Assessment of the 1994 snow crab fishery off eastern Cape Breton (Areas 20-24)

by

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ABSTRACT

Total 1994 landings in Areas 20-24 declined by 24% from 1993 due to a commensurate decline in commercial CPUE. Declines in CPUE occurred throughout Areas 20-24 with but one exception: the offshore portion of Area 24. The general decline in CPUE appears to be due to lower abundance. At-sea sampling indicates lower pre-recruit CPUE in Areas 21 and 23, a trend observed elsewhere in Atlantic snow crab. The incidence of soft crab in the catch was relatively high in 1994, and may be related to high effort, which is at near record levels. For these reasons we recommend no increase in effort (i.e. the number of potential trap hauls per day) for any of Areas 20-24 in 1995.

Individual boat quotas, and associated dock-side monitoring, had no apparent effect on the distribution of fishing effort in Area 23. If boat quotas are introduced in other Areas, effort controls should remain in place because reliable estimates of snow crab biomass for Areas 20-24 are not currently possible.

Soft crab comprised up to 50% of the trap catch (by number), and up to 26% of the landed catch in some Areas. This results in substantial resource waste because soft crab have low meat content, low value, and are vulnerable to handling mortality. Methods for reducing the percentage of soft crab are needed where soft crab incidence is high. Possible approaches are discussed.

RÉSUMÉ

En 1994, les débarquements totaux des zones 20 à 24 ont diminué de 24 % par rapport à 1993, en raison d'une baisse correspondante des PUE. Ce recul des PUE s'est produit dans l'ensemble des zones 20 à 24, sauf dans les eaux du large de la zone 24. Il semble dû à une baisse de l'abondance. Les échantillons prélevés en mer dénotent de plus faibles PUE de pré-recrues dans les zones 21 et 23, tendance observée ailleurs dans la pêche du crabe des neiges de l'Atlantique. Les crabes à carapace molle étaient relativement nombreux parmi les prises en 1994, phénomène qui est peut-être relié à l'effort élevé, proche des niveaux records. C'est pourquoi nous recommandons que l'effort (soit le nombre potentiel de casiers levés par jour) ne soit pas accru dans les zones 20 à 24 en 1995.

Les quotas individuels par bateau et le contrôle à quai qui y est associé n'ont pas eu d'effets apparents sur la distribution de l'effort de pêche dans la zone 23. Si des quotas par bateau sont adoptés dans d'autres zones, il faudra continuer de régir l'effort parce qu'il n'est pas possible actuellement d'obtenir des estimations fiables de la biomasse de crabe des neiges dans les zones 20 à 24.

Les crabes à carapace molle représentaient jusqu'à 50 %, en nombre, des prises au casier et jusqu'à 26 % des débarquements dans certaines zones. Il en résulte un gaspillage important de la ressource, parce que ces crabes contiennent peu de chair, ont peu de valeur et sont également susceptibles de mortalité par manipulation. Il convient de trouver des moyens de réduire le pourcentage de crabes à carapace molle là où il est élevé. On discute ici des moyens possibles d'y parvenir.

INTRODUCTION

The fishery for snow crab off the east coast of Cape Breton Island (Areas 20 to 24 on Fig. 1) began in the late 1970s. Landings rose rapidly to a peak in 1979; landings and catch per unit effort (CPUE) then dropped precipitously. By 1985 the fishery was deemed to be on the verge of commercial extinction (Elner and Robichaud 1985). Eastern Cape Breton snow crab stocks were thought to be unproductive due to marginal snow crab habitat and little endemic recruitment (Elner and Bailey 1986). In 1986 a pulse of pre-recruits entered commercial catches of snow crab in all areas off eastern Cape Breton (Elner and Robichaud 1987). The consistency of recruitment over the next few years caused re-evaluation of the original interpretation (Elner et al. 1990), and crab stocks off eastern Cape Breton now appear to be more productive than first thought. Total landings for Areas 20-24 in 1992 and 1993 were higher than the 1979 peak.

Analyses of catch rate, spatial distribution of effort, biomass, and population structure for the period 1978-93 indicate that the increased landings after 1986 resulted from 3 factors: (i) increased abundance and biomass; (ii) expanded fishing area; (iii) increased total effort (Tremblay et al. 1994). Fishing effort appears to have been driven mainly by catch rate, although snow crab price was a factor in some years. Estimated exploitation rates (using Leslie analysis) were highly variable, but averaged about 50% for Areas 23 and 24. For Areas 20-22, mean exploitation was higher (59%) and stock performance lower than in Areas 23 and 24. Landings in Areas 20-22 have not reached the 1979 levels, and catch rates were never as high as in Areas 23 and 24.

Management of these fisheries has been based strictly on effort controls (season, licenses, and trap limits) since 1982 because of the difficulty in setting quotas where recruitment is unpredictable. License number has remained stable except for Area 24 where a total of 7 new licenses were added between 1989 and 1991. These are all restricted to offshore grounds that were fished little prior to 1989.

Current issues in snow crab Areas 20-24 include questions of additional access (new participants) to the fishery, individual boat quotas, and the landings of soft-shelled crab (recently molted crab, often referred to as "white" or "light" by industry). In 1993 Science was asked for advice on additional effort in Areas 23 and 24. Science can provide advice only on total effort levels (i.e. the number of potential trap hauls per day, or number of licenses times trap limit); how that effort is distributed is a socio-economic issue. Based on trends in estimated exploitation rates, and the possibility of declining recruitment, we recommended[1] that any increase in effort be no greater than 10% for no more than 2-3 years; no effort was added in 1994.

Area 23 license-holders voted for a 65,000 lb (29,478 kg) individual boat quota for the 1994 fishery. They were interested in spreading the resource over a greater number of years; we could not provide a biologically based TAC, and the individual boat quota was

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[1] From "Biological advice on question of additional access to Scotia-Fundy Snow crab Areas 23 and 24" by M.J. Tremblay and M.E. Eagles. Unpublished document reviewed at Halifax Lab in February 1994.

based on previous years landings rather than on any scientific information. Because this was a new management measure, we were interested in any potential changes in fishing patterns or fishing practices that might result.

The problem of the landing of soft crab in Areas 20-24 is Area- and time-specific. Most fishers are against landing such crab because of the wastage: they are low value due to low meat content and high mortality. Leaving soft crab on the bottom allows the crab to harden and increase in value. Through much of the 1980s few soft crab were found and landing them was not an issue. In the late 1980's this began to change with the appearance of a major recruitment pulse. Area 23 fishers have voluntarily returned most soft crab to the water at least since 1991 (Tremblay et al. 1992); fishers from the other Areas have followed this practice to a lesser extent. There were several reports of high percentages of soft crab in the landed catch of Area 24 fishers in 1994.

Here we assess the 1994 snow crab fishery in Areas 20-24 and address the following issues: (i) the advisability of additional effort (potential trap hauls per day) in snow crab Areas 20-24 in 1995; (ii) whether the adoption of an individual boat quota and dock-side monitoring (DSM) in Area 23 has changed fishing patterns; and (iii) the extent of the soft-shell problem in the different Areas, and possible solutions.

MATERIALS AND METHODS

Areas used for assessment purposes

Areas 20-21, and the inshore portion of Area 22, have traditionally been assessed together because they comprise a contiguous area (Fig. 2). A separate offshore ground is recognized for Area 22. The inshore grounds of Areas 23 and 24 (within about 20 miles of shore - Fig. 2) have been fished more or less continuously since 1978, whereas the offshore grounds (beyond 20 miles to as much as 80 miles from shore) have been fished intensively only since the late 1980s (Tremblay et al. 1994). For these reasons we track the inshore and offshore grounds separately, even though there are no reasons to suspect that they are different stocks.

Landings, catch rate and effort, and price

Landings - Landings by Area were estimated by combining data from several sources: (i) sales slips collected from crab buyers; (ii) log sheets from snow crab vessels and (iii) dock-side monitoring sheets (Area 23 only). Landings from sales slips were compiled by Commercial Data Division, DFO, while landings from fishing logs were compiled and analyzed by Biological Sciences Branch, DFO. Where landings differed among sources, the highest value was used.

Catch rate and effort - Logs have been completed by snow crab fishers in Areas 20-24 since 1978. These have been collected by biologists or Statistical Officers, but have generally been examined only by biologists. Log sheet returns as a percentage of all active fishers

ranged from 35% (1981) to 100% (1978 and 1985). Data quality has been variable, but on average 75% of the active fishers have provided logs that include daily effort (number of traps fished) and landed catch (Tremblay et al. 1994). In 1994 Area 23 fishers went to dock-side monitoring (DSM) and there was an attempt to incorporate fishing log information on the DSM sheets. As a result the traditional fishing logs were completed by only a few Area 23 fishers.

Fishing logs (or DSM sheets) were the data sources for estimating catch per unit effort (CPUE). Comparative trap indices are unavailable (Tremblay et al. 1994) and we present both unstandardized catch rate (total landings divided by total trap number regardless of trap type) and standardized catch rate: that of the most common trap for the Area. To estimate total effort for each Area we divide the total annual landings for the given Area by the catch rate of the most common trap type (Tremblay et al. 1994).

It has been standard practice to use mean weekly CPUE to estimate exploitation rate and biomass using Leslie analysis (e.g. Elner and Bailey 1986; Elner et al. 1986, 1990). Analyses for the entire time period do reflect some meaningful trends; e.g. higher exploitation rates in Areas 20-22 where estimated trap density per km^2 is also highest (Tremblay et al. 1994). However there are several reasons to suspect that Leslie analysis is misleading for detecting annual differences in exploitation rate in the eastern Cape Breton snow crab Areas, which is not surprising given the assumptions of Leslie analysis (Miller and Mohn 1993). First, year to year differences in estimated exploitation rate were sometimes substantial (Tremblay et al. 1994), and greater than would be expected given annual differences in effort. Second, Leslie analysis cannot be used for the sometimes important offshore grounds because of changes in area (km^2) fished and extensive trap movement. Third, changes in industry selectivity for soft crab make inter-annual comparisons of exploitation rate and biomass difficult. For example in 1994 anecdotal evidence indicates fishers in Areas 20-22 returned a greater percentage of soft crab to the bottom. Thus the 1994 CPUE would be expected to be lower than previous years all else being equal.

