



## Eastern Nova Scotia Snow Crab

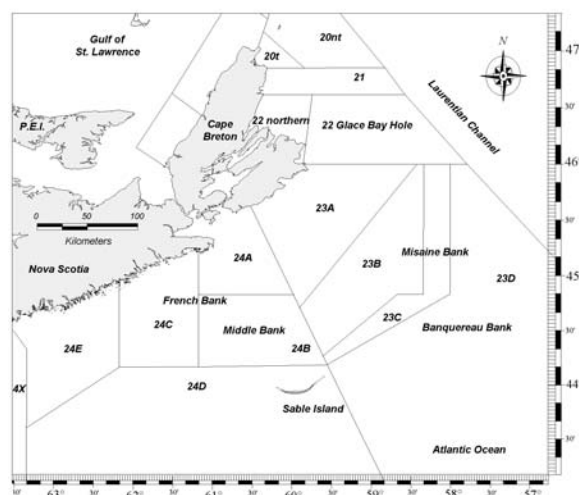
### Background

Snow crab (*Chionoecetes opilio*) are crustaceans like lobster and shrimp, with a flat, almost circular, body and five pairs of spider-like legs. The hard outer shell is periodically shed in a process called moulting. After moulting, crabs have a soft shell for a period of time. Unlike lobsters, male and female snow crab do not continue to moult throughout their lives. Females stop growing after the moult in which they acquire a wider abdomen for carrying eggs. This occurs at shell widths less than 95 mm. Male snow crab stops growing after the moult in which they acquire relatively large claws on the first pair of legs. This can occur at shell widths as small as 40 mm. Female crabs produce eggs that are carried beneath the abdomen for approximately 2 years. The eggs hatch in late spring or early summer and the tiny newly hatched crab larvae spend 12-15 weeks free floating in the water. At the end of this period, they settle on the bottom. It then takes at least 8-9 years for snow crab males to reach legal size.

The minimum legal shell width is 95 mm, and female crabs are not kept by industry. Soft-shelled crab is defined by shell hardness of the right claw (<68 durometer units). The term "white crab" describes both new-soft and clean hard-shelled crab (carapace conditions 1 and 2 respectively). Fishing is by baited square or conical traps constructed of wire or tubular steel and netting. The traps are set on muddy or sand-mud bottoms at temperatures ranging from 50 to 280m.

Since 1999, stock status is evaluated based on an annual trawl survey, which began in 1997. The size frequency distributions showed a substantial decrease in future recruitment categories from 1997 to 2000, while the commercially exploitable category remained stable. Trends in CPUE in all CFAs during the same period did not suggest any sign of stock decline.

Management areas in ENS do not reflect biological distribution of the resource, and using them as a reference point to present the trawl survey results compromise the reliability of the biomass estimates. Therefore trawl survey results are shown based on biological units only: northern ENS, comprised of areas 20, 21 and 22, and southern ENS, comprised of areas 23 and 24.



### Summary

- During the 2001 fishing season, the catch was 9,917t. Overall, catch rates have increased in CFA 20 (64.8 kg/th), CFA 21 (93.4 kg/th), CFA 22 (105.1 kg/th) and CFA 24 (96.2 kg/th), while CFA 23 (82.6 kg/th) had comparable results to 2000.
- In the northern portion of ENS, a new trawl survey was conducted in September and biomass of commercial-sized crab was estimated at 3,920t for 2002.
- In the southern portion of ENS, biomass estimate of commercial-sized male crabs available to the 2002 fishery would be 24,300t.
- Size frequencies from trawl survey indicate a decrease in recruitment for future years.
- Bottom temperatures fell in 2001 making them more favorable for crab compared to conditions observed during the previous 2 years.
- Biomass of fishable crab is expected to decline in the future.

### *The Fishery*

Harvesting of snow crab off the coast of eastern Nova Scotia (ENS) began in the late 1970s. Landings rose to a peak of 1,634t in 1979. Landings and catch-per-unit-effort (CPUE) then collapsed and by 1985 this fishery was believed to be near commercial extinction. A pulse of pre-recruits entered the commercial catches of snow crab in all Crab Fishing Areas (CFAs) in 1986, and landings rose from 1987 to 1993 when peak levels were reached at 2,016t. In 1994, total landings declined by 23% and remained stable at that level until 1996. Afterward, landings increased steadily to reach 3,599t in 1999.

