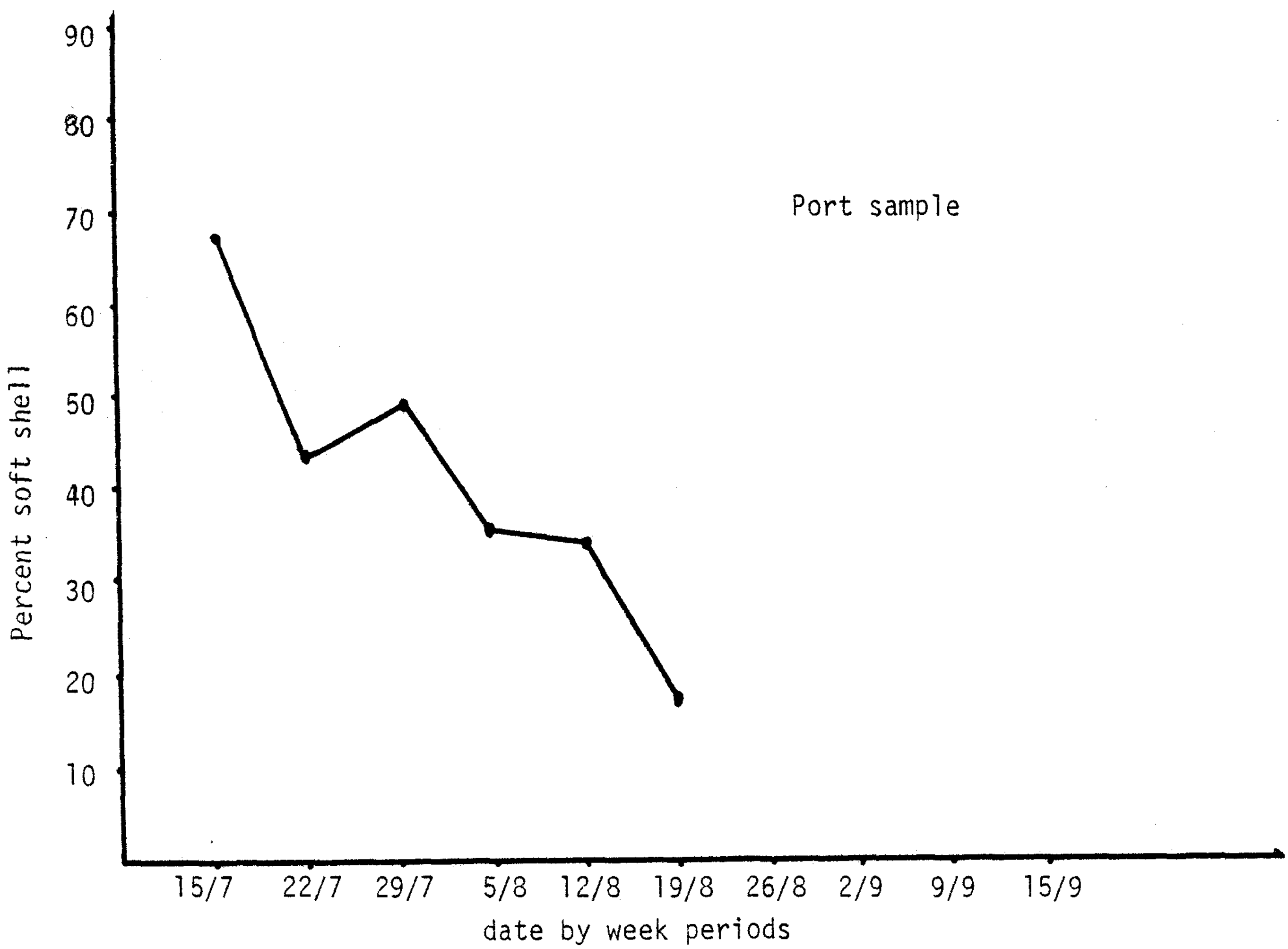


Fig. 13. Leslie graph of cumulative weekly landings of snow crabs against CPUE for areas 2 and 3 (plus 4 component), northeastern (middle-eastern) Cape Breton, in 1980.

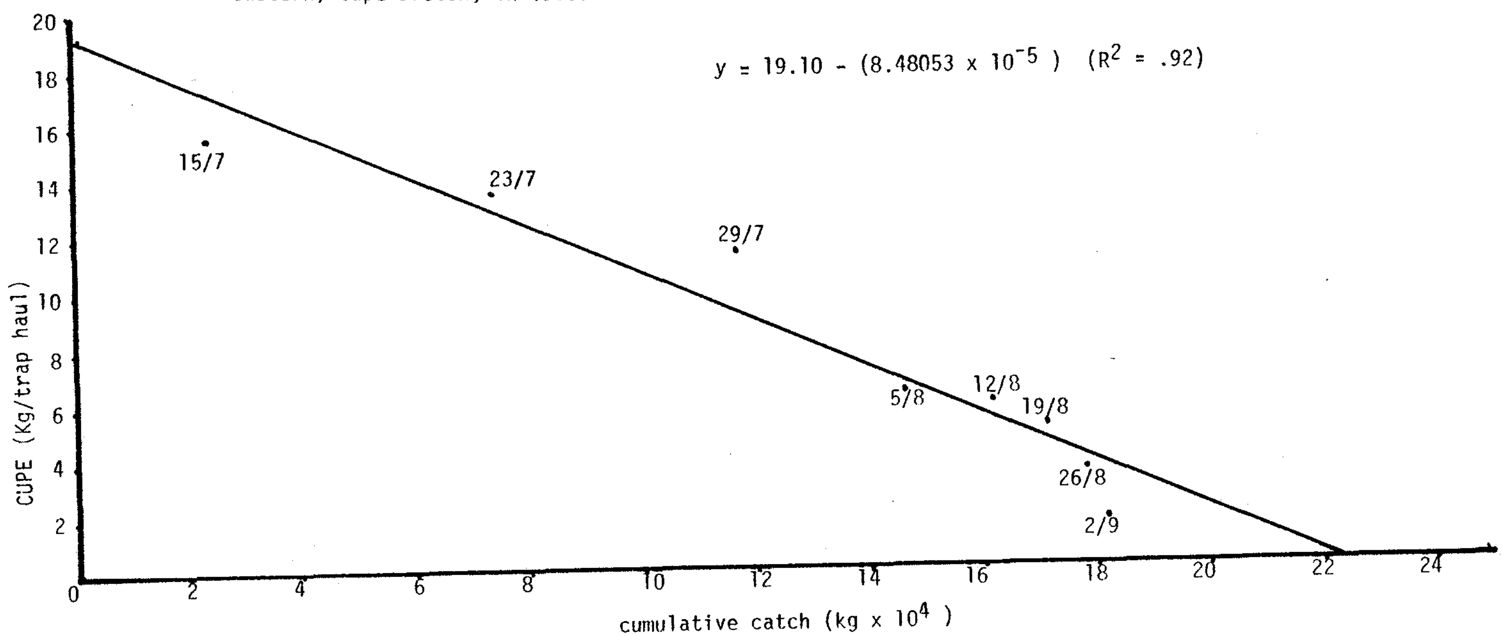
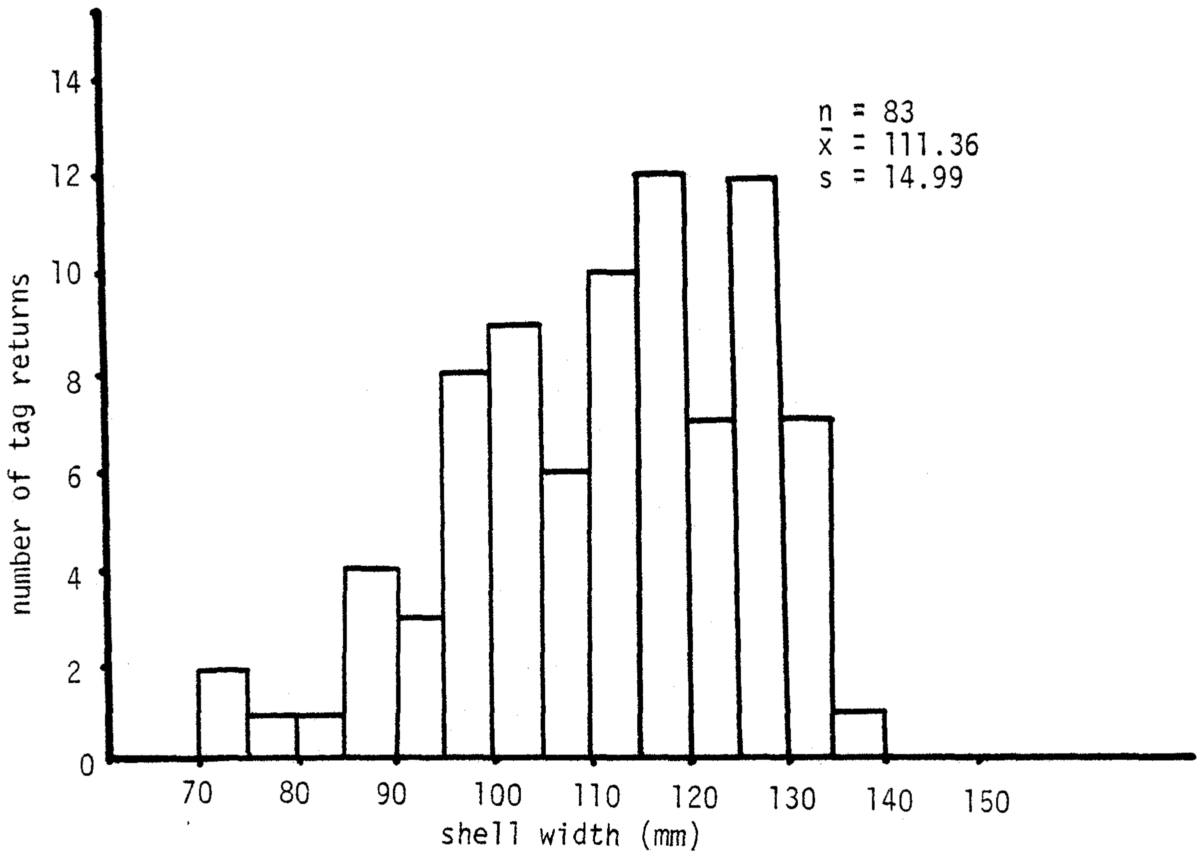


