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# Assessment of the 1998 snow crab (*Chionoecetes opilio*) fisheries off eastern Nova Scotia (Areas 20 to 24 (and 4X)), Canada.

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## ABSTRACT

The 1998 total landings in eastern Nova Scotia (ENS) were 35% higher than those of 1997. There was a 55% increase in the seasonal catch-per-unit-of-effort (CPUE) and a 15% reduction in total fishing effort compared to last year. The increase in landings was mostly the result of a 50% increase in individual boat quotas in Area 21 (from 10,000lbs to 15,000lbs), a slight increase in IBQ in Areas 23 and 24 (from 52,000lbs to 55,000lbs), and the introduction of new allocations (for a total of 500t) for temporary fishers in Areas 23 and 24. The overall picture for ENS in 1998 (compared to 1997) can be summarized as follow: all Areas have reached their quotas with a higher CPUE which increased 33% in Area 23 to 75% in Area 20 (Areas 21 and 22 = 50%, Area 24 = 37%), while the reported fishing effort were similar (Areas 21, 23 and 24) or 35% to 55% lower (Areas 22 and 20, respectively). A higher than usual concentration of snow crab was found in the 4X exploratory fishery and was located along the NAFO fishing boundary 4W/4X, on the 4X side.

The second comprehensive trawl survey was carried out in ENS in 1998. In 1997, fishery parameters estimated from this survey were not considered reliable because of uncertainties, such as the size-weight relationship and the discriminant functions. In addition, the rough bottom configuration found in ENS is quite different from what is found in the southern Gulf of St. Lawrence (GSL) where this method has been developed. In 1998, a new size-weight relationship and discriminant function have been established specifically for ENS snow crab population. The technique for biomass estimation by taking bottom configuration factor into account is currently been investigated, and possible problems and solutions are discussed in this document. In the meantime, the management of this fishery must still primarily rely on the assessment based on the fishery dependent data.



## RÉSUMÉ

Les débarquements totaux de 1998 à l'est de la Nouvelle-Écosse (E.N.-É.) étaient de 35 % supérieurs à ceux de 1997. Il y a eu une augmentation de 55 % dans les prises-par-unité-d'effort (PUE) saisonnières, et une diminution de 15 % de l'effort total comparée à l'année dernière. Cette augmentation dans les débarquements a été principalement causée par une augmentation des quotas individuels par bateau (QIB) de 50 % dans la zone 21 (de 10,000 lb à 15,000 lb), par une petite augmentation des QIBs des zones 23 et 24 (de 52,000 lb à 55,000 lb), et par l'introduction de nouvelles allocations (totalisant 500 t) destinées aux pêcheurs temporaires des zones 23 et 24. Globalement, la pêcherie de l'E.N.-É. peut se résumer ainsi: toutes les zones ont atteint leurs quotas avec des PUEs qui ont augmenté de 33 % dans la zone 23 à 75 % dans la zone 20 (les zones 21 et 22 = 50%), et la zone 24 = 37 %), tandis que l'effort de pêche est resté similaire (zones 21, 23 et 24) ou a diminué de 35 à 55 % (zones 22 et 20, respectivement) en comparaison avec 1997. Dans le cas de la pêche exploratoire de 4X, une concentration de crabes des neiges supérieures à la normale a été trouvée le long de la limite de démarcation des zones de pêche de l'OPANO 4W/4X.

Le deuxième relevé scientifique de chalutage de grande envergure a été réalisé à l'E.N.-É. en 1998. En 1997, les différents paramètres estimés à partir des ces données brutes n'étaient pas considérés fiables, et cela à cause d'incertitudes entourant l'application de la méthode du relevé scientifique, telles que la relation entre la largeur de carapace et le poids, et la fonction discriminante. De plus, le substrat et la configuration du fond marin retrouvé à l'E.N.-É. sont très différents de ceux que l'on trouve dans le sud du golfe du Saint-Laurent (GSL), là où cette méthode fut initialement développée. En 1998, une nouvelle relation entre la largeur de carapace et le poids, et une nouvelle fonction discriminante ont été développées spécifiquement pour la population de crabes des neiges de l'E.N.-É.. Une technique d'estimation de la biomasse qui tient compte du facteur de la configuration du fond marin est présentement à l'essai. Les problèmes et les solutions entourant cette technique sont discutés dans ce document. Entre-temps, la gestion de cette pêcherie doit dépendre principalement d'une évaluation des stocks qui est basée sur des données qui sont directement reliées à la pêche (livre de bord, observateur,...).

## INTRODUCTION

Harvesting of snow crab, *Chionoecetes opilio*, off the eastcoast of Nova Scotia (Areas 20 to 24; Fig. 1) began in the late 1970's. Landings rose rapidly with an increasing effort to a peak in 1979 but landings and catch-per-unit-of-effort (CPUE) then collapsed within four fishing seasons (Tremblay *et al.* 1994). In 1985, this fishery was believed to be near commercial extinction (Elner and Robichaud 1985). However, a pulse of pre-recruits entered the commercial catches of snow crab in all Areas in 1986 (Elner and Robichaud 1987). Total landings rose rapidly from 1989 to 1993 when peak levels were reached at 2016 t (Tremblay and Eagles 1996). In 1994, total landings declined by 23% to 1551 t, and remained stable at that level in 1995 and 1996. Catch rates in 1994, 1995 and 1996 were influenced by individual boat quotas, whether or not soft-shell crab were retained, and reduced fishing season in some Areas.

Analysis of catch rate, spatial distribution of effort, biomass and population structure from 1978-1993 indicate that the increased landings after 1986 resulted from an increase of abundance and biomass, an expanded fishing area and an increase of total effort (Tremblay and Eagles 1995). Although the value of snow crabs was a factor in some years, fishing effort appears to have been driven mainly by catch rate (Tremblay and Eagles 1995). A high incidence of soft-shelled crab in the 1994 and 1995 catches (up to 50%) was associated with a near record high effort (Tremblay and Eagles 1996).

From 1982 to 1993, the management of these fisheries was based strictly on effort controls (seasons, licenses and trap limits). The number of licenses remained stable except for Area 24 where 7 new licenses were added between 1989 and 1991. Substantial changes to the management of these fisheries were introduced in each Area from 1994 to 1997. Individual boat quotas (IBQ) were imposed in all Areas except for Area 22 which operated with a fleet cap. Other changes introduced during that period were a mandatory logbooks used by all fishers for both dockside monitoring and the scientific data base, 100% dockside monitoring, landings not more than 0-10% softshell crabs, at-sea monitoring by certified observer of a percentage of sea days, and a biodegradable "panel" on traps to prevent ghost fishing. Some voluntary measures were requested by fishers, such as a shortened season (Area 21), no fishing on Sundays (Area 22), a reduction of the trap limit from 30 to 25 (Area 21), and tagging of soft-shell crab by the license holders (Areas 23 and 24). The number of licenses in Areas 20, 21 and 22 remained unchanged from 1994 to 1997. However, in 1995 nine temporary (1 year) licenses were allowed in Area 23 and ten in Area 24, with each temporary license permitted to land 10,000 lbs. (4.5 t) with 10 traps per license. In 1996, the number of temporary permits was reduced to 3 in Area 23 and 4 in Area 24. However, in both Areas, 30,000lbs (13.6 t) were allocated to Natives on a temporary and communal basis. In 1997, the IBQ of fishers in Areas 23 and 24 was lowered from 55,000 to 52,000 lbs in order to bring the four First Nations allocations (introduced in 1996) to full quota status while allocating quota to more temporary permits (six in each of these two Areas) without increasing effort over that of the past two years. It is intended that these four Native licenses will remain in the fishery in future years, thereby changing the total number of full-quota licenses to 24 (from 22) in Area 23 and to 23 (from 21) in Area 24.

In addition to the fishing activities on "traditional" grounds off eastern Nova Scotia, exploration for snow crab has been conducted further southwest, and further offshore (NAFO Division 4X). Four vessels fished in late 1994 and in 1995. In 1996, the trap limit was raised to 250 traps from 100 (majority of them are the smaller 3' diameter type, so called Japanese conical trap), and was subjected to dockside monitoring for the first time. Only 1 fisher reported landings of snow crab in 1997 for a total of 1,800 kg that was fished between April and May.

There was no change in the 1998 management plan of Area 20 compared to 1997 (Table 1). The IBQ of fishers in Area 21 was increased from 10,000 lbs to 15,000 lbs, and the fishery reverted back to the regular fishing season. This Area had been on a voluntary shortened season since 1996. IBQs have been introduced for the first time in Area 22 in 1998. An industry-designed separation of the fleet into northern and southern components was incorporated into the 1998 management plan, and fishers were able to fish in only one area. The IBQ of the northern portion was 22,000 lbs, while the southern component had 27,000 lbs. In Area 23, the 1998 management plan allowed for an increase in IBQ from 52,000 to 55,000 lbs and the allocation of 10 temporary permits of 25t that had to be fished outside "traditional" fishing grounds. In Area 24, the IBQ was reduced from 52,000 to 50,000 lbs in 1998. This Area also had an allocation of 10 new temporary permits of 25t that had to be fished outside "traditional" fishing grounds.

An experimental trawl survey was conducted, in 1996, as a potential supplementary tool to the traditional method of assessment of the ENS snow crab fisheries. Twenty-three trawl stations were sampled prior to the fishery, covering mostly the inshore area of Area 23 and part of Area 24. This trawl survey produced results that matched the high catch rates and landings found for the same area (Biron *et al.* 1997). The following year (1997), the first large-scale annual trawl survey was conducted prior to the fishery, from May 15 to June 14, and comprised 150 stations, one station within each 10° latitude by 10° longitude grid (Biron *et al.*, 1998a). Overall, there are 26 stations in Area 22, and 62 sets in each of Areas 23 and 24. The data from this first annual survey were analyzed and the first biomass estimations and/or abundance in numbers were produced for the area surveyed. However, at the Scientific Committee of the Regional Assessment Process (RAP) in January 1998, it was felt that it was premature to present these results because of uncertainties concerning the direct application of the southern GSL kriging method to ENS (Biron *et al.* 1998a). It was suggested that these points be addressed before attempting to analyze data and produce any biomass estimate.

In the present document, the 1998 snow crab fishery from Areas 20 to 24, as well as the NAFO Division 4X, is being assessed. Also, following the second annual trawl survey, an accurate biomass level could not yet be estimated from the raw data collected because of uncertainties with the method. These uncertainties are discussed and recommendations are made for next year's survey.

## MATERIALS AND METHODS

### Landings, catch rate and effort

In 1998, data on landings and fishing effort were obtained from the mandatory logbook completed by all fishers for both dockside monitoring and the scientific database. Copies of the original completed logs and the compiled electronic database were obtained from the Statistic Division of the Maritimes Region of the Department of Fisheries and Oceans. Thereafter, total seasonal landings for each Area were obtained from a revised preliminary report produced by the Statistic Division in late December 1998, and may slightly differ from results presented in the Stock Status Report in January 1999. All fishers submitted their logs, but not all logs were usable; some have one or more missing or erroneous values such as missing number of trap used or incomprehensive fishing position. In 1998, over 85% of the logs received had complete information and were used in this analysis.

*Northern and outer components in Area 22* - In 1998, an industry-designed separation of the fleet into northern and southern (outer) components was incorporated into the management plan, and fishers were supposed to fish in only one area. The exact

coordinates for the outer fishing grounds, as well as the graphic representation of these two components are shown in Fig. 2. Although under a competitive fishery management, sharing of these same fishing grounds in Area 22 was guided by a "gentlemen's agreement" in 1996 and 1997 allocating fishers to inshore (northern component) or offshore (southern component) regions (Biron et al. 1998a). Therefore, landings, effort and calculated CPUE were determined for northern and southern grounds in that Area for 1998, while the 1996-97 data is presented as historic references for these two components.

*Traditional and non-traditional fishing grounds in Areas 23 and 24-* Due to a continuous increase in demand for access to the snow crab fishery in eastern Cape Breton, DFO fishery managers have asked if effort could be added in Areas 23 and 24. DFO Science examined this request based on the preliminary evaluation of the bottom configuration and depth of traditionally covered fishing grounds and outer zones (within the snow crab fishing area, but not frequently used by traditional fishers; Biron et al., 1998b). Traditional and non-traditional fishing grounds (Fig. 3) were determined as a result of the *ad hoc* Regional Advisory Process (RAP) meeting in Sydney on April 23, 1998 (Anonymous 1998b). Permanent fishers were allowed to fish anywhere in their respective Area (traditional and non-traditional grounds), while temporary permit holders were confined to the non-traditional fishing grounds only.

*Landings* - Total landings by Area are the sum of landings from the logs received for each Area. The geographic distribution of landings was presented as a sum of total landings within each 10° latitude by 10° longitude grid (10 X 7 nautical miles grid). The fishing positions were taken from the logs.

*CPUE and effort* - The average CPUE corresponds to the ratio of total landings ($y_i$) to the number of trap hauled ($tf_i$) reported in the logs: $CPUE = \sum y_i / \sum tf_i$. The total effort (total number of trap hauls: F) was then estimated from total landings (Y) divided by average CPUE: $F = Y / CPUE$. The geographic distribution of fishing effort was presented as a sum of number of trap hauls within each 10° latitude by 10° longitude grid. The fishing positions were taken from the logs. The geographic distribution of average CPUE was calculated within each of these grids. Information from the exploratory fishery (Area 4X) was analyzed separately from the "traditional" fisheries (Areas 20 – 24).

## Morphological study

A morphological study was realized in 1998 to answer two of the recommendations formulated at the 1997 RAP meeting, and which consisted of the elaboration of a size-weight relationships and a discriminant function that would be specific to ENS (Biron et al. 1998a). More than 750 snow crab males between 40 and 160 mm of carapace width caught during the 1998 trawl survey were brought to the DFO Moncton laboratory for measurement. All measurements were made on live animals and any specimen showing signs of water loss by injuries or extreme weakness was immediately discarded. The measurements of the chela height (ChH), chela width (ChW), chela length (ChL), the carapace width (CW), the carapace length (CL) were taken to the nearest 0.01mm with an electronic caliper (Digimatic caliper model 500-172, Mitutoyo Corp.). Other measurements included the weight, durometer and carapace condition (Appendix 1) for each specimen.

*Discriminant function-* Terminal (adult) and non-terminal (adolescent) individuals can be identified using chela morphometry by plotting logarithms of ChH against logarithms of CW (Conan and Comeau 1986). Data from adult and adolescent crabs fit into two distinct ellipses with parallel major axes (Conan and Comeau 1986). The actual analysis of the data was executed by using the discriminant analysis sub-routine program of the SYSTAT 8.0 for window statistical analysis package.

*Size weight relationship-* Size-weight relationships are expressed by the following equation:

$$W = a * CW^b$$

where W is the total wet weight in gram, CW is the carapace width in mm, "a" is the intercept in log scale and "b" is the slope.

In the present document, parameters from the size-weight relationships are estimated from a linear regression fitted to the natural logarithm transformed size – weight data. The previous equation is therefore transformed into the following equation:

$$\ln W = A + b * \ln CW$$

where $A = \ln a$.

**Sea sampling by certified observers**

Sea sampling data means only data collected by certified observers. For each randomly-sampled trap, the total number of male crabs, the position and depth of the trap were recorded, and a sub-sample of 40 crabs were taken randomly for the following measurements: CW, ChH, the carapace condition (on a scale of 1 to 5; appendix 1) and the hardness of the right claw (Foyle *et al.* 1989). Snow crab with claw hardness less than 68 in durometer readings were considered as soft-shell crab (Hébert *et al.,* 1992).

In an attempt to better describe (illustrate) any differences observed between Areas, or within any given Area (e.g. northern / outer areas, traditional / non-traditional fishing grounds), a "qualitative concept" is introduced to the sea-sampling information. Therefore, catch composition information (derived from the sea sampling data) is categorized within three groups (soft shell, old, and good crab; based on carapace condition and durometer information) and three CW size-classes (CW less than 95 mm, 95 to 102 mm, and larger than 102 mm). As previously stated "soft shell crab" regroups crab with claw hardness less than 68 in durometer reading (excluding any crab of carapace condition 4 and 5). "Old crab" refers to all the crab of carapace condition 5. "Good crab" includes all the other crabs that are not soft shell or old crab.

**Annual trawl survey**

*Trawl sampling* – In 1998, the number of stations to be sampled for the large-scale annual trawl survey increased from 150 to 240 and the survey now covers the fishing grounds of Areas 20 and 21 as well as parts of the non-traditional fishing grounds of Areas 23 (30 trawl stations) and 24 (30). The trawl survey was conducted prior to the fishery in Area 20 (15 trawl stations), 21 (15), 22 (26) and 23 "traditional grounds"(62) (from May 20 to June 17), and after the fishery in Area 23 "non-traditional grounds" and 24 (62) (from Sept. 25 to Nov. 14). A Bigouden *Nephrops* trawl originally developed for Norway lobster (*Nephrops norvegicus*) fishery in France is used (20 m opening with a 27.3 m foot rope on which is mounted a 3.2 m long, 8 mm galvanized chain; Conan *et al.* 1994). Each tow varies between 4 and 8 minutes at an average speed of 2 knots, depending on the depth, current speed and sediment type. The horizontal opening of the trawl was measured, every 7 seconds, with a SCANMAR net sensor. The distance of each tow was estimated from the position (Latitude / Longitude) recorded at the beginning and end of tow. The swept surface was then calculated based on the distance trawled and net width.

A systematic random design was used to determine the location of the 240 stations, one station within each 10° latitude by 10° longitude grid. The duration of each tow, as well as depth was recorded. The following measurements were taken for all snow crab

captured in each tow: CW, ChH and the carapace condition, for the males; CW, the width of the fifth abdominal segment and the color of the eggs and gonads, for the females.

*Kriging* - A geostatistical method, kriging was used to estimate annual and density contours of different biological categories of the snow crab biomass (Conan 1985; Conan *et al.* 1988). Kriging is described by Clark (1979) and its analytical basis was defined by Matheron (1970). It consists of two procedures 1) analyzing and modeling the covariance between sampling units as a function of distance between their locations, and 2) calculating optimal weights to be attributed to each sampling unit for calculating a predicted average characteristic of a given region to be assessed. Mapping of the whole area surveyed is the next step and, using point kriging and a fitted variogram; map of isodensity contours and isovariance contours is then generated for this area. We further use block kriging for estimating average density and variance over the whole area, and thereby estimating the total number of crab present in a given area.

The abundance of snow crab estimated by kriging was converted into biomass according to the size-weight relationship and size-frequency histograms. To convert size to weight, size-weight relationships were calculated according to molt stage, the morphological maturity and sampling season. Also, the model assumes that trawl efficiency is 100% for individuals larger than 30 mm CW.

*Morphological maturity* - We used the terminology "adolescent" (small claw) for non-terminal molt males and "adult" (large claw) to represent the terminal molt males (Sainte-Marie *et al.* 1995). The distinction between the two groups is based on the relationship between CW and ChH proposed by Conan and Comeau (1986).

*Carapace condition* - Crabs were categorized into five groups based on the carapace condition and hardness (Anonymous 1994). Crabs identified as carapace condition 1 or "New soft" and carapace condition 2 or "Clean" with durometer reading less than 68 were considered as postmolt soft-shell crab (called soft-shell crab in this document).

## RESULTS

### Fishery

Five "traditional" Crab Fishery Areas (CFA- 20 to 24) were exploited in 1998. In addition, there was a total of 20 temporary permits of 25t each, representing new allocations of 250t in CFA 23 and 250t in CFA 24, that were granted to give access to areas that have been determined as non-traditional fishing areas (Anonymous 1998a). These allocations and the determination of traditional and non-traditional fishing grounds (Fig. 3) were determined as a result of the *ad hoc* Regional Advisory Process (RAP) meeting in Sydney on April 23, 1998 and recommendation by Science (Anonymous 1998b). There was again this year four vessel conducting an exploratory fishery in NAFO Division 4X.

The 1998 total landings in ENS were 35 % higher compared to 1997 (Table 2, Fig. 4). The average CPUE for the "traditional" fishery off ENS was 58.0 kg per trap haul (kg/th), while the average fishing effort was 38,600 trap hauls (Table 2). Overall, this represents an increase in CPUE of more than 55% compared to the 1997 (37.3 kg/th) level, and a reduction in fishing effort of 14% (44,900 trap hauls). The seasonal geographic distribution is presented for landings (Fig. 5), CPUE (Fig. 6) and fishing effort (Fig. 7), as well as the location of the logbook positions recorded by the fishers (Fig. 8).

The average CPUE for all Areas was the highest in the recorded history (Table 2). The size-frequency data (Fig. 11) suggest the presence of new recruitment in Areas 20

(10% small claws), Area 21 (15%), Area 23 (27%) and 24 (13%). Overall, the presence in of small claw crab (in percentage) has decreased in Area 20 and 24, and increased by more than 80% in Area 23.

Area 20

*Fishing distribution* – As in previous years, the fishing effort was concentrated along the snow crab boundaries of Areas 19/20 and 20/21.