From 1982 to 1993, the management of these fisheries was based strictly on effort controls (seasons, licenses and trap limits). Substantial changes to management measures were introduced in each CFA from 1994 to 2000; individual boat quotas (IBQ) or individual transferable quotas (ITQ) were imposed in all CFAs; 100% dockside monitoring; a mandatory logbook for both dockside monitoring and the scientific data base; landings not more than 0-10% soft-shell crabs; at-sea monitoring by certified observers; a biodegradable panel on traps to prevent ghost fishing; the introduction of sub-areas in 1998 to ensure the distribution of the fishing effort; and the number of traps allowed was increased from 30 to 40 in CFA 24 in 1999, and from 30 to 45 in CFA 23 in 2000. In CFA 22, an industry-designed separation of the fleet (since 1996) into northern and outer areas was incorporated into the management plan (with a separate TAC designed for each area), and fishermen were supposed to fish in only one area. In 2000, TAC increased to 118t in CFA 20, to 363t in CFA 21, to 318t in 'CFA 22 northern' (while remaining the same at 216t in 'CFA 22 outer'), to 4,425t in CFA 23;

and to 4,374t in CFA 24. Existing allocations for temporary fishermen increased from 50t in CFA 20, to 2,683t in CFA 23, and to 2,686t in CFA 24. There were no changes in the number of permanent licenses in all CFAs, but the number of temporary permit holders increased from 4 in 1999 to 5 in 2000 in CFA 20, from 13 to 53 in CFA 23, and from 22 to 56 in CFA 24.

There were no changes in the management Areas and sub-areas in ENS in 2001 compared to 2000. In 2001, the fishing season in CFAs 23 and 24 started July 1<sup>st</sup> (June 1<sup>st</sup> in 2000) in all sub-areas, except 23D and 24D which remained June 1<sup>st</sup> as in 2000.

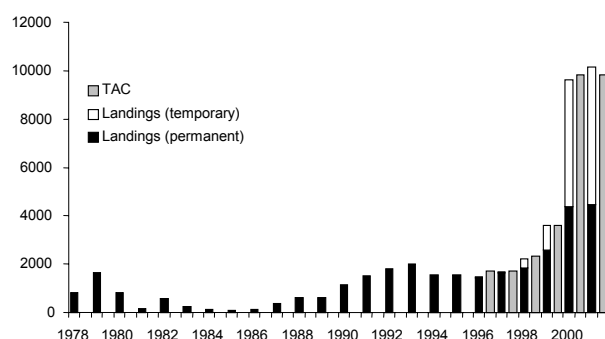
Landings, catch rate (kg/trap haul), fishing effort (total # of th) and fishing locations were derived from the mandatory logbooks completed by all fishermen for both dockside monitoring and the scientific database.

In northern ENS, there was no change in the TAC of CFA 20 (118t), CFA 21 (363t) and CFA 22 northern (318t) compared to 2000, but there was a 50t increase in CFA 22 outer (from 217t to 267t). In southern ENS, there was an overall increase in TAC from 8,799t in 2000 to 8,823t in 2001. A breakdown by area showed an increase in TAC from 4,425t in 2000 to 4,760t in 2001 in CFA 23, but a decrease from 4,374t to 4,062 in CFA 24. In each of CFAs 23 and 24, 100t of 'new allocation' was given to 3 exploratory permits to conduct a trap survey along the slope of the Scotian Shelf.

**Permanent and Temporary Allocations.**

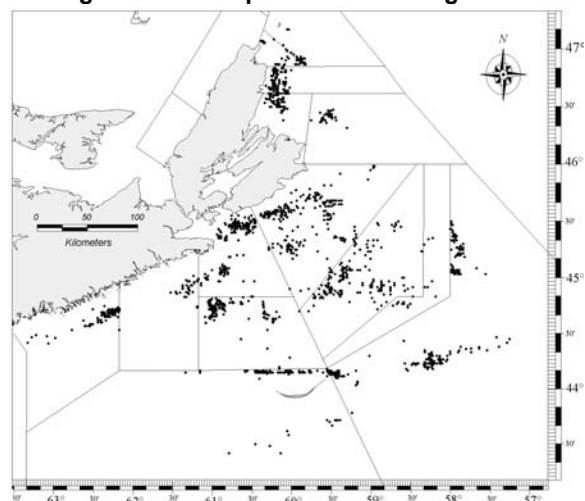
CFA	Permanent		temporary	
	allocations (t)	licences	Allocations (t)	licences
20	68	5	50	6
21	363	32	-	-
22(northern)	318	20	-	-
22(outer)	267	17	-	-
23	1,776	24	3,085	61
24	1,656	23	2,506	59

The overall TAC for ENS in 2001 was 9,848t (excluding slope surveys) compared to 9,814t in 2000. Total reported **landings** in 2001 were 9,917t. There was a 16% decrease in total fishing effort compared to 2000.