Fig. 14. Size frequency of male snow crabs tagged in 1979 and recaptured during the 1980 fishing season in areas 2 and 3, northeastern Cape Breton.



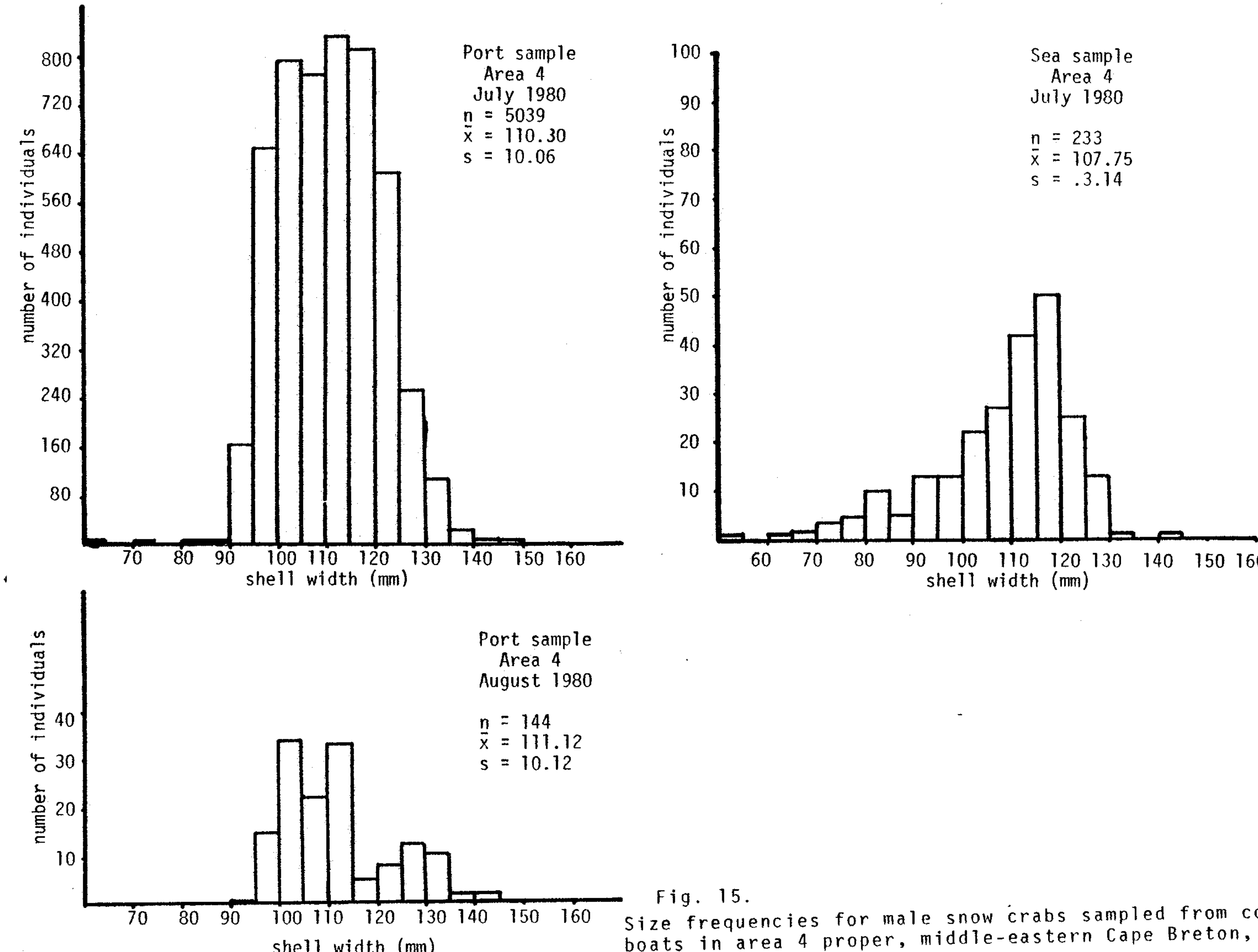
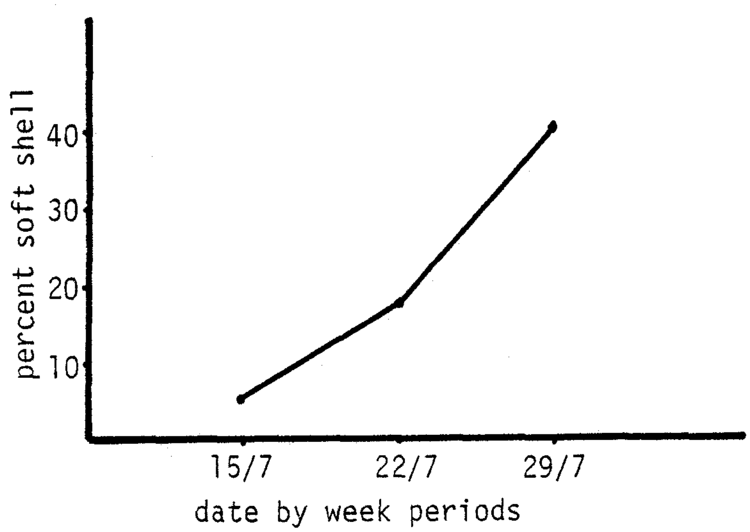