*Landings* - Total landings in 1998 (45 t) are similar to the landings of 1997 (Table 3). Landings occurred within 4 weeks, from July 22 to August 11 (Table 4).

*CPUE and effort* - The average CPUE was 35.5 kg/th in 1998, which represents an increase of 75% compared to 1997 (20.2 kg/th)(Table 3, Fig. 9). Meanwhile, total effort (1,272 trap hauls) decreased by 55% compared to the 2,246 trap hauls in 1997 (Fig. 10).

*At-sea sampling by observers* - The catch composition derived from the at-sea samples showed that 95% of the measured crabs were adult males greater than 95 mm (Tables 5a and 6a). Adolescent males accounted for less than 8% of the catches. The averaged seasonal soft-shell crab percentages were 15%. The mean CW was 116.4 mm (Fig. 11).

Area 21

*Fishing distribution* – The fishing occurred exclusively in the inshore area; the only fishing ground which seems to be productive in the Area.

*Landings* - Total landings in Area 21 were 216t, 48% higher than those of 1997 (Table 7) were. However this was expected since the quota went up 50%. On average, all fishers met their new IBQ. Again in 1998, and even though the IBQ was increased from 10,000 to 15,000lbs between 1997 and 1998, Area 21 had the shortest season of all Areas with landings occurring from July 22 to August 05.

*CPUE and effort* - The seasonal CPUE of 53.0 kg/trap haul is the highest value ever recorded since 1978, 50% higher than 1997 (35.7 kg/trap haul), which was the second highest recorded value for that Area (Table 7, Fig. 9). The effort (4,073 trap hauls) is similar to last year, both years being the lowest effort recorded in the last ten years (Fig. 10).

*At-sea sampling by observers* - The soft-shell crab percentage of 23.7% is 15% lower than the percentage reported for 1997 (27.5%) (Table 5b). The sample size (N=679) of the measured crabs is almost 3 times higher in number than that of last year (240 crabs), representing 3 sea-trip of 17 sampled traps (Table 6b). Adolescent males represented 15% of the catch composition (Table 5b). The mean CW (108.2 mm) of at-sea samples was smaller to the one reported in 1997 (107 mm) (Fig. 11).

Area 22

*Fishing distribution* – This area was separated into a northern component and an outer component, with the majority of fishers concentrating their effort towards the boundary between Areas 22 and 21 in the northern area. In the outer area, fishers concentrated there fishing around the Glace Bay hole.

*Landings* - Area 22 total landings in 1998 were 15% higher than those of 1997 (Table 9). In the northern portion, 24 fishers landed 244t within 3-4 weeks, while 13 fishers landed 152t in a period of 3 weeks in the outer component (Table 10). This represent a 30%

increase in the landings coming from the northern fishing grounds compared to last year data, while the landings in the outer portion remained approximately similar compared to 1997 (Table 11). Area 22 fished from July 22 to August 8 (northern fishing grounds) or August 12 (outer fishing grounds).

*CPUE and effort* - The average seasonal CPUE of 38.2 kg/th is almost double that of 1997 (Table 9, Fig. 9). In the northern fishing grounds, the average catch rate was 34.5 kg/th in 1998, representing an increase of 12% compared to 30.7 kg/th in 1997 (Table 11). The average seasonal CPUE of 45.6 kg/th in the outer area in 1998 (Table 10) is three times higher than that reported for 1997 (Table 11). Total effort for the whole Area in 1998 (10,387 trap hauls) is 35% lower than 1997 (16,472 trap hauls) (Table 11, Fig. 10). The breakdown shows that the seasonal effort for the northern grounds was 7,077 trap hauls in 1998, and 3,333 trap hauls for the outer area (Table 10).

*At-sea sampling by observers* – Due to misunderstandings between governmental and non-governmental parties involved in the collection of sea-sampling data this year, no sea-sampling occurred in Area 22 in 1998. This problem has been handled by DFO management, and is not expected to occur again in the future.

Area 23

*Fishing distribution* - Fishing locations based on logbooks received from Area 23 fishers (Fig. 8) show that all permanent license holders have fished within the limit of the traditional fishing grounds, while the temporary license holders remained in the non-traditional fishing grounds as per their permit condition. In Area 23, permanent licenses data is synonymous with traditional fishing ground data, as temporary or non-traditional refer to the same data set.

*Landings* – Total landings in 1998 were 813t (Table 12). A breakdown by status shows that permanent license holders captured 599t and temporary license holders landed 207t (Table 13). Landings occurred from August 7 to September 15 (permanent licenses) or October 18 (temporary permits).

*CPUE and effort* - The average Area seasonal catch rate of 77.0 kg/th is 33% higher than the average of 1997 (57.8 kg/th), and the highest recorded value for this Area (Table 12, Fig. 12). The Area total effort of 10,550 trap hauls is comparable to the total of last year (10,232 trap hauls). The 1998 seasonal catch rate of permanent license holders of 84.1 kg/th is 43% higher than last fishing season value of 58.7 kg/th, while the total effort reported of 7,122 trap hauls in 1998 is 25% lower than those of 1997 (9,675 trap hauls). Meanwhile, the temporary license holders have reported a seasonal CPUE of 63.0 kg/th and a total effort of 3,398 trap hauls for the non-traditional fishing grounds (Fig. 13).

*At-sea sampling by observers* - The seasonal percentage of soft-shell crab is 8.6% of total catches (Table 5c). This year data showed that 18% of the hard-shell adult males were under the legal carapace size limit of 95mm (Table 5c), which represents a decrease of about 40% in undersize adult males compared to 1997. Adolescent male crabs accounted for 10% of the total catches in 1998, a decrease of 22% compared to last year.

The number of crabs sampled during the 1998 sea-sampling (N=5,078) is 40% lower than last year, and the number of crabs sampled are evenly distributed between traditional (N=2,394) and non-traditional (N=2,684) fishing grounds (Tables 14). The seasonal percentage of soft-shell crab in the traditional grounds is 10% of total catches, while it is 7.5% in the non-traditional area (Table 14). Data also show that almost 30% of the hard-shell adult males caught in the traditional fishing grounds were under the legal carapace size limit of 95mm, while this value is less than 10% in the non-traditional

grounds of Area 23. Adolescent male crabs accounted for about 7% of the total catches of permanent license holders, while this percentage is double for the temporary permit holders. The arbitrary comparison of the "quality" of catch composition from at-sea sampling between traditional and non-traditional fishing grounds shows that the concentration of old crab found in the respective catches is similar, but the distribution among the three size classes differs with the non-traditional grounds having larger older crabs than traditional grounds (Table 15). The comparison of the quality of crab point out a marked differences between the two groups if we compare the distribution percentages of their respective three size-classes (Table 15). The concentration of good crab in the traditional fishing grounds shows that 25% of its sea-sampling specimen are falling under the legal size of 95mm, 21% are between 95mm and 102mm, and 30% are larger than 102mm, while these are 10%, 25% and 50% respectively for the non-traditional area (Table 15). The average CW (104.3mm) of measured individuals is 4 mm larger than that in 1997 (Fig. 11).

Area 24

*Fishing distribution* - Fishing locations based on logbooks received from Area 24 fishers (Fig. 8) show that at least 5 permanent license holders fished in the non-traditional fishing grounds; 2 westerly and 3 southerly to the limit of the traditional fishing grounds. Temporary license holders remained in the non-traditional fishing grounds as per their permit condition. In Area 24, data for permanent licenses do not refer to the same data set as traditional fishing ground data.

*Landings* – Total landings in 1998 were 745t (Table 16). A breakdown by status shows that permanent license holders captured 577t and temporary license holders landed 168t (Table 17). Landings occurred from August 03 to September 25 in Area 24 for both permanent and temporary fishers.

*CPUE and effort* - The average Area seasonal catch rate of 62.0 kg/th is 37% higher than the average of 1997 (45.2 kg/th), and the highest recorded value for this Area (Table 16, Fig. 12). The Area total effort of 12,019 trap hauls is comparable to the total of last year (12,498 trap hauls)(Fig. 13). The 1998 seasonal catch rate of permanent license holders of 62.8 kg/th is 35% higher than last fishing season value of 46.4 kg/th, while the total effort reported of 9,193 trap hauls in 1998 is 20% lower than those of 1997 (11,589 trap hauls). Meanwhile, temporary permit holders have reported a seasonal CPUE of 59.1 kg/th and a total effort of 2,839 trap hauls.

*At-sea sampling by observers* - The seasonal percentage of soft-shell crab (22.47%) derived from the sea-sampling data is 25% higher than last year (Table 5d). The 1998 data showed that 24.37% of the hard-shell adult males were under the legal carapace size limit of 95mm (Table 5d), representing an increase of about 40% in undersize adult males compared to 1997. Adolescent male crabs accounted for 10.5% of the total catches in 1998; a decrease of 13% compared to last year.

The number of crabs sampled during the 1998 sea-sampling (N=3,996) is 45% lower than last year, and the distribution of the number of crabs sampled is not evenly separated between permanent (N=3,756) and temporary (N=240) license holders (Table 18), nor between traditional (N=3,583) and non-traditional (N=413) fishing grounds (Table 19). The concentration of "good" crab in the traditional fishing grounds shows that 26% of its sea-sampling specimen are falling under the legal size of 95mm, 19% are between 95mm and 102mm, and 30% are larger than 102mm (Table 20). The average CW (99.4mm) of measured crabs is 5mm smaller to last year (Fig. 11).

Exploratory fishery in NAFO Division 4X;

*Fishing distribution* – A higher than usual concentration of snow crab was found along the NAFO fishing boundary 4W/4X, on the 4X side. This resulted in the relocation of the fishing effort of three fishers to that area from the fishing grounds surrounding Brown, Baccaro, and Roseway Banks. The 4th fisher maintained his exploratory fishing activity as usual.

*Landings* - Total landings in 1998 are 54t, and are the highest landing to date for this exploratory fishery (Table 21). Landings occurred mainly during the first half of the year, from February 3 to June 23 (Table 22), and from November 5th to December 20.

*CPUE and effort* - The seasonal CPUE of 5.4 kg/trap haul is the highest value ever recorded since 1994 (Tables 21 and 22). The total effort is 7,774 trap hauls (Table 21).

## Morphological study

*Size-weight relationship*- The size-weight relationship for adult hard-shell males in ENS is expressed by the function $W = 1.543 \times 10^{-4} CW^{3.206}$. The regression plot of the ln of the weight against the ln of the CW (Fig. 14) shows a good correlation ($R^2 = 0.97831$).

*Discriminant function*- The following discriminant function;

$$Y = 19.775707 \ln(ChH) - 25.324040 \ln(CW) + 56.649941,$$

will assign individuals to the correct groups in 99% of cases (for adult males: $Y > 0$). By plotting logarithms of ChH against logarithms of CW, the ENS data from adult and adolescent crab fitted into two distinct ellipses with parallel major axes (Fig. 15).

## Annual trawl survey

A total of 214 stations (out of the 240) were successfully sampled during the 1998 trawl survey. The remaining stations, all in Area 23 non-traditional grounds, had to be abandoned because of the lateness of the survey and poor weather conditions during the fall. There are 15, 15, 26, 66 (62 stations in the traditional grounds and 4 in non-traditional grounds), and 92 (62 sets in the traditional grounds and 30 in non-traditional grounds) stations in Areas 20, 21 22 23 and 24 respectively.

Out of the 214 trawl stations surveyed in 1998, 118 (Areas 20,21, 22 and 23 traditional) were surveyed before the fishing season, and 96 stations (Area 24 traditional and non-traditional and four stations in Area 23 non-traditional) were surveyed after the fishing season (Fig. 16). During the survey, 9,556 males and 7,413 females were captured and measured. Amongst the 9,556 males, 1,640 (17.1%) were mature (adult) larger than 95 mm. Male histograms (Fig. 17) indicated that there were several modes of adolescent (future recruitment), but these ones are less predominant than those in the 1997 histogram. The total area covered for biomass estimation by kriging was 34,300 $km^2$. The different variograms used in the kriging calculations indicate that there is a covariance effect between the values sampled ranging from 10 to 90 km.

Area 20

The total area covered by the survey was 630 $km^2$. There were 168 males and 317 females collected and measured. Amongst the males caught, 20.2% were adults greater than 95 mm. Very little future recruitment can be observed in the male > 95 mm histogram (Fig. 17). The average CW of commercial crab was 110.0 mm.

Area 21

The area covered by the survey in Area 21 totaled 920 $km^2$. A total of 141 males and 378 females were caught and measured. Close to 30% of the males were mature greater than 95 mm. Very little future recruitment can be observed in the male > 95 mm histogram (Fig. 17). The average CW of commercial crab was 114.0 mm.

Area 22

In Area 22, the total area covered by the survey was 4,250 $km^2$ and the number of crab caught was 1,669 males and 1,104 females, and 22.6% of the males were adults larger than 95 mm. Several modes of recruitment can be identified in the male histogram (Fig. 17). The northern portion covered an area of 1,258 $km^2$, while the outer area covered 3,512 $km^2$ (Fig. 2). The comparison between the northern and outer histograms (Fig. 18) shows that the northern component has a higher recruitment than the outer area. Although both components have similar distribution of adult males, larger size males were found in the northern portion. The average CW of commercial crab was 108.7 mm.

Area 23

The total area covered by the survey was 14,000 $km^2$. There were 3,488 males and 3,375 females collected and measured. Amongst the males caught, 10.1% were mature greater than 95 mm. One large and distinct pulse of future recruitment can be observed in the male histogram (Fig. 17). The average CW of commercial crab was 105.2 mm.

Area 24

The area covered by the survey in Area 24 totaled 14,500 $km^2$. A total of 4,021 males and 2,238 females were caught and measured. Slightly more than 20% of the males were mature greater than 95 mm. The male histogram of Area 24 (Fig. 17) shows only one large pulse of adolescent males. The histogram for the traditional and non-traditional fishing grounds both show 2 pulses of recruitment, but the size class are different; it seems to be pulses of size classes of 50 and 70 mm in the non-traditional grounds, and 70 and 90 mm in the case of the traditional grounds (Fig. 19). The number of adult males is also more important in the traditional fishing grounds. The average CW of commercial crab was 111.6 mm.

Biomass distribution

The 1997 contour of density map for adult males greater than 95mm show 3 major concentrations of adult male that are located in the "offshore" fishing grounds, with smaller patches inshore (Fig. 20). Of the 3 major concentrations, the one located in Area 23 was mainly composed of crab of carapace condition 1 and 2, while the other two in Area 24 were mostly crabs of carapace condition 3 and 4. These maps also indicate that the concentration of adult male found inshore of Area 22 was mainly composed of crab of carapace condition 1 and 2.

In 1998, there was one major concentration of adult male that was located between Canso, Missaine, Banquereau and Middle Banks, surrounded by smaller patches (Fig. 21). The bulk of adult male crabs found in Area 23 and 24 was composed of crab of carapace condition 3 and 4, while the continuous concentration in Area 21 and 22 (northern) and a high density patch found in the outer portion of Area 22 were mainly composed of crab of carapace condition 1 and 2.

## DISCUSSION

The 1998 total landings in eastern Nova Scotia were 35% higher than those of 1997. There was a 55% increase in the seasonal CPUE and a 15% reduction in total fishing effort compared to last year. The increase in landings was mostly the result of the 50% increase in IBQ in Area 21 (from 10,000 to 15,000lbs), a slight increase in IBQ in Areas 23 and 24 (from 52,000 to 55,000lbs), and the introduction of new allocations (for a total of 500t) for temporary permit holders in Areas 23 and 24. Hence all Areas have reached their quotas with a higher CPUE which increased 33% in Area 23 to 75% in Area 20 (Areas 21 and 22 = 50%, Area 24 = 37%), while the reported fishing effort were similar (Areas 21, 23 and 24) or 35% to 55% lower (Areas 22 and 20, respectively). However, because of the increase in landings allowed in Area 21 in 1998, some snow crab buyers in the northern portion of ENS (Areas 20, 21 and 22) dealt with this increase in snow crab to be process by asking fishers to fish their traps every second day. In 1997, especially in Area 20, attempts were made to fish each trap every day. This may result in a false increase of CPUE value caused by a longer immersion time (underestimation of fishing effort). The similar phenomenon was observed in the Area 12 fishery since 1994 (Hébert *et al.,* 1999).

### Population structure

The catch composition established by the sea-sampling in 1997 showed the highest rate of adolescent males in Area 22 and 23 (27%), while the lowest rate was found in Areas 20 (12%) and 24 (13%). The highest seasonal percentage of soft-shell crab was estimated (38.5%) in Area 22, while the lowest percentages were found again in Areas 20 (14%) and 24 (18%). The 1998 sea-sampling by observers shows that the highest rate of adolescent males was found in Area 23 (27%), while the lowest rate was found in Areas 20 (10%) and 24 (13%). However, in 1998, no sea-sampling data were collected by observers in Area 22.

The increase in average size observed in Area 23 (from the sea-sampling) and Area 24 (from the trawl survey) are probably attributable to the non-traditional fishing grounds sampling (or lack of). Only 4 trawl survey stations were sampled in the non-traditional grounds of Area 23 out of the 66 stations, while 30 stations were sampled in non-traditional grounds of Area 24 out of the 92 stations done for this Area. In the same manners, about 50% of the snow crab sampled during the sea-sampling came from the non-traditional fishing grounds, while this contribution falls to 10% in the sea-sampling of Area 24. Therefore, the difference in number of sample s makes certain results look better when both Areas are compared, or compared with the results of the other Areas. The sea-sampling from Area 23 illustrate clearly that the non-traditional fishing grounds have little undersized snow crab (12%) and a high proportion of large crab over 102mm (58.5%) compared to the traditional fishing grounds sea-sampling which shows higher concentration of undersized adult crabs (33.5%) and lower concentration of large crab over 102mm (38%). Both groups have similar concentration of the intermediate size snow crab. It is possible this difference between the traditional and non-traditional percentage in size-class is simply attributable to the fishing activity; the larger crab in the traditional fishing grounds of Areas 23 and 24 have been exploited over the years, while the non-traditional territories are basically virgin fishing grounds.

The histograms of size frequency distribution, especially those generated from the research trawl survey, indicate that in general Area 22 has the highest density of immature and adolescent males, especially in the northern portion of this Area. Although adolescent crab can be observed in all Areas, only Area 22 shows a strong presence of smaller immature crabs. The comparison of Area 22 northern and outer data shows that both

grounds have more or less the same population structure (number and similar modes), and that the major differences consisted in the high quantity of future recruitment found in the northern component and larger carapace size of mature crabs that are found in the outer area.

The continual high percentage of soft-shell crab combined with a multitude of other factors seem to indicate that the inshore grounds of Area 22 might be a nursery area (e.g. larval settlement and juvenile growing area). Some of these other factors are; -the high density of adolescent; -the small average carapace size; -the high number of future recruitment modes; -the fact that high recruitment predicted in the past does not materialize; -and the observations drawn from the research survey. Although there are indications that such a nursery may also be present elsewhere in Areas 23 and 24 (i.e. patches of high concentration of smaller adolescent crabs), in Area-22 it coincides with the best fishing grounds available in the whole Area. Because of its small fishing Area and the high number of fishers, it is presently impossible to suggest a redistribution of effort within the inshore portion to protect this highly productive ground.

**NAFO 4X exploratory fishery**

This exploratory fishery has encountered higher concentration of crab in 1998 compared to any previous year. Although the seasonal CPUE of 5.4 kg/trap haul is higher than the usual 1 or 2 kg/trap haul, it is still 10 times lower than the seasonal value of 58.0 kg/trap haul found in ENS. This increase in CPUE is solely due to the higher density concentration of snow crab that was found along the NAFO fishery boundary 4X/4W, and the resulting concentration of fishing effort by three of the four fishermen. The finding of this higher than usual concentration of crabs prompted us to review the fishing location found on the historical logbooks (1994 to 1997). The usual exploratory activity since this fishery started in 1994 has been predominantly around the major banks of 4X, such has Brown, Baccaro and Roseway. However, 1 fisherman fished extensively the exact same area between June 25 and August 9 of 1995 than that "newly" discovered concentration of crab in 1998. The CPUE for that period was less than 2.0 kg/trap haul (1.87). No higher density of crab was found (or present) at that time.

Following a meeting organized by the southwest Nova Scotia Area management in Yarmouth on June 25, 1998, it was decided to create a "protected" area that would cover the newly found concentration of snow crab for the 1999 fishery season. The rational for that protected area is to ensure that a "reasonable" fishing effort is deployed around this concentration by limiting the number of 145 traps allowed to each fisherman of 4X to only 30 in the protected area. 100% dock side monitoring is recommended to obtain the accurate landings. Nevertheless, the discovery of a concentration of snow crab with a higher density has created a new interest in the exploration of the NAFO 4X fishing grounds. Also at that meeting, DFO Science was asked to elaborate a research protocol for the protected grounds and its surrounding area. A gridwork has been established for this protocol that will concentrate mainly on the territory along the NAFO fishing boundary of 4X/4W in 1999, but to be expanded toward uncovered grounds in the following years. Another meeting will be organized for January 1999, and the details and logistic of this protocol should be finalized at that time. The research protocol concerning the exploration of NAFO 4X fishing grounds should be in place before the 1999 fishing season which is anticipated to start early February.