Here we take a more conservative approach in our use of fishing log data by using the CPUE data only as an index of abundance as suggested by Miller and Mohn (1993). Where possible we try to account for recent changes in the extent to which industry retains soft crab..

Note that landings, CPUE and effort figures cannot be finalized until approximately 1 year after the season ends due to late submission of sales slips and fishing logs.

Price - The mean annual dockside price for snow crab is estimated by dividing total landed value by total landed weight. Data on price were obtained from the Commercial Data Division of DFO.

Samples of the commercial catch

At-sea samples were obtained in Area 21, Area 22 and Area 23 inshore grounds. Sample number in the past has been limited (usually 1-2 samples per year per Area - Tremblay et al. 1994). In 1994 6 at-sea samples were obtained from Area 23 because this Area is the only one with at least one annual sample from 1978-93, and because the size structure in these samples reflected changes in recruitment in the 1980s

(Tremblay et al. 1994). Port samples were obtained as follows: Area 22 (offshore grounds), Area 23 (inshore and offshore grounds) and Area 24 (inshore and offshore grounds).

Sea samples consisted of measuring carapace width (CW), assessing shell condition, measuring claw height and noting the size and colour of the egg clutch in mature females.

For snow crab shell condition we follow the terminology proposed by CAFSAC (Invertebrates and Marine Plants Subcommittee Report 91/19). The terminology reflects two ways of classifying shells: relative age (stages I to IV) and shell hardness (soft or hard as measured by a durometer).

Term	Stage	Durometer reading	Carapace Condition
New	I	< 68	brightly coloured, iridescent, soft, no epibionts, chelae easily bent
Inter-mediate	II	variable	brightly coloured, somewhat iridescent, may have epibionts, chelae not easily bent
Old	III	≥ 68	dull brown dorsally and yellow-brown ventrally, no iridescence, shell abrasion evident, epibionts
Very old	IV	N/A	carapace very dirty and soft, decay may be evident especially at leg joints
Soft	I-II	< 68	
Hard	II-IV	≥ 68	

We have not used the durometer routinely, but regard new-shelled crabs as synonymous with soft-shelled crab. For brevity and consistency we use the term soft crab to refer to recent molters. Terms such as "white" or "light" are often used by industry and refer mainly to Stage I crab, but may include part of Stage II crab. The Gulf of St. Lawrence and Newfoundland snow crab fisheries restrict the capture of soft crab by monitoring the shell hardness with durometers.

Chelae morphometry distinguishes snow crab that are still growing from those that are in terminal molt. Small-clawed (SC) crab that are still growing are separated from large-clawed (LC) crab that are in terminal molt by plotting claw height against carapace width. Here we use the cutting line equations given in Elner et al. 1988:

$$Ln(CH) = -2.849661 + 1.288020 * Ln(CW) \quad [Areas\ 23\text{-}24]$$

$$Ln(CH) = -3.135785 + 1.348113 * Ln(CW) \quad [Areas\ 20\text{-}22]$$

where CH is chela height and CW is carapace width.

Indices of recruitment to the fishery that were examined by Tremblay et al. (1994) include the percentage of sub-legal crab (< 95 mm

CW) in at-sea samples, and the percentage of sub-legal, SC crab in at-sea samples. For the 1978-93 period the percentage of short crab was correlated with commercial CPUE several years later but when the analysis was restricted to the 1985-93 period, this relationship was less evident. Here we add the data from the 1994 sea samples, and estimate the CPUE of pre-recruits (SC crab that are 78-95 mm CW) as follows:

$$\text{PR CPUE} = \text{PR Wt/Legal Wt} * \text{commercial CPUE}$$

Where PR Wt is pre-recruit weight (kg) in the sea sample(s); Legal Wt is the weight of legal crab (>= 95 mm CW, SC and LC) in the sea sample(s); and commercial CPUE is the CPUE (kg/trap) of the landed catch for the day(s) of the sea sample. Sea sample weights were estimated using the width-weight regression in Taylor and Warren (1989).

Fishing patterns in Area 23 under individual boat quotas

The establishment of individual boat quotas in the snow crab fishery (and the associated dock-side monitoring, or DSM) has the potential to change the pattern of fishing. For example in Area 23 it was thought that fishers who in previous years exceeded 65,000 lb (the 1994 individual boat quota) by fishing offshore might move closer to shore. After examining the DSM sheets, and talking with fishers, it became obvious that some of the location information was faulty due to fishers' concerns over confidentiality of location information. To address the question of whether there was any movement inshore, phone interviews of 19 of 22 Area 23 license-holders were conducted in February 1995.

RESULTS

Areas 20-22

Landings - Total 1994 landings in Areas 20-22 dropped for the first time since 1986 (Fig. 3). The decrease was substantial (34% lower than 1993), but 1994 landings of 379 mt were still above the long term mean of about 313 mt. There was variation among Areas in the extent of the decline (Table 1). The inshore grounds of Area 22 dropped 31%, while the offshore grounds declined by 39%. Area 21 also declined (39%), but in Area 20 landings increased 31% (from 20 t to 29 t).

Catch rate and effort - Standardized CPUE declined in all Areas and grounds by 33-60% (Table 1, Fig. 3). CPUE is now below the long-term mean in each of Areas 20-22. CPUE on the inshore grounds of Area 22 declined by 33%, and on the offshore grounds by 39%. In Area 21 CPUE was 60% lower than 1993, and in Area 20 CPUE was 34% lower. These declines appear to be partly due to fishers in several ports returning more soft crab than in previous years.

Total effort in 1994 was about 35% greater than 1993, and is now almost 50% above the long-term mean (Fig. 3, Table 1). Increased effort occurred on all grounds, except for the offshore grounds of Area 22 (Table 1).

Samples of the commercial catch - The percentage of snow crab in different shell stages in at-sea samples indicates a relatively high percentage of soft crab on the grounds (Table 2). In Area 21 about 25% of crabs were soft, while in Area 22 over 50% were soft. Anecdotal evidence indicates there was considerable selection against soft crab by returning them to the sea. Comparison of at-sea and port samples supports this: the percentage of soft crab in the offshore port sample (21%) was lower than that in the inshore sea samples (Table 2). This assumes no inshore-offshore difference in the percentage of soft crab.

The width frequency of snow crab from commercial samples (Fig. 4) shows the catch is spread mainly over 2 molt groups (95-114, and 115-134 mm CW). The percentage of SC crabs is substantial between 95 and 105 mm CW, while above about 125 mm CW virtually all crab had large claws and were thus in terminal molt. The higher percentage of soft crab in the Area 22 sea samples was accompanied by a lower mean size, and higher percentage of SC crab (Table 2). The apparent selection against soft crab resulted in a lower percentage of SC legal crab in the port sample (Fig. 4).

Some interesting interannual trends in the population structure of snow crab in Area 21 (Neil's Harbour) are apparent from sea samples obtained between 1988 and 1994 (Tables 3 and 4). First the percentage of soft crab was generally high from 1988-1991, lower in 1992-93, and moderate in 1994 (Table 3). Second, the pre-recruit index (CPUE of SC crab 78-94 mm CW) was high in 1990 and 1992 but 1993 and 1994 are the lowest for the period (Table 4). Together with the reduced CPUE in 1994, these data are consistent with reduced recruitment to the fishery in 1994, and possibly for the coming few years.

Area 23

Landings - Total landings in 1994 were down by 35% compared to 1993, but are still above the long term mean (Fig. 5, Table 1). The 1994 decline was greater on the inshore grounds (44%) than the offshore grounds (28%) (Table 1).

Catch rate and effort - Standardized CPUE declines in 1994 on the inshore and offshore grounds mirrored landings declines: 44% inshore, and 34% offshore. Inshore CPUE was equal to the long-term mean, while offshore CPUE was substantially less (Table 2). Inshore effort was the same as 1993, while offshore effort was up marginally (Table 1). Inshore effort is close to the long-term mean, while offshore effort is markedly higher.

Samples of the commercial catch - A total of 6 at-sea samples were obtained from the inshore grounds in August and September. Grouped by month, they indicate that 40-50% of the crab in traps were soft (Table 2). There is selection by fishers against these soft crab (both by returning soft crab to the sea and by avoiding areas with soft crab), as evidenced by their low percentage (about 8%) in port samples (Table 2). Area 23 snow crab fishers have selected against soft crab for several years (Tremblay et al. 1992). We had no at-sea samples from the offshore grounds but interviews with those who fished there indicate a lower percentage of soft crab, perhaps 10-30%. In any case the port samples of the offshore catch indicate that only 6% of the landed catch was soft.

The inshore trap catch in Area 23 was distributed over a wide size range (Fig. 6). The percentage of SC crab on the inshore grounds was similar to Areas 21-22 but the landed catch had a lower percentage (2-5%) than Area 22 (Table 2).

Some trends are apparent in the at-sea samples over the last 9 years (Tables 5 and 6). The percentage of soft crab increased from less than 15% in 1986-87 to more than 40% in 1988-89. Since 1992 the percentage of soft crab has increased. The pre-recruit index (CPUE of SC crab 78-94 mm CW) was highest from 1987-1989, lower in 1990-91 and lowest from 1992-94 (Table 6). This index is potentially sensitive to the commercial CPUE on the day of the at-sea sample (which could be unrepresentative of the season), and to the selection against soft crab (soft crab contribute to the estimated legal weight within the sea samples, but may not be actually landed). To examine the effect of these variables, we calculated the index in two additional ways: (i) by using the mean annual CPUE from Table 1 (Pre-recruit CPUE'); and (ii) by assuming that the landed catch over the time period has consisted of a maximum of 8% soft-shell, and by using an adjusted commercial CPUE (higher because it estimates what landed catch would have been if all soft crab were landed). Both pre-recruit CPUE' and CPUE" (Table 7) showed the same trends as the unadjusted index (Table 6). These data suggest that the recruitment pulse that entered the fishery in the mid to late 1980's has passed through, and that commercial CPUE will decline in the next few years.