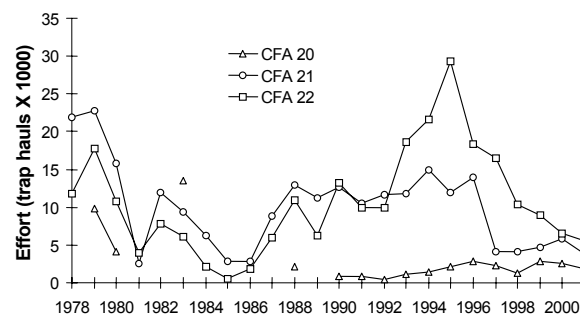
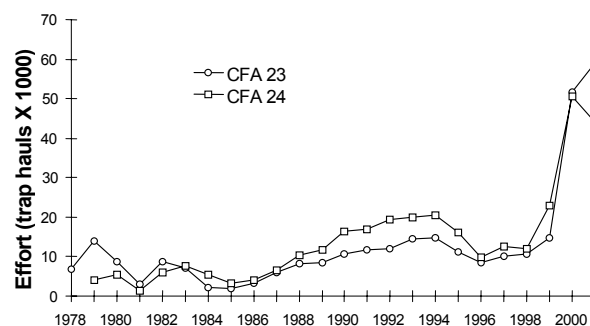
**Landings (t)****Landings (t) in Eastern Nova Scotia.**

CFA	Average 1990-94	Average 1995-99	1999	2000	2001
20	17	55	90	118	117
21	159	178	291	364	363
22	238	346	518	535	586
23	555	768	1,300	4,401	4,805
24	662	762	1,400	4,300	4,043
<b>Total</b>	<b>1,631</b>	<b>2,109</b>	<b>3,599</b>	<b>9,718</b>	<b>9,917</b>

An agreement between snow crab and shrimp fishermen concerning the sharing of mutual fishing grounds resulted in the closure for 3 weeks of some prime fishing areas.

**Fishing Positions Reported in 2001 Logbooks**

The reported **fishing effort** was lower in CFA 20 (-30%), CFA 21 (-34%), CFA 22 (-18%) and CFA 24 (-12%), and higher in CFA 23 (14%) compared to 2000.

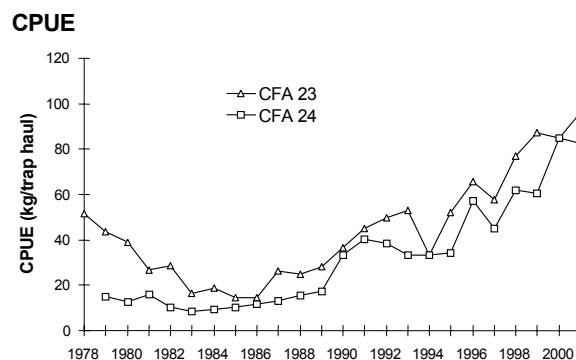
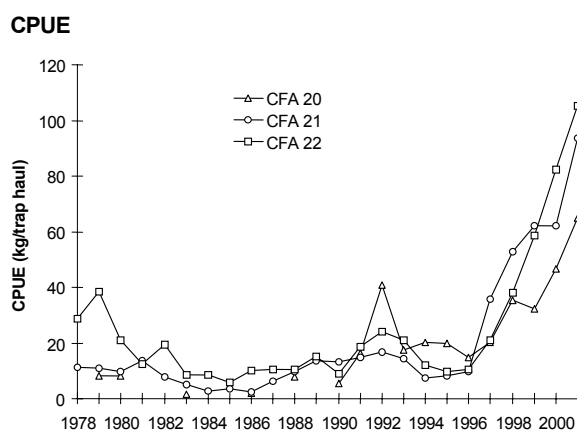
**Fishing Effort****Fishing Effort**

**At-sea sampling** of the commercial catch to evaluate the percentage of soft-shelled crab prior to sorting was conducted through a certified observer program in all CFAs in

2001. Samples of male crab were categorised by shell characteristics (size, hardness) and claw height. In 2001, at-sea sampling in northern ENS was limited because of the shortness of these fisheries (in sea-days), combined with the high density of crab on the fishing grounds. Estimated CPUEs (by trap, trip or sub-areas) based on the at-sea sampling have validated the CPUEs derived from the logbook.