**Annual trawl survey**

Following last year presentation of the 1st annual trawl survey preliminary results for ENS to the Scientific Committee of the Regional Assessment Process (RAP), it was felt that it was premature to present these results because of uncertainties concerning the direct

application of the southern GSL kriging method to ENS. It was also suggested that these points be addressed before attempting to analyze data and produce any biomass estimate in the future. Therefore, all biomass estimations and/or abundance in numbers were withdrawn from the stock assessment research document, as well as the contour of density (distribution) maps of all the different categories presented at the RAP meeting. In this later case, the feeling was that it might produce a false impression of a "very" important biomass in the surveyed and non-surveyed area of eastern NS. And it was generally accepted that by themselves, with no other year(s) to compare it to, it could only lead to a potential misrepresentation of the snow crab population in eastern NS.

The "uncertainties" or "unknown factors" thought to influence the accuracy of the biomass estimates during the 1997 RAP meeting were: 1) A size-weight relationship specific to ENS which had not yet been determined, and the southern GSL model had to be used until a specific model was established; 2) The discriminant functions used to assign individuals to the correct adult (large claw) or adolescent (small claw) groups in 99% of cases was based on a small sample of raw data collected by R.W. Elner (pers. comm.) in 1985-86 and calculated by M. Comeau (pers. comm.) in 1990. One of the models had been developed for the contiguous area in CFA 20-21, and the other for the traditional fishing grounds of Areas 23 and 24. A single model developed on samples collected throughout the surveyed area would certainly have given a more representative and accurate distribution for adult and adolescent groups. Therefore, we questioned whether or not the discriminant functions established from the sampling in the traditional fishing area in 1985-86 truly represented the 32,000 $km^2$ surveyed that year. Furthermore, the measurements of the CW and CH from 1985-86 were taken to the nearest millimeter, which produce discriminant functions that are less accurate than measurements with decimals; 3) Another concern was the different type of bottom found in ENS. In the southern GSL, where the research trawl survey method was developed to evaluate the snow crab population, the bottom is more or less uniform; most of its surface ranging in depth of <30 to 100 m. In eastern NS, this type of bottom (or at least comparable) comprise almost 50% of the surveyed area, and is mainly present as a relatively narrow strip along the shore and many large fishing banks. At the time, the other 50% of surface surveyed was comprised of large areas of rough bottom forming gullies, passages and holes in and around fishing banks and the narrow strip along the shore. The depth of this mountainous terrain ranged between 100 to over 200 m. Further observations indicated that the 3 major concentrations of male adult crabs greater than 95 mm found in the offshore portion of the surveyed area in CFA 23 and 24 were mostly located within these rough grounds; an area surrounded by Canso, French and Middle Banks; a second area which is surrounded by Middle, Sable Island and the western tip of Banquereau Banks, at the end of the Gully; and the last one was reported within the area between Missaine and Banquereau Banks, near Artimon Bank. Since it could easily result in an over-estimation of the biomass, we are solving this problem in collaboration with fishermen (gathering first hand information on their fishing grounds), and DFO Hydrographic Services (providing us with detailed depth contour electronic charts).

The first two uncertainties described above have been dealt with and it is now clear that their impact on the biomass estimations, although real, would have been negligible overall. The southern GSL discriminant function and the new eastern NS discriminant function, when plotted against this year data, are almost identical. However the southern GSL discriminant function could have favored the adolescent group over the adult. The size-weight relationship developed for ENS produced similar crab weights than the southern GSL when both relations where tested with fictive snow crab carapace widths; with the southern GSL always giving weights that were slightly superior to the new eastern NS relationship (in the order of 1 to 20 grams). In either case, the new eastern NS size-weight relationships and the new discriminant function will have to be reassessed, but not in the immediate future.

The comparison of the stock density distribution of 1997 and 1998 (Figs. 15 and 16) shows a consistency in the evolution of the stock distribution of snow crab between both years. The high density patches and general pattern that can be seen on the 1998 map can be reasonably traced back to its origin on the 1997 map. The three large adult male concentrations observed in 1997 seems to have spread out into many smaller patches in 1998. This movement seems also to be stronger (or more apparent) in its westerly advancement. For both years, the majority of stations with high snow crab density found within a "patch" are also the deepest ones. In other word, above a certain depth, there seem to be little or no concentration of commercial (< 95mm) snow crab. It might also be simply related to environmental conditions such as warmer water since snow crab would avoids these habitats.

The implications that certain grounds do not have crab above a certain depth is considerable in the assessment of the biomass of eastern NS. One can easily accept the concept that when an island is encountered in the middle of a given area being surveyed for snow crab, the surface covered by this island and its immediate shallow surrounding area have to be considered somehow in the analysis (it is after all a safe assumption that no snow crab population lives on the island). Otherwise, if two stations with high density of crab are found on each side of the island, the analysis would irremediably determine that the island (which has no sampled stations) was a densely snow crab covered habitat, which we know is false. In a similar manner, we need to consider a minimum depth above which the grounds covered by the survey would be excluded from the analysis of the biomass estimations of eastern NS snow crab stock, or again substituted by zeros. For example, the largest continuous high density patch in the shape of an elongated S found at the center of Areas 23 and 24, in its present form, coverts most of Middle Bank along its edge, the facing edge of Sable Island Bank and the whole western tip of Banquereau Bank, as well as all the "islands" of higher grounds found in between these three major banks. If the cutting line was at a depth of 100 meters, which is one of the depth that will have to be considered, then none of the banks and higher grounds in between would be considered as high density grounds. It would then become obvious that the crab were actually situated in the gullies in between the major banks, which would results in a narrower and more defined patch with a Swiss cheese look to it. In such a possibility, the surface considered habitable by the snow crab and used for the analysis would be far less than it is currently considered.

In the coming year, the work on the analysis of the trawl survey in ENS will focus mainly on the impact of bottom depth and configuration have on the biomass estimates, as well as to establish an acceptable solution to include (or exclude) this variable into our stock assessment. Now that we have a better understanding of the snow crab population dynamic in the deepest water of eastern NS (compared to our previous experiences that was solely based on the southern GSL), we need to meet with the different fisherman associations to exchange knowledge of their fishing grounds. During the *ad hoc* RAP meeting in Sydney on April 23, 1998 (Anonymous, 1998b), a group of fishers from Area 24 showed the gathering a map of their Area with regions that, they claimed, was denuded of snow crab. The survey of 1998 seems to supports most of their claims. We also need to consider the fact that depth might not be the limiting environment factor here, or at least certainly not the only one. The work realized by Drinkwater et al. (1997) and Drinkwater (1998) seems to indicate that the "sudden" apparition of snow crab in eastern NS in the 90's was related to a cooling of the water temperature on the Scotian Shelf. The slow progression of the colder water had progressively increased the surface of the snow crab habitat. Therefore, one can stipulate that a reversed trend in the cooling tendency toward a warming up could therefore result in a decrease of this livable habitat. Even if in this case depth was not the limiting factor, it could still be used to exclude the warmer and unfavorable habitat.

## OUTLOOK FOR AREAS 20-24 AND 4X

Area 20-24

Stock status appears better than previous years. Catch rates have increased in all Areas, although changes in fishing habits (fishing every second day rather than every day) explain some of the marked increase in the northern portion of ENS. A new survey indicates that the resource is widely distributed, particularly in Areas 23 and 24 and that there are concentrations of crab outside where the bulk of the fishery occurred in 1998. However, Area 20 seems to be extremely dependent on incoming snow crab from Area 19 and 21. Furthermore, there was no future recruitment observed in that Area from the trawl survey, and this might results in more fluctuation in the catch from year to year. Results from the trawl survey indicate that the bulk of the adult male snow crab stock greater than 95mm in Areas 23 and 24 was mainly composed of older crab of categories 3 and 4, while these were of categories 1 and 2 in Areas 20, 21 and 22. At least one more survey will be required before reliable biomass estimates will be available. The survey indicates that there are good signs of new recruits, particularly in Areas 22, 23 and 24. Based on results of the first (1997) and second (1998) trawl surveys, which this year covered all Areas of ENS, there is indication that the biomass has increased in 1998 compared to 1997. There is also indication of recruit (primarily adolescent between 56mm and 95mm) that should enter the fishery in the next 2 to 3 years. However, the absence of immature in all Areas (but for Area 22) seems to indicate that the biomass will start to decrease (fluctuate) after that period if this population follows a life cycle comparable to other known snow crab stock.

Area 4X

The 4X fishery needs to be examined for potential as a legitimate fishery. A higher than usual concentration of snow crab was found along the NAFO fishing Boundary 4W / 4X, on the 4X side. Since then, the exploratory fishery has been focussed on this large concentration of snow crab but it is not conducting a systematic search of the entire 4X area. A proper evaluation of resource status is required.

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## Appendix 1

Classification of carapace stages based on carapace condition, durometer reading and corresponding approximate age after terminal molt (modified from CAFSAC 1991; Anonymous 1994).

| Category | Stage | Durometer reading | Carapace condition | Approximate age after terminal molt |
|---|---|---|---|---|
| New soft | I | < 68 | brightly colored, iridescent, soft, no epibionts, chelae easily bent. | 0-5 months |
| Clean | II | variable | brightly colored, some iridescence, may have epibionts, chelae not easily bent | 5 months- 1 year |
| Inter-mediate | III | > 68 | dull brown dorsally and yellow-brown ventrally, no irridescence, shell abrasion evident, epibionts. | 8 months -3 years |
| Old | IV | > 68 | carapace very dirty but hard, decay may be present at leg joints, epibionts removable at processing plant. | 2 - 5 years |
| Very old | V | variable | carapace very dirty and may be soft (durometer reading < 68), progression of decay may be evident, epibionts not removable at processing plant. | 4-6 years |

**Table 1.** Summary of the Management Plan measures for 1998.[1]

| Area | Season | Regular licenses | Traps allowed | Quota per regular licenses (lbs) | Temporary permits | Traps allowed | Quota per temporary permits (lbs) |
|---|---|---|---|---|---|---|---|
| 20 | July 22- Sept. 15 | 5 | 30 | 20,000 | none | none | none |
| 21 | July 22- Sept. 15 | 32 | 25 | 15,000 | none | none | none |
| 22 | Northern group:[2] | | | | | | |
| | July 22- Sept. 1st | 25 | 30 | 22,000 | none | none | none |
| | Southern group:[2] | | | | | | |
| | July 22- Sept. 8 | 12 | 30 | 27,000 | none | none | none |
| 23 | July 22- Sept 15 | 24 | 30 | 55,000 | 10 | 30 | 55,000 |
| 24 | July 22- Sept. 30 | 23 | 30 | 55,000 | 10 | 30 | 55,000 |
| 4X | year round | 4[3] | 145[4] | competitive | none | none | none |

[1] Information from Integrated fishery management plan (Anonymous, 1998a)
[2] Both groups have agreed not to fish on Sundays.
[3] These are exploratory fishing licenses in the 4X portion of CFA 24.
[4] Provided the majority of them are the smaller 3' diameter Japanese conical type.

**Table 2.** Landings of snow crab (*Chionoecetes opilio)* for eastern Nova Scotia (Areas 20 to 24), 1978 - 1998.

| Year | Active licenses/permits | Logbooks received | Landing Statistics (t) | Total mean CPUE (kg/trap haul) | Total Effort (1000's of trap hauls) |
|---|---|---|---|---|---|
| 1978 | 42 | 42 | 801 | 28.4 | 28.2 |
| 1979 | 98 | 89 | 1,634 | 28.7 | 56.9 |
| 1980 | 99 | 81 | 819 | 19.8 | 41.4 |
| 1981 | 55 | 19 | 156 | 21.8 | 7.2 |
| 1982 | 67 | 56 | 554 | 16.7 | 33.2 |
| 1983 | 97 | 80 | 259 | 9.6 | 27.0 |
| 1984 | 51 | 38 | 124 | 8.6 | 14.4 |
| 1985 | 29 | 24 | 89 | 8.7 | 10.2 |
| 1986 | 29 | 23 | 120 | 10.2 | 11.8 |
| 1987 | 61 | 49 | 361 | 12.6 | 28.7 |
| 1988 | 88 | 74 | 596 | 14.6 | 40.8 |
| 1989 | 100 | 85 | 616 | 18.7 | 32.9 |
| 1990 | 102 | 87 | 1,152 | 25.4 | 45.4 |
| 1991 | 101 | 91 | 1,533 | 30.9 | 49.6 |
| 1992 | 104 | 77 | 1,797 | 32.5 | 55.3 |
| 1993 | 113 | 85 | 2,016 | 28.1 | 71.7 |
| 1994 | 117 | 83 | 1,551 | 21.2 | 73.2 |
| 1995 | 134 | 41 | 1,554 | 22.0 | 70.6 |
| 1996 | 124 | 124 | 1,491 | 29.6 | 50.3 |
| 1997 | 133 | 133 | 1,677 | 37.3 | 44.9 |
| 1998 | 141 | 140 | 2,238 | 58.0 | 38.6 |
| Average (all) | | | 1,007 | 23.0 | 36.9 |
| Average (95-98) | | | 1,740 | 36.7 | 51.1 |

**Table 3.** Landings, catch rate and effort statistics for snow crab Area 20, 1978 - 1998.

| Year | Active boats | Logbooks received | Landing statistics (t) | Mean CPUE (kg/trap haul) | Total Effort (1000's of trap hauls) |
|---|---|---|---|---|---|
| 1978 | - | 0 | 61 | - | - |
| 1979 | 8 | 3 | 80 | 8.2 | 9.8 |
| 1980 | 8 | 3 | 34 | 8.3 | 4.1 |
| 1981 | 6 | 0 | 2 | - | - |
| 1982 | - | 0 | 2 | - | - |
| 1983 | 12 | 2 | 23 | 1.7 | 13.5 |
| 1984 | 2 | 0 | 10 | - | - |
| 1985 | 1 | 0 | 1 | - | - |
| 1986 | 2 | 1 | 0 | 1.9 | - |
| 1987 | 3 | 0 | 1 | - | - |
| 1988 | 4 | 2 | 17 | 7.9 | 2.2 |
| 1989 | 5 | 0 | 8 | - | - |
| 1990 | 4 | 2 | 5 | 5.3 | 0.9 |
| 1991 | 4 | 3 | 14 | 16.3 | 0.9 |
| 1992 | 3 | 3 | 18 | 40.6 | 0.4 |
| 1993 | 4 | 4 | 20 | 17.3 | 1.2 |
| 1994 | 5 | 4 | 29 | 20.2 | 1.4 |
| 1995 | 5 | 1 | 44 | 19.8 | 2.2 |
| 1996 | 5 | 5 | 43 | 14.7 | 2.9 |
| 1997 | 5 | 5 | 45 | 20.2 | 2.3 |
| 1998 | 5 | 4 | 45 | 35.5 | 1.3 |
| average (all) | | | 24 | 15.6 | 3.3 |
| average (95-98) | | | 44 | 22.6 | 2.2 |

**Table 4.** Weekly landings, catch rate and effort statistics for snow crab Area 20, 1997.

| week | landings (kg) | CPUE (kg/trap haul) | Effort (total number of trap hauls) |
|---|---|---|---|
| July 20 | 15,402 | 47.5 | 324 |
| July 27 | 15,597 | 31.5 | 495 |
| Aug. 03 | 4,393 | 27.3 | 161 |
| Aug. 10 | 694 | 19.3 | 36 |
| total[1] | 45,163 | 35.5 | 1,272 |

[1] Total seasonal landings and seasonal CPUE were used to obtain these results.

**Table 5.** Seasonal catch composition, in percentage, from at-sea samples for eastern Nova Scotia in 1998.

**a)** Catch composition in Area 20 (%).

| Coverage | | Size | Hard shell crab | | Soft shell crab | | By maturity stage | | Total |
|---|---|---|---|---|---|---|---|---|---|
| trip | trap | | small claw | large claw | small claw | large claw | small claw | large claw | |
| 4 | 23 | < 95 mm | 0.29 | 4.14 | 0.29 | 0.14 | 0.57 | 4.28 | 4.85 |
| | | > 95 mm | 2.57 | 77.89 | 4.57 | 10.13 | 7.13 | 88.02 | 95.15 |
| | | total | 2.85 | 82.03 | 4.85 | 10.27 | 7.70 | 92.30 | 100.00 |

**b)** Catch composition in Area 21 (%).

| Coverage | | Size | Hard shell crab | | Soft shell crab | | By maturity stage | | Total |
|---|---|---|---|---|---|---|---|---|---|
| trip | trap | | small claw | large claw | small claw | large claw | small claw | large claw | |
| 3 | 17 | < 95 mm | 1.03 | 6.33 | 1.76 | 0.15 | 2.80 | 6.48 | 9.28 |
| | | > 95 mm | 5.15 | 63.77 | 6.63 | 15.17 | 11.78 | 78.94 | 90.72 |
| | | total | 6.18 | 70.10 | 8.39 | 15.32 | 14.58 | 85.42 | 100.00 |

**c)** Catch composition in Area 23 (%).

| Coverage | | Size | Hard shell crab | | Soft shell crab | | By maturity stage | | Total |
|---|---|---|---|---|---|---|---|---|---|
| trip | trap | | small claw | large claw | small claw | large claw | small claw | large claw | |
| 14 | 132 | < 95 mm | 1.93 | 18.00 | 1.44 | 1.14 | 3.37 | 19.14 | 22.51 |
| | | > 95 mm | 5.28 | 66.19 | 1.73 | 4.29 | 7.01 | 70.48 | 77.49 |
| | | total | 7.21 | 84.19 | 3.17 | 5.43 | 10.38 | 89.62 | 100.00 |

**d)** Catch composition in Area 24 (%).

| Coverage | | Size | Hard shell crab | | Soft shell crab | | By maturity stage | | Total |
|---|---|---|---|---|---|---|---|---|---|
| trip | trap | | small claw | large claw | small claw | large claw | small claw | large claw | |
| 16 | 101 | < 95 mm | 2.53 | 24.37 | 2.78 | 4.05 | 5.31 | 28.42 | 33.73 |
| | | > 95 mm | 1.70 | 48.92 | 3.53 | 12.11 | 5.23 | 61.04 | 66.27 |
| | | total | 4.23 | 73.29 | 6.31 | 16.16 | 10.54 | 89.46 | 100.00 |

**Table 6.** Seasonal catch composition, in number, from at-sea samples for eastern Nova Scotia in 1998.

**a)** Catch composition in Area 20 (in number).

| Coverage | | Size | Hard shell crab | | Soft shell crab | | By maturity stage | | Total |
|---|---|---|---|---|---|---|---|---|---|
| trip | trap | | small claw | large claw | small claw | large claw | small claw | large claw | |
| 4 | 23 | < 95 mm | 2 | 29 | 2 | 1 | 4 | 30 | 34 |
| | | > 95 mm | 18 | 546 | 32 | 71 | 50 | 617 | 667 |
| | | total | 20 | 575 | 34 | 72 | 54 | 647 | 701 |

**b)** Catch composition in Area 21 (in number).

| Coverage | | Size | Hard shell crab | | Soft shell crab | | By maturity stage | | Total |
|---|---|---|---|---|---|---|---|---|---|
| trip | trap | | small claw | large claw | small claw | large claw | small claw | large claw | |
| 3 | 17 | < 95 mm | 7 | 43 | 12 | 1 | 19 | 44 | 63 |
| | | > 95 mm | 35 | 433 | 45 | 103 | 80 | 536 | 616 |
| | | total | 42 | 476 | 57 | 104 | 99 | 580 | 679 |

**c)** Catch composition in Area 23 (in number).

| Coverage | | Size | Hard shell crab | | Soft shell crab | | By maturity stage | | Total |
|---|---|---|---|---|---|---|---|---|---|
| trip | trap | | small claw | large claw | small claw | large claw | small claw | large claw | |
| 14 | 132 | < 95 mm | 98 | 914 | 73 | 58 | 171 | 972 | 1143 |
| | | > 95 mm | 268 | 3361 | 88 | 218 | 356 | 3579 | 3935 |
| | | total | 366 | 4275 | 161 | 276 | 527 | 4551 | 5078 |

**d)** Catch composition in Area 24 (in number).

| Coverage | | Size | Hard shell crab | | Soft shell crab | | By maturity stage | | Total |
|---|---|---|---|---|---|---|---|---|---|
| trip | trap | | small claw | large claw | small claw | large claw | small claw | large claw | |
| 16 | 101 | < 95 mm | 101 | 974 | 111 | 162 | 212 | 1136 | 1348 |
| | | > 95 mm | 68 | 1955 | 141 | 484 | 209 | 2439 | 2648 |
| | | total | 169 | 2929 | 252 | 646 | 421 | 3575 | 3996 |

**Table 7.** Landings, catch rate and effort statistics for snow crab Area 21, 1978 - 1998.

| Year | Active licenses | Logbooks received | Landing statistics (t) | Mean CPUE (kg/trap haul) | Total Effort (1000's of trap hauls) |
|---|---|---|---|---|---|
| 1978 | 16 | 16 | 247 | 11.3 | 21.9 |
| 1979 | 27 | 27 | 243 | 10.7 | 22.7 |
| 1980 | 31 | 25 | 153 | 9.7 | 15.8 |
| 1981 | 22 | 1 | 34 | 13.6 | 2.5 |
| 1982 | 20 | 18 | 94 | 7.9 | 11.9 |
| 1983 | 27 | 25 | 48 | 5.1 | 9.4 |
| 1984 | 19 | 13 | 18 | 2.9 | 6.2 |
| 1985 | 10 | 7 | 10 | 3.5 | 2.9 |
| 1986 | 12 | 8 | 7 | 2.5 | 2.8 |
| 1987 | 21 | 15 | 56 | 6.4 | 8.8 |
| 1988 | 24 | 19 | 125 | 9.6 | 13.0 |
| 1989 | 30 | 27 | 154 | 13.7 | 11.2 |
| 1990 | 31 | 27 | 167 | 13.1 | 12.7 |
| 1991 | 29 | 27 | 157 | 14.9 | 10.5 |
| 1992 | 31 | 28 | 196 | 16.7 | 11.7 |
| 1993 | 30 | 28 | 168 | 14.2 | 11.8 |
| 1994 | 31 | 29 | 107 | 7.2 | 14.9 |
| 1995 | 32 | 7 | 100 | 8.3 | 12.0 |
| 1996 | 32 | 32 | 136 | 9.7 | 13.9 |
| 1997 | 32 | 32 | 146 | 35.7 | 4.1 |
| 1998 | 32 | 32 | 216 | 53.0 | 4.1 |
| average (all) | | | 123 | 12.8 | 10.7 |
| average (95-98) | | | 150 | 26.7 | 8.5 |

**Table 8.** Weekly landings, catch rate and effort statistics for snow crab Area 21, 1997.

| week | landings (kg) | CPUE (kg/trap haul) | Effort (total number of trap hauls) |
|---|---|---|---|
| July 20 | 111,540 | 68.7 | 1,623 |
| July 27 | 97,721 | 43.8 | 2,229 |
| Aug. 03 | 6,633 | 26.6 | 249 |
| total[1] | 215,894 | 53.0 | 4,073 |

[1] Total seasonal landings and seasonal CPUE were used to obtain these results.