Fig. 15.
Size frequencies for male snow crabs sampled from commercial boats in area 4 proper, middle-eastern Cape Breton, during the 1980 fishing season.

Fig. 16. Percentage frequency of occurence of shell states throughout the 1980 fishing season in area 4, middle-eastern Cape Breton.



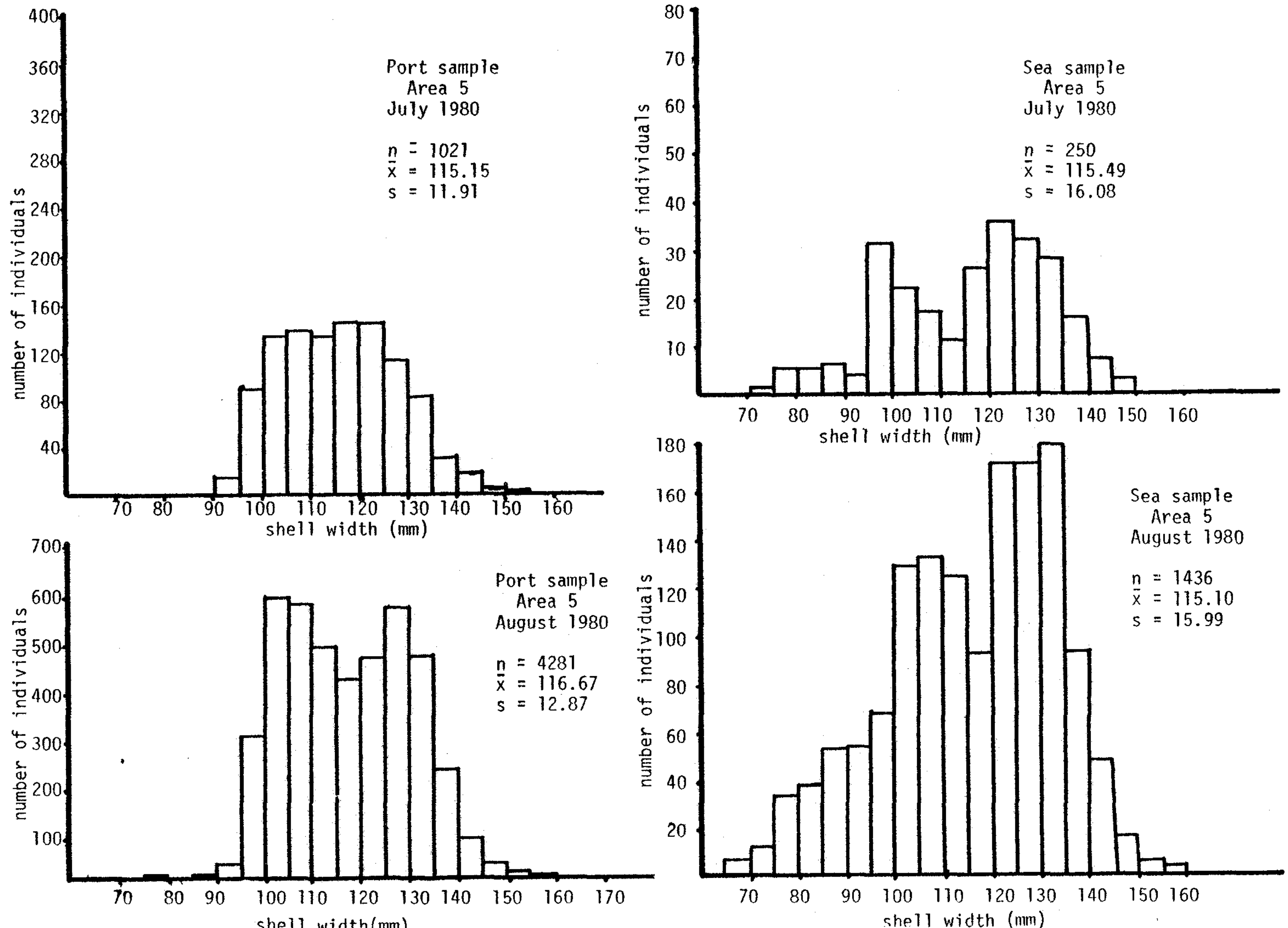


Fig. 17. Size frequencies of male snow crabs sampled from commercial boats during the 1980 fishing season in area 5, southeastern Cape Breton.

Fig. 18. Percentage frequency of occurrence of shell states throughout the 1980 fishing season in area 5, southeastern Cape Breton.

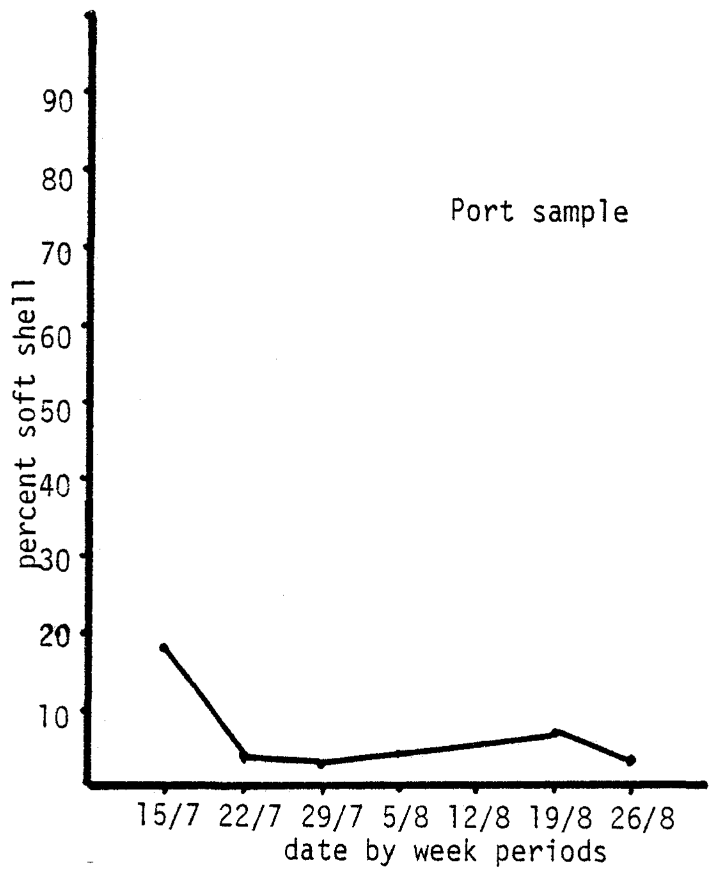


Fig. 19. Size-frequency histogram for male snow crabs in area 5, southeastern Cape Breton, caught during pre-season trapping, January -February, 1980.