Overall in southern ENS, the weekly soft shell crab percentages, derived from the observer coverage, slowly increased during the first 10 to 12 weeks to 20% and more at the end of the fishery, although trends were different by area, going from a rapid increase (CFA 24A) to always remaining under 10% (CFA 24B).

**Catch rate** has been generally increasing since the mid-90s. In 2001, there was a 23% increase in average CPUE compared to 2000. Increases in CPUEs were observed in CFA 20 (from 46.7 to 64.8 kg/th), CFA 21 (from 62.1 to 93.4 kg/th) CFA 22 (from 68.6 to 87.9 kg/th in Area 22 northern and from 106.0 to 135.9 kg/th in the Area 22 outer) and CFA 24 (from 84.9 to 96.2 kg/th), while CFAs 23 (82.6 kg/th) had comparable results to 2000 (85.0 kg/th).

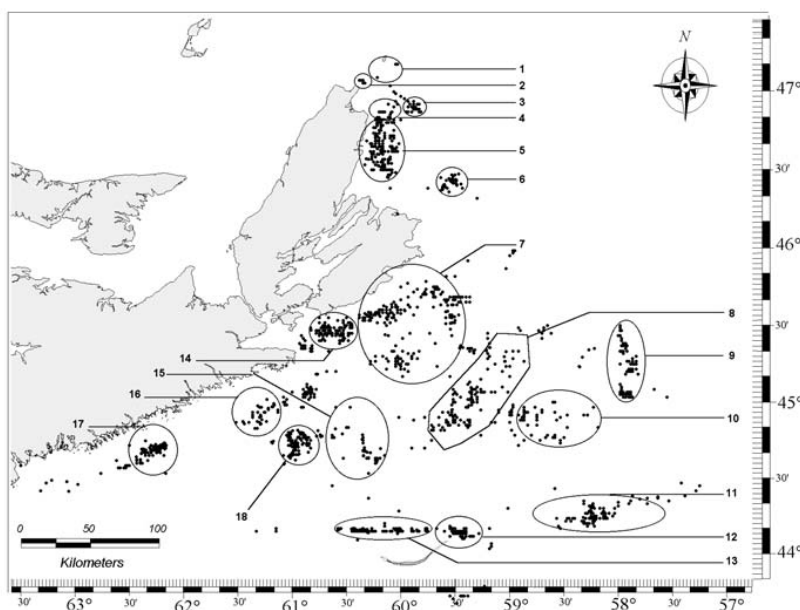


These fisheries have been undergoing substantial changes since the mid-1990s and catch rates may be affected by the move towards more efficient fishing gear, an early and longer fishing season, changes in soak time and fishing pattern, and seasonal movement of crab. Other important factors that may affect CPUE are the differences in fishing experience between permanent and temporary fishermen, as well as the particularity of their designated fishing grounds, including the fact that some previously exploited areas in the past were restricted to the shrimp fishery during 3 weeks in 2001. Therefore CPUE is not used as an index of abundance.

CPUE and fishing effort in ENS were fairly well distributed amongst all the available fishing grounds in 2001, regardless of the fishermen's status or any specific fishing area. The area around St Paul Island (#1) was quickly abandoned in 2001 because tide and current were too strong for the gear to fish properly (mean CPUE of 5.4kg/th). All but 3 of the fishing grounds saw their mean CPUE increase compared to 2000. Decreases have been seen in 23B (#8), Artimon (#9) and Gully (#12) areas of 23D.

