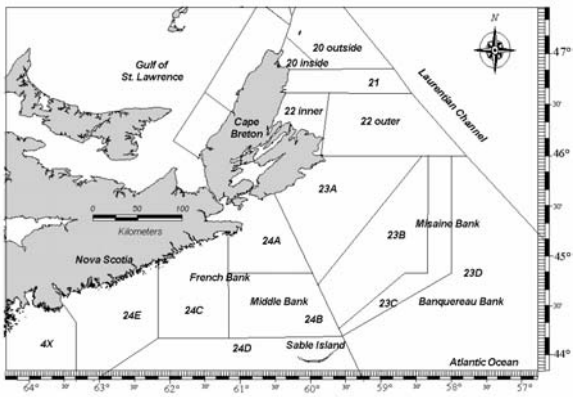
Eastern Nova Scotia Snow Crab

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 95mm. Male snow crab stops growing after the moult in which they acquire relatively large claws on the first pair of legs 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 95mm, 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 depths ranging from 50 to 280m.

Management areas in eastern Nova Scotia (ENS) do not reflect the biological distribution of the resource. Therefore trawl survey results are shown based on biological units only: northeastern NS (N-ENS), comprised of areas 20, 21 and 22, and southeastern NS (S-ENS), comprised of areas 23 and 24.



Summary

- Reported landings were 10,186t against a TAC of 10,315t for the 2002 fishing season.
- The 2002 annual survey was conducted in late summer / early fall in consideration to seasonal movement that had been affecting the spring surveys in the past. This was the first time that a complete survey was conducted after the fishery in ENS.
- The fishable biomass index for 2003 was 2,800t in N-ENS and 24,350t in S-ENS.
- Size frequencies and abundance index from trawl survey indicate a continued decrease in recruitment.
- The fishable biomass index in the originally surveyed areas has been declining, which is expected to accelerate in all areas if recruitment do not improve.
- Mature female abundance has been decreasing since 1997-1998 and is low, which may impact the reproductive potential.
- Bottom temperatures were near their long term mean in 2002, being warmer than 2001 and the extended cold period from mid-1980s to the late 1990s, but colder than 1999-2000.
- Due to uncertainties associated with the stock assessment and negative signs of recruitment, fishable biomass and reproductive potential, it is strongly recommended not to increase harvesting levels in 2003.

The Fishery

Harvesting of snow crab off the coast of eastern Nova Scotia (ENS) began in the late 1970's. Landings peaked at 1,634t in 1979, but these fisheries were believed to be near commercial extinction by 1985 (89t). From 1982 to 1993, management was based on effort controls (seasons, licenses and trap limits) and saw average annual landings of 768t. Substantial changes to management measures were introduced from 1994 to 1999, such as individual boat quota (IBQ), 100% dockside monitoring, mandatory logbook, at-sea monitoring by certified observers and the introduction of sub-areas to ensure the distribution of fishing effort. Landings remained stable around 1500t between 1994 and 1997, then rose quickly to 3,600t by 1999.

In 1999, for the first time in ENS, the stock status was evaluated based on a trawl survey that began in 1997. Estimated biomass and density contour maps from 1997 to 1999 revealed a wider distribution of the resource than exploited at the time, especially in the southern portion of ENS. Consequently, TACs increased from 900t in 1999 to 1,015t in 2000 in northeastern Nova Scotia (N-ENS), and from 2,700t to 8,800t in southeastern Nova Scotia (S-ENS). There were no changes in the number of permanent licenses in all CFAs during 1997-1999 but temporary permit holders were introduced in CFA 20, CFA 23, and CFA 24.

In 2002, compared to 2001, the TAC in N-ENS was increased by 50% in CFAs 20, 21 and 22 inner and 10% in CFA 22 outer. There were 5 permanent licenses and 6 temporary permits in CFA 20, 32 permanents in CFA-21 and 37 permanents in CFA-22. Two fishermen in CFA-22 changed fishing ground in 2002, bringing the number to 22 permanents in the northern area and 15 in the outer area.