**Table 9.** Landings, catch rate and effort statistics for snow crab Area 22, 1978 - 1998.

| Year | Active licenses | Logbooks received | Landing statistics (t) | Mean CPUE (kg/trap haul) | Total Effort (1000's of trap hauls) |
|---|---|---|---|---|---|
| 1978 | 15 | 14 | 341 | 28.9 | 11.8 |
| 1979 | 35 | 35 | 684 | 38.4 | 17.8 |
| 1980 | 26 | 24 | 227 | 21.0 | 10.8 |
| 1981 | 11 | 3 | 50 | 12.5 | 4.0 |
| 1982 | 21 | 14 | 153 | 19.6 | 7.8 |
| 1983 | 26 | 21 | 52 | 8.5 | 6.1 |
| 1984 | 7 | 7 | 18 | 8.6 | 2.1 |
| 1985 | 8 | 7 | 3 | 6.0 | 0.5 |
| 1986 | 5 | 3 | 18 | 10.0 | 1.8 |
| 1987 | 16 | 14 | 63 | 10.5 | 6.0 |
| 1988 | 29 | 22 | 114 | 10.4 | 11.0 |
| 1989 | 26 | 20 | 93 | 15.0 | 6.2 |
| 1990 | 26 | 21 | 119 | 9.0 | 13.2 |
| 1991 | 24 | 23 | 183 | 18.5 | 9.9 |
| 1992 | 27 | 15 | 240 | 24.2 | 9.9 |
| 1993 | 40 | 27 | 390 | 21.0 | 18.6 |
| 1994 | 38 | 28 | 259 | 12.0 | 21.6 |
| 1995 | 37 | 11 | 284 | 9.7 | 29.3 |
| 1996 | 37 | 37 | 189 | 10.3 | 18.3 |
| 1997 | 37 | 37 | 343 | 20.8 | 16.5 |
| 1998 | 37 | 37 | 396 | 38.2 | 10.4 |
| average (all) | | | 20.1 | 16.8 | 11.1 |
| average (95-98) | | | 30.3 | 19.8 | 18.6 |

**Table 10.** Weekly landings, catch rate and effort statistics for snow crab Area 22 in 1998.

**a)** Weekly landings statistics

| week | landings (kg) | | |
|---|---|---|---|
| | all | northern | outer area |
| July 20 | 128,452 | 79,018 | 49,434 |
| July 27 | 191,250 | 113,160 | 78,090 |
| Aug. 3 | 75,302 | 50,266 | 24,147 |
| Aug. 10 | 1,301 | 1,301 | |
| total[1] | 396,305 | 244,292 | 152,011 |

**b)** Weekly catch rate statistics

| week | CPUE (kg/trap haul) | | |
|---|---|---|---|
| | all | northern | outer area |
| July 20 | 50.1 | 45.0 | 61.1 |
| July 27 | 39.3 | 36.0 | 45.3 |
| Aug. 3 | 26.0 | 24.2 | 30.8 |
| Aug. 10 | 18.6 | 18.6 | |
| total[1] | 38.2 | 34.5 | 45.6 |

**c)** Weekly effort statistics

| week | Effort (total number of traps hauls) | | |
|---|---|---|---|
| | all | northern | outer area |
| July 20 | 2,564 | 1,755 | 809 |
| July 27[1] | 4,861 | 3,139 | 1,722 |
| Aug. 3 | 2,892 | 2,079 | 783 |
| Aug. 10 | 70 | 70 | |
| total[1] | 10,387 | 7077 | 3,333 |

[1] Total seasonal landings.

**Table 11.** Seasonal snow crab landings, catch rate and effort statistics, global and for the two different fishing grounds, in Area 22 in 1996, 1997 and 1998.

**a)** Landings statistics

| year | landings (kg) | | |
|---|---|---|---|
| | all | northern | outer area |
| 1996[1] | 175,250 | 89,900 | 85,350 |
| 1997[1] | 343,039 | 184,796 | 158,243 |
| 1998 | 396,305 | 244,292 | 152,011 |

**b)** Catch rate statistics

| year | CPUE (kg/trap haul) | | |
|---|---|---|---|
| | all | northern | outer area |
| 1996[1] | 10.4 | 12.5 | 8.7 |
| 1997[1] | 20.8 | 30.7 | 15.1 |
| 1998 | 38.2 | 34.5 | 45.6 |

**c)** Effort statistics

| year | Effort (total number of traps hauls) | | |
|---|---|---|---|
| | all | northern | outer area |
| 1996[1] | 16,894 | 7,192 | 9,846 |
| 1997[1] | 16,472 | 6,020 | 10,470 |
| 1998 | 10,387 | 7,081 | 3,333 |

**d)** Number of fishers per areas

| year | Number of fishers per areas | | |
|---|---|---|---|
| | all | northern | outer area |
| 1996[1] | 37 | 10 | 27 |
| 1997[1] | 37 | 17 | 20 |
| 1998[2] | 37 | 24 | 13 |

[1] Based on inshore – offshore data of 1997 (Biron et al., 1997).
[2] In 1998, a fisher was considered to belong to a given area if at least 75% of his catch came from that given area. In these few cases, the landings and effort were still separated according to the fisher's given locations.

**Table 12.** Landings, catch rate and effort statistics for snow crab in Area 23, 1978 - 1998.

| Year | Active licenses/permits | Logbooks received | Landing statistics (t) | Mean CPUE (kg/trap haul) | Total Effort (1000's of trap hauls) |
|---|---|---|---|---|---|
| 1978 | - | 15 | 347 | 51.5 | 6.7 |
| 1979 | - | 22 | 608 | 43.4 | 14.0 |
| 1980 | - | 21 | 343 | 39.0 | 8.8 |
| 1981 | - | 10 | 82 | 26.5 | 3.1 |
| 1982 | - | 21 | 253 | 28.8 | 8.8 |
| 1983 | - | 26 | 119 | 16.5 | 7.2 |
| 1984 | - | 7 | 41 | 18.6 | 2.2 |
| 1985 | 5 | 5 | 28 | 14.7 | 1.9 |
| 1986 | 6 | 6 | 49 | 14.4 | 3.4 |
| 1987 | 14 | 11 | 157 | 26.2 | 6.0 |
| 1988 | 21 | 18 | 207 | 24.9 | 8.3 |
| 1989 | 25 | 23 | 243 | 28.3 | 8.6 |
| 1990 | 27 | 24 | 386 | 36.4 | 10.6 |
| 1991 | 23 | 22 | 528 | 44.8 | 11.8 |
| 1992 | 22 | 18 | 595 | 49.6 | 12.0 |
| 1993 | 26 | 16 | 770 | 53.1 | 14.5 |
| 1994 | 22 | 22 | 497 | 33.4 | 14.9 |
| 1995 | 31 | 7 | 576 | 51.8 | 11.1 |
| 1996 | 27 | 27 | 564 | 65.6 | 8.6 |
| 1997 | 30 | 30 | 592 | 57.8 | 10.2 |
| 1998 | 34 | 34 | 813 | 77.0 | 10.6 |
| average (all) | | | 371 | 38.2 | 8.7 |
| average (95-98) | | | 636 | 63.1 | 10.1 |

**Table 13.** Weekly landings, catch rate and effort statistics for snow crab Area 23 in 1998.

**a)** Weekly landings statistics

| week | landings (kg) | | |
|---|---|---|---|
| | all | permanent | temporary |
| Aug. 3 | 41,258 | 29,238 | 12,020 |
| Aug. 10 | 145,230 | 131,151 | 14,079 |
| Aug. 17 | 257,176 | 218,199 | 38,977 |
| Aug. 24 | 119,079 | 98,821 | 20,258 |
| Aug. 31 | 79,545 | 62,137 | 17,408 |
| Sept. 7 | 80,734 | 53,570 | 27,164 |
| Sept. 14 | 29,023 | 4,584 | 24,439 |
| Sept. 21 | 34,229 | - | 34,229 |
| Sept. 28 | - | - | - |
| Oct. 5 | 21,470 | - | 21,470 |
| Oct. 12 | 4,053 | - | 4,053 |
| total[2] | 812,807 | 598,700 | 206,832 |

**b)** Weekly catch rate statistics

| week | CPUE (kg/trap haul) | | |
|---|---|---|---|
| | all | permanent | temporary |
| Aug. 3 | 75.4 | 86.0 | 58.1 |
| Aug. 10 | 72.9 | 83.0 | 34.1 |
| Aug. 17 | 82.6 | 88.4 | 60.5 |
| Aug. 24 | 77.1 | 80.9 | 62.5 |
| Aug. 31 | 75.1 | 80.1 | 61.5 |
| Sept. 7 | 74.5 | 80.6 | 69.7 |
| Sept. 14 | 74.4 | 77.7 | 73.8 |
| Sept. 21 | 65.2 | - | 65.2 |
| Sept. 28 | - | - | - |
| Oct. 5 | 95.4 | - | 95.4 |
| Oct. 12 | 72.4 | - | 72.4 |
| total[2] | 77.0 | 84.1 | 63.0 |

**c)** Weekly effort statistics

| week | Effort (total number of traps hauls) | | |
|---|---|---|---|
| | all | permanent | temporary |
| Aug. 3 | 547 | 340 | 207 |
| Aug. 10 | 1,993 | 1,580 | 413 |
| Aug. 17 | 3,113 | 2,469 | 644 |
| Aug. 24 | 1,545 | 1,221 | 324 |
| Aug. 31 | 1,059 | 776 | 283 |
| Sept. 7 | 1,084 | 665 | 390 |
| Sept. 14 | 390 | 59 | 331 |
| Sept. 21 | 525 | - | 525 |
| Sept. 28 | - | - | - |
| Oct. 5 | 225 | - | 225 |
| Oct. 12 | 56 | - | 56 |
| total[2] | 10,550 | 7,122 | 3,398 |

[1] Including landings from July 25+26

[2] Total seasonal landings.

**Table 14.** Comparison of the seasonal catch composition from at-sea samples between traditional and non-traditional fishing grounds for Area 23 in 1998.

**a)** Catch composition <u>in percentage</u> of traditional fishing grounds.

| Coverage | | Size | Hard shell crab | | Soft shell crab | | By maturity stage | | Total |
|---|---|---|---|---|---|---|---|---|---|
| trip | trap | | small claw | large claw | small claw | large claw | small claw | large claw | |
| 10 | 64 | < 95 mm | 2.63 | 27.90 | 1.75 | 1.80 | 4.38 | 29.70 | 34.08 |
| | | > 95 mm | 1.75 | 57.81 | 0.84 | 5.51 | 2.59 | 63.32 | 65.92 |
| | | total | 4.38 | 85.71 | 2.59 | 7.31 | 6.97 | 93.02 | 100.00 |

**b)** Catch composition <u>in number</u> of traditional fishing grounds.

| Coverage | | Size | Hard shell crab | | Soft shell crab | | By maturity stage | | Total |
|---|---|---|---|---|---|---|---|---|---|
| trip | trap | | small claw | large claw | small claw | large claw | small claw | large claw | |
| 10 | 64 | < 95 mm | 63 | 668 | 42 | 43 | 105 | 711 | 816 |
| | | > 95 mm | 42 | 1384 | 20 | 132 | 62 | 1516 | 1578 |
| | | total | 105 | 2052 | 62 | 175 | 167 | 2227 | 2394 |

**c)** Catch composition <u>in percentage</u> of <u>non</u>-traditional fishing grounds.

| Coverage | | Size | Hard shell crab | | Soft shell crab | | By maturity stage | | Total |
|---|---|---|---|---|---|---|---|---|---|
| trip | trap | | small claw | large claw | small claw | large claw | small claw | large claw | |
| 4 | 68 | < 95 mm | 1.30 | 9.16 | 1.16 | 0.56 | 2.46 | 9.72 | 12.18 |
| | | > 95 mm | 8.42 | 73.66 | 2.53 | 3.20 | 10.95 | 76.86 | 87.82 |
| | | total | 9.72 | 82.82 | 3.69 | 3.76 | 13.41 | 86.58 | 100.00 |

**d)** Catch composition <u>in number</u> of <u>non</u>-traditional fishing grounds.

| Coverage | | Size | Hard shell crab | | Soft shell crab | | By maturity stage | | Total |
|---|---|---|---|---|---|---|---|---|---|
| trip | trap | | small claw | large claw | small claw | large claw | small claw | large claw | |
| 4 | 68 | < 95 mm | 35 | 246 | 31 | 15 | 66 | 261 | 327 |
| | | > 95 mm | 226 | 1977 | 68 | 86 | 294 | 2063 | 2357 |
| | | total | 261 | 2223 | 99 | 101 | 360 | 2324 | 2684 |

**Table 15.** Comparison of the quality of catch composition from at-sea samples between traditional and non-traditional fishing grounds for Area 23 in 1998.

**a)** Qualitative comparison of catch composition in percentage of traditional fishing grounds.

| Coverage | | Size | Good crab | Old crab | Soft shell crab | Total |
|---|---|---|---|---|---|---|
| trip | trap | | | | | |
| 10 | 64 | < 95 mm | 24.84 | 3.75 | 4.88 | 33.48 |
| | | > =95 – 102<= | 21.21 | 1.33 | 5.74 | 28.28 |
| | | >102 mm | 30.23 | 2.97 | 5.04 | 38.24 |
| | | | | | | 100.00 |

**b)** Qualitative comparison of catch composition in number of traditional fishing grounds.

| Coverage | | Size | Good crab | Old crab | Soft shell crab | Total |
|---|---|---|---|---|---|---|
| trip | trap | | | | | |
| 10 | 64 | < 95 mm | 636 | 96 | 125 | 857 |
| | | > =95 – 102<= | 543 | 34 | 147 | 724 |
| | | >102 mm | 774 | 76 | 129 | 979 |
| | | | | | | 2,560 |

**c)** Qualitative comparison of catch composition in percentage of non-traditional fishing grounds.

| Coverage | | Size | Good crab | Old crab | Soft shell crab | Total |
|---|---|---|---|---|---|---|
| trip | trap | | | | | |
| 4 | 68 | < 95 mm | 9.50 | 1.01 | 1.71 | 12.23 |
| | | > =95 – 102<= | 25.66 | 1.53 | 2.12 | 29.30 |
| | | >102 mm | 50.28 | 4.58 | 3.61 | 58.47 |
| | | | | | | 100.00 |

**d)** Qualitative comparison of catch composition in number of non-traditional fishing grounds.

| Coverage | | Size | Good crab | Old crab | Soft shell crab | Total |
|---|---|---|---|---|---|---|
| trip | trap | | | | | |
| 4 | 68 | < 95 mm | 255 | 27 | 46 | 328 |
| | | > =95 – 102<= | 689 | 41 | 57 | 787 |
| | | >102 mm | 1350 | 123 | 97 | 1,570 |
| | | | | | | 2,685 |

**Table 16.** Landings, catch rate and effort statistics for snow crab Area 24, 1978 - 1998.

| Year | Active licenses/permits | Logbooks received | Landing statistics | Mean CPUE (kg/trap haul) | Total Effort (1000's of trap hauls) |
|---|---|---|---|---|---|
| 1978 | - | - | - | - | - |
| 1979 | 4 | 4 | 61 | 14.8 | 4.1 |
| 1980 | 10 | 10 | 70 | 12.8 | 5.5 |
| 1981 | 5 | 5 | 21 | 15.8 | 1.3 |
| 1982 | 7 | 7 | 62 | 10.1 | 6.1 |
| 1983 | 13 | 11 | 64 | 8.4 | 7.6 |
| 1984 | 13 | 12 | 52 | 9.2 | 5.6 |
| 1985 | 6 | 5 | 35 | 10.2 | 3.4 |
| 1986 | 7 | 5 | 49 | 11.9 | 4.1 |
| 1987 | 11 | 9 | 84 | 12.9 | 6.5 |
| 1988 | 13 | 13 | 163 | 15.7 | 10.4 |
| 1989 | 18 | 17 | 201 | 17.2 | 11.7 |
| 1990 | 19 | 18 | 543 | 33.3 | 16.3 |
| 1991 | 21 | 16 | 682 | 40.1 | 17.0 |
| 1992 | 22 | 14 | 743 | 38.5 | 19.3 |
| 1993 | 21 | 17 | 662 | 33.3 | 19.9 |
| 1994 | 21 | 21 | 682 | 33.4 | 20.4 |
| 1995 | 31 | 8 | 550 | 34.4 | 16.0 |
| 1996 | 27 | 27 | 560 | 57.1 | 9.8 |
| 1997 | 29 | 29 | 565 | 45.2 | 12.5 |
| 1998 | 33 | 33 | 745 | 62.0 | 12.0 |
| average (all) | | | 330 | 25.8 | 10.5 |
| average (95-98) | | | 605 | 49.7 | 12.6 |

**Table 17.** Weekly landings, catch rate and effort statistics for snow crab Area 24 in 1998.

**a)** Weekly landings statistics

| week | landings (kg) | | |
|---|---|---|---|
| | all | permanent | temporary |
| Aug. 3 | 128,355 | 110,232 | 18,123 |
| Aug. 10 | 148,021 | 121,544 | 28,036 |
| Aug. 17 | 203,968 | 146,719 | 55,690 |
| Aug. 24 | 82,742 | 70,502 | 12,240 |
| Aug. 31 | 81,619 | 54,860 | 26,759 |
| Sept. 7 | 67,112 | 48,554 | 18,558 |
| Sept. 14 | 24,968 | 18,463 | 6,505 |
| Sept. 21 | 8,130 | 6,255 | 1,875 |
| **total**[2] | **744,915** | **577,129** | **167,786** |

**b)** Weekly catch rate statistics

| week | CPUE (kg/trap haul) | | |
|---|---|---|---|
| | all | permanent | temporary |
| Aug. 3 | 75.3 | 78.3 | 61.0 |
| Aug. 10 | 66.8 | 70.7 | 53.0 |
| Aug. 17 | 62.5 | 63.6 | 60.1 |
| Aug. 24 | 66.6 | 66.6 | 66.2 |
| Aug. 31 | 55.9 | 56.5 | 54.3 |
| Sept. 7 | 47.9 | 44.0 | 69.9 |
| Sept. 14 | 46.8 | 42.8 | 63.8 |
| Sept. 21 | 34.3 | 30.2 | 62.5 |
| **total**[2] | **62.0** | **62.8** | **59.1** |

**c)** Weekly effort statistics

| week | Effort (total number of traps hauls) | | |
|---|---|---|---|
| | all | permanent | temporary |
| Aug. 3 | 1,705 | 1,408 | 297 |
| Aug. 10 | 2,217 | 1,718 | 529 |
| Aug. 17 | 3,262 | 2,307 | 927 |
| Aug. 24 | 1,243 | 1,058 | 185 |
| Aug. 31 | 1,461 | 971 | 493 |
| Sept. 7 | 1,400 | 1,104 | 266 |
| Sept. 14 | 533 | 431 | 102 |
| Sept. 21 | 237 | 207 | 30 |
| **total**[2] | **12,019** | **9,193** | **2,839** |

[2] Total seasonal landings.