Fishing patterns in Area 23 under individual boat quotas - Phone interviews with fishers indicate there was no directed movement inshore as a result of individual boat quotas. Apparently the higher CPUE offshore (Table 1) compensates for any additional expenses in fishing this far from shore. Fishers were generally satisfied with DSM. Several suggested that concerns over confidentiality of location could be remedied by returning to maintenance of logs on fishing effort and location for biologists, with DSM restricted to the tabulation of landings.

Area 24

Landings - Unlike Areas 20-23, total 1994 landings in Area 24 were essentially unchanged from 1993 (Table 2, Fig. 6). The grounds differed however; landings from inshore declined about 15%, while landings from the offshore grounds actually increased by 17%.

Catch rate and effort - Compared to 1993, standardized CPUE in 1994 mirrored landings: a decrease of 7% inshore, and an increase of 9% offshore. CPUE in both inshore and offshore was greater than the long-term mean (Table 2). Total effort in Area 24 was down marginally from 1993; inshore effort was down 9%, while offshore effort (including the exploratory area) was up 9% (Table 2). Effort is well above the long-term mean on both the inshore and offshore grounds.

Samples of the commercial catch - Only port samples were obtained in Area 24. They indicate that low percentages of soft crab were landed from the inshore grounds (Table 2). The landed catch from the offshore

portion of Area 24 was distinguished from other Areas by having the highest percentage of soft crab (26%) and SC crab (27%).

Snow crab price in Areas 20-24

The price received by fishers increased substantially from 1993 ($3.06/kg) to 1994 ($6.78/kg). By Area the mean prices per kg were: $7.76 (Area 20); $7.92 (Area 21); $7.66 (Area 22); $7.74 (Area 23); and $5.51 (Area 24). The lower price in Area 24 reflects the lower price for soft crab.

DISCUSSION

Total 1994 landings in Areas 20-24 were 24% lower than 1993, even though total effort was similar (Table 1). The decline in landings is due to commensurate declines in CPUE. CPUE decreased everywhere with the exception of the offshore grounds of Area 24. CPUE might also have been lower for these grounds if fishers there had landed less soft crab. Unfortunately sampling in 1993 was not adequate to determine the extent to which soft crab was landed in Area 24. The declines in CPUE in most of Areas 20-24 appear to be the result of a decline in abundance. A change in fishing practice in Areas 20-22 (greater selection against soft crab) probably contributed to decreased CPUE, but cannot account for the 33-60% drops in CPUE there. Total effort for Areas 20-24 is near the all-time high and will likely continue at this level with the current high price for snow crab.

Low recruitment trends within Areas 20-24 may be part of a larger pattern occurring in Atlantic snow crab. In the Southern Gulf of St. Lawrence for example the abundance of pre-recruits (SC crab 76-94 mm CW) has declined since 1991. Similar declines in recruitment are apparent off Newfoundland and Quebec. Pre-recruit CPUE in Area 23 for 1992-1994 was low relative to 1987-1991; pre-recruit CPUE in Area 21 was low in 1993 and 1994. The snow crab resource in Areas 20-24 will decline in the near future if pre-recruit CPUE is a reliable predictor of recruitment.

Accurate landing forecasts even one year in advance are difficult for eastern Cape Breton for several reasons. One is the low level of commercial catch sampling and uncertain sampling variability. Increased sampling would increase confidence in pre-recruit trends, but other forecasting difficulties would remain. The future size and molt status of a group of SC crab cannot be reliably predicted because they can skip-molt, molt to large-claw (terminal molt), or molt to a larger SC crab. There is also the question of when a legal-sized crab will actually be harvested. If soft crab are retained, they are landed at least one year earlier than if they are returned to the bottom. As a result of these uncertainties, biological advice must be based on trends, rather than accurate forecasts.

Decreases in landings, commercial CPUE and pre-recruit CPUE suggest that the large recruitment pulse that fed the fishery in the late 1980s and early 1990s has passed. The fact soft crab comprised a substantial portion of the trap catches indicates this decline is different from that of the early 1980's, when soft crab were rare

(Tremblay et al. 1994). In light of this broad picture, we address some of the current concerns in Areas 20-24 below.

Additional effort in Areas 20-24

Based on trends in CPUE, effort, incidence of soft crab, and pre-recruit CPUE, we believe increasing effort (i.e. the number of potential trap hauls per day, or number of licenses times trap limit) is ill-advised for any of Areas 20-24. CPUE in 1994 was down markedly in most Areas, and the incidence of soft crab was higher than in 1993. Total effort is near the all-time high, and it is expected that more effort would only increase the percentage of soft crab in the trap catches. Where soft crab incidence is high, methods for limiting effort to current levels or even decreasing effort should be explored. The high incidence of soft crab in the at-sea and landed catch is addressed below (see Problem of high catches of soft crab).

In 1994 we advised that any increase in effort in Areas 23 and 24 be marginal and temporary: "... no more than 10% for a fixed period of 2-3 years." Based on fishery performance this year and recent stock trends, even this marginal effort increase is questionable. In Areas 20-22 effort is already relatively high, landings never rebounded to the peak in 1979, and CPUEs have been consistently lower than Areas 23 and 24 (Tremblay et al. 1994).

Individual boat quotas (IBQs) and dock-side monitoring (DSM)

Based on the experience in Area 23, DSM appears to have had no strong effect on the distribution of fishing effort. Interviews indicate fishers did not move closer to shore than in previous years, and there was no indication of unreported landings. We suggest that fishers concerns about the confidentiality of trap location information be addressed by returning to the system whereby separate logs for trap number and location are maintained for Science.

If IBQs are introduced in other Areas, it is important that all current effort controls (season, trap limits) remain in place. This is because the IBQs must remain as "caps on landings", since it is not currently possible to provide reliable estimates of snow crab biomass for Areas 20-24. Thus IBQs cannot be set as for southern Gulf of St. Lawrence snow crab, where total biomass estimates are made from an extensive trawl survey, and the exploitable portion of the biomass is divided up among the license-holders.

Individual boat quotas in Areas 20-24 may act as another effort control if they are set low enough. In 1994 the landings of a few Area 23 fishers may have been limited by the landings cap, but most did not reach the individual boat quota of 29,478 kg (mean landings were less than 23,000 kg). IBQs should be arrived at during meetings with industry, and should be based on socio-economic factors, as well as recent trends in landings, CPUE and recruitment indices.

Problem of high catches of soft crab

The resource wastage and potential handling mortality resulting from landing soft crab is perhaps the most important unresolved management issue in Areas 20-24. Compared to the 20-50% incidence of soft crab in traps in Areas 20-24, the incidence of soft crab off western Cape Breton is much lower. From 1992-1994 the incidence of soft crab in traps in Area 18 ranged from 1-10%; in Area 19 from 2-7% (Yvon Chiasson, DFO Moncton, pers. comm.). High percentages of soft crab on the fishing grounds sometimes occur in other Regions, but the occurrence of soft crab in the landed catch is unique to Scotia-Fundy. In the Gulf Region and the Newfoundland Region there are measures in place that restrict the landing of soft-shelled crab. Scotia-Fundy has not adopted such measures, apparently because of the costs associated with monitoring, or questions about the ability to enforce regulations barring the retention of soft crab.

The problem of soft crab in the landed catch may be related to high effort. As such one solution would be to reduce effort, but it is unknown how large a reduction would be needed. More direct solutions include:

(i) Closing the fishery when the percentage of soft crab goes above a certain level. This could be based on a durometer measure of shell hardness. Monitoring could be done at sea (the Gulf approach) or in port.

(ii) Preventing the landing of any soft crab using a durometer as a legal measure (the Newfoundland approach).

(iii) Allowing industry to self-regulate by convincing buyers and fishers that landing soft crab is against their interest (as in Area 23).

The Gulf approach has the advantage of protecting future recruitment by directly reducing any mortality associated with handling soft crab at sea, but is probably the most expensive option. Monitoring the landed catch is less costly than at-sea monitoring, and would prevent the retention of soft crab. As such it would probably encourage fishers to move traps out of areas where soft crab are abundant. The Newfoundland approach requires more investigation since we are not expert in enforcement and are unsure why this measure is not applied elsewhere. Letting buyers and fishers police themselves will work in some Areas but is less workable in others due to competition among buyers and among fishers.

A pilot project should be initiated to monitor the shell hardness (with durometers) of snow crab in the landed catch of at least one Area. The data collected could be used to develop guidelines for future action (adoption of closure guidelines or possible legal measure), or to regulate the landing of soft crab during the pilot project. Discussion with all interested parties is required to decide if such a project is workable and whether there are resources to support it.

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Table 1. Landings, catch rate and effort statistics for snow crab Areas 20-24, 1978-94.