In S-ENS, the TAC in 2002 remained similar to that of 2001 at 8,822t, with 4,776t in CFA 23 and 4,046t in CFA 24. IBQs of permanents license holders also remained the same but the number of their permanent licenses increased, from 24 in 2001 to 37 in 2002 in CFA 23 (54%) and from 23 to 34 licenses in CFA 24 (48%). Therefore, existing temporary license allocations in 2002 decreased from 2,985t to 2,038t in CFA 23, and from 2,406t to 1,564t in CFA 24, compared to 2001. The temporary permit holders decreased from 59 in 2001 to 38 in 2002 in CFA 23 (-35%) and from 57 to 40 licenses in CFA 24 (-30%).

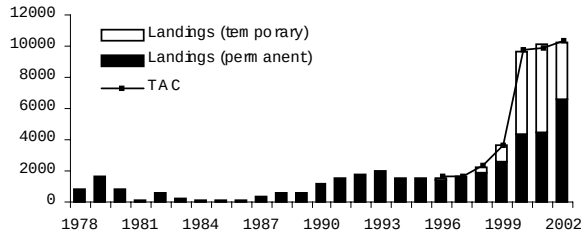
Landings, catch rate (CPUE: kg/trap haul), fishing effort (total catch / CPUE = total number of trap hauls) and fishing locations were derived from the mandatory logbooks completed by all fishermen.

Permanent and Temporary Allocations

	permanent		temporary	
CFA	allocations (t)	licences	allocations (t)	permits
20	102	5	75	6
21	545	32	-	-
22 (inner)	477	22	-	-
22 (outer)	294	15	-	-
23	2,738	37	2,038	38
24	2,482	34	1,564	40
Total	6,638	145	3,677	84

The overall TAC for ENS in 2002 was 10,315t (excluding slope surveys) compared to 9,848t in 2001. Total reported **landings** in 2002 were 10,186t.

Landings (t)

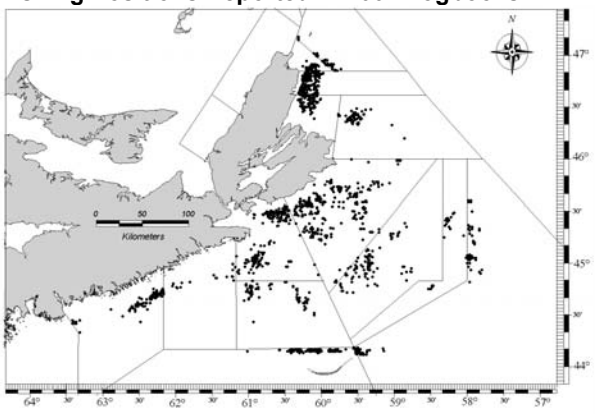


Landings (t) in Eastern Nova Scotia

CFA	Average 1990-94	Average 1995-99	2000	2001	2002
20	17	55	118	117	175
21	159	178	364	363	547
22	238	346	535	586	773
23	555	768	4,401	4,805	4,672
24	662	762	4,300	4,043	4,019
Total	1,631	2,109	9,718	9,917	10,186

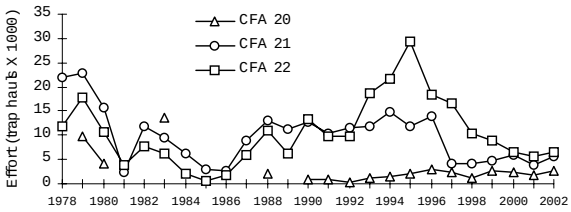
In 2002, fishing effort and distribution was influenced by sub-area boundaries and an imposed sharing arrangement with shrimp fishermen concerning the use of mutual fishing grounds. Accordingly, some areas in S-ENS were closed to the crab fishery for part of the year.