CPUE Distributed by Cluster of Fishing Location

Group #	2000 CPUE	2001 CPUE	Trend
1	31.9	-	
2	50.6	68.6	+
3	38.6	43.9	+
4	56.5	106.8	+
5	66.0	84.1	+
6	98.5	139.1	+
7	102.9	115.3	+
8	104.0	94.2	-
9	62.7	47.7	-
10	109.7	131.4	+
11a	74.4	-	
11b	-	58.4	
12	65.1	51.2	-
13	81.8	83.6	≈
14	76.6	106.6	+
15	94.6	121.2	+
16	91.9	106.6	+
17	48.7	63.7	+
18	107.4	130.5	+



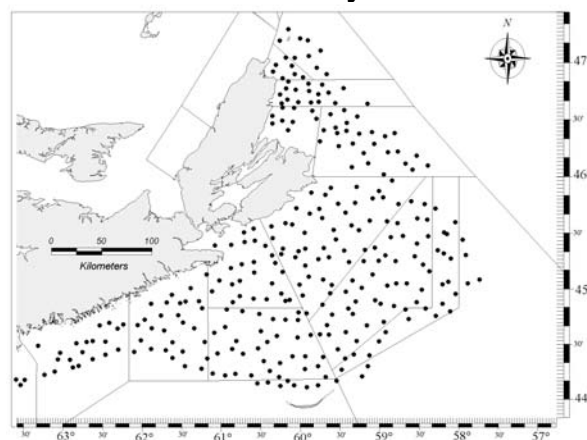
Estimation of the mortality caused by fishing activities on recently moulted male snow crabs (soft and white) was done in cooperation with a fisherman. Soft and white crab were captured by trapping and returned in closed traps to the bottom. After three days, these traps were fished and the number of dead crab counted. In 2001, the mortality rates caused by the fishery was estimated at  $16\% \pm 4.1\%$  for soft shell crab and  $5\% \pm 5.5\%$  for white crab, representing 79t in northern ENS and 179t in southern ENS.

### Resource Status

Stock status for 2001 is primarily based on an annual **trawl survey** that was introduced in 1997. In 2001, the northern survey started in April, which is slightly earlier than normal but it finished before the fishery. In contrast, the southern survey started in May, as usual, but due to vessel problems, could not be completed until 20 July, three weeks into the fishery.

A total of 303 trawl stations were completed in CFAs 20-24, which encompassed areas (34,000 km<sup>2</sup>) of the Cabot Strait, Sydney Bight and Scotian Shelf.

### Distribution of Trawl Survey Stations in 2001



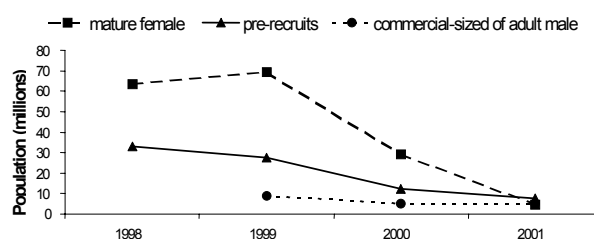
Changes were made to the computations used to develop survey biomass estimates that would correspond more closely to the biomass supporting the fishery. The effect of change in survey vessels and analytical technique was not assessed.

**Total biomass** means all commercial-sized adult at the time of the survey; **exploitable**

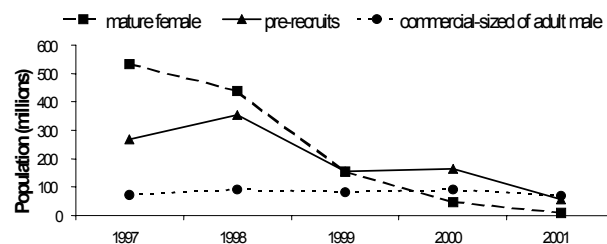
**biomass** means commercial-sized adult and of carapace condition 3, 4 and 5 at the time of the survey; **recruitment to the fishery** means commercial-sized adult males of carapace condition 1 and 2 at the time of the survey (these will not enter the fishery following the current survey, but the following year); and **pre-recruits** means adolescent males greater than 56mm at the time of the survey.

The number of trawl stations sampled has increased from 150 in 1997 to 303 in 2001, and the surface to be covered by the survey is expected to increase again in 2002. Consequently, increasing the total surveyed area renders comparison difficult between years. In order to allow for comparison among years, the overall trends of mature females, pre-recruits and commercial-sized adult males are reported based on the original surface that was surveyed in 1997 for southern ENS (17,623 km<sup>2</sup>) and 1998 for northern ENS (4,250 km<sup>2</sup>). The survey size frequency distribution of male crab is reported for the total surface surveyed every year.