**Table 18.** Comparison of the seasonal catch composition from at-sea samples between permanent and temporary status for Area 24 in 1998.

**a)** Catch composition <u>in percentage</u> of permanent.

| Coverage | | Size | Hard shell crab | | Soft shell crab | | By maturity stage | | Total |
|---|---|---|---|---|---|---|---|---|---|
| trip | trap | | small claw | large claw | small claw | large claw | small claw | large claw | |
| 15 | 95 | < 95 mm | 2.69 | 24.49 | 2.96 | 3.94 | 5.64 | 28.43 | 34.08 |
| | | > 95 mm | 1.76 | 47.84 | 3.54 | 12.78 | 5.30 | 60.62 | 65.92 |
| | | total | 4.45 | 72.33 | 6.50 | 16.72 | 10.94 | 89.05 | 100.00 |

**b)** Catch composition <u>in number</u> of permanent.

| Coverage | | Size | Hard shell crab | | Soft shell crab | | By maturity stage | | Total |
|---|---|---|---|---|---|---|---|---|---|
| trip | trap | | small claw | large claw | small claw | large claw | small claw | large claw | |
| 15 | 95 | < 95 mm | 101 | 920 | 111 | 148 | 212 | 1068 | 1280 |
| | | > 95 mm | 66 | 1797 | 133 | 480 | 199 | 2277 | 2476 |
| | | total | 167 | 2717 | 244 | 628 | 411 | 3345 | 3756 |

**c)** Catch composition <u>in percentage</u> of temporary.

| Coverage | | Size | Hard shell crab | | Soft shell crab | | By maturity stage | | Total |
|---|---|---|---|---|---|---|---|---|---|
| trip | trap | | small claw | large claw | small claw | large claw | small claw | large claw | |
| 1 | 6 | < 95 mm | 0.00 | 22.50 | 0.00 | 5.83 | 0.00 | 28.33 | 28.33 |
| | | > 95 mm | 0.83 | 65.83 | 3.33 | 1.67 | 4.17 | 67.50 | 71.76 |
| | | total | 0.83 | 88.33 | 3.33 | 7.50 | 4.17 | 95.83 | 100.00 |

**d)** Catch composition <u>in number</u> of temporary.

| Coverage | | Size | Hard shell crab | | Soft shell crab | | By maturity stage | | Total |
|---|---|---|---|---|---|---|---|---|---|
| trip | trap | | small claw | large claw | small claw | large claw | small claw | large claw | |
| 1 | 6 | < 95 mm | 0 | 54 | 0 | 14 | 0 | 68 | 68 |
| | | > 95 mm | 2 | 158 | 8 | 4 | 10 | 162 | 172 |
| | | total | 2 | 212 | 8 | 18 | 10 | 230 | 240 |

**Table 19.** Comparison of the seasonal catch composition from at-sea samples between traditional and non-traditional fishing grounds in Area 24 in 1998.

**a)** Catch composition <u>in percentage</u> of permanent.

| Coverage | | Size | Hard shell crab | | Soft shell crab | | By maturity stage | | Total |
|---|---|---|---|---|---|---|---|---|---|
| trip | trap | | small claw | large claw | small claw | large claw | small claw | large claw | |
| 14 | 90 | < 95 mm | 2.46 | 24.53 | 2.90 | 4.02 | 5.36 | 28.55 | 33.90 |
| | | > 95 mm | 1.79 | 47.45 | 3.60 | 13.26 | 5.39 | 60.70 | 66.10 |
| | | total | 4.24 | 73.91 | 6.50 | 17.28 | 10.75 | 89.25 | 100.00 |

**b)** Catch composition <u>in number</u> of permanent.

| Coverage | | Size | Hard shell crab | | Soft shell crab | | By maturity stage | | Total |
|---|---|---|---|---|---|---|---|---|---|
| trip | trap | | small claw | large claw | small claw | large claw | small claw | large claw | |
| 14 | 90 | < 95 mm | 88 | 879 | 104 | 144 | 192 | 1023 | 1215 |
| | | > 95 mm | 64 | 1700 | 129 | 475 | 193 | 2175 | 2368 |
| | | total | 152 | 2648 | 233 | 619 | 385 | 3198 | 3583 |

**c)** Catch composition <u>in percentage</u> of temporary.

| Coverage | | Size | Hard shell crab | | Soft shell crab | | By maturity stage | | Total |
|---|---|---|---|---|---|---|---|---|---|
| trip | trap | | small claw | large claw | small claw | large claw | small claw | large claw | |
| 2 | 11 | < 95 mm | 3.15 | 23.00 | 1.70 | 4.36 | 4.84 | 16.47 | 32.20 |
| | | > 95 mm | 0.97 | 61.74 | 2.91 | 2.18 | 3.87 | 63.93 | 67.80 |
| | | total | 4.12 | 84.75 | 4.60 | 6.53 | 8.72 | 91.28 | 100.00 |

**d)** Catch composition <u>in number</u> of temporary.

| Coverage | | Size | Hard shell crab | | Soft shell crab | | By maturity stage | | Total |
|---|---|---|---|---|---|---|---|---|---|
| trip | trap | | small claw | large claw | small claw | large claw | small claw | large claw | |
| 2 | 11 | < 95 mm | 13 | 95 | 7 | 18 | 20 | 113 | 133 |
| | | > 95 mm | 4 | 255 | 12 | 9 | 16 | 264 | 280 |
| | | total | 17 | 350 | 19 | 27 | 36 | 377 | 413 |

**Table 20.** Comparison of the quality of catch composition from at-sea samples between traditional and non-traditional fishing grounds for Area 24 in 1998.

**a)** Qualitative comparison of catch composition in percentage of traditional fishing grounds.

| Coverage | | Size | Good crab | Old crab | Soft shell crab | Total |
|---|---|---|---|---|---|---|
| trip | trap | | | | | |
| 15 | 95 | < 95 mm | 25.99 | 1.14 | 7.00 | 34.13 |
| | | > =95 – 102<= | 18.83 | 0.16 | 7.58 | 26.57 |
| | | >102 mm | 30.39 | 0.11 | 8.80 | 39.30 |
| | | | | | | 100.00 |

**b)** Qualitative comparison of catch composition in number of traditional fishing grounds.

| Coverage | | Size | Good crab | Old crab | Soft shell crab | Total |
|---|---|---|---|---|---|---|
| trip | trap | | | | | |
| 15 | 95 | < 95 mm | 980 | 43 | 264 | 1287 |
| | | > =95 – 102<= | 710 | 6 | 286 | 1002 |
| | | >102 mm | 1146 | 4 | 332 | 1482 |
| | | | | | | 3771 |

**c)** Qualitative comparison of catch composition in percentage of non-traditional fishing grounds.

| Coverage | | Size | Good crab | Old crab | Soft shell crab | Total |
|---|---|---|---|---|---|---|
| trip | trap | | | | | |
| 1 | 6 | < 95 mm | 22.08 | 0.42 | 5.83 | 28.33 |
| | | > =95 – 102<= | 26.25 | 0.83 | 3.33 | 30.42 |
| | | >102 mm | 37.50 | 2.08 | 1.67 | 41.25 |
| | | | | | | 100.00 |

**d)** Qualitative comparison of catch composition in number of non-traditional fishing grounds.

| Coverage | | Size | Good crab | Old crab | Soft shell crab | Total |
|---|---|---|---|---|---|---|
| trip | trap | | | | | |
| 1 | 6 | < 95 mm | 53 | 1 | 14 | 68 |
| | | > =95 – 102<= | 63 | 2 | 8 | 73 |
| | | >102 mm | 90 | 5 | 4 | 99 |
| | | | | | | 240 |

**Table 21.** Landings of snow crab (*Chionoecetes opilio)* for the exploratory fishery in NAFO Division 4X, 1995 - 1998.

| Year | Active licenses/permits | Logbooks received | Landing Statistics (t) | Total mean CPUE (kg/trap haul) | Total Effort (1000's of trap hauls) |
|---|---|---|---|---|---|
| 1994 | 3 | 3 | 0.1 | 1.24 | 0.1 |
| 1995 | 4 | 4 | 17.4 | 1.38 | 12.6 |
| 1996 | 3 | 3 | 11.8 | 1.01 | 11.7 |
| 1997 | 1 | 1 | 1.8 | 2.30 | 0.8 |
| 1998 | 4 | 4 | 41.6 | 5.35 | 7.8 |
| Average (all) | | | 14.5 | 2.26 | 6.6 |

**Table 22.** Monthly landings, catch rate and effort statistics for the exploratory fishery in NAFO Division 4X in 1998.

| week | landings (kg) | CPUE (kg/trap haul) | Effort (total number of trap hauls) |
|---|---|---|---|
| February | 10,316 | 4.27 | 2,418 |
| March | 21,356 | 6.49 | 3,290 |
| April | 5,918 | - | - |
| May | 3,933 | - | - |
| June | 807 | - | - |
| total[1] | 41,610 | 5.35 | 7,774 |

[1] Total seasonal landings and seasonal CPUE were used to obtain these results.