Fishing Positions Reported in 2002 Logbooks



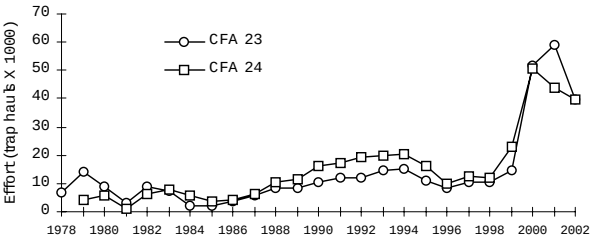
While reported **fishing effort** in N-ENS increased by 40% to 14,791 trap hauls in 2002, compared to 2001, it remained low in comparison to the long term trend.

Fishing Effort for N-ENS



The total effort in S-ENS decreased by 23% to 69,100 trap hauls in 2002 compared to 2001, representing a 33% decrease in CFA-23 and 10% in CFA-24. Fishing effort remained high compared to the long term trend.

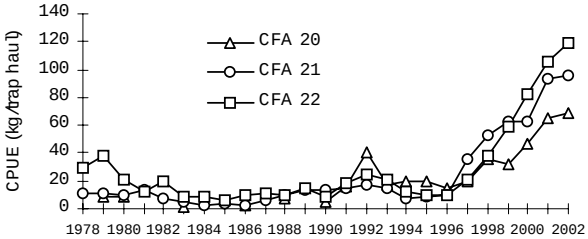
Fishing Effort for S-ENS



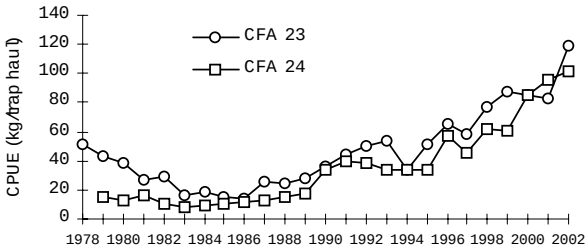
According to **at-sea sampling** of the commercial catch, the proportion of soft-shelled (<5%), adolescent (5 to 20%), undersize crab (5 to 15%) and skip-molter (<5%) in the catch remained low. The majority of crab in the catch (70 to 90%) were male adults of carapace conditions 3 (66%) and 3M (18%).

Catch rate (CPUE) has been generally increasing since the mid-1990s. In 2002, increases in CPUEs were observed in all CFAs compared to 2001.

CPUE for N-ENS



CPUE for S-ENS

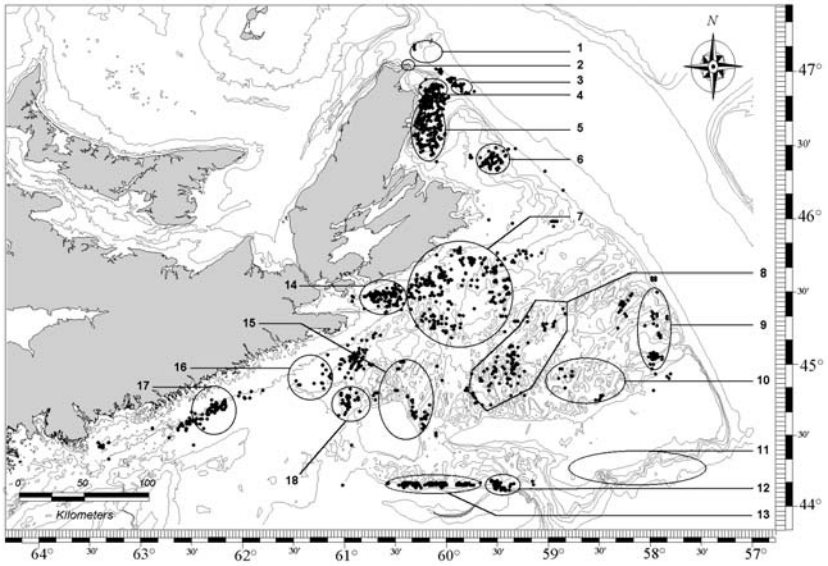


There is uncertainty in using CPUE as an index of abundance. Catch rates are affected by changes in fishing gear, season, soak time, fisherman experience, fishing pattern, closures and seasonal movement.