Number of Mature Females, Pre-recruits and Commercial-sized Adult Males in Northern ENS

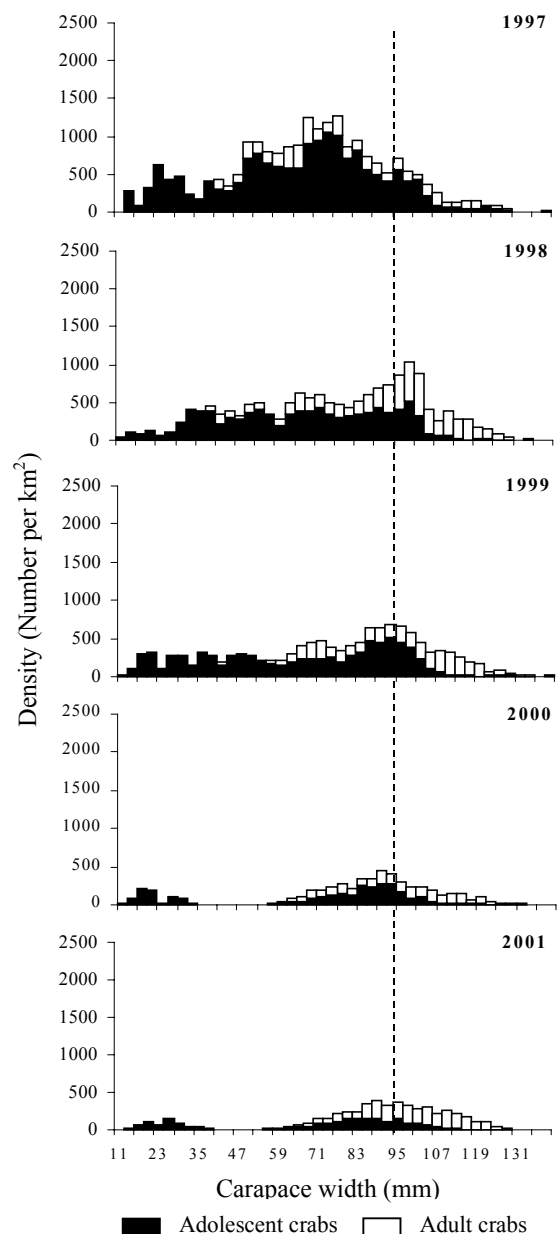


Number of Mature Females, Pre-recruits and Commercial-sized Adult Males in Southern ENS

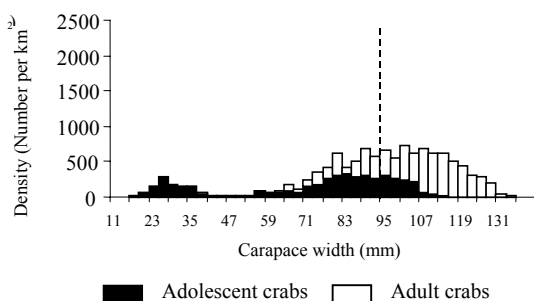


Mature females and pre-recruits have been decreasing since 1997-98, while that of commercial-sized adult males have remained constant over the same period. The size frequency distributions show a substantial decrease in adolescent males from 1997 to 2001 in both northern and southern areas.

Survey Size Frequency of Male Crab in Northern ENS



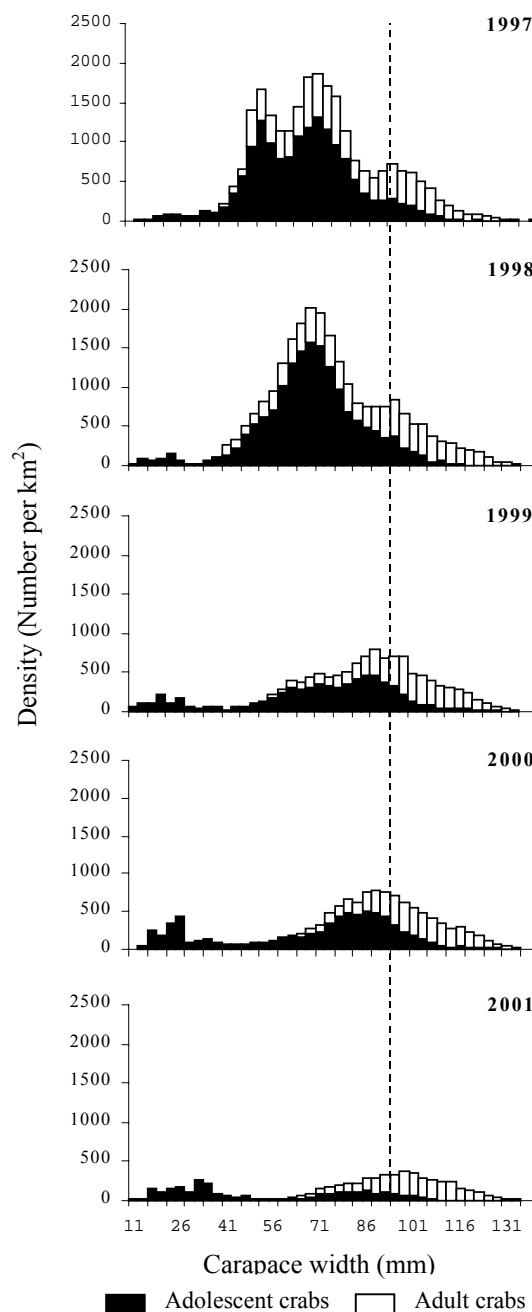
**Survey Size Frequency of Male Crab in Northern ENS from 2001 September Survey**