Year	No. of active boats	No. of logbooks received	Landing Statistics: Sales Slips (mt)	Landing Statistics: logbooks (mt)	Landing Statistics: Actual[1] (mt)	Mean CPUE (kg/trap haul): Standardized	Mean CPUE (kg/trap haul): All traps	Total Effort (1000's of trap hauls): Standardized	Total Effort (1000's of trap hauls): All traps
Area 20									
1978	-	0	61	0	61	0	0	0	0
1979	8	3	80	14	80	9.5	8.2	8.4	9.8
1980	8	3	34	11	34	11.4	8.3	3.0	4.1
1981	6	0	2	0	2	-	-	-	-
1982	-	0	2	0	2	-	-	-	-
1983	12	2	23	0	23	1.7	1.7	13.5	13.5
1984	2	0	10	0	10	-	-	-	-
1985	1	0	1	0	1	-	-	-	-
1986	2	1	0	0	0	1.9	1.9	-	-
1987	3	0	1	0	1	-	-	-	-
1988	4	2	17	8	17	7.0	7.9	2.4	2.2
1989	5	0	8	0	8	-	-	-	-
1990	4	2	5	2	5	5.4	5.3	0.9	0.9
1991	4	3	6	14	14	27.2	16.3	0.5	0.9
1992	3	3	7	18	18	78.3	40.6	0.2	0.4
1993	4	4	14	20	20	17.3	17.3	1.2	1.2
1994	5	4	29	24	29	11.5	11.5	2.5	2.5
Mean					19	17.1	11.9	3.3	3.6
Area 21									
1978	16	16	247	91	247	10.9	11.3	22.7	21.9
1979	27	27	243	193	243	10.6	10.7	22.9	22.7
1980	31	25	153	106	153	10.0	9.7	15.3	15.8
1981	22	1	34	1	34	13.6	13.6	2.5	2.5
1982	20	18	94	72	94	8.3	7.9	11.3	11.9
1983	27	25	48	35	48	5.5	5.1	8.7	9.4
1984	19	13	18	13	18	2.8	2.9	6.4	6.2
1985	10	7	6	10	10	3.5	3.5	2.9	2.9
1986	12	8	7	6	7	2.3	2.5	3.0	2.8
1987	21	15	56	54	56	8.1	6.4	6.9	8.8
1988	24	19	125	106	125	10.0	9.6	12.5	13.0
1989	30	27	154	133	154	25.8	13.7	6.0	11.2
1990	31	27	167	151	167	12.6	13.1	13.3	12.7
1991	29	27	157	151	157	18.7	14.9	8.4	10.5
1992	31	28	196	193	196	25.4	16.7	7.7	11.7
1993	30	28	168	151	168	16.7	14.2	10.1	11.8
1994	31	29	103	100	103	6.7	7.2	15.4	14.3
Mean					116	11.3	9.6	10.4	11.2
Area 22 - Inshore									
1978	11	10	67	195	195	28.5	19.2	6.8	10.2
1979	18	18	97	139	139	42.3	20.1	3.3	6.9
1980	14	14	92	63	92	15.7	12.6	5.9	7.3
1981	11	3	50	7	50	21.3	12.5	2.3	4.0
1982	10	8	31	24	31	13.8	8.1	2.2	3.8
1983	14	14	1	15	15	5.9	4.5	2.5	3.3
1984	3	3	0	3	3	4.1	3.5	0.7	0.9
1985	8	7	0	3	3	6.2	6.3	0.5	0.5
1986	4	3	3	11	11	6.0	6.0	1.8	1.8
1987	13	12	34	33	34	9.2	8.1	3.7	4.2
1988	21	16	54	69	69	9.6	8.0	7.2	8.6
1989	19	14	67	58	67	17.1	13.4	3.9	5.0
1990	20	16	67	59	67	11.9	9.8	5.6	6.8
1991	16	15	115	120	120	21.6	16.9	5.6	7.1
1992	19	12	125	92	125	19.1	19.1	6.5	6.5
1993	20	14	95	87	95	12.4	13.0	7.7	7.3
1994	16	11	66	51	66	8.3	7.6	8.0	8.7
Mean					70	14.9	11.1	4.4	5.5

Table 1 cont'd.

Year	No. of active boats	No. of logbooks received	Landing Statistics: Sales Slips (mt)	Landing Statistics: logbooks (mt)	Actual[1] (mt)	Mean CPUE (kg/trap haul): Standardized	Mean CPUE (kg/trap haul): All traps	Total Effort (1000's of trap hauls): Standardized	Total Effort (1000's of trap hauls): All traps
Area 20-22 - Inshore									
1978	27	26	375	286	375	10.8	15.7	34.7	23.9
1979	53	48	420	346	420	10.2	12.9	41.2	32.6
1980	53	42	279	180	279	10.0	10.4	27.9	26.8
1981	39	4	86	7	86	13.6	12.6	6.3	6.8
1982	30	26	127	96	127	8.3	8.0	15.3	15.9
1983	53	41	72	51	72	5.2	4.9	13.8	14.7
1984	24	16	28	16	28	2.9	3.0	9.7	9.3
1985	19	14	8	13	13	1.9	3.9	6.8	3.3
1986	18	12	9	17	17	3.1	3.9	5.5	4.4
1987	37	27	90	87	90	6.1	6.9	14.8	13.0
1988	49	37	195	182	195	9.1	8.9	21.4	21.9
1989	54	41	229	192	229	12.3	13.6	18.6	16.8
1990	55	45	239	212	239	11.8	11.8	20.3	20.3
1991	49	45	277	286	286	15.0	15.8	19.1	18.1
1992	53	43	328	304	328	15.1	18.3	21.7	17.9
1993	54	46	277	258	277	13.2	14.0	21.0	19.8
1994	57	44	197	175	197	6.7	8.0	29.4	24.6
Mean					192	9.1	10.2	19.3	17.1
Area 22 - Offshore									
1978	4	4	146	111	146	121.2	90.2	1.2	1.6
1979	17	17	545	449	545	50.1	50.1	10.9	10.9
1980	12	10	135	87	135	39.1	39.1	3.5	3.5
1981	-	-	-	-	-	-	-	-	-
1982	11	6	122	92	122	30.2	30.2	4.0	4.0
1983	12	7	37	26	37	13.4	13.4	2.8	2.8
1984	4	4	15	13	15	13.4	12.8	1.1	1.2
1985	0	0	0	0	0	0	0	0	0
1986	1	0	7	0	7	-	-	-	-
1987	3	2	29	21	29	16.4	16.4	1.8	1.8
1988	8	6	34	45	45	19.0	18.6	2.4	2.4
1989	7	6	24	26	26	20.3	21.0	1.3	1.2
1990	6	5	52	45	52	21.0	18.3	5.6	6.4
1991	8	8	47	63	63	23.6	22.5	2.7	2.8
1992	8	3	115	61	115	37.5	33.4	3.1	3.4
1993	20	13	295	181	295	25.1	26.1	11.8	11.3
1994	22	15	181	140	181	15.4	14.7	11.8	12.3
Mean					121	31.8	29.1	4.6	4.7
Area 23 - Inshore									
1978	15	15	276	347	347	62.3	51.5	5.6	6.7
1979	24	18	462	454	462	39.7	38.6	11.6	12.0
1980	24	14	289	266	289	39.4	36.0	7.3	8.0
1981	11	7	50	67	67	25.0	22.9	2.7	2.9
1982	19	13	175	183	183	31.4	26.7	5.8	6.9
1983	21	18	73	92	92	17.8	15.3	5.2	6.0
1984	10	5	21	30	30	14.5	15.7	2.1	1.9
1985	5	5	4	28	28	11.0	14.7	2.5	1.9
1986	6	6	21	49	49	11.5	14.4	4.3	3.4
1987	13	10	146	125	146	25.9	26.1	5.6	5.6
1988	17	15	159	136	159	20.4	22.1	7.8	7.2
1989	18	17	69	138	138	22.9	22.6	6.0	6.1
1990	12	12	105	176	176	29.9	28.7	5.9	6.1
1991	10	10	192	202	202	35.7	34.4	5.7	5.9
1992	9	7	226	170	226	44.5	40.4	5.1	5.6
1993	11	6	349	168	349	55.8	49.1	6.3	7.1
1994	16	16	194	193	194	31.0	29.5	6.3	6.6
Mean					185	30.5	28.8	5.6	5.9

Table 1 cont'd.

Year	No. of active boats	No. of logbooks received	Landing Statistics: Sales Slips (mt)	Landing Statistics: logbooks (mt)	Actual[1] (mt)	Mean CPUE (kg/trap haul): Standardized	Mean CPUE (kg/trap haul): All traps	Total Effort (1000's of trap hauls): Standardized	Total Effort (1000's of trap hauls): All traps
Area 23 - Offshore									
1979	-	4	146	144	146	72.7	72.7	2.0	2.0
1980	-	7	54	50	54	69.0	69.0	0.8	0.8
1981	-	3	11	15	15	65.9	65.9	0.2	0.2
1982	-	10	67	70	70	36.2	36.2	1.9	1.9
1983	-	8	22	27	27	23.2	23.2	1.2	1.2
1984	-	2	8	11	11	33.7	33.7	0.3	0.3
1985	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0
1987	1	1	11	11	11	25.9	25.9	0.4	0.4
1988	4	3	48	27	48	44.0	44.0	1.1	1.1
1989	7	6	45	105	105	41.4	41.4	2.5	2.5
1990	15	12	203	210	210	46.8	46.8	4.5	4.5
1991	13	12	328	316	326	55.8	55.8	5.9	5.9
1992	13	11	369	327	369	57.0	57.0	6.4	6.4
1993	14	10	421	244	421	57.0	57.0	7.4	7.4
1994	16	16	303	303	303	37.5	36.4	8.1	8.3
Mean					151	47.6	47.5	3.1	3.1
Area 24 - Inshore									
1978	-		4	-		-			
1979	4	4	61	32	61	14.8	14.8	4.1	4.1
1980	10	10	62	70	70	12.8	12.8	5.5	5.5
1981	5	5	9	21	21	15.8	15.8	1.3	1.3
1982	7	7	56	62	62	10.1	10.1	6.1	6.1
1983	13	11	7	64	64	8.6	8.4	7.5	7.6
1984	13	12	52	47	52	9.2	9.2	5.6	5.6
1985	6	5	35	32	35	10.2	10.2	3.4	3.4
1986	7	5	46	49	49	11.9	11.9	4.1	4.1
1987	11	9	84	77	84	12.9	12.9	6.5	6.5
1988	12	12	105	120	120	13.4	13.4	9.0	8.9
1989	12	11	160	116	160	16.7	16.7	9.6	9.6
1990	11	10	292	259	292	27.3	27.3	10.7	10.7
1991	10	6	353	222	353	35.6	35.6	9.9	9.9
1992	11	6	430	251	430	38.6	38.6	11.1	11.1
1993	10	10	364	362	364	30.8	30.8	11.8	11.8
1994	12	12	304	307	307	28.6	28.6	10.7	10.7
Mean					149	18.6	18.6	7.3	7.3
Area 24 - Offshore									
1988	1	1	41	43	43	29.2	29.2	1.5	1.5
1989	2	2	12	20	20	16.2	16.2	1.2	1.2
1990	4	4	138	145	145	40.4	40.4	3.6	3.6
1991	4	3	119	106	119	40.8	40.8	2.9	2.9
1992	4	2	108	56	108	31.5	31.5	3.4	3.4
1993	4	2	136	74	136	46.1	46.1	3.0	3.0
1994	4	4	125	139	139	35.7	35.7	3.9	3.9
Mean					101	34.3	34.3	2.8	2.8
Area 24 Exploratory Area									
1989	4	4	21	19	21	24.1	24.1	0.9	0.9
1990	4	4	108	105	106	54.5	54.5	2.0	2.0
1991	7	7	196	210	210	48.0	49.8	4.4	4.2
1992	7	6	205	186	205	43.0	43.0	4.8	4.8
1993	7	5	162	123	162	32.0	32.0	5.1	5.1
1994	7	5	211	186	211	44.3	42.3	4.8	5.0
Mean					153	41.0	41.0	3.7	3.7