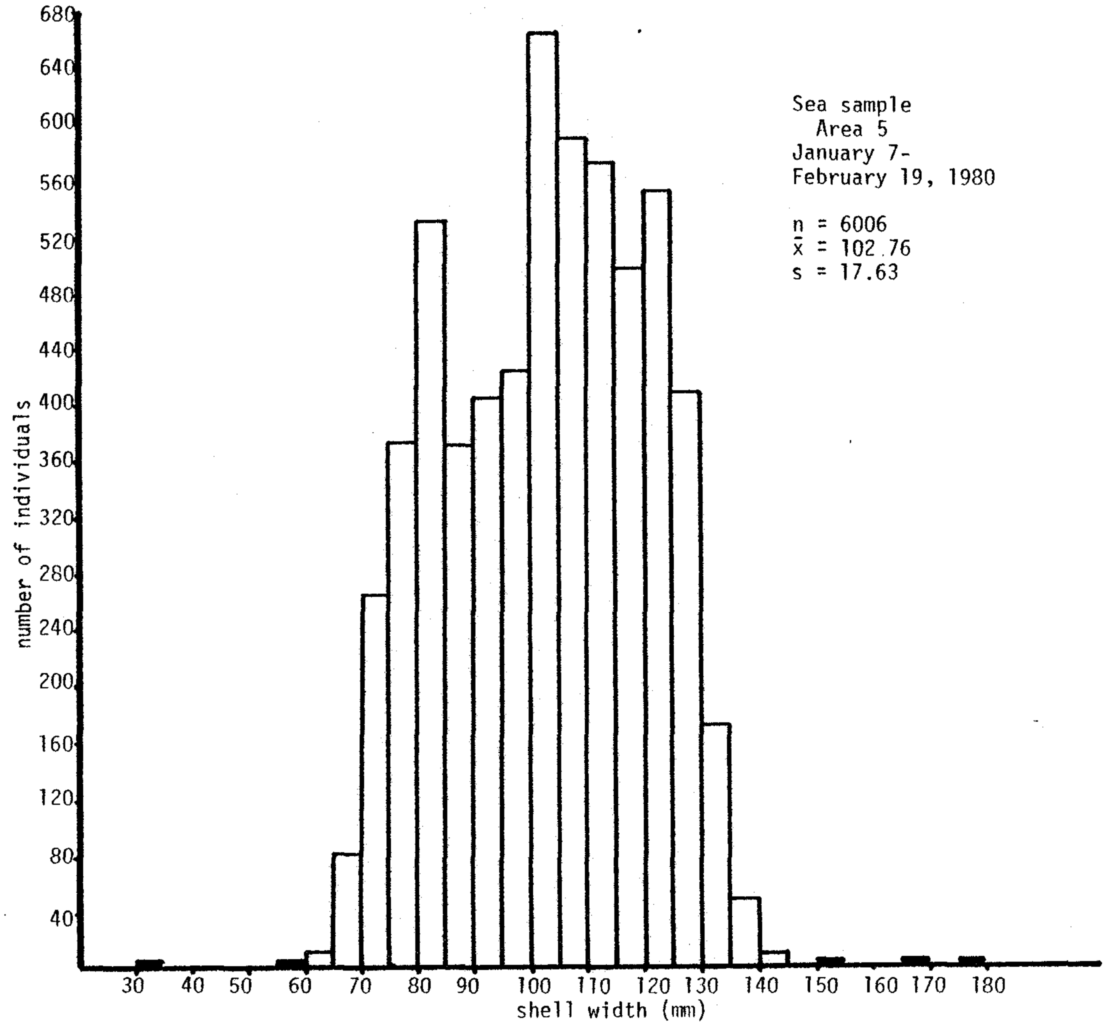
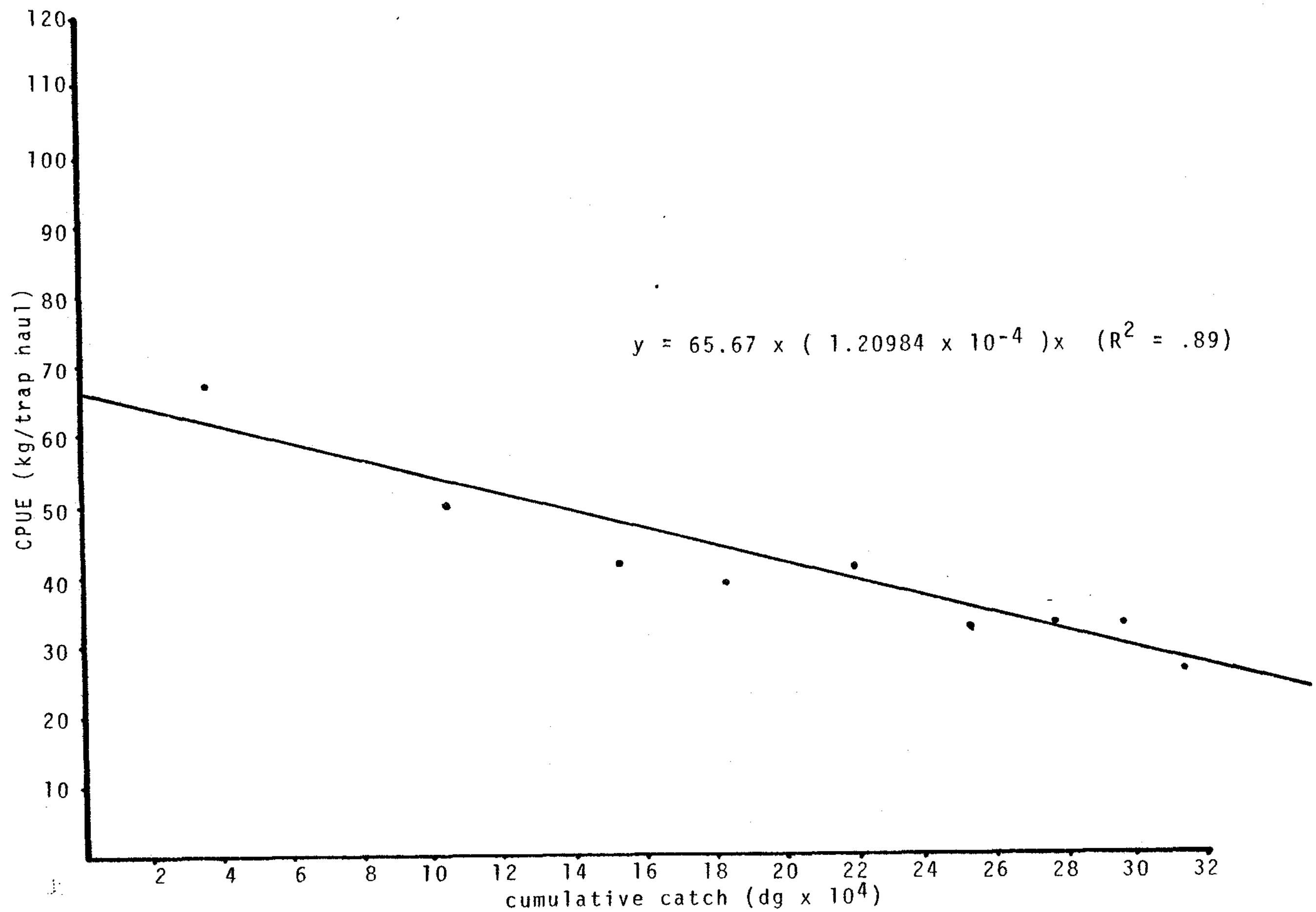


Fig. 20. Leslie graph of cumulative weekly landings of snow crabs against CPUE for area 5, southeastern Cape Breton, in 1980.