Overall, CPUE and fishing effort in ENS were well distributed amongst all the available fishing grounds in 2002. In northern ENS, the area around St. Paul Island (#1) and the one along the demarcation line with CFA-19 (#2) saw little activity in 2002 (as in 2001). All but 4 of the fishing grounds saw their mean CPUE increase compared to 2001. Decreases have been seen in CFA-20 outside (#3), Glace Bay Hole (#6) and the fishing grounds west of Middle Bank (#18) areas. The highest increase was observed in the N-ENS trough and in CFAs-23 and 24 sub-areas A and B.

CPUE Distributed by Fishing Grounds

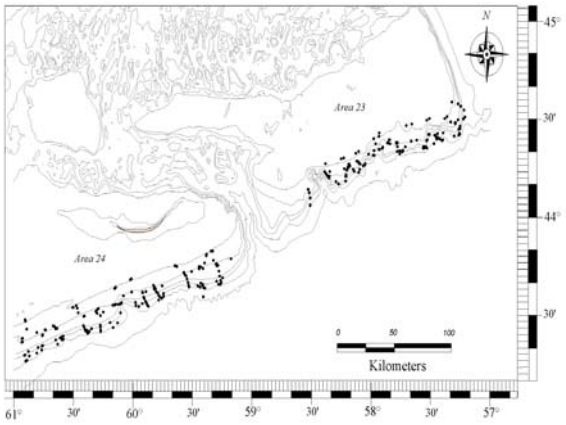
Fishing Ground #	2000 CPUE	2001 CPUE	2002 CPUE	Trend
1	31.9	-	6.15	
2	50.6	68.6	-	
3	38.6	43.9	38.6	-
4	56.5	106.8	120.8	+
5	66	84.1	129.8	+
6	98.5	139.1	129.5	-
7	102.9	115.3	140.0	+
8	104.0	94.2	135.0	+
9	62.7	47.7	70.7	+
10	109.7	131.4	134.5	+
11a	74.4	-	-	
11b	-	58.4	-	
12	65.1	51.2	79.3	+
13	81.8	83.6	89.3	+
14	76.6	106.6	114.3	+
15	94.6	121.2	152.1	+
16	91.9	106.6	110.9	+
17	48.7	63.7	63.9	=
18	107.4	130.5	121.3	-



Resource Status

A systematic trap survey was conducted in summer and fall 2001, and spring and fall 2002, along the edge of the Scotian Shelf to determine the distribution, density (mean number of crab / trap) and movement pattern (by tagging) of snow crab. The survey occurred within the slope of Banquereau and Sable Island Banks. No effort was permitted within the Sable Gully candidate area. From this protected area, the survey extended northward to 45°00' latitude in CFA 23 and eastward to the 61°00' longitude in CFA 24.

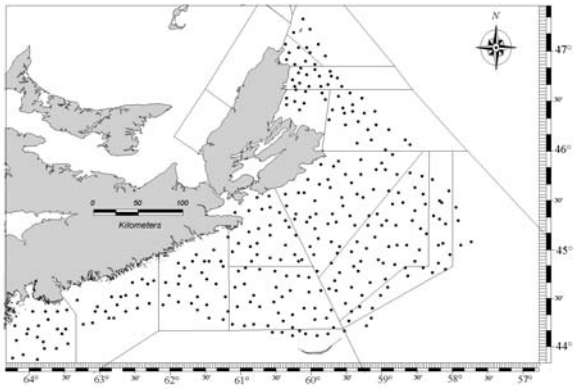
Trap Survey Locations in Spring 2002



The exploratory trap surveys have shown the presence of adult and adolescent male snow crab along the slope of the Scotian Shelf at depth from 60 to 400 m, but mostly from 60 to 200 m. Larger average carapace width and higher proportion of older crab may have indicated a certain degree of accumulation of the stock. The increase in the proportion of adolescent caught on the slope between 2001 and 2002 may be an indicator of a decrease in the number of available adult males rather than an increase in recruitment (i.e. number of adolescent caught similar between 2 years). The available snow crab biomass for the slopes of CFAs-23 and 24 remained unknown.