Areas 20-24 Total

Year	No. of active boats	No. of logbooks received	Landing Statistics: Sales slips (mt)	Landing Statistics: logbooks (mt)	Landing Statistics: Actual[1] (mt)	Total mean CPUE	Total Effort (1000's of trap hauls)
1978	42	42	801	748	801	28.4	28.2
1979	98	89	1,634	1,425	1,634	28.7	56.9
1980	99	81	819	652	819	19.8	41.4
1981	55	19	156	110	156	21.8	7.2
1982	67	56	554	503	554	16.7	33.2
1983	97	80	239	259	259	9.6	27.0
1984	51	38	124	105	124	8.6	14.4
1985	29	24	89	73	89	8.7	10.2
1986	29	23	120	115	120	10.2	11.8
1987	61	49	361	321	361	12.6	28.7
1988	88	74	596	552	596	14.6	40.8
1989	100	85	571	616	616	18.7	32.9
1990	102	87	1,144	1,152	1,152	25.4	45.4
1991	101	91	1,533	1,404	1,533	30.9	49.6
1992	104	77	1,797	1,354	1,797	32.5	55.3
1993	113	85	2,016	1,408	2,016	28.1	71.7
1994	117	83	1,515	1,443	1,515	21.8	69.5
Mean					832	19.8	36.7

[1] Actual landings were the higher of the 2 estimates (sales slips and logbooks) for each year.

Table 2. Summary of commercial catch samples in 1994. Sample types are at-sea (S) and in port (P). S-leg is the legal portion of a sea sample. SC is small-clawed. Sampling ports were Neil's Harbour (NH), Little River (LR), Glace Bay (GB), Louisbourg (LOU), L'Ardoise (L'ARD) and Canso (CAN).

Date	Area	Port	Grounds	Sample type	N males	Mean CW	% in shell stage: I	II	III	IV	% SC
July 27	21	NH	Inshore	S	374	108.9	26	14	57	3	16
				S-leg	311	113.1	24	12	63	1	
Aug 1-25	22	LR	Inshore	S	1867	105.7	53	5	41	1	21
				S-leg	1423	111.7	51	5	43	1	
Aug 5-27	22	GB	Offshore	P	993	110.3	21	59	15	4	12
Aug 3-20	23	LOU	Inshore	S	1313	105.8	41	26	27	7	17
				S-leg	945	114.1	42	25	30	3	
Sep 3-15	23	LOU	Inshore	S	1255	111.4	50	14	28	7	19
				S-leg	998	118.2	49	15	32	4	16
Aug 8-24	23	LOU	Inshore	P	671	112.7	9	39	46	6	5
Aug 8-24	23	LOU	Offshore	P	606	112.1	6	29	56	9	2
Aug 9-30	24	L'ARD	Inshore	P	561	124.7	7	42	49	2	4
Aug 2-Sep8	24	CAN	Offshore	P	241	110.6	26	6	58	10	27

Table 3. Percentage of soft crab (Stage 1) and small-clawed crab in sea samples from Neils Harbour (Area 21) from 1988 to 1994.

	Tot N	Mean CW (mm)		N (%) by shell condition and claw size	
Date	males	All	legal	Soft	Small-clawed
Jul 27/94	374	108.9	113.1	98 (26)	60 (16)
Aug 4/93	215	111.4	115.0	13 (6)	14 (7)
Jul 29/92	413	103.5	109.7	57 (14)	216 (52)
Aug 14/91	352	105.6	107.5	190 (54)	175 (50)
Jul 26/90	399	101.2	106.3	262 (66)	215 (54)
Aug 9/89	337	109.1	112.7	80 (24)	79 (23)
Aug 25/88	365	91.0	103.7	126 (35)	118 (32)

Table 4. Pre-recruit index for sea samples from Neils Harbour from 1988 to 1994. 78-94 is CW in mm; SC is small-clawed. Commercial CPUE (kg/trap) is from day of sea sample. Weights were estimated from sea sample CW using width-weight regression in Taylor and Warren (1989).

	N (%) by CW and chela size		Estimated wt (kg) in sea sample		Commercial CPUE	Pre-recruit CPUE
Date	78-94	78-94/SC	≥ 95	78-94/SC	≥ 95	78-94/SC
Jul 27/94	59 (16)	20 (5)	194.4	6.6	12.0	0.4
Aug 4/93	24 (11)	4 (2)	123.1	1.3	24.4	0.3
Jul 29/92	113 (27)	98 (24)	165.2	27.1	30.1	4.9
Aug 14/91	40 (11)	31 (9)	164.4	9.1	13.2	0.7
Jul 26/90	115 (29)	94 (24)	142.7	26.1	16.6	3.1
Aug 9/89	48 (14)	36 (11)	174.0	8.3	12.1	0.6
Aug 25/88	212 (58)	83 (23)	53.5	23.3	1.1	0.5

Table 5. Percentage of soft crab (Stage 1) and small-clawed crab in sea samples from Louisbourg (Area 23) from 1986 to 1994.

Date	Tot N males	Mean CW (mm) All	Mean CW (mm) legal	N (%) by shell condition and claw size: Soft	Small-clawed
Aug 3-20/94	1313	105.8	114.1	537 (41)	224 (17)
Jul 27/93	363	113.0	116.5	79 (22)	68 (19)
Aug 6/92	210	109.2	115.4	14 (7)	19 (9)
Aug 22/91	196	101.4	108.3	53 (27)	64 (33)
Jul 27/90	158	102.1	110.6	21 (13)	17 (11)
Aug 2/89	411	97.3	106.2	208 (51)	193 (47)
Aug 10-23/88	932	97.3	108.2	365 (39)	359 (39)
Aug 6-22/87	363	94.7	107.8	1 (0)	92 (25)
Aug 6-27/86	1296	100.3	109.2	181 (14)	419 (32)

Table 6. Pre-recruit index for sea samples from Louisbourg from 1986 to 1994. 78-94 is CW in mm; SC is small-clawed. Commercial CPUE (kg/trap) is from day(s) of sea sample. Weights were estimated from sea sample CW using width-weight regression in Taylor and Warren (1989). Pre-recruit CPUE is Wt 78-94/SC + Wt ≥ 95 * Commercial CPUE.

Date	N (%) by CW and chela size: 78-94	78-94/SC	Estimated Wt (kg) in sea sample: ≥ 95	78-94/SC	Commercial CPUE ≥ 95	Pre-recruit CPUE 78-94/SC
Aug 3-20/94	298 (23)	76 (6)	610.3	19.7	23.6	0.8
Jul 27/93	30 (8)	11 (3)	221.3	3.0	48.3	0.7
Aug 6/92	45 (21)	5 (2)	108.4	1.6	26.8	0.4
Aug 22/91	45 (23)	13 (7)	75.2	3.5	24.8	1.2
Jul 27/90	51 (32)	6 (4)	34.3	1.7	25.6	1.2
Aug 2/89	151 (37)	66 (16)	95.4	17.7	21.1	3.9
Aug 10-23/88	353 (38)	157 (17)	275.4	41.9	23.9	3.6
Aug 6-22/87	160 (44)	40 (11)	86.9	10.4	32.4	3.9
Aug 6-27/86	422 (33)	161 (12)	454.6	41.3	16.2	1.5

Table 7. Sensitivity of calculation of pre-recruit index for Area 23 to (i) value used for CPUE, and (ii) the fact that the estimated weight of legal sized crab in sea samples includes soft crab that have not all been landed in recent years. Data are as in Table 6. Pre-recruit CPUE' (kg/trap) is calculated in the same manner as Pre-recruit CPUE (Table 6) except that seasonal mean CPUE is used instead of CPUE on day(s) of sea sample. Soft Crab Return is an estimate of the percentage of the legal-sized catch that was returned at sea assuming the landed catch was 8% soft crab (approximate level in 1994 - see Table 2). Pre-recruit CPUE" accounts for this selection against soft crab by using an estimate of what the CPUE on the day(s) of the sea sample (Table 6) would have been if this soft crab was landed.