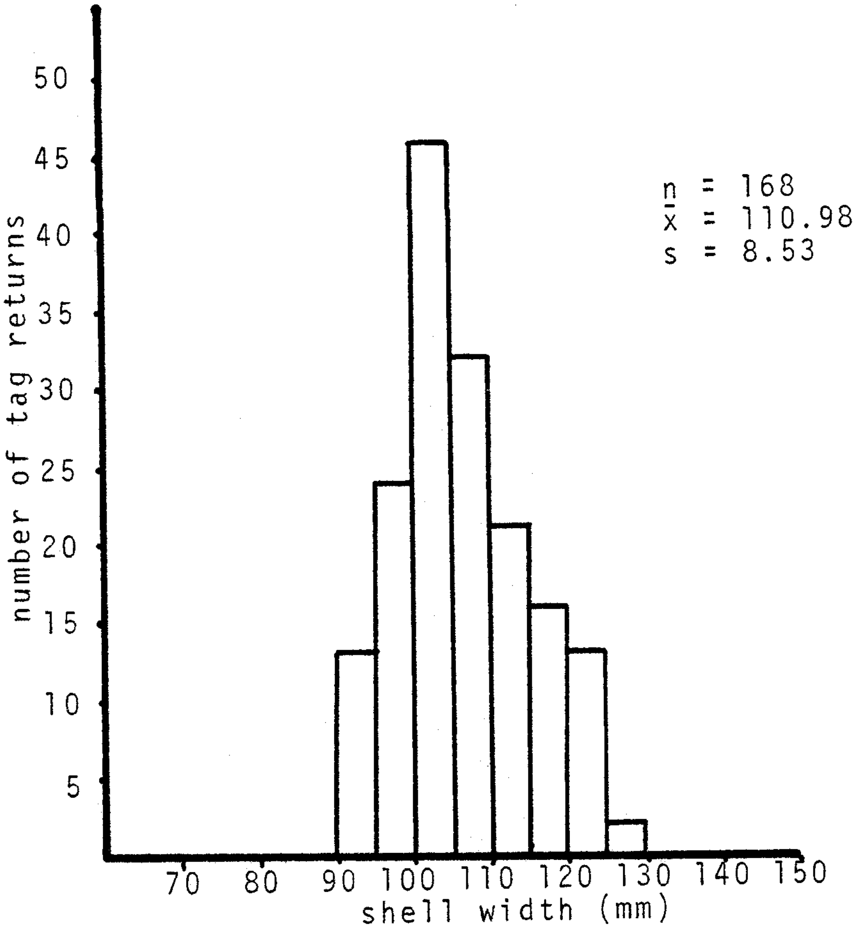
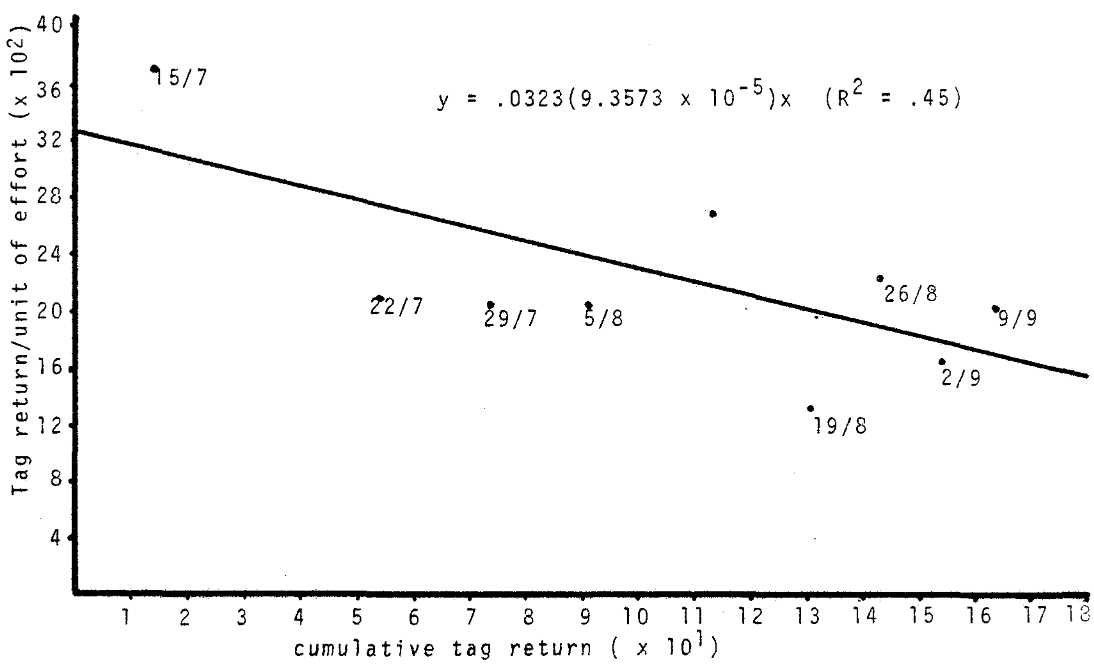


Fig. 21. Size frequency of male snow crabs tagged in 1979 and recaptured during the 1980 fishing season in area 5, southeastern Cape Breton.

Fig. 22. Leslie graph of weekly tag returns against effort in area 5, southeastern Cape Breton, in 1980.