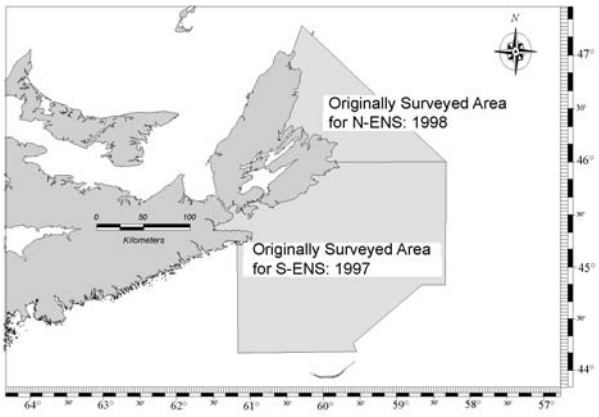
Stock status for the rest of ENS in 2002 is primarily based on an annual **trawl survey** that was introduced in 1997. Between 1997-2001, the annual snow crab trawl surveys have been conducted in the spring. In 2002, the annual survey for ENS was carried out between August 13 and Sept. 24 for S-ENS (241 tows) and Oct. 10 to 16 for N-ENS (59 tows), and encompassed areas of the Cabot Strait, Sydney Bight and Scotian Shelf. The 59 stations in N-ENS were also trawled in May and July 2002.

Distribution of Trawl Survey Stations in 2002



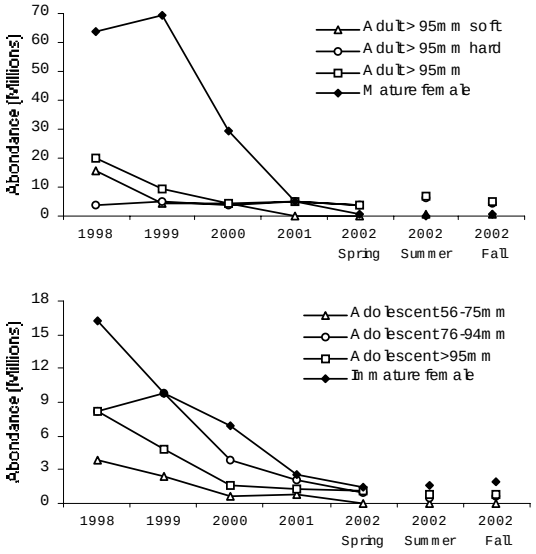
The number of trawl stations sampled during the annual survey has increased from 150 in 1997 to 322 in 2000, and dropped to 303 in 2001 and 300 in 2002. Consequently, increasing the total surveyed area renders comparison difficult between years. In order to allow for comparison among years, the overall trends of pre-recruits and commercial-sized adult males are reported based on the original surface that was surveyed in 1997 for S-ENS and 1998 for N-ENS.