Date	Seasonal mean CPUE ≥ 95	Pre-recruit CPUE' 78-94/SC	Soft Crab Return (%)	Pre-recruit CPUE" 78-94/SC
Aug 3-20/94	31.0	1.0	33%	1.0
Jul 27/93	55.8	0.8	14%	0.7
Aug 6/92	44.5	0.6	0%	0.4
Aug 22/91	35.7	1.7	19%	1.4
Jul 27/90	29.9	1.4	5%	1.3
Aug 2/89	22.9	4.2	43%	5.6
Aug 10-23/88	20.4	3.1	31%	4.8
Aug 6-22/87	25.9	3.1	0%	3.9
Aug 6-27/86	11.5	1.0	6%	1.6

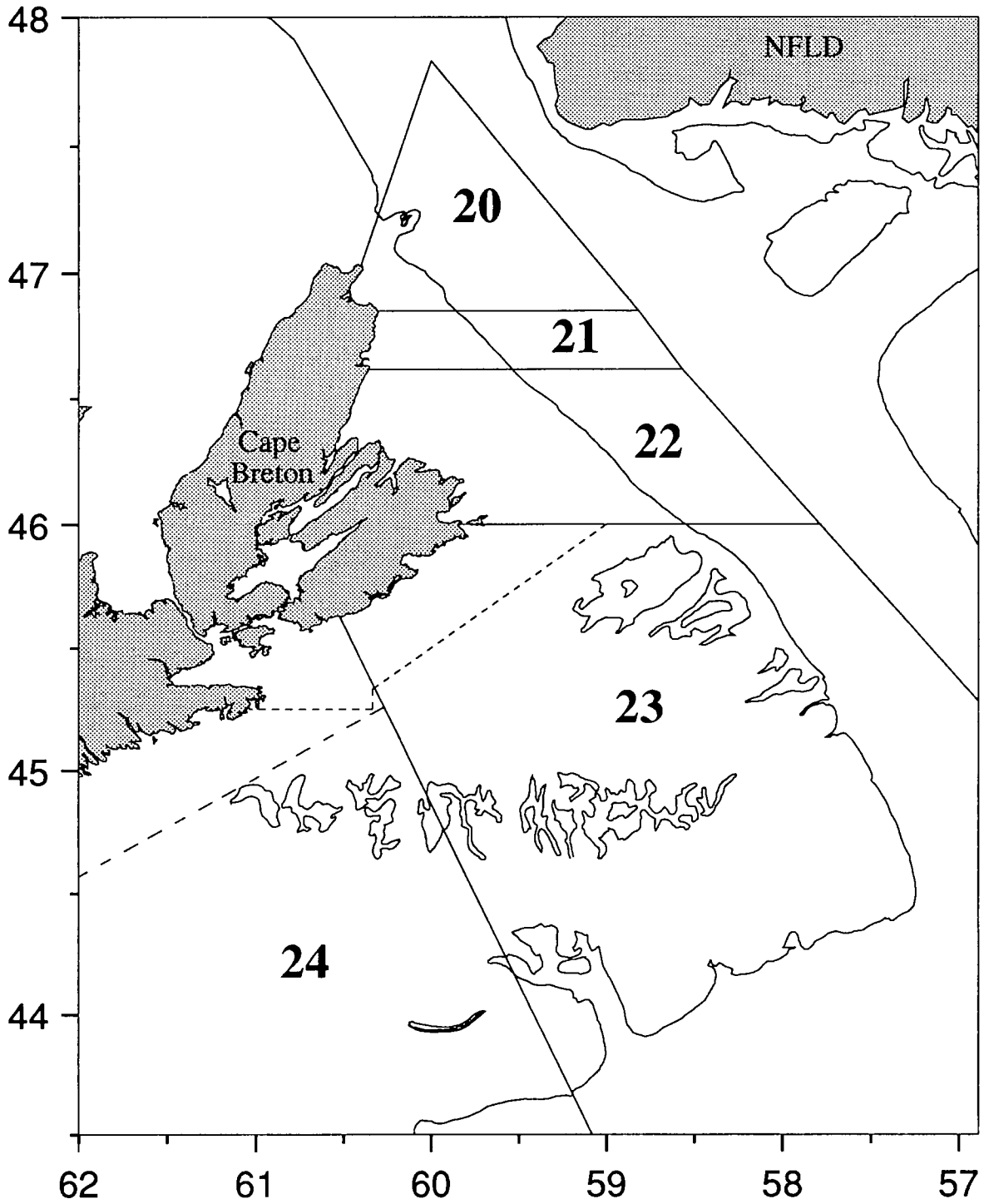

Figure 1. Snow crab Areas off eastern (Areas 20-24) and western (Areas 18-19) Cape Breton.

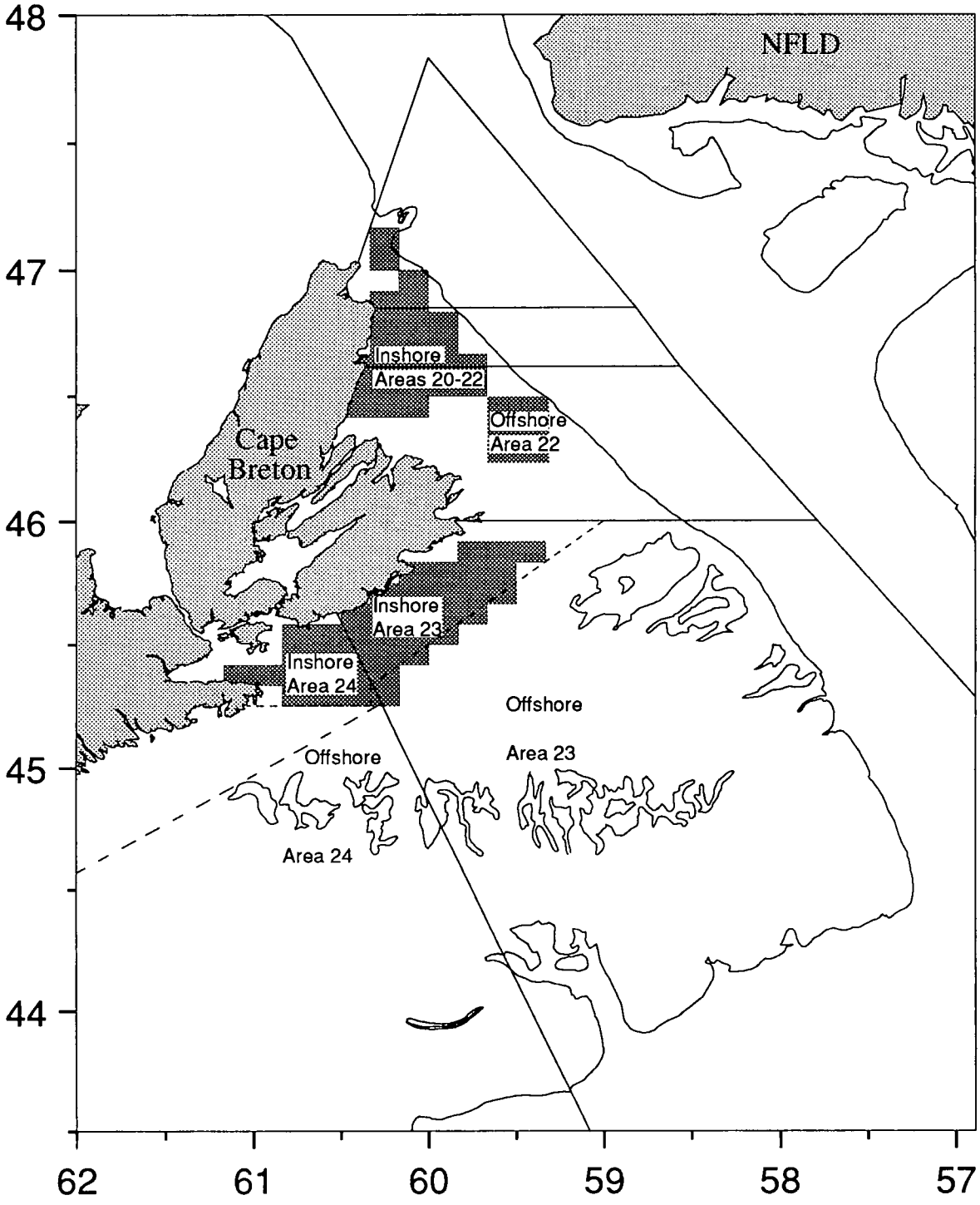

Figure 2. Eastern Cape Breton fishing Areas showing inshore and offshore grounds used for assessment purposes. Shaded areas show where most fishing occurs in Areas 20-22 and the inshore grounds of Areas 23 and 24. Fishing location in offshore grounds of Areas 23 and 24 is more variable.