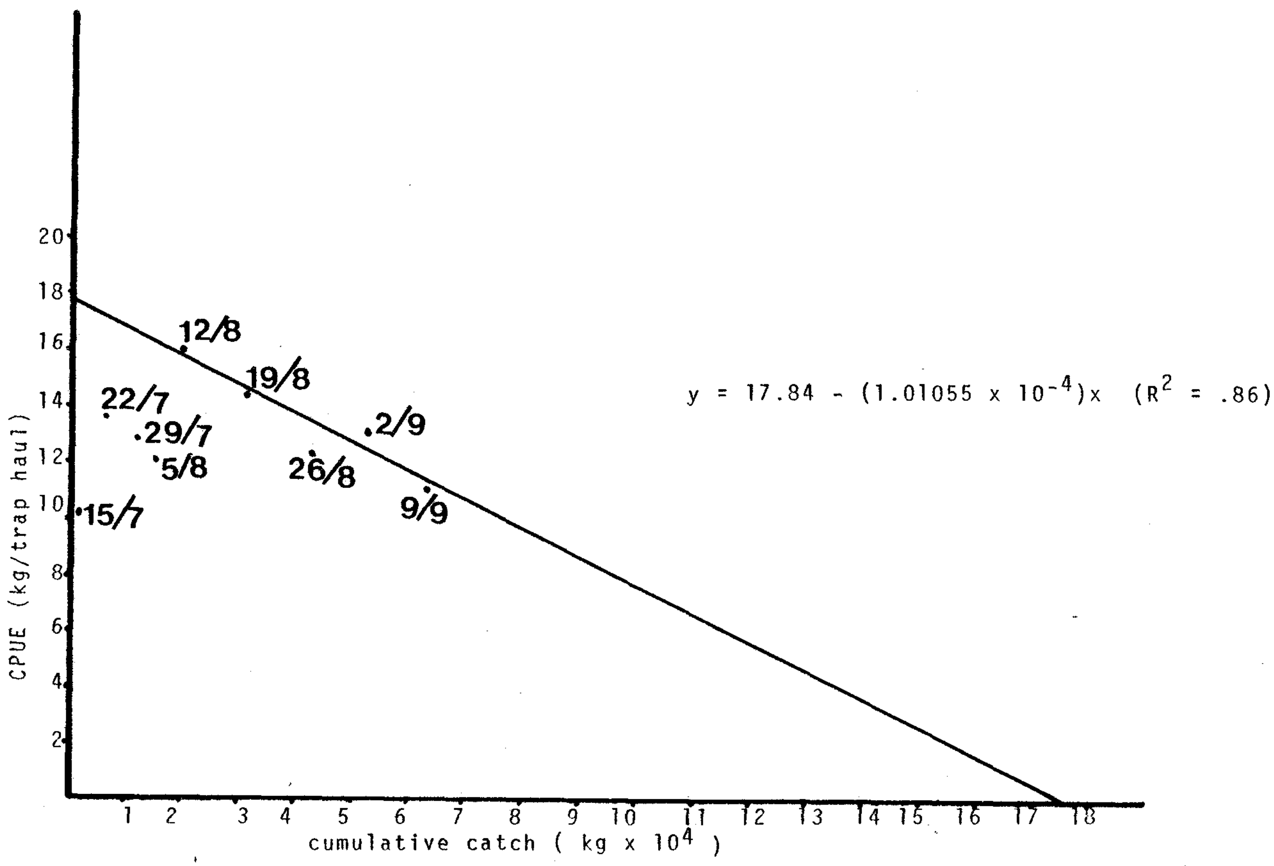


Fig. 23. Leslie graph of cumulative weekly landings of snow crabs against CPUE for area 6, southern Cape Breton, in 1980.

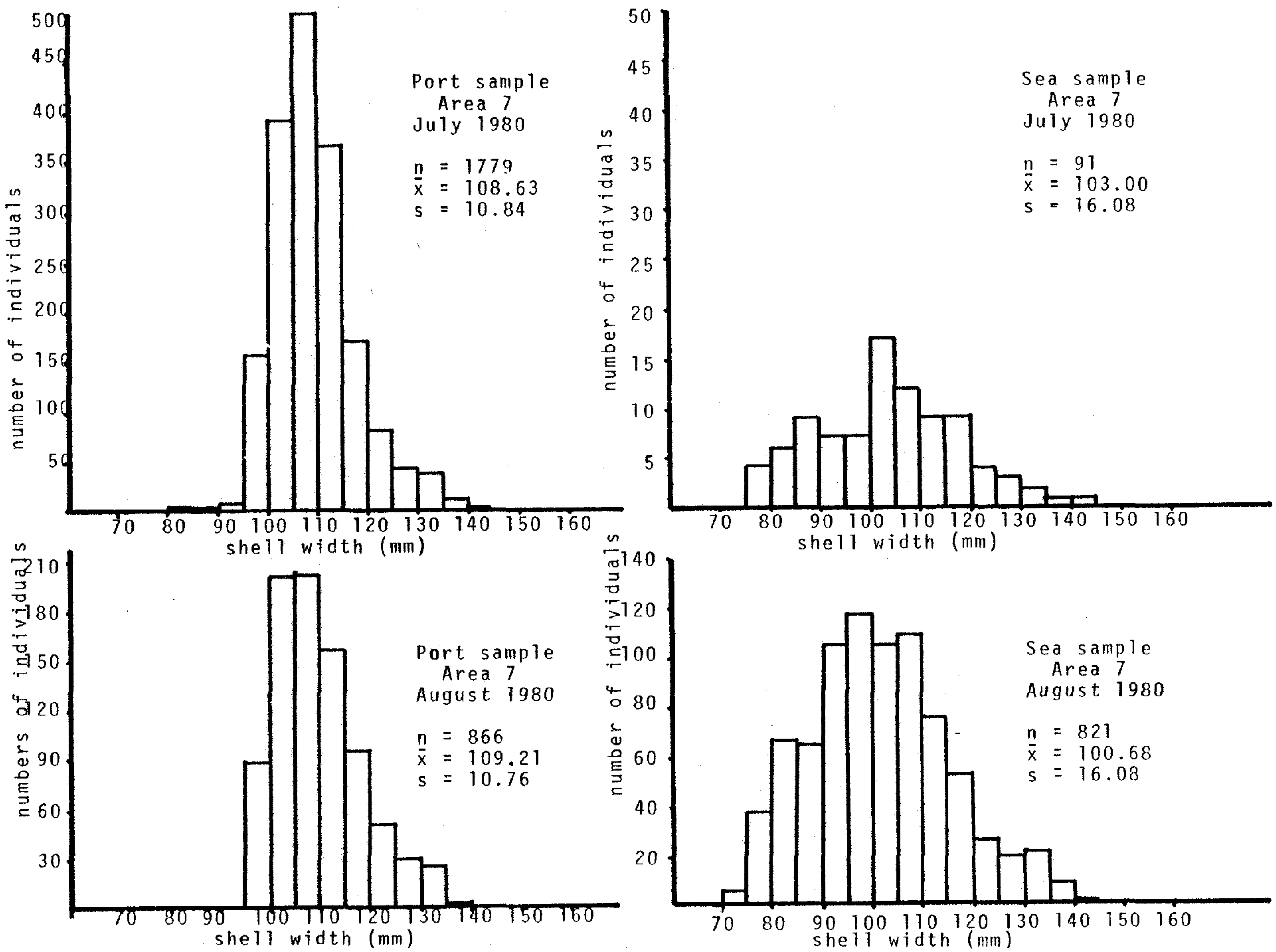


Fig. 24. Size frequencies of male snow crabs sampled from commercial boats during the 1980 fishing season in area 7, southwestern Cape Breton.