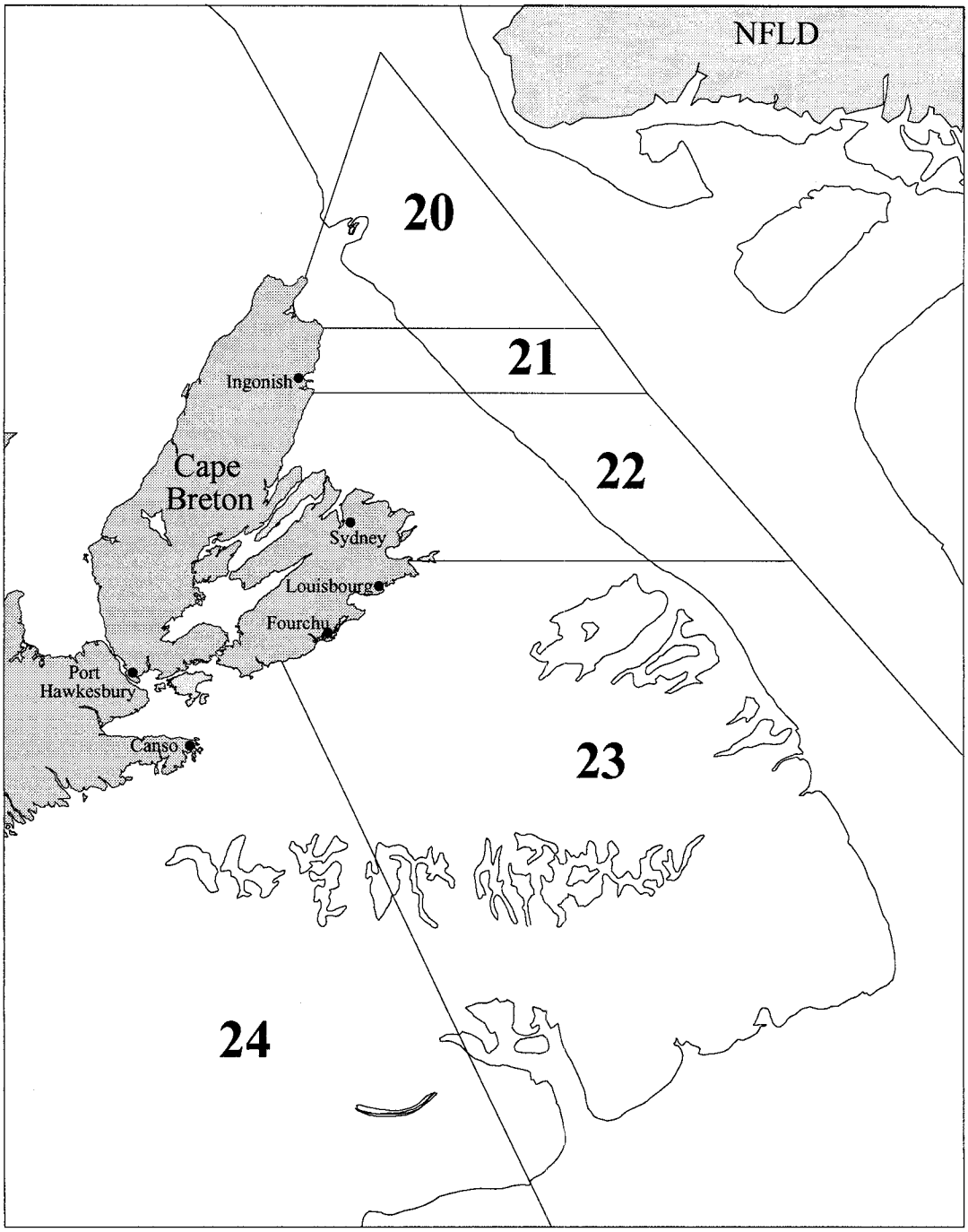



**Figure 1.** Snow crab Areas off eastern Nova Scotia.

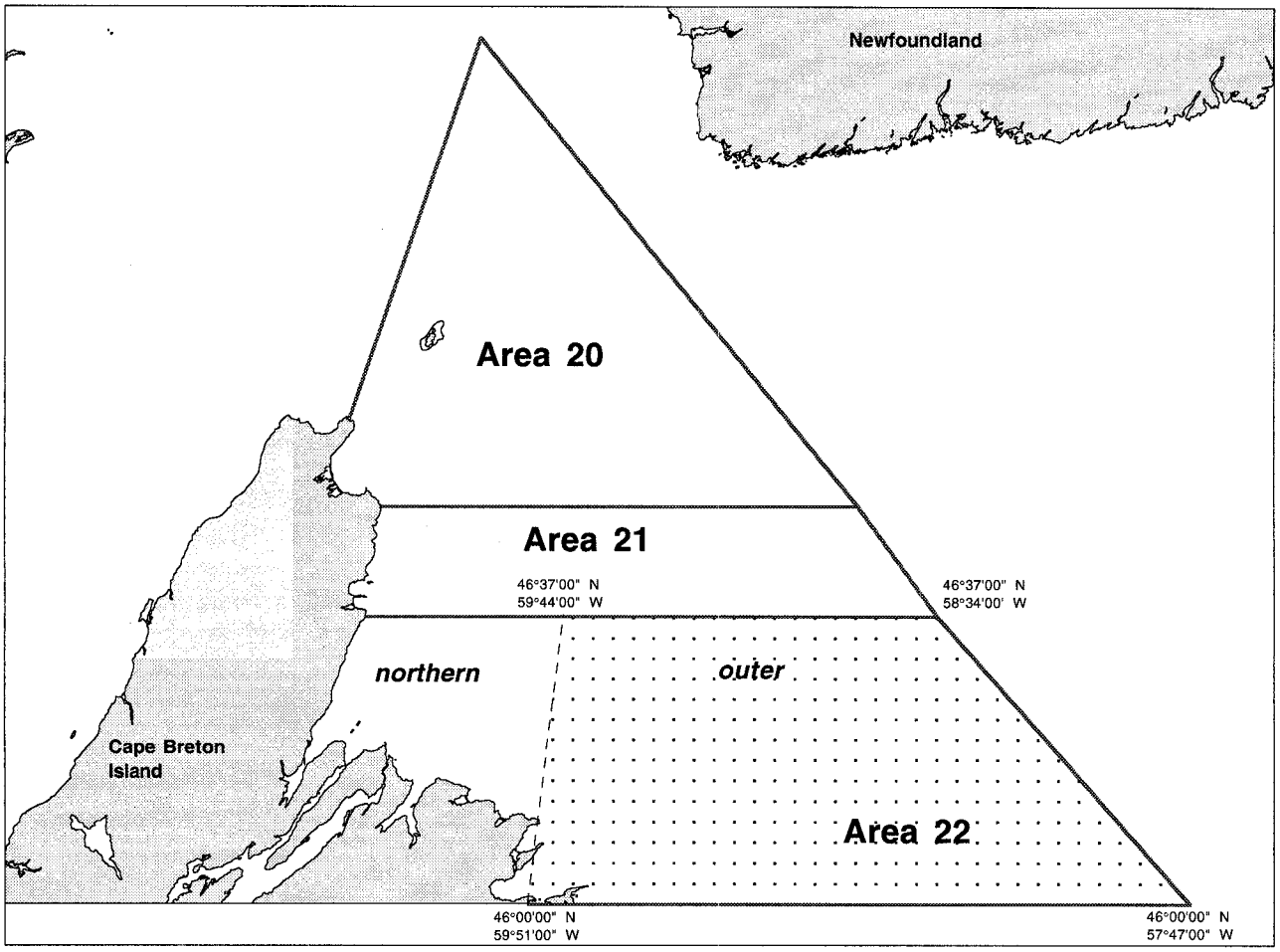



**Figure 2.** Fishing ground limits of the northern and outer (southern) components of Area 22 in 1998.

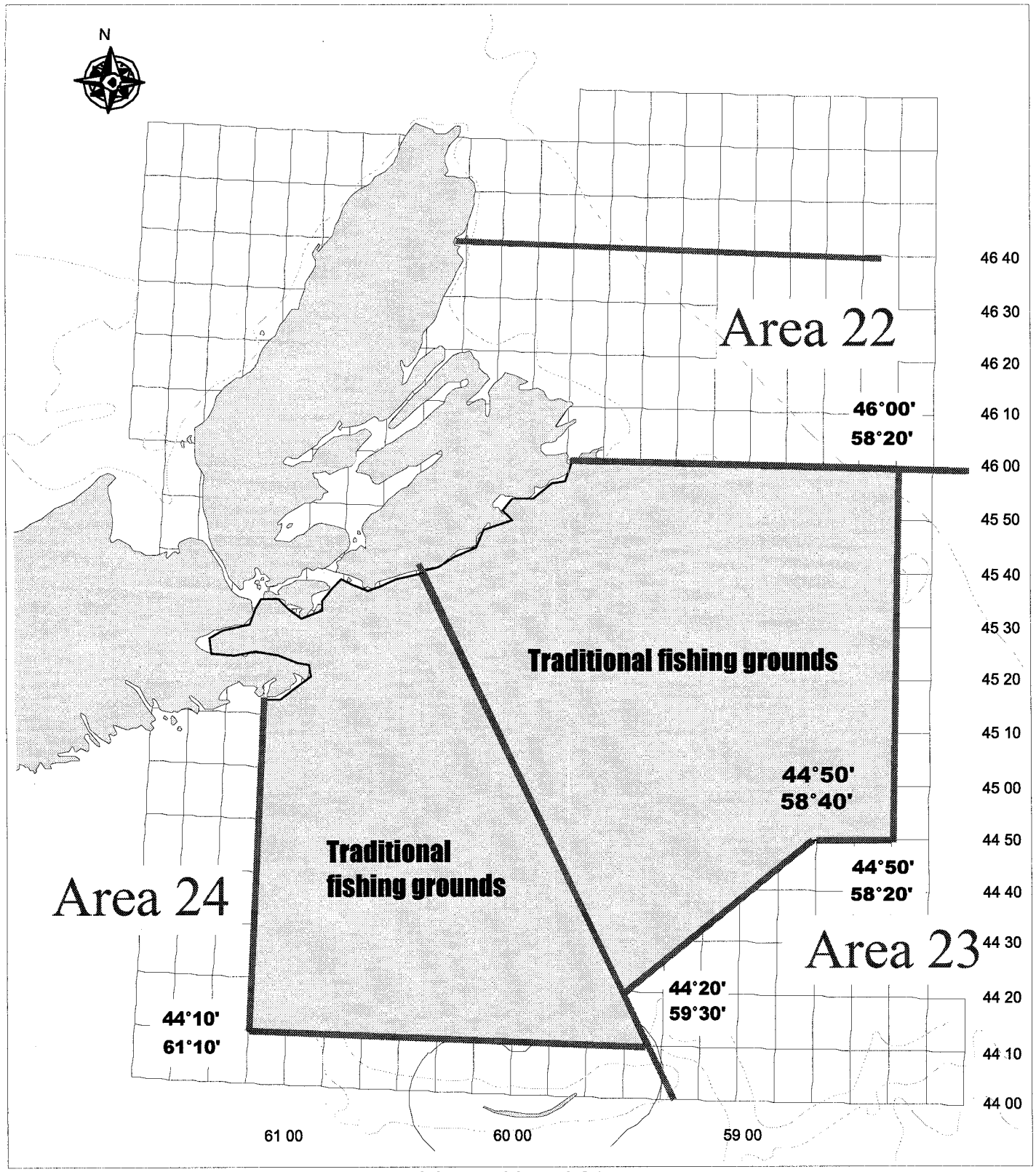



**Figure 3**. Traditional fishing grounds of Areas 23 and 24.

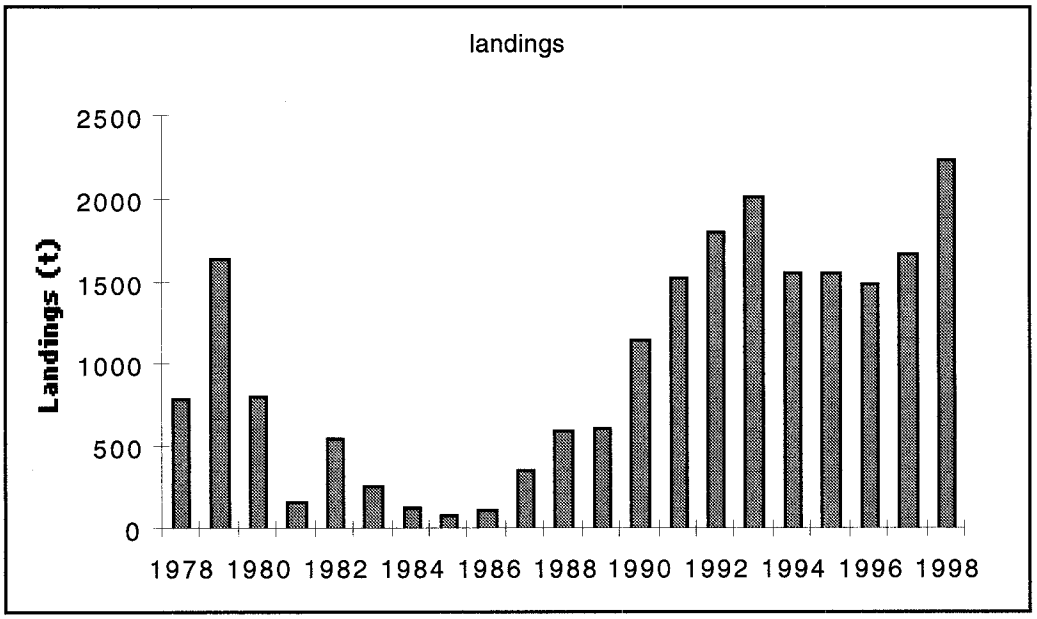



**Figure 4.** Snow crab landings (t) in eastern Nova Scotia from 1978 to 1998.

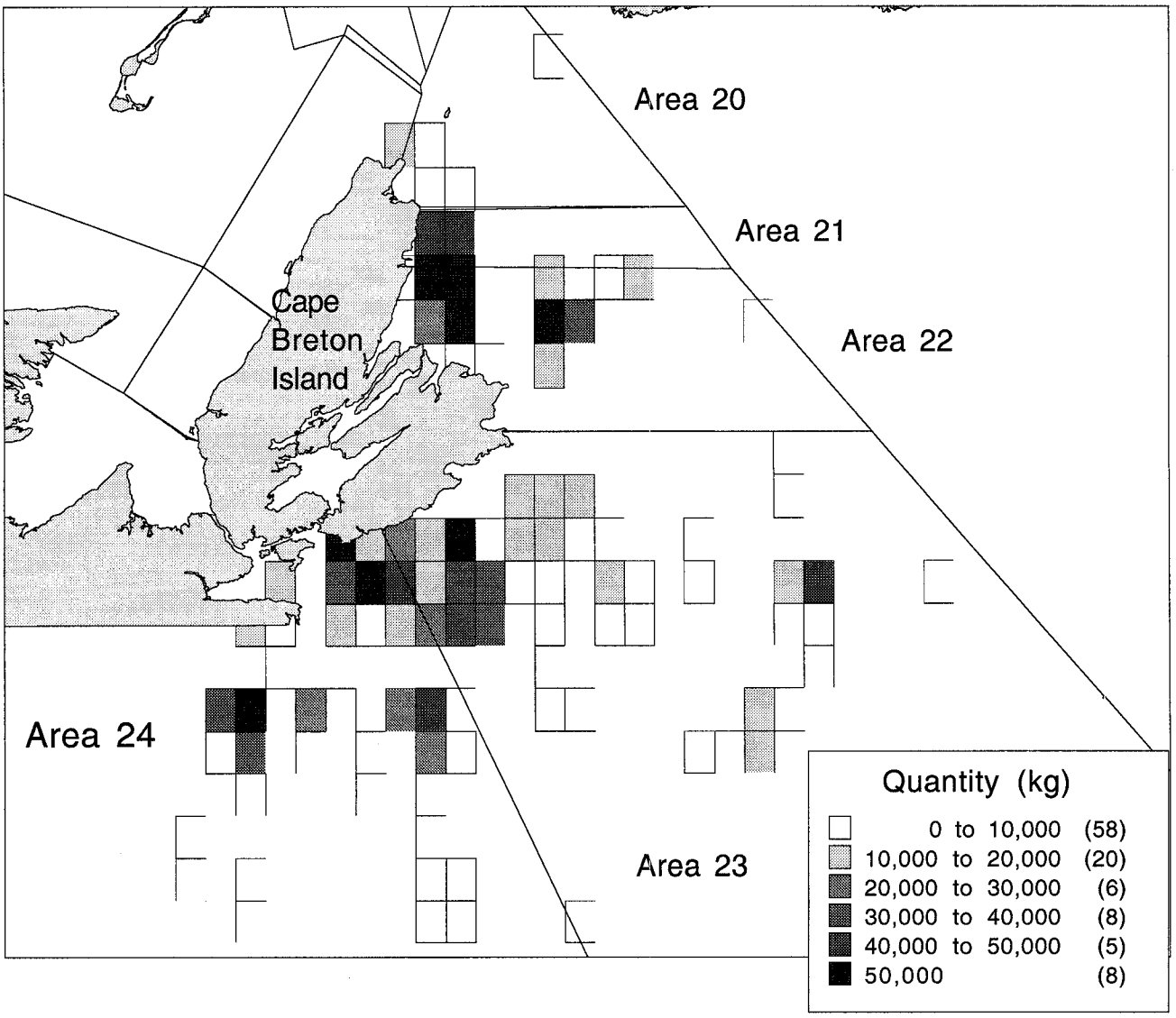



**Figure 5.** Seasonal distribution of snow crab landings( kg) in ENS in 1998.

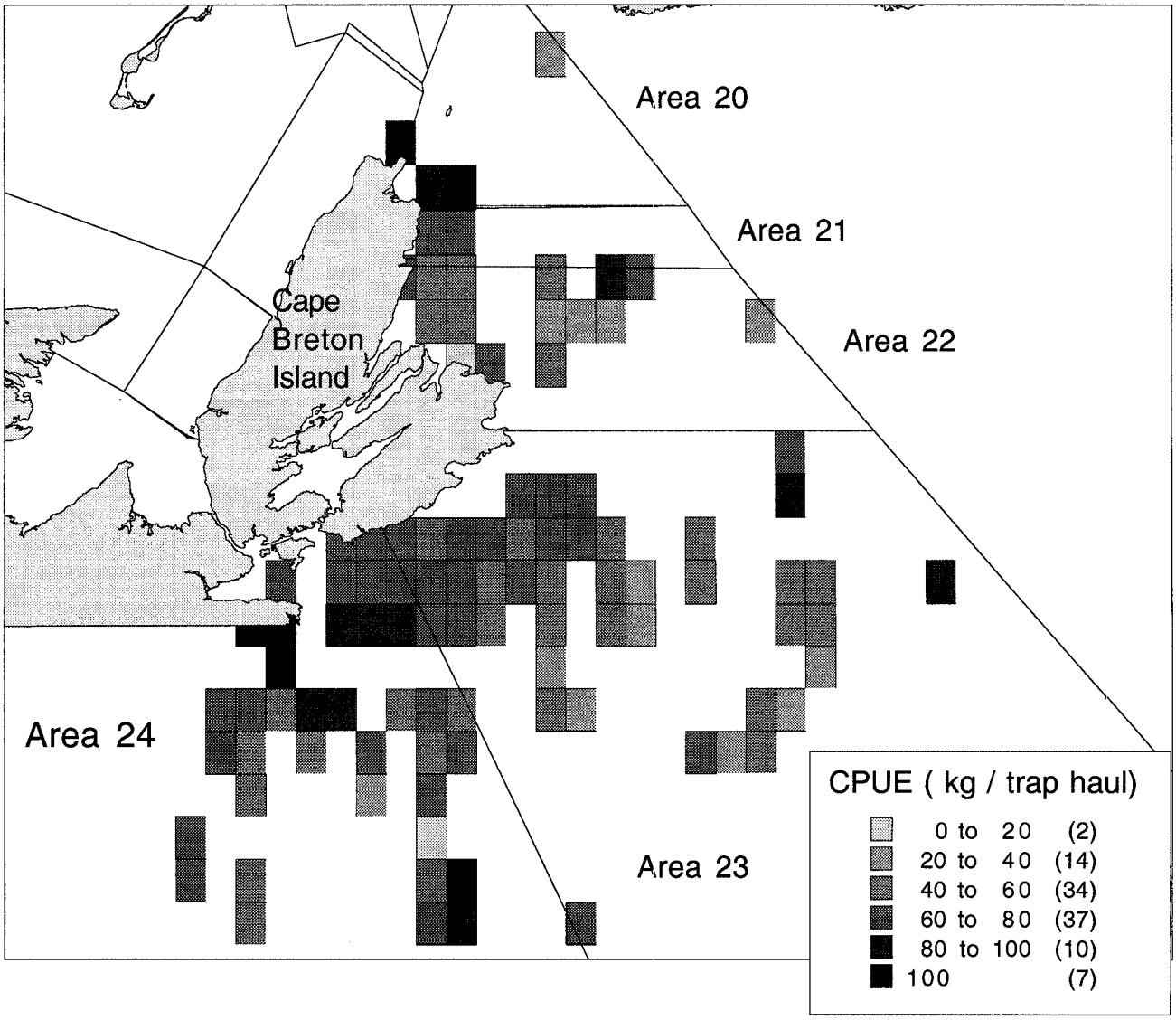



**Figure 6.** Seasonal distribution of the CPUE (kg/trap haul) in ENS in 1998.

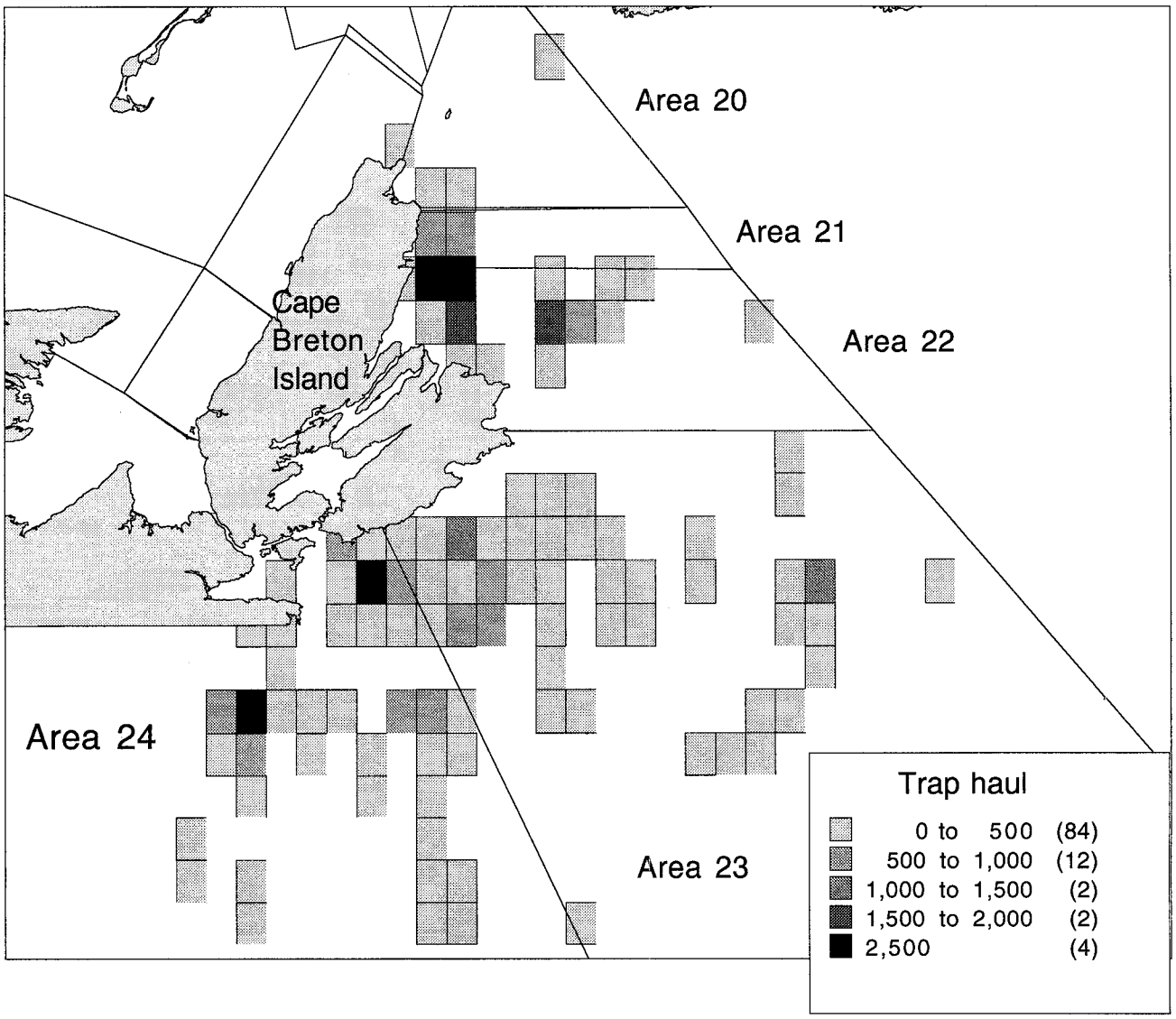



**Figure 7.** Seasonal distribution of effort ( # of trap hauls) in ENS in 1998.

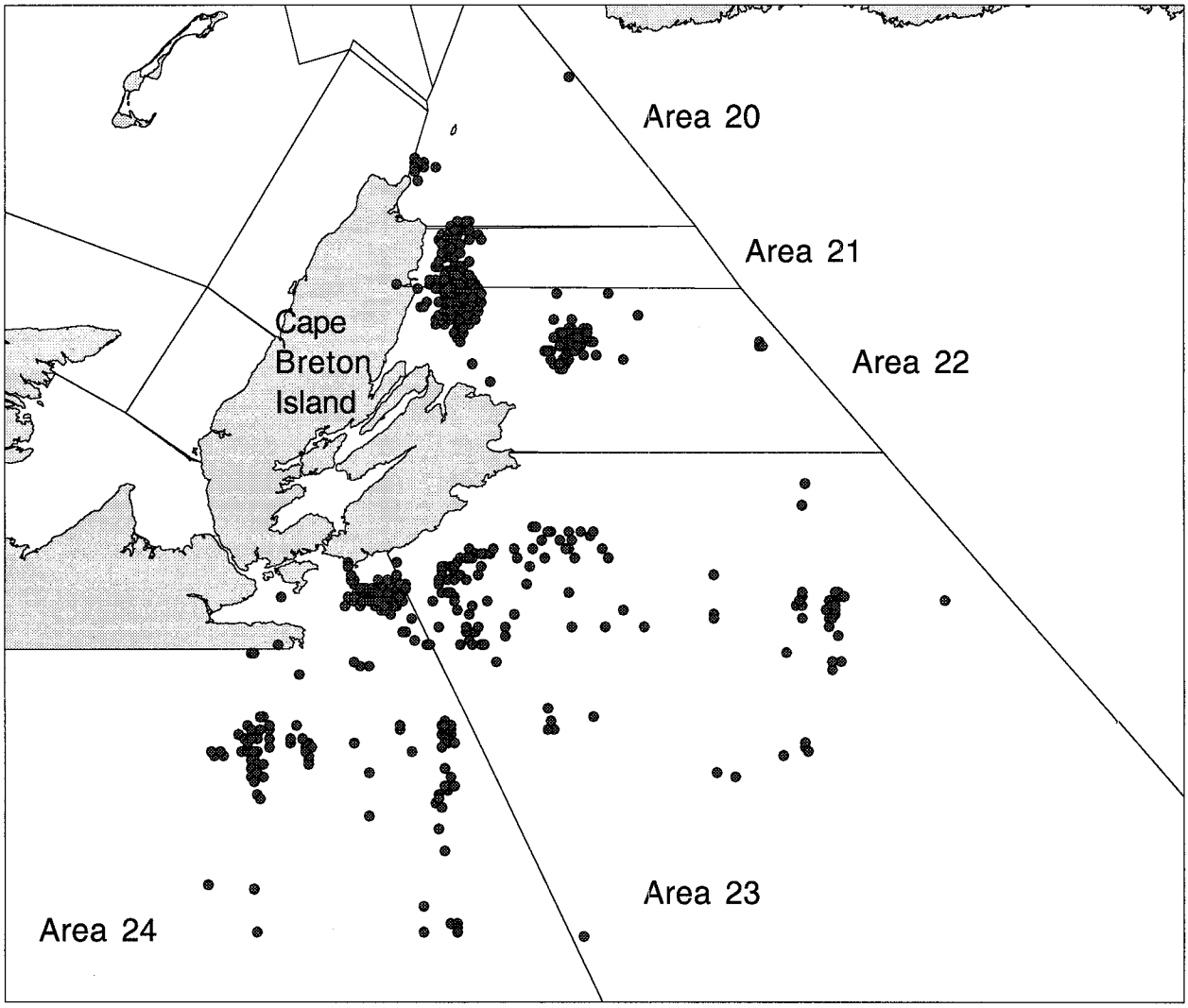



**Figure 8.** Reported logbook positions in eastern Nova Scotia in 1998.

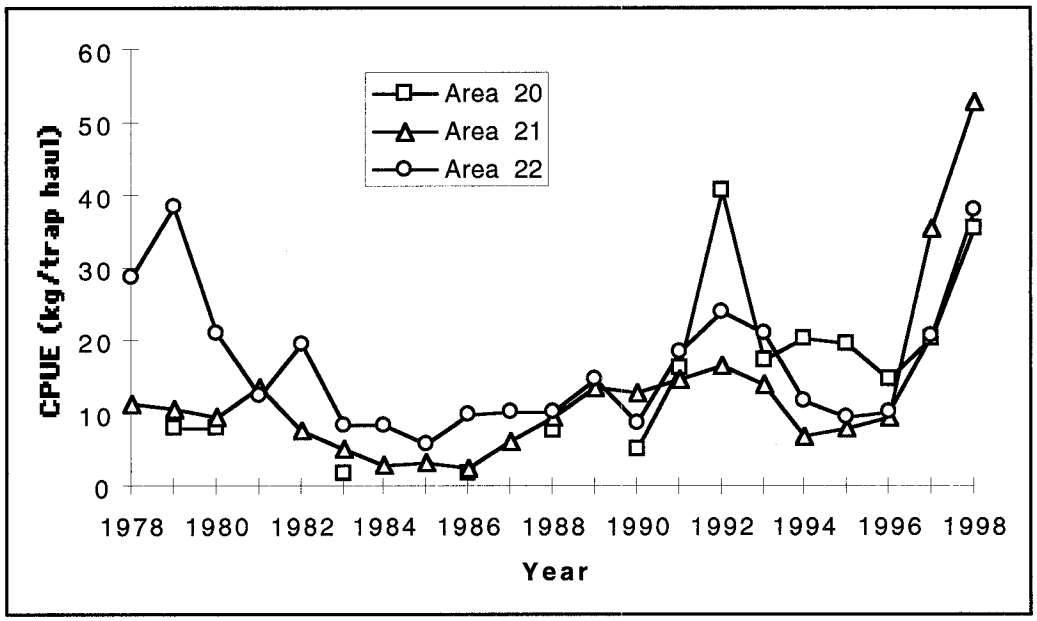