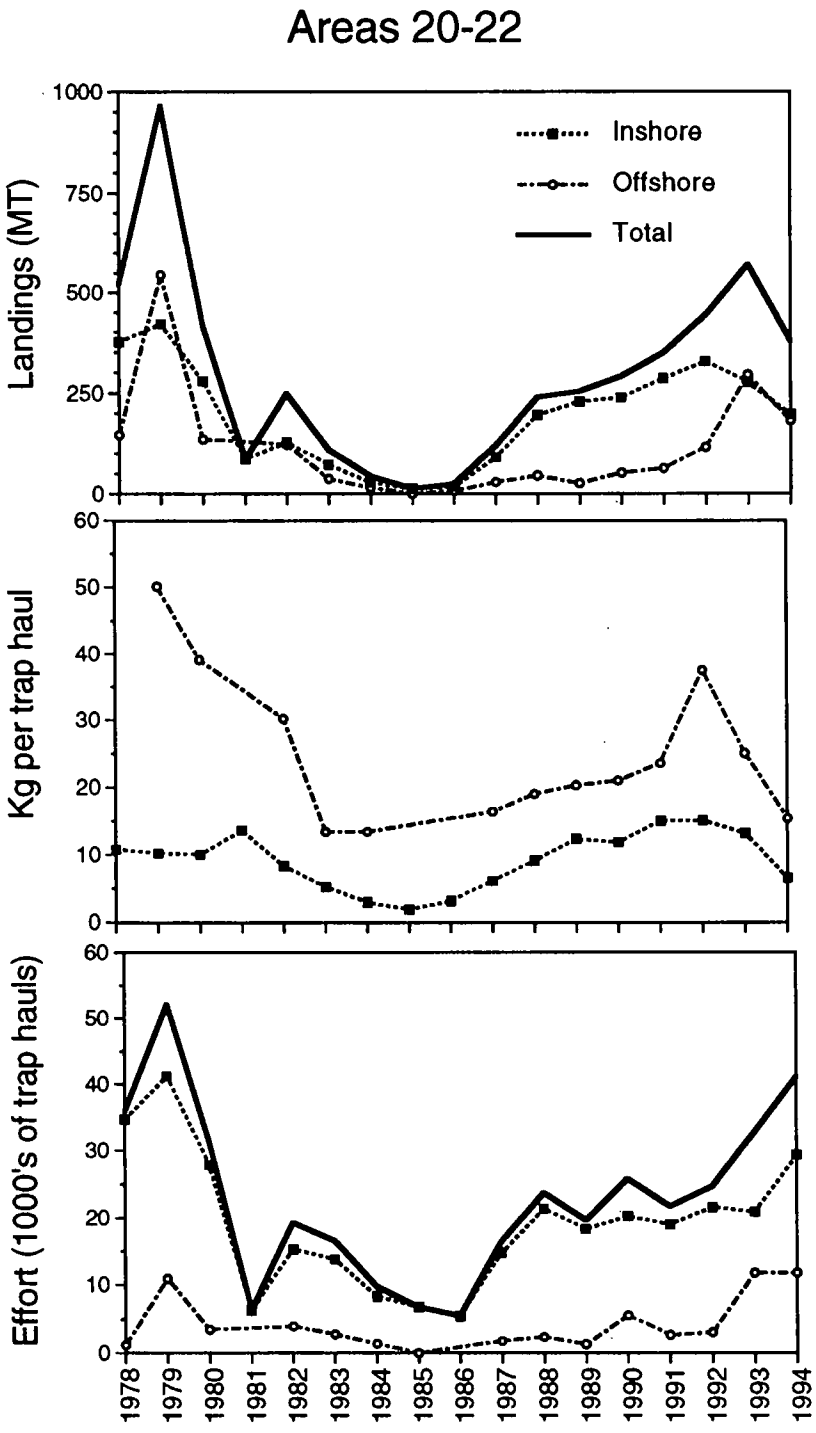

Figure 3. Historical landings, catch rate and effort in Areas 20-22.

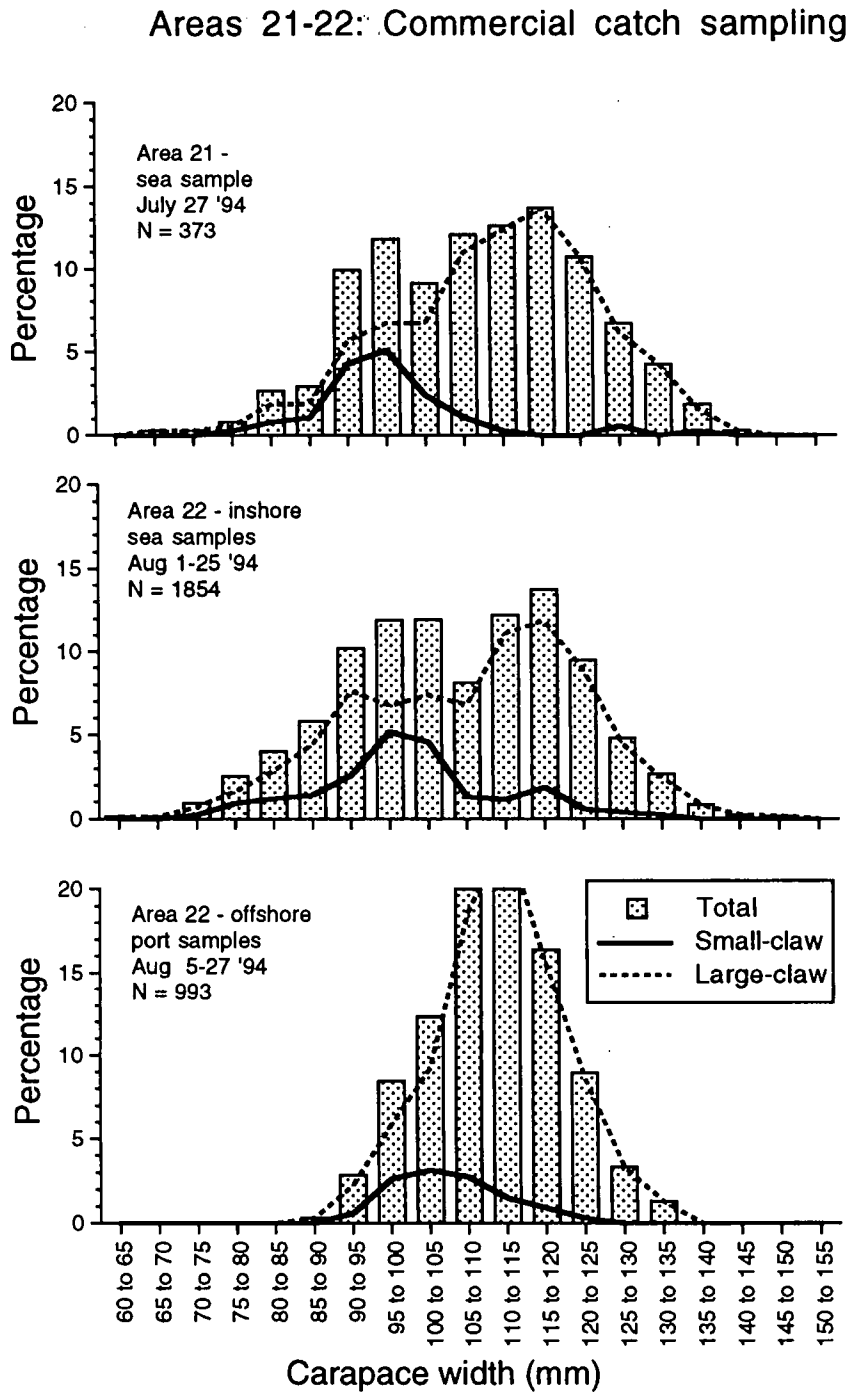

Figure 4. Width-frequency plots of snow crab measured during sampling of the commercial catch in Areas 20-22.

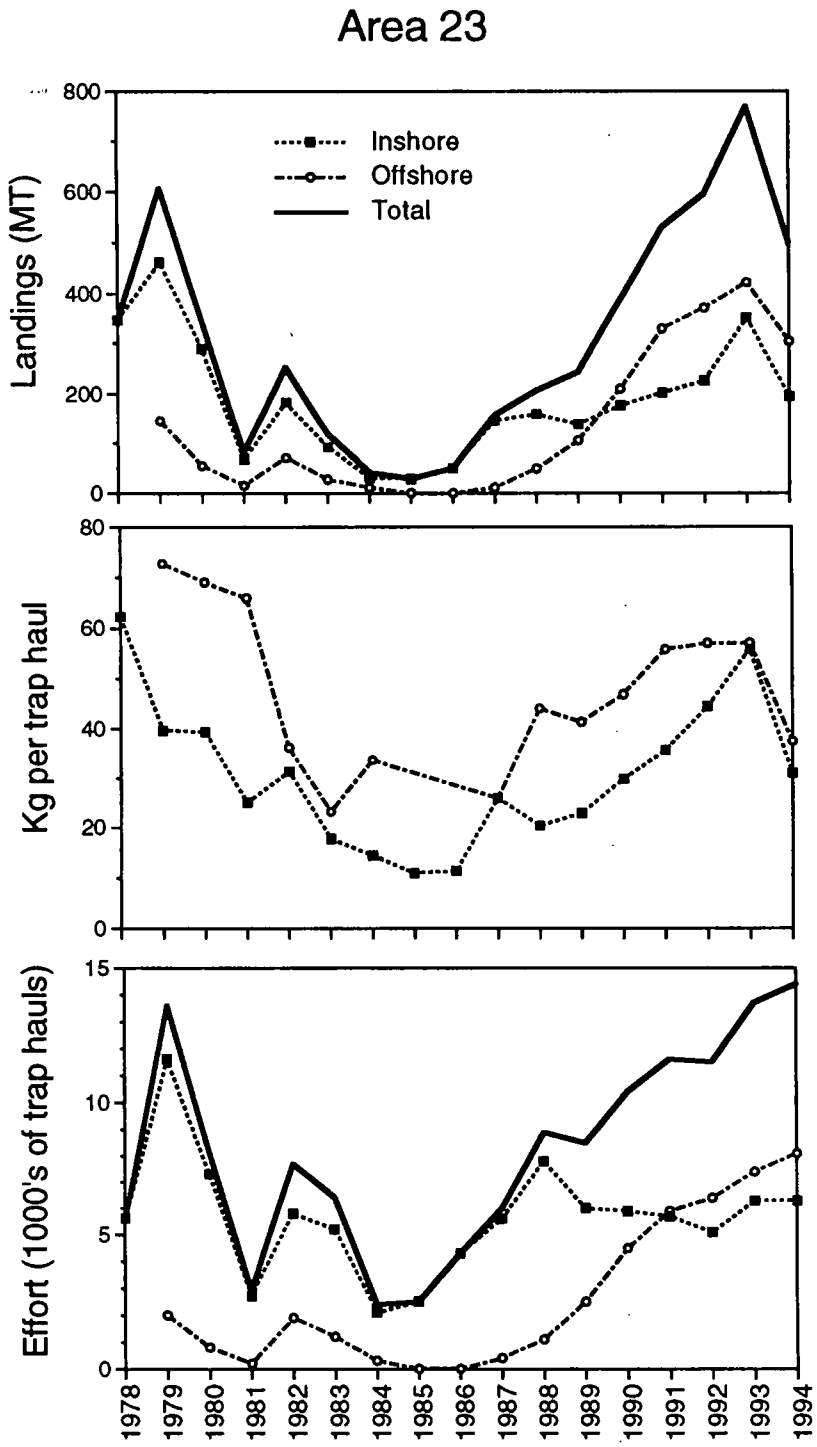

Figure 5. Historical landings, catch rate and effort in Area 23.