Originally Surveyed Areas

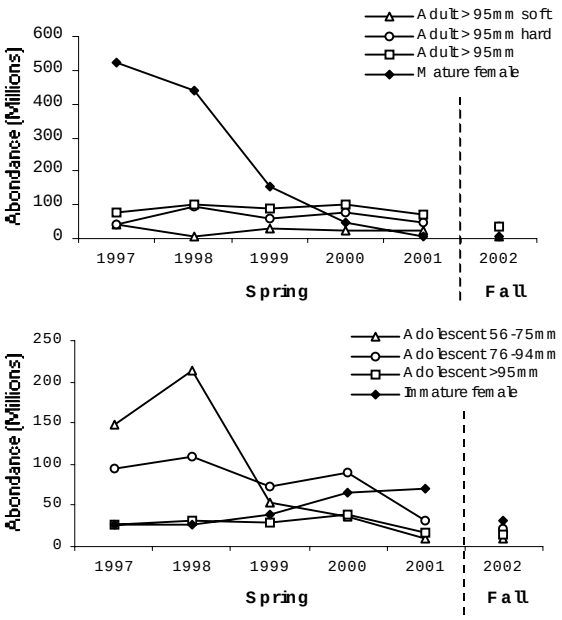


Abundance of Commercial-Sized Adult, Pre-recruits Males and Females in Originally Surveyed Area

N-ENS



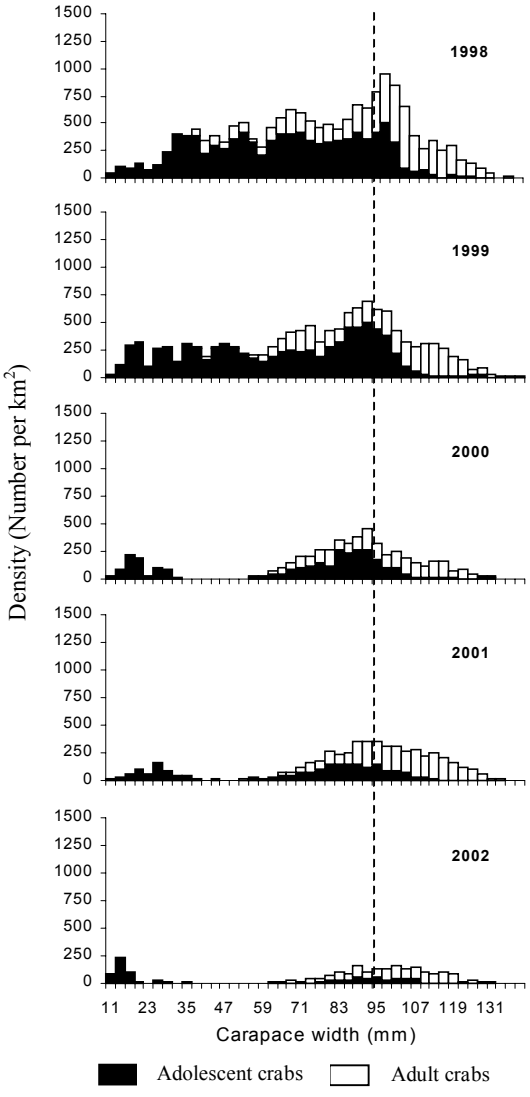
S-ENS



In N-ENS, the abundance of soft-shelled adult males has decreased from 1998-99, while hard-shelled adult male has remained constant during the same period. In S-ENS, the abundance of commercial size adult males has been slowly decreasing since its high abundance period of 1998-2000. In both regions, abundance of male and female adolescent was similar to 2001, with low recruitment in comparison to earlier years. Adult female abundance and distribution was generally low and almost exclusively comprised of multiparous females distributed along the inside of Sable Island Bank and sub-areas 24E and 24C, with smaller concentration north of Banquereau and around Misaine Banks.

The size frequency distributions in N-ENS show a substantial decrease in adolescent males from 1998 to 2002.