**Figure 9.** CPUE for Areas 20, 21 and 22 from 1978 to 1998.

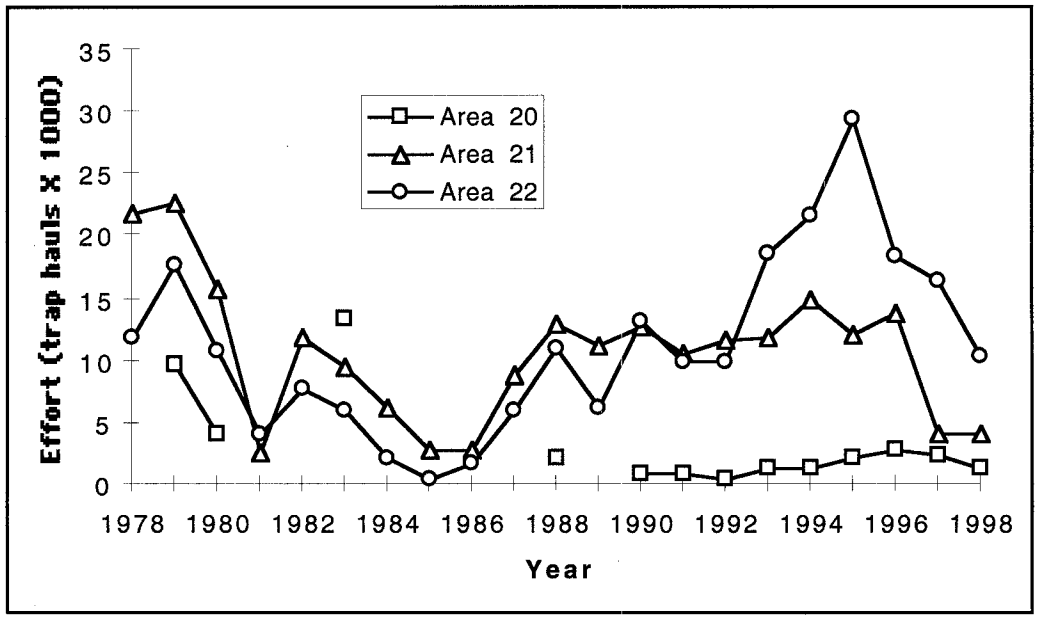
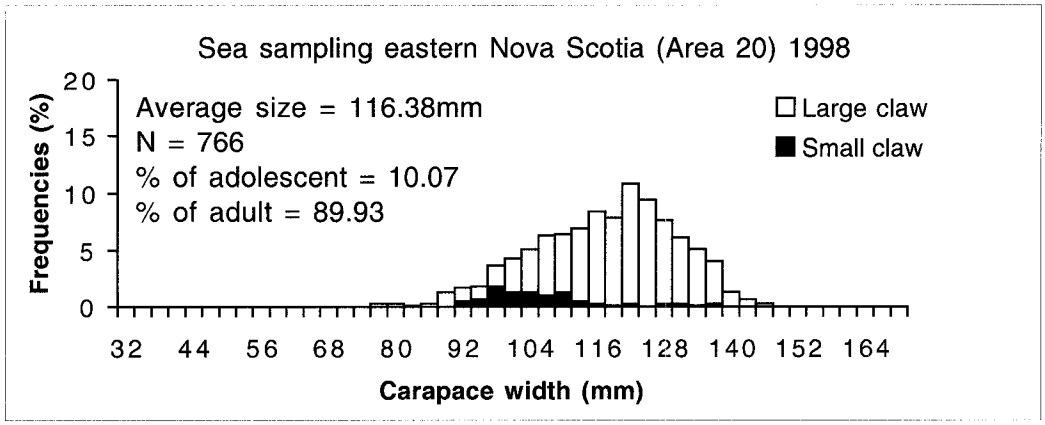
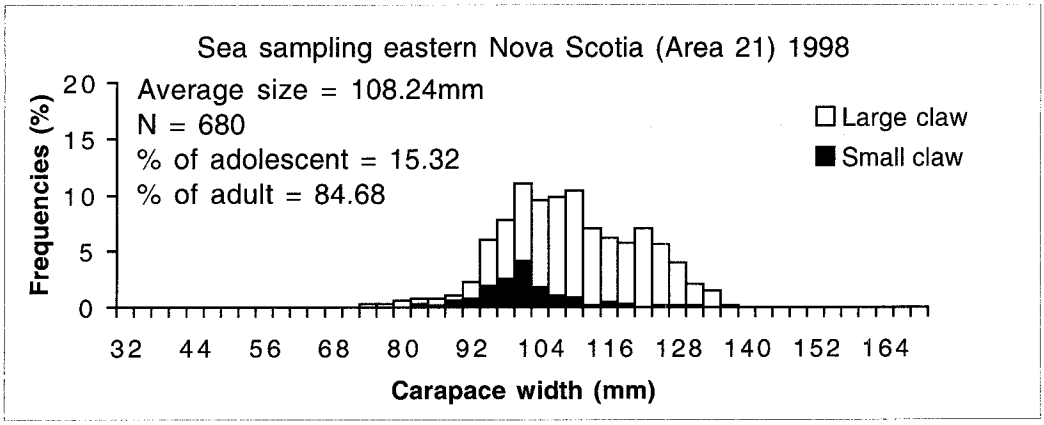
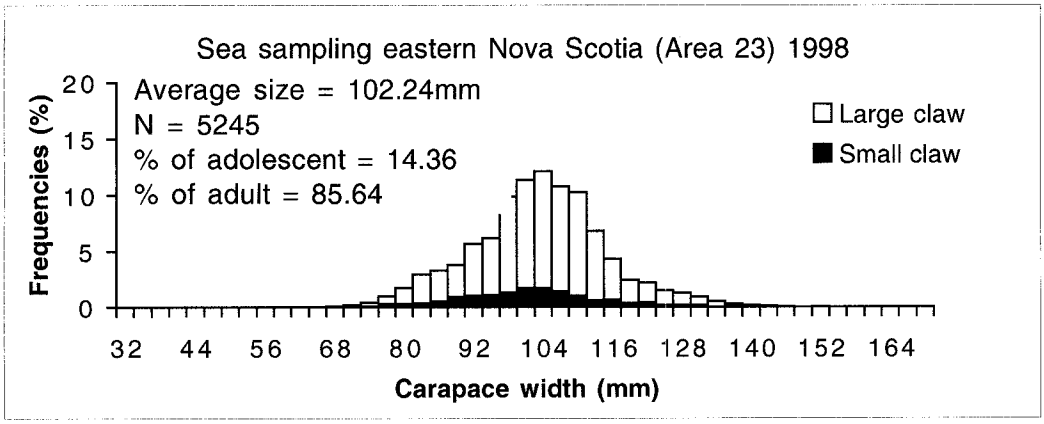



**Figure 10.** Fishing effort for Areas 20, 21 and 22 from 1978 to 1998.



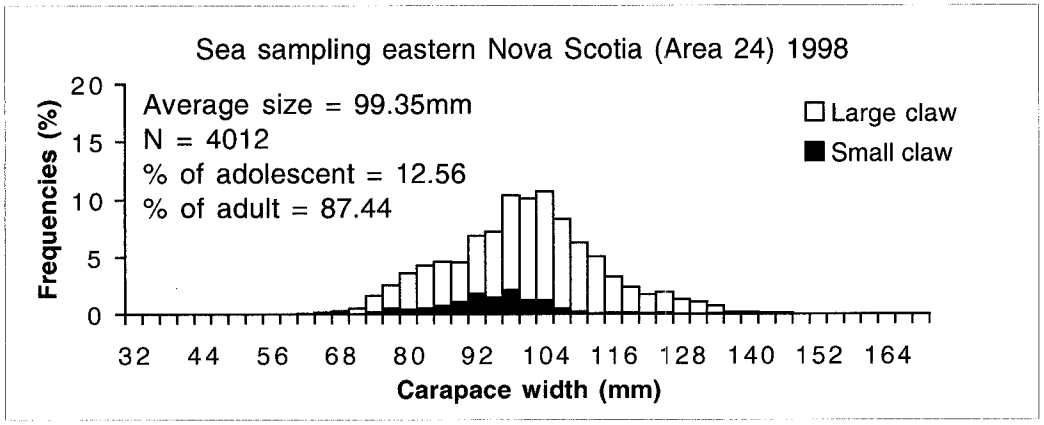




**Figure 11**. Histograms of size frequency distribution from the sea sampling in Areas 20, 21, 23 and 24.

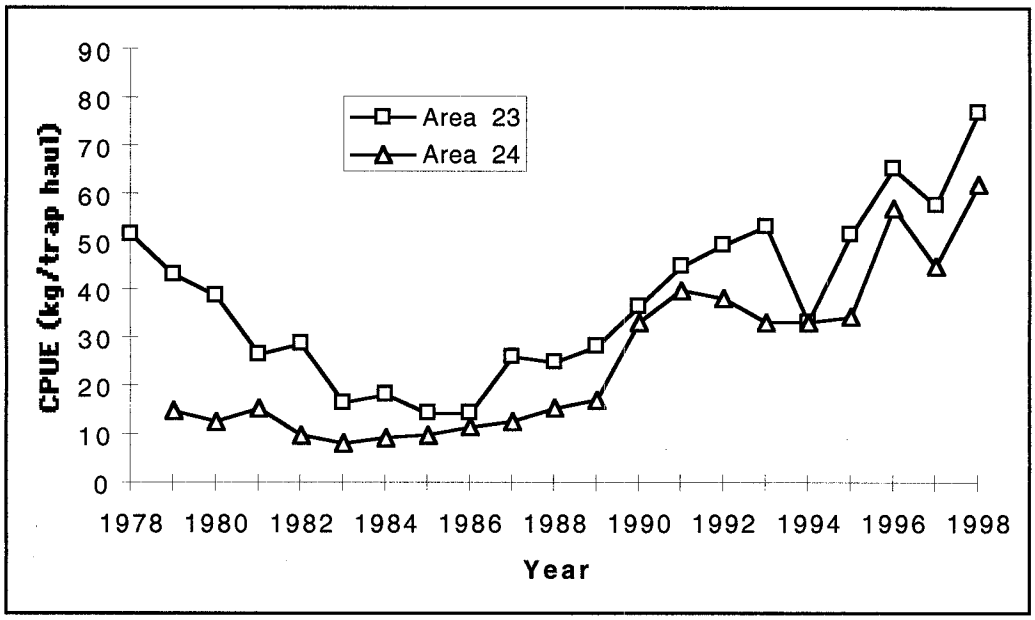



**Figure 12.** CPUE for Areas 23 and 24 from 1978 to 1998.

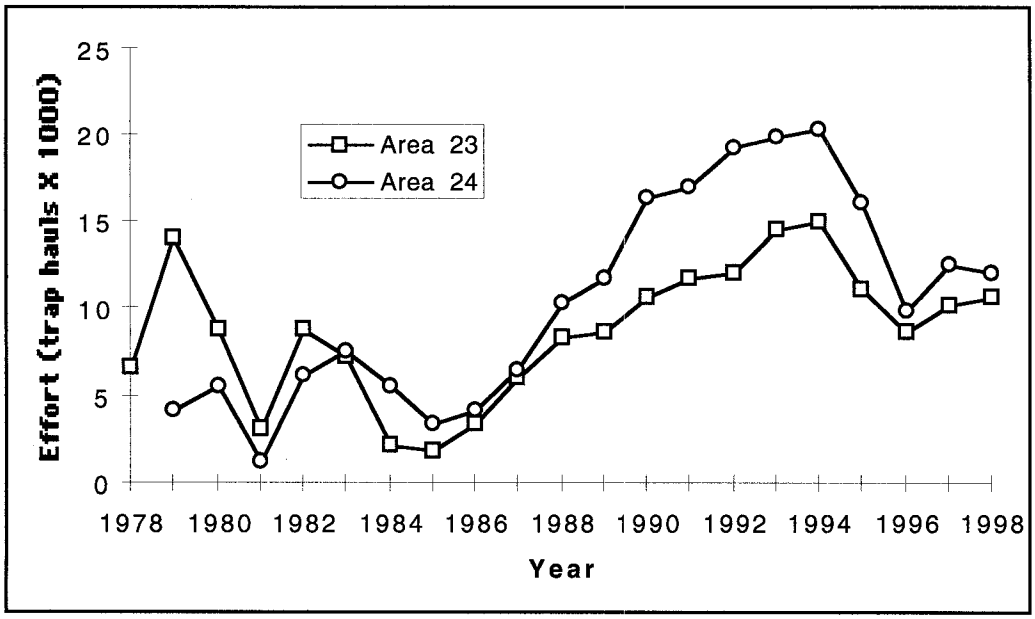



**Figure 13.** Fishing effort for Areas 23 and 24 from 1978 to 1998.

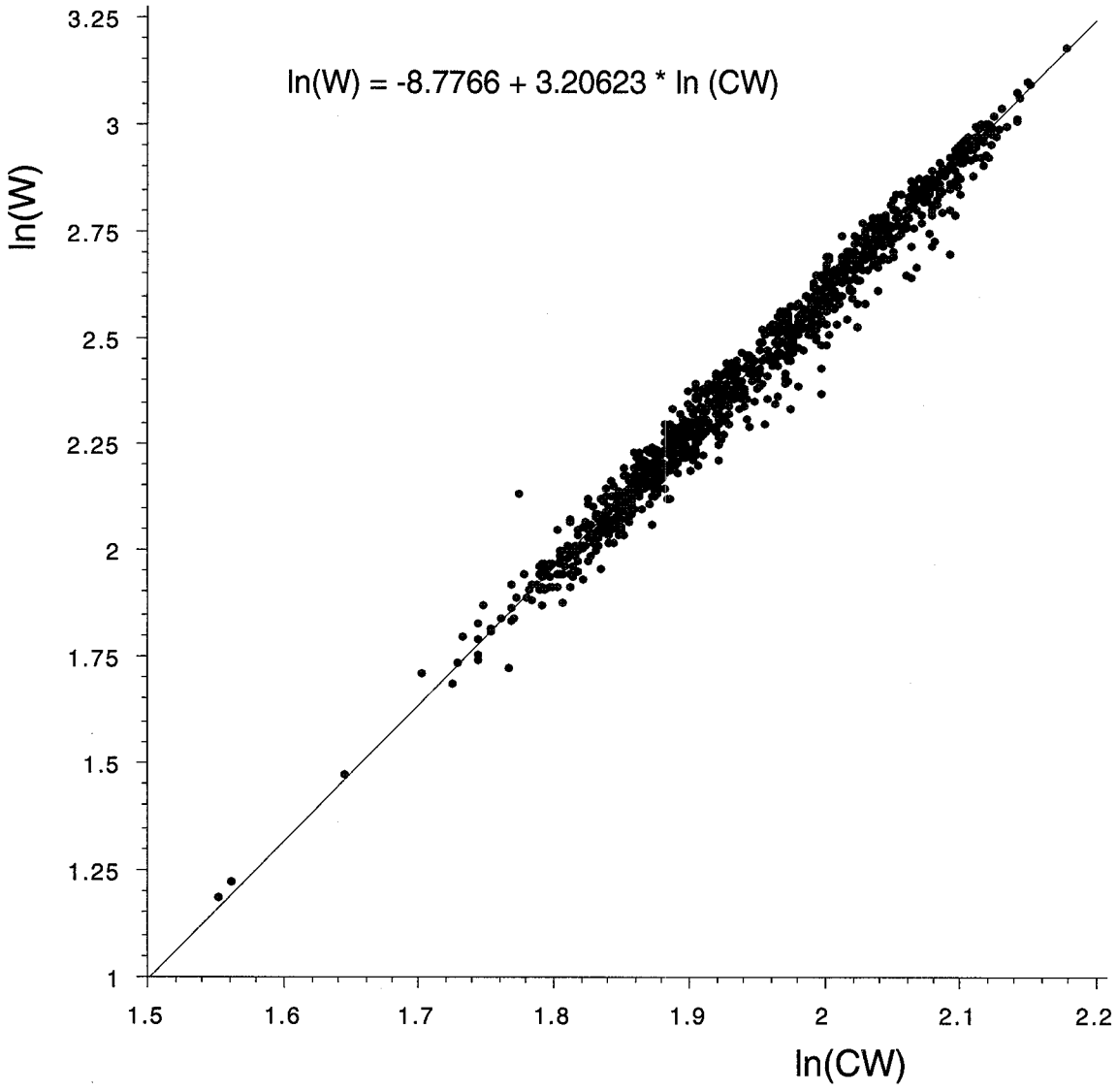



**Figure 14**. Carapace width (CW) - weight (W) relationship for samples taken in eastern Cape Breton Areas during 1998

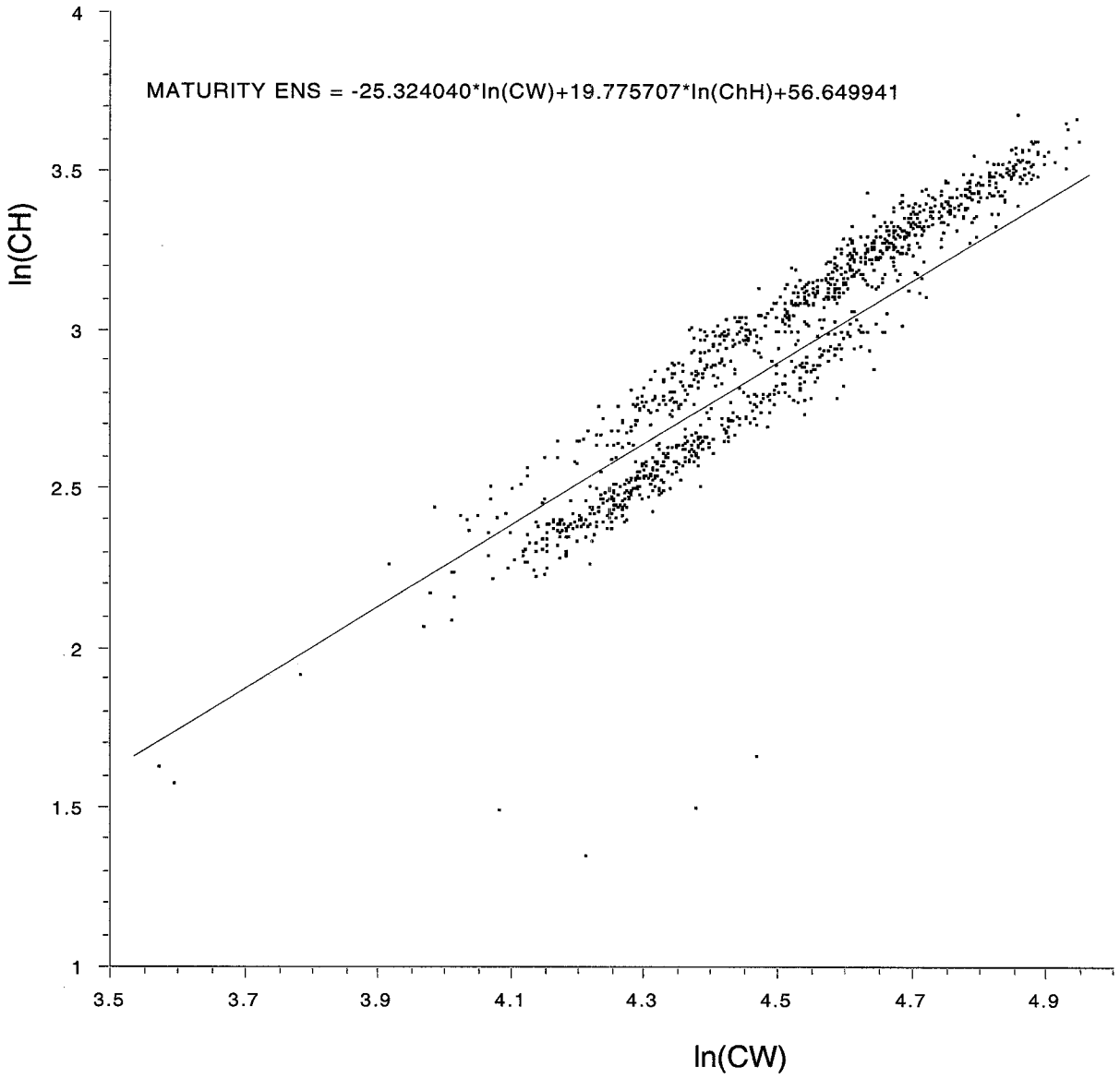



**Figure 15**. Discrimant function for eastern Cape Breton Areas showing the cutting line separating the two groups of points (adolescent and adult).