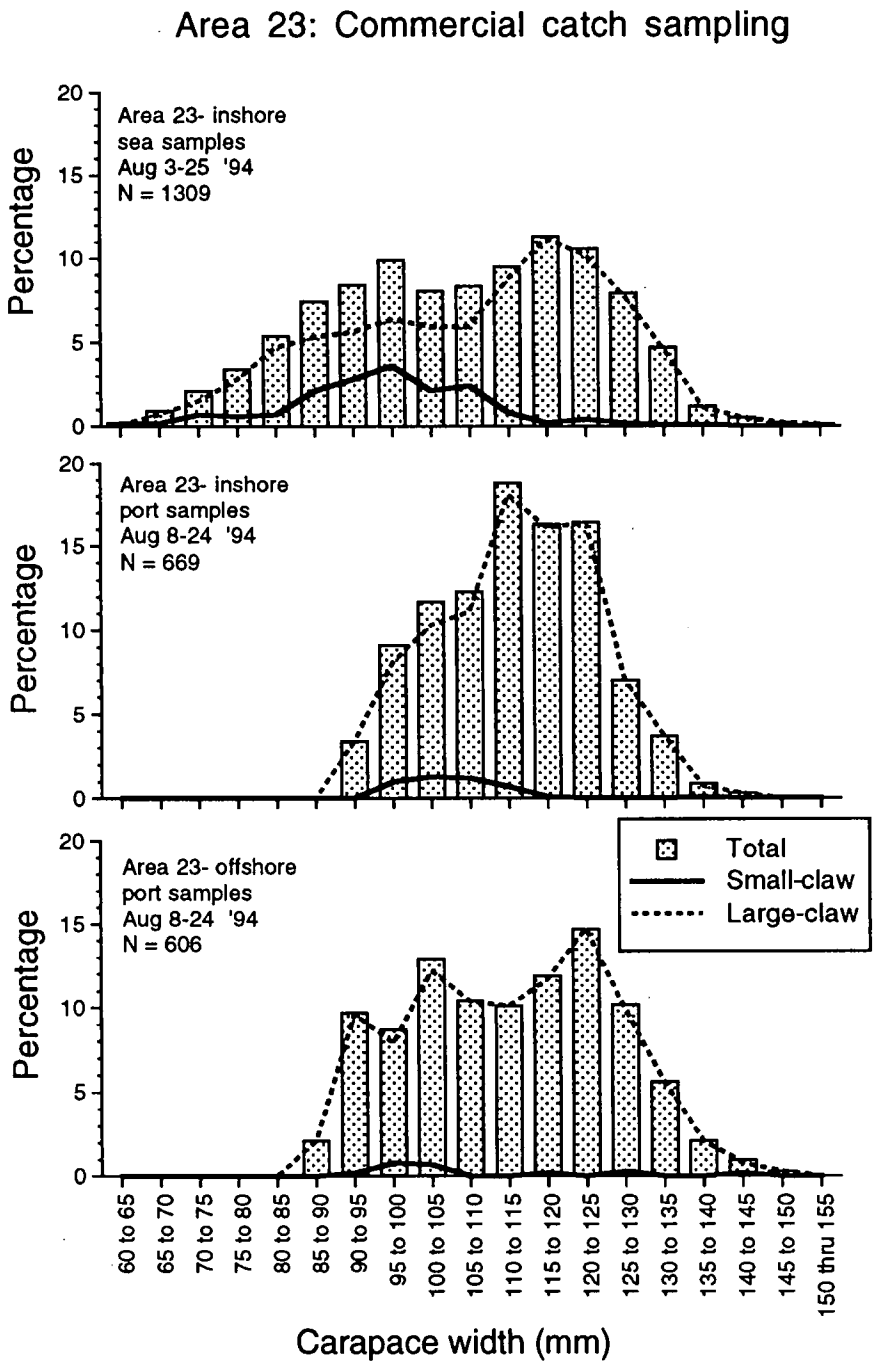

Figure 6. Width-frequency plots of snow crab measured during sampling of the commercial catch in Area 23.

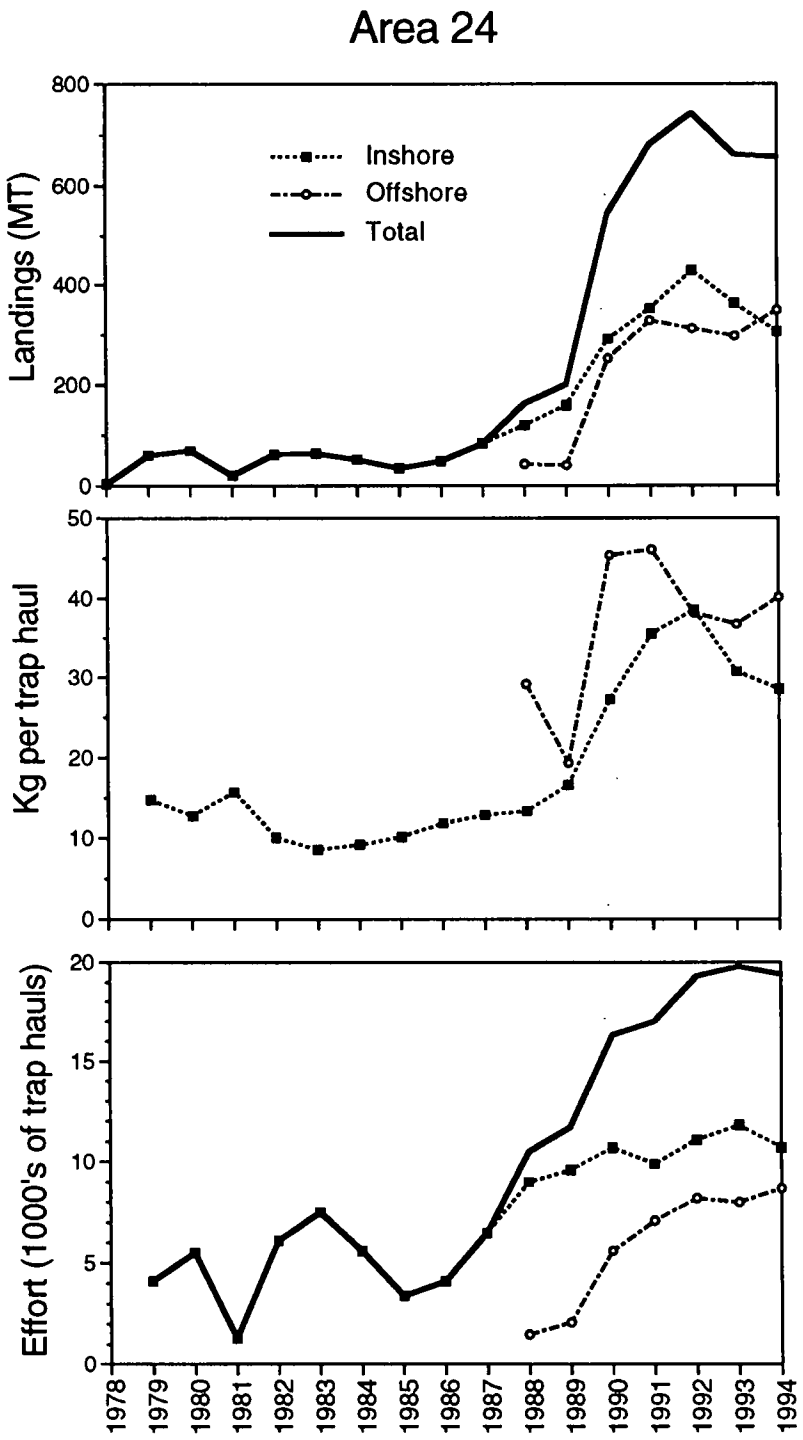

Figure 7. Historical landings, catch rate and effort in Area 24.

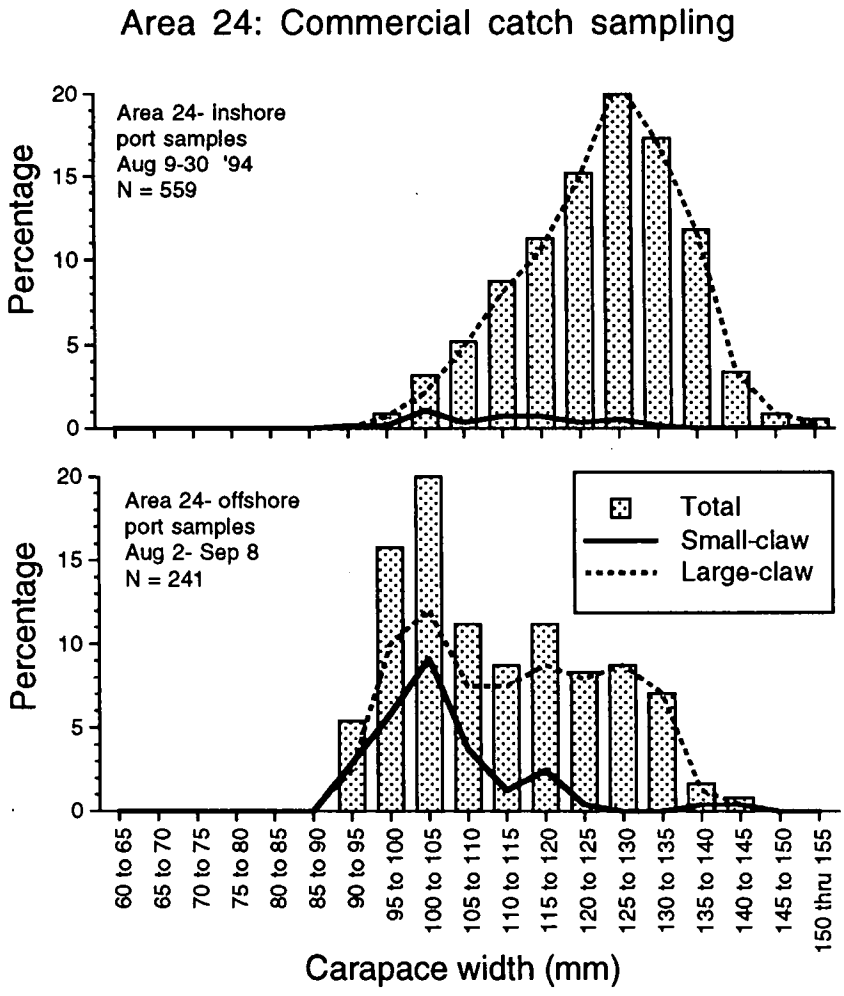

Figure 8. Width-frequency plots of snow crab measured during sampling of the commercial catch in Area 24.