Snow crab of carapace condition 5 (very old crab) is not expected to contribute to the 2002 fishery due to high natural mortality. In 2001, the amount of old category 5 crabs has been estimated at  $62 \pm 45$ t in northern ENS and  $208 \pm 169$ t in southern ENS.

In northern ENS, 30 trawl stations were revisited in September. These extra stations were used to estimate commercial-sized adult male biomass in the fall for comparison with the biomass estimated from the May 2001 annual survey. The May survey missed the recruitment to the fishery, and the prediction of this category of crab is primordial establishing future exploitable biomass.

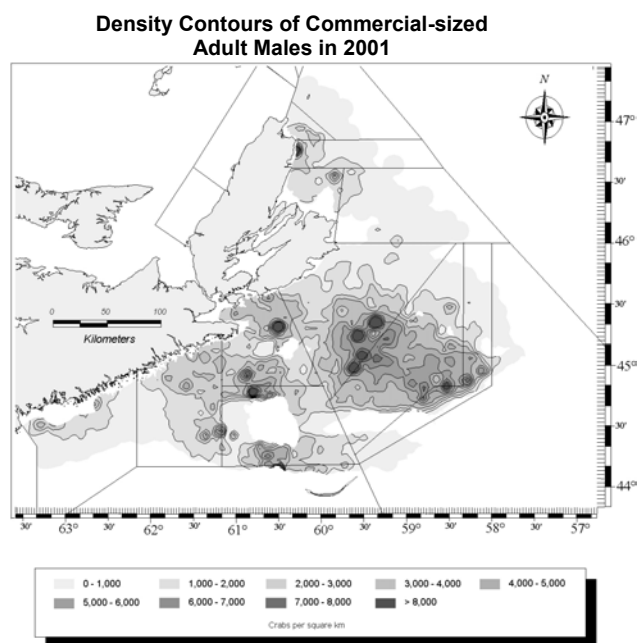
**Survey Size Frequency of Male Crab in Southern ENS**



The September 2001 survey in northern ENS indicated that there were 3,982t of total biomass. Assuming that most of the snow crab habitat in northern ENS was covered by the trawl survey and that no other losses other than category 5 crab will occur in the mean time, the biomass of commercial-sized

crab was estimated to be 3,920t in 2002 (3,982t – 62t of category 5).

In southern ENS, the 2001 survey indicated that there were 33,139t of total biomass of commercial-sized adult males. The fishery in CFAs 23 and CFA 24 harvested 8,456t (trap survey and commercial landings from slope not included), plus the soft and white crab mortality from the fishery was estimated at 189t, and the amount of old crab with carapace condition 5 was estimated at 208t. Thus assuming that all major fishing grounds in southern ENS have been covered by the trawl survey in 2001 and that no other losses will occur in the meantime, the biomass of adult male crabs is estimated to be 24,286t in 2002.



### *Sources of Uncertainty*

Although 2001 was by far the best at-sea observer coverage ever done in CFAs 23 and 24, the coverage was too sparse near the end of the season to produce representative results on a combined weekly and sub-area basis.

By using September total biomass in northern ENS, and by eliminating sources of underestimation in southern ENS, the relative abundance indexes are believed to be more representative of the snow crab population, and include more of the stock area.