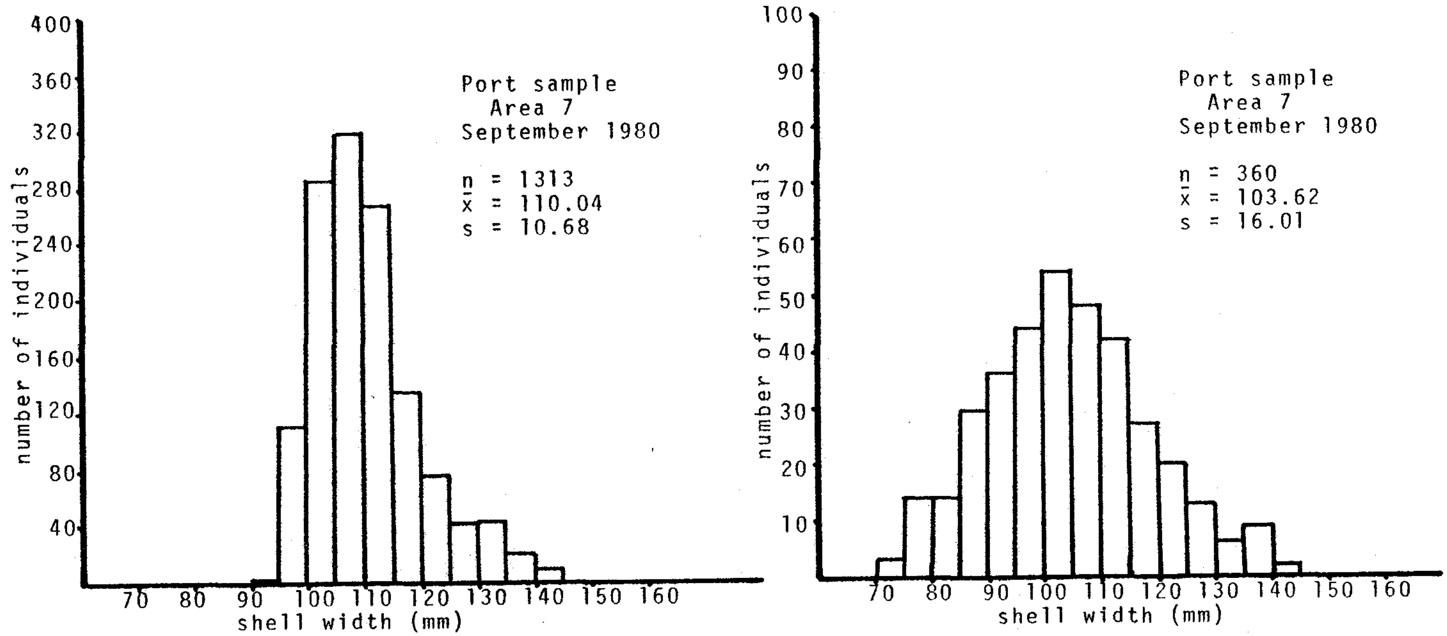
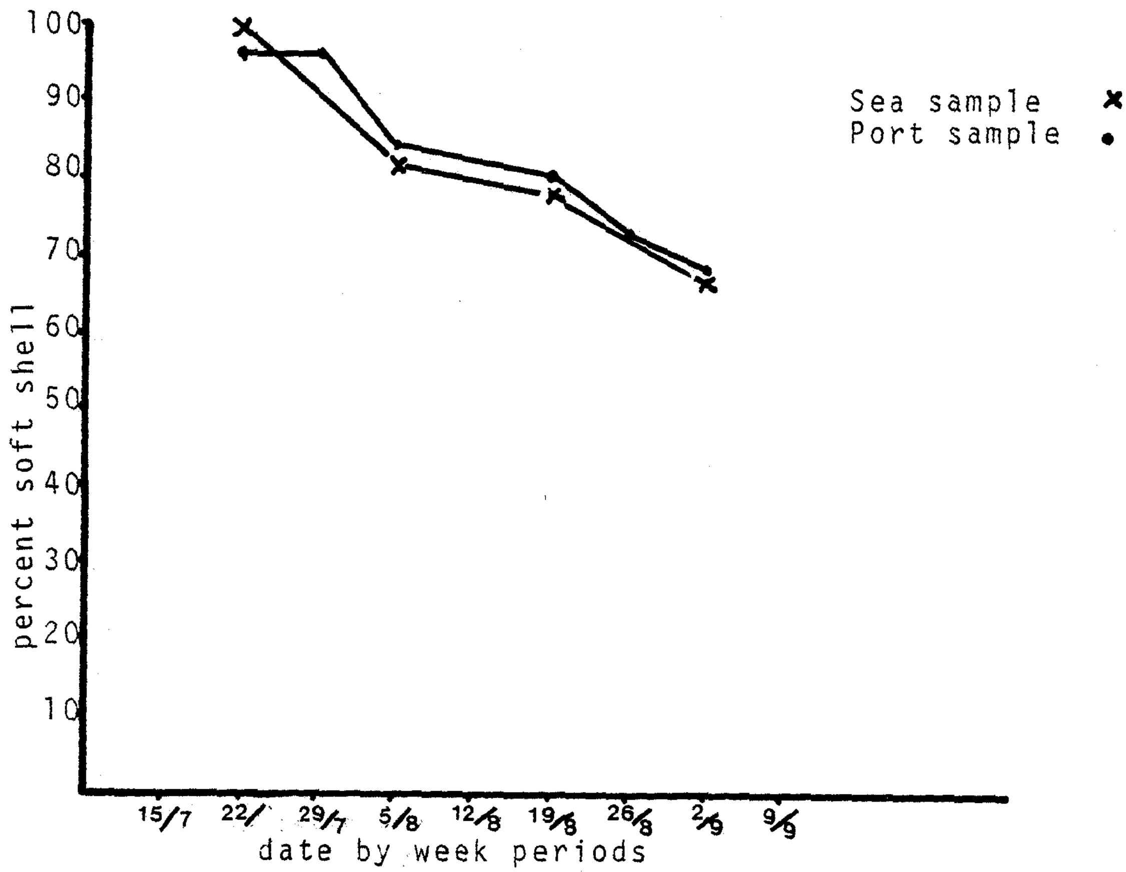


Fig. 24 Size frequencies of male snow crabs sampled from commercial boats during the 1980 fishing season in area 7, southwestern Cape Breton.

Fig. 25. Percentage frequency occurrence of shell states throughout the 1980 fishing season in area 7, southwestern Cape Breton.