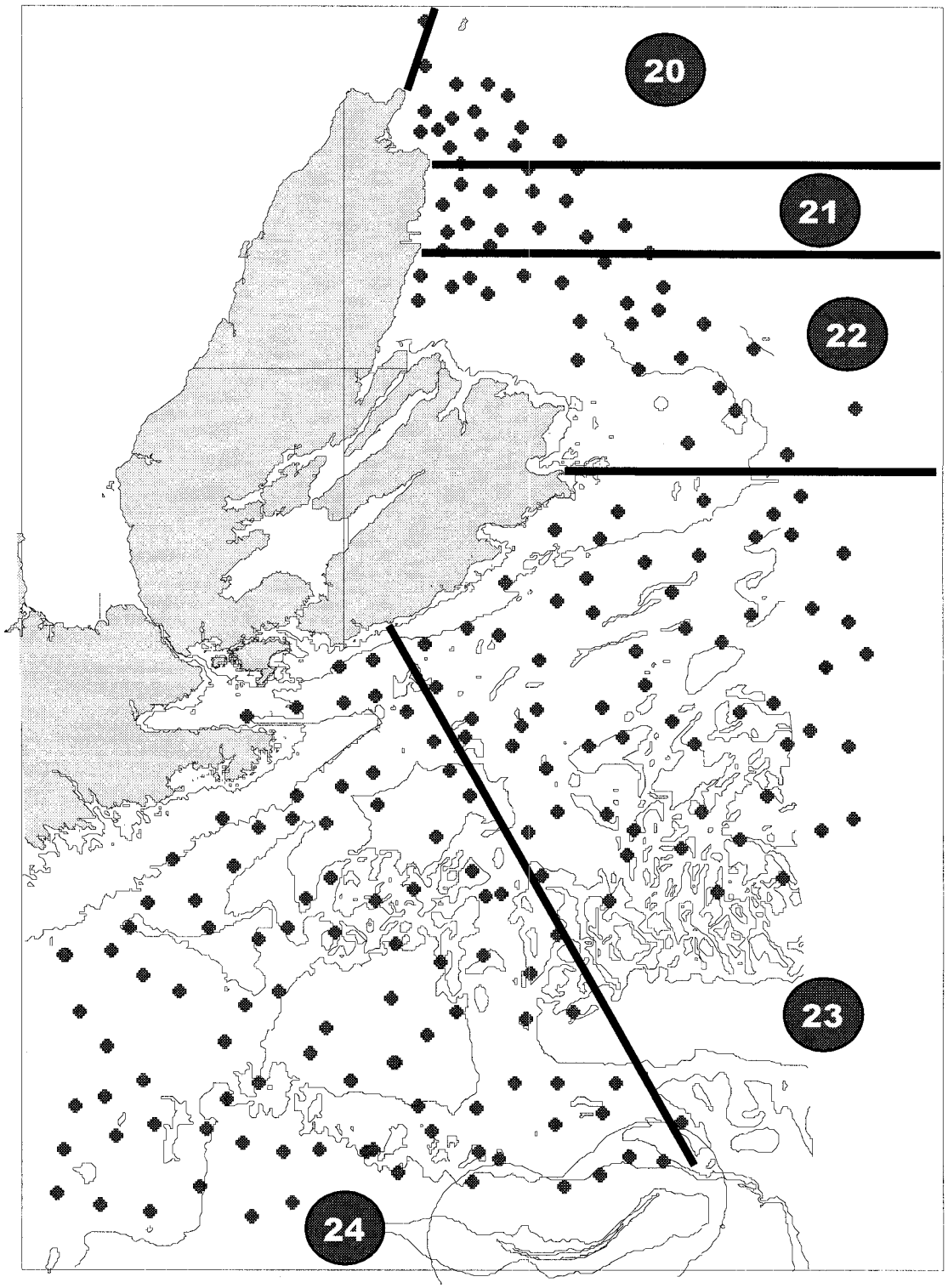



**Figure 16**. Location of trawl survey stations (N=214) in 1998.

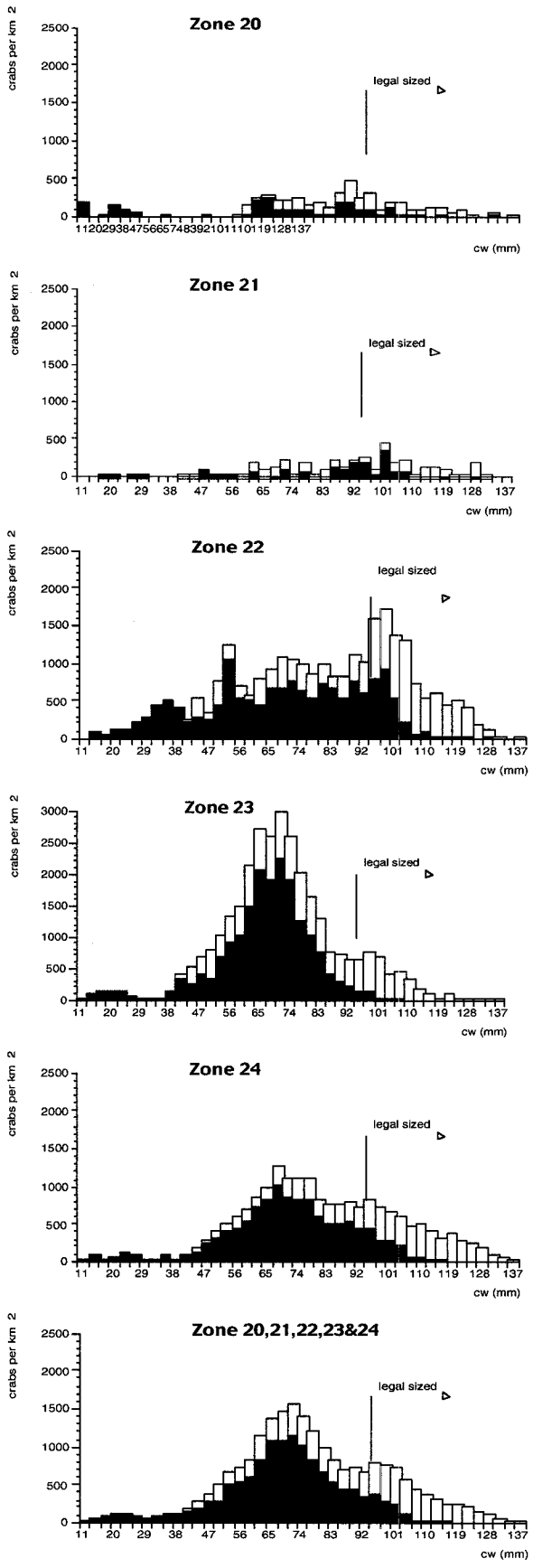



**Figure 17**. Male histograms for eastern Nova Scotia from the trawl survey in 1998.

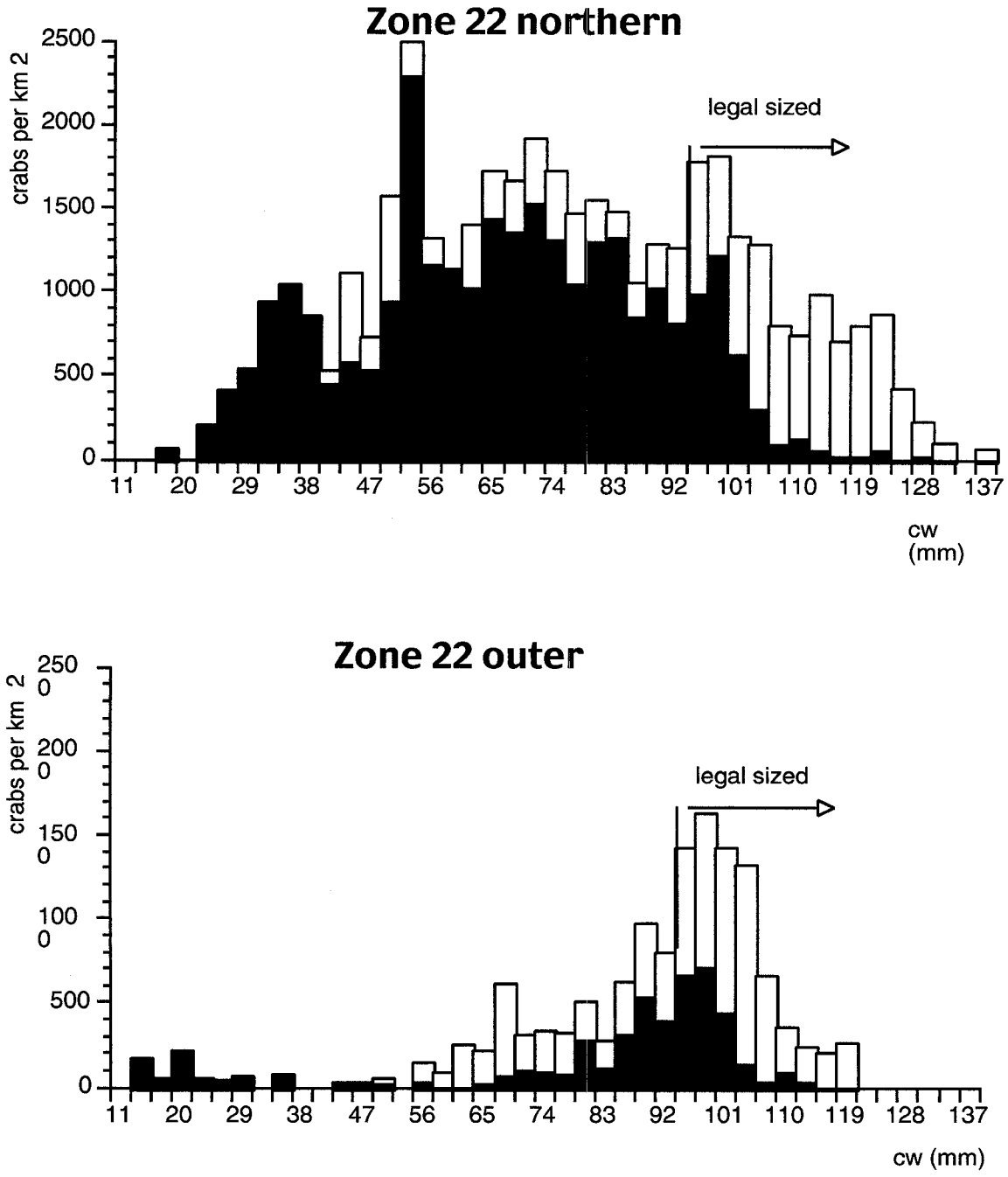



**Figure 18**. Males histograms of size frequency distribution from the 1998 trawl survey in the northern and outer (southern) portions of Area 22.

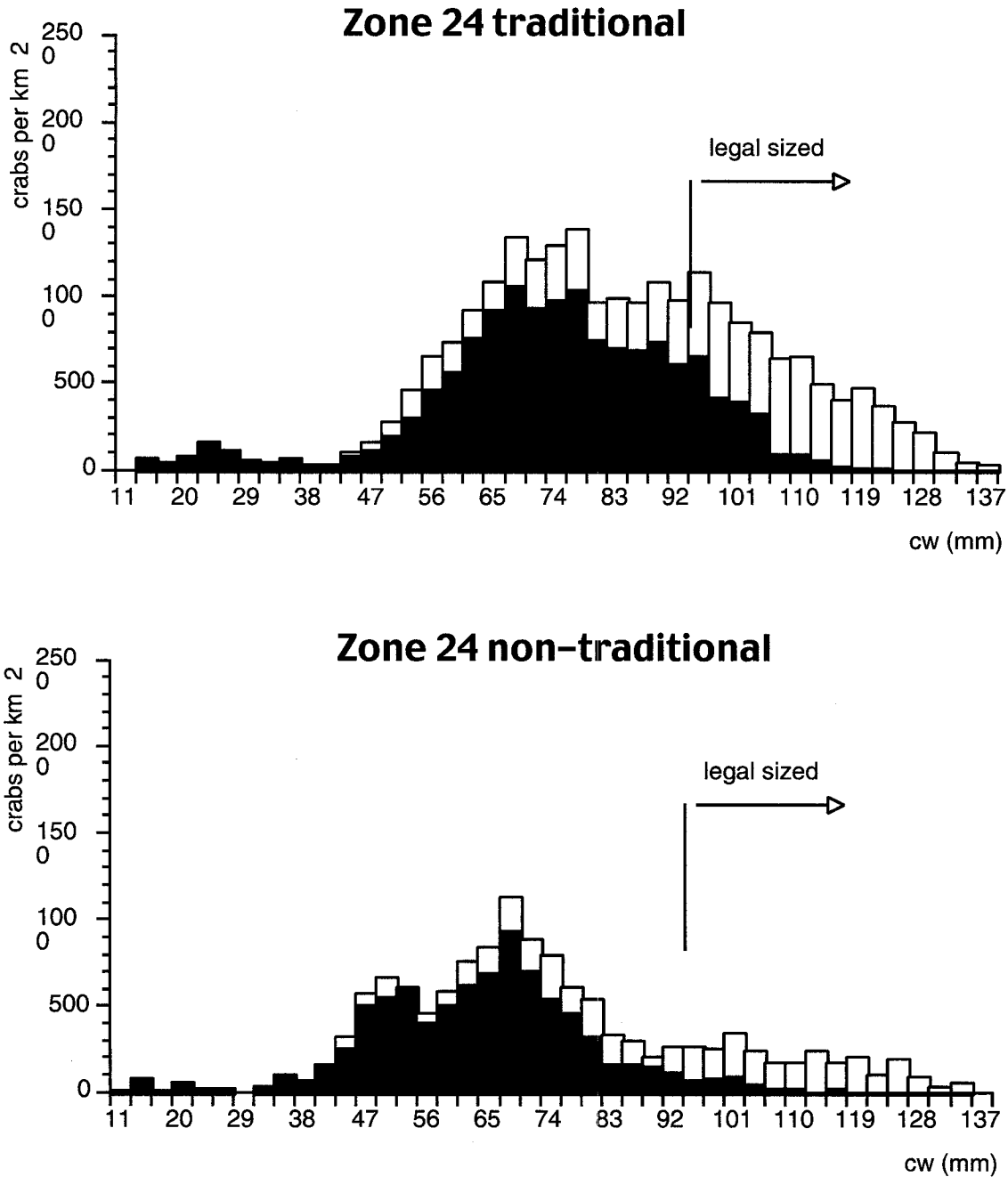



**Figure 19**. Males histograms of size frequency distribution from the 1998 trawl survey in the traditional and non-traditional fishing grounds of Area 24.

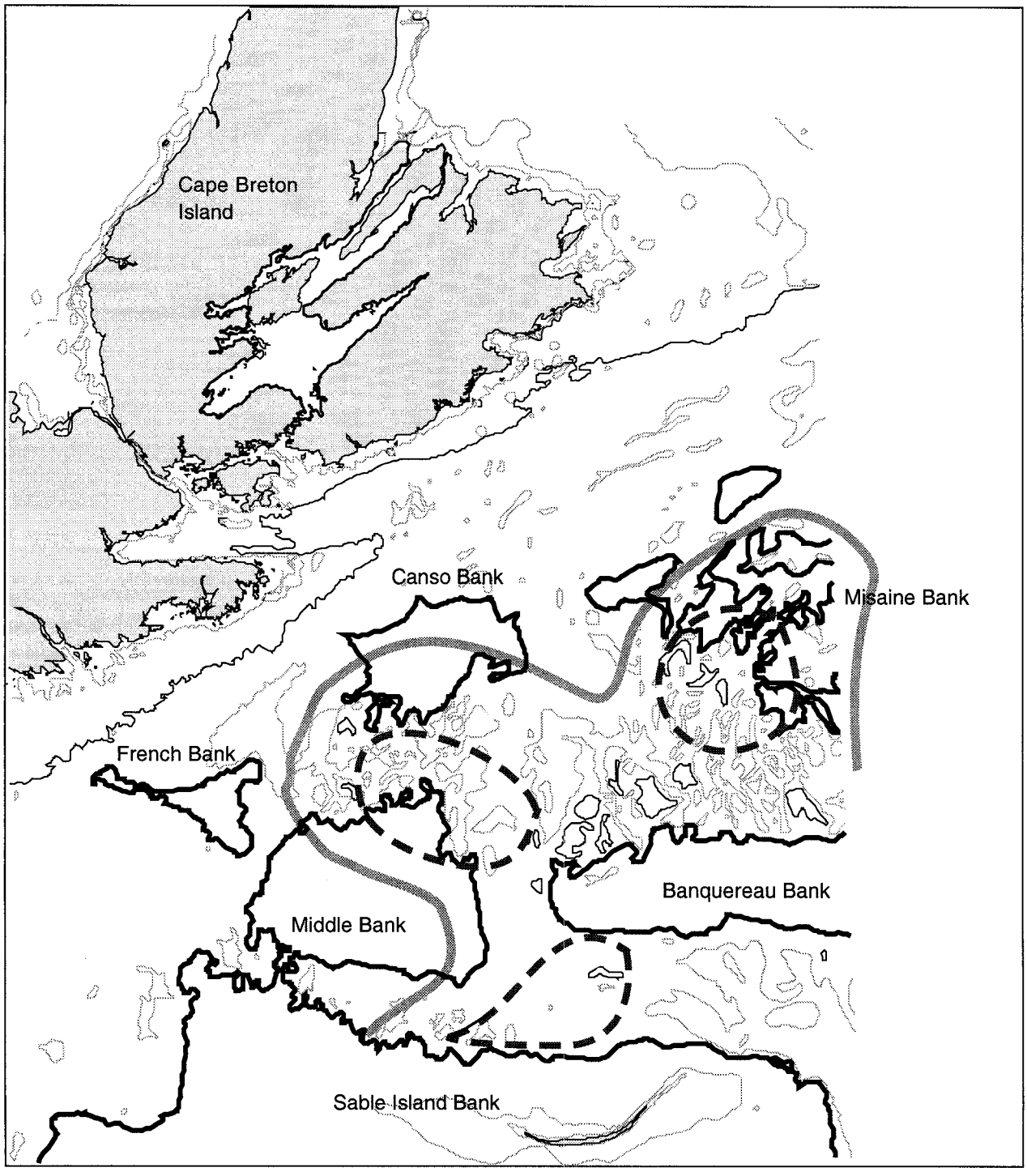



**Figure 20**. Graphical representation of the snow crab density distribution found in eastern Nova Scotia in 1997 (dashed line areas = highest density patches, solid grey line = area containing high density of crab).

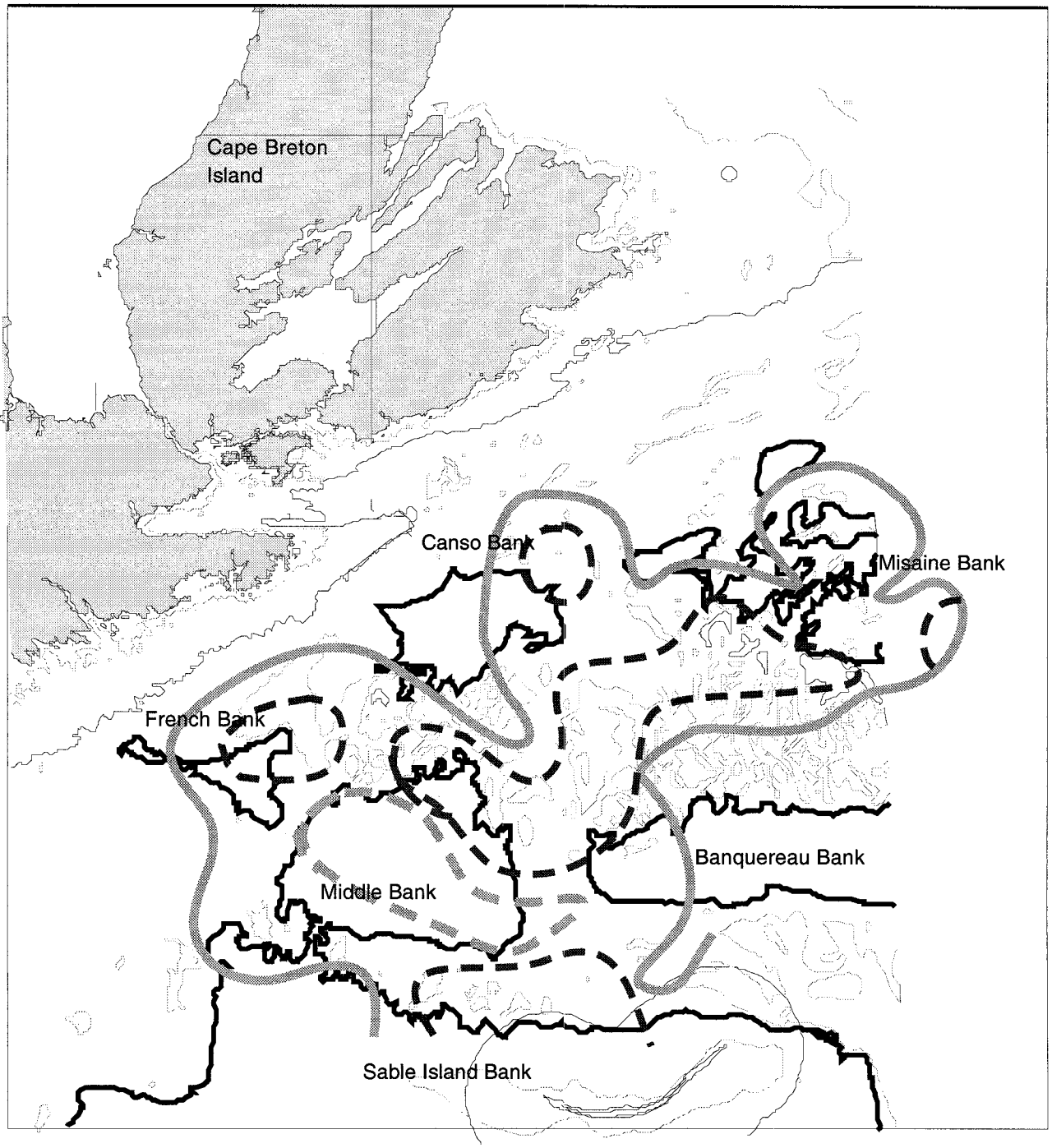



**Figure 21**. Graphical representation of the snow crab density distribution found in eastern Nova Scotia in 1998 (dashed dark line areas = highest density patches, solid grey line = area containing high density of crab, dashed grey area = area containing very low density of crab).