The current "biomass estimates" provided should not be considered as absolute as the mortality of commercially exploitable crab between the time of survey and the fishing season has not been taken into account. Cross checking of biomass estimates in the past several years in the southern Gulf of St. Lawrence indicated over-estimation of the biomass. The current pre-season trawl survey in ENS makes the estimates more uncertain as the fishing mortality occurring during the fishing season following the survey is not considered. In addition, the effect of change in survey vessels and analytical technique could not be assessed, and the pre-recruit abundance and fishable biomass seems not be closely correlated. The estimation of "biomass" was based on the assumption that the catchability of crab in front of trawl net foot rope was 100%. Until these uncertainties are assessed, the estimates are considered as relative and the application of exploitation rate to this biomass should not be practiced.

The geographic distribution of females, juveniles, adolescents and undersized adult males is different from that of commercial-sized adult. Further studies are required to improve our knowledge on the distribution of all size-classes of male and female snow crab. The categorisation of older crab (category 5) based on the carapace condition index developed for the southern Gulf of St. Lawrence may not be directly applicable in ENS.



Seasonal movement between shallow and deeper areas may occur between the time of the trawl survey and the beginning of the subsequent fishing season. Movement of crab amongst CFAs is assumed but was not explicitly taken into account in this assessment.

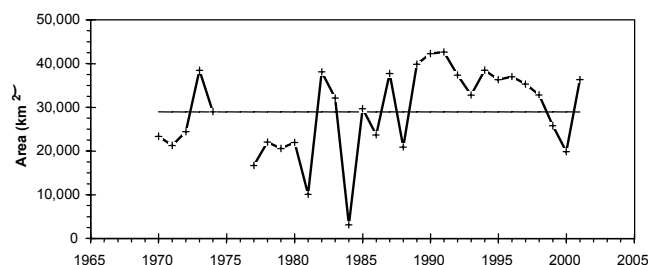
### *Ecosystem Considerations*

Cold bottom temperatures ( $<4^{\circ}\text{C}$ ) exist year-round in the deeper area northeast of French, Middle and Banquereau Banks (CFAs 20 to 23, with 24A and 24B), as well as in a narrow band along the shore (24C and E) that ends in southwestern Nova Scotia (4X fishery). At the time of the trawl survey, the coldest bottom temperatures ( $-0.5^{\circ}$  to  $+2^{\circ}\text{C}$ ) were found near shore off southern Cape Breton, gradually increase to  $5^{\circ}$ - $6^{\circ}\text{C}$  to the east in Laurentian Channel and to  $6^{\circ}$ - $7^{\circ}\text{C}$  on the shallow water of Banquereau, Sable Island and Middle Banks to the south and west. The warmest temperatures in 2001 were in the southwestern portion of CFA 24 (Emerald Basin, Western Bank and Middle Bank). This spatial pattern is typical of that seen in most years.

Bottom temperatures in the northeastern Scotian Shelf during 2001 were generally colder than the long-term average (1971-2000). They also cooled relative to 2000, thereby reversing the warming trend in the region that began in the mid-1990s. The snow crab habitat index, defined by the area of the bottom with temperatures of  $-1^{\circ}$  to  $3^{\circ}\text{C}$ , increased after having declined gradually over the previous four years. Given that colder conditions in this region are considered to be advantageous for snow crab in these areas, the higher snow crab habitat index and the colder-than-average bottom temperatures indicate that bottom conditions were more favourable for the snow crab in 2001 compared to conditions

observed during the previous two years. The cause of the cooling in 2001 is unclear but recent reports suggest that it may have originated from the Gulf of St. Lawrence, in turn produced by an inflow of Labrador Shelf waters to the Gulf via the Strait of Belle Isle.

Snow Crab Habitat Index



### *Outlook*

Estimates of fishable biomass for the 2002 fishery are 3,920t for northern ENS and 24,286t for southern ENS. Based on the survey size frequency information, the decline is greater in pre-recruit sizes, which suggests the decline in adult crab will accelerate in future years. Future surveys will provide information on the strength of these incoming year classes, but the prognosis for the coming years is not promising.

The numerical biomass projections are only relative indications of stock population due to inherent uncertainties within the estimation process.

### *Management Considerations*

The amount of soft and white crabs being captured in a snow crab fishery can be reduced by: an earlier fishing season; a shorter fishing season; good husbandry practices (e.g. careful handling of crab; quick return to the water; voluntarily moving out of an area with high density of soft shell crab); redistribution/reduction of

fishing effort; and closure of grids/sub-areas/fisheries.

Relevant to Snow Crab. DFO Can. Sci. Adv. Sec. Res. Doc. 2002/043.

### ***For more Information***

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