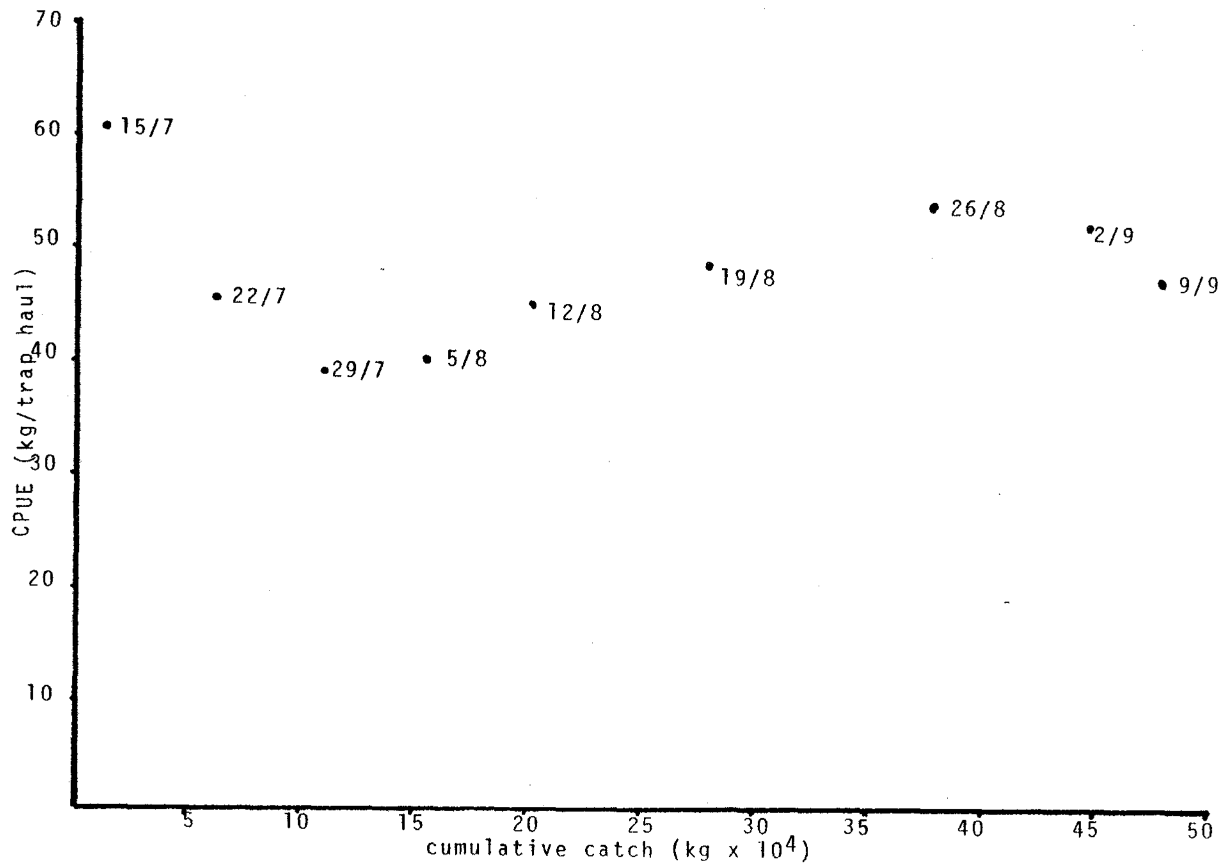


Fig. 26. Cumulative weekly landings of snow crabs against CPUE for area 7, southwestern Cape Breton, in 1980.

Revision of TAC for Area #1

-1980 Stock:

Mean catch per unit effort (CPUE) from 18 Area #1 logbooks (48 fishing traps) during first week of 1980 season = 115.6 kg per trap haul.

Based on 1978 catchability ($q = 4.7287 \times 10^{-5}$), initial population at

$$\text{start of 1980 season (July 15)} = \frac{\text{CPUE}}{q} = 2445 \text{ MT} \quad (1)$$

Based on 1979 catchability ($q = 5{,}802 \times 10^{-5}$), initial population at

$$\text{start of 1980 season (July 15)} = \frac{\text{CPUE}}{q} = 1992 \text{ MT} \quad (2)$$

Mean of (1) and (2) = 2219 MT = Estimated initial biomass in Area #1 at start of 1980 season.

As 848 MT left in Area #1 at end of 1979 season
(2219 - 848) MT = 1371 MT have been added to stock between the end of the 1979 season and the start of the 1980 season.

-For comparison:

Equivalent biomass (B_e) present on July 15 for 1978 and 1979:

1978

$$B_e = \frac{\text{CPUE July 15}}{q} + \begin{matrix}\text{Total catch}\\ \text{to July 15}\end{matrix} = 1533 + 656 = 2189 \text{ MT}$$

1979

$$B_e = \frac{\text{CPUE July 15}}{q} + \begin{matrix}\text{Total catch}\\ \text{to July 15}\end{matrix} = 1267 + 598 = 1865 \text{ MT}$$

Hence, the 1980 July 15 biomass is 30 MT above the 1978 level and 354 MT above the 1979 level - however, substantial biomass increases occurred after July 15 in 1978 and 1979; possibly this will not occur in 1980.

- TAC'S:

1979 TAC set at 115,000 lbs/unit (27 units) = 1406 MT
1980 " " " 80,000 " " = 980 MT

An increase of 244 MT (25%) to the 1980 TAC (to just crop the between season biomass increase and keep the stock relatively stable) would give a revised TAC of 1224 MT and 100,000 lbs/unit.

With a 1224 MT TAC and no further biomass addition the stock will have an end-of-season biomass of 995 MT and will have endured a 55% exploitation rate. This situation compares to end-of-season totals of 1075 and 848 MT in 1978 and 1979, respectively.

Appendix II, Article from the "Scotia Sun' newspaper of 13 August, 1980 on the 1980 Cape Breton snow crab fishery.

Crab fishermen get both good and bad news

There was good news and there was bad news for Cape Breton crab fishermen last week. The good news was that quotas will be increased along the west coast of the island from Margaree to Cape St. Lawrence. The 27 fishermen licensed to set traps in that area will be allowed to harvest an additional 20,000 pounds this season over the island-wide quota of 80,000 pounds. It'll mean an extra $5,000 for each fisherman.

The bad news is that no one's completely sure how much more crab Cape Breton fishermen will be able to sell. Two companies, National Sea Products and Cape Bald Packers, have stopped buying altogether to let their plants gear up for the District 8 lobster season in New Brunswick.

Just two or three weeks ago, crab industry spokesmen were beginning to shed the pessimism that prevailed throughout the spring. Just as suddenly, the gloom has returned. Processors began 1980 with large inventories carried over from last year. Much of that product was dumped at distress prices, and now it's returning to haunt Canadian sales efforts.

It seems that Belgian firms bought large quantities of frozen Canadian crab at rock bottom prices and then canned it for re-sale. This canned product is now underselling Canadian canned crab from this year's catch by a substantial margin.

To make matters worse, processors say the amount of crab carried over from last year, and sold in Europe early this year, has taken a large chunk out of the total sales Canada can anticipate for 1980. For example, the amount of Canadian frozen crab sold to Belgium in the first four months of this year is two-and-a-half times the amount sold in all of 1979.

Of course, all this takes place against a background of generally depressed world fish markets. Moreover, Cape Breton crab is competing against a glut of crab from New Burnswick's much larger offshore fishery.

In many areas of Cape Breton, it's virtually impossible for a fisherman to reach even the 80,000-pound quota. The limits are simply theoretical values. In other areas, a few of the most ambitions and skillful fishermen will reach the quota, while the average will not. In the best districts, like the shore from Margaree to Cape St. Lawrence, reaching the quota is a piece of cake.

Prices are as variable as purchasing policies. the UMF and Cape Bald Packers are paying 28 cents per pound, the same price that prevails in New Brunswick. Nickerson and National Sea only 24. Price comparisons are difficult because some companies supply ice, some unload boats for fishermen and some charge less for bait.

In general, though, there appears to be no justification for paying a lower price in Cape Breton than in New Brunswick. It's true that collection and shipping costs are higher in Cape Breton, but on average crab caught here is better, with higher meat yields that more than compensate buyers for any incresed costs. In my view, Nickerson and National Sea are simply gypping their fishermen by four cents per pound.

There are two exceptions to this supply and price picture. In Port Hood and Glace Bay, fishermen have been landing large amounts of soft shelled, recenly molted crabs. The yields for these crabs are so low as to make them almost worthless for processors, who either refuse to take them at all or pay only 15 cents a pound.

The best summary is that those who got into the crab fishery a few years ago, and paid for all their gear during those bonanza years, will have a satisfactory income from the crab season this year. Those with newly purchased gear will have only a fair season at best. Those with new gear in areas where molted crab predominate are facing serious financial problems.

Once the season ends, we can certainly expect demands from Cape Breton fishermen for protection against overfishing by New Brunswick's much larger offshore fishery.

Parker Barss Donham