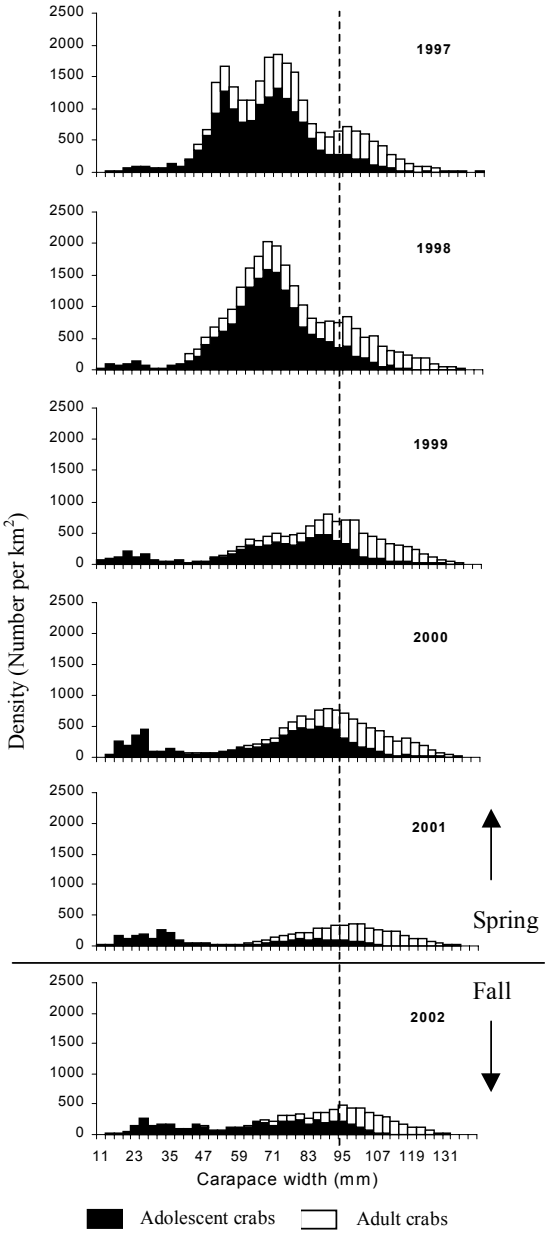
Survey Size Frequency of Male Crab in N-ENS



The size frequency distributions in S-ENS show a substantial decrease in adolescent males from 1997 to 2002.

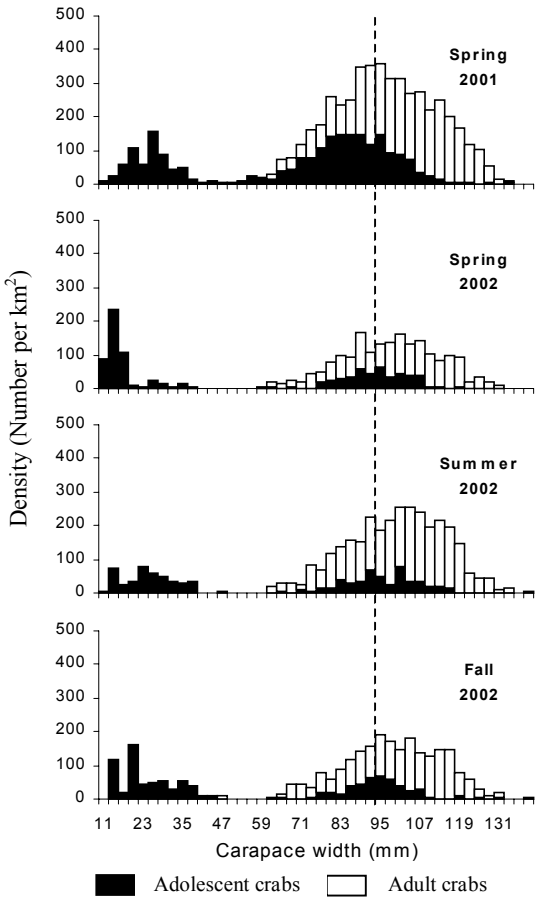
Overall, the size frequencies and abundance index from trawl surveys indicate a continued decrease in recruitment.

Survey Size Frequency of Male Crab in S-ENS



In N-ENS, during 2002, the density of adolescents remained similar throughout the three seasonal surveys, while adults increased from spring to summer. The highest concentration of commercial crab was distributed within the near shore trough shared by CFAs 20, 21 and 22, and on Smokey Bank.

Seasonal Survey Size Frequency of Male Crab in N-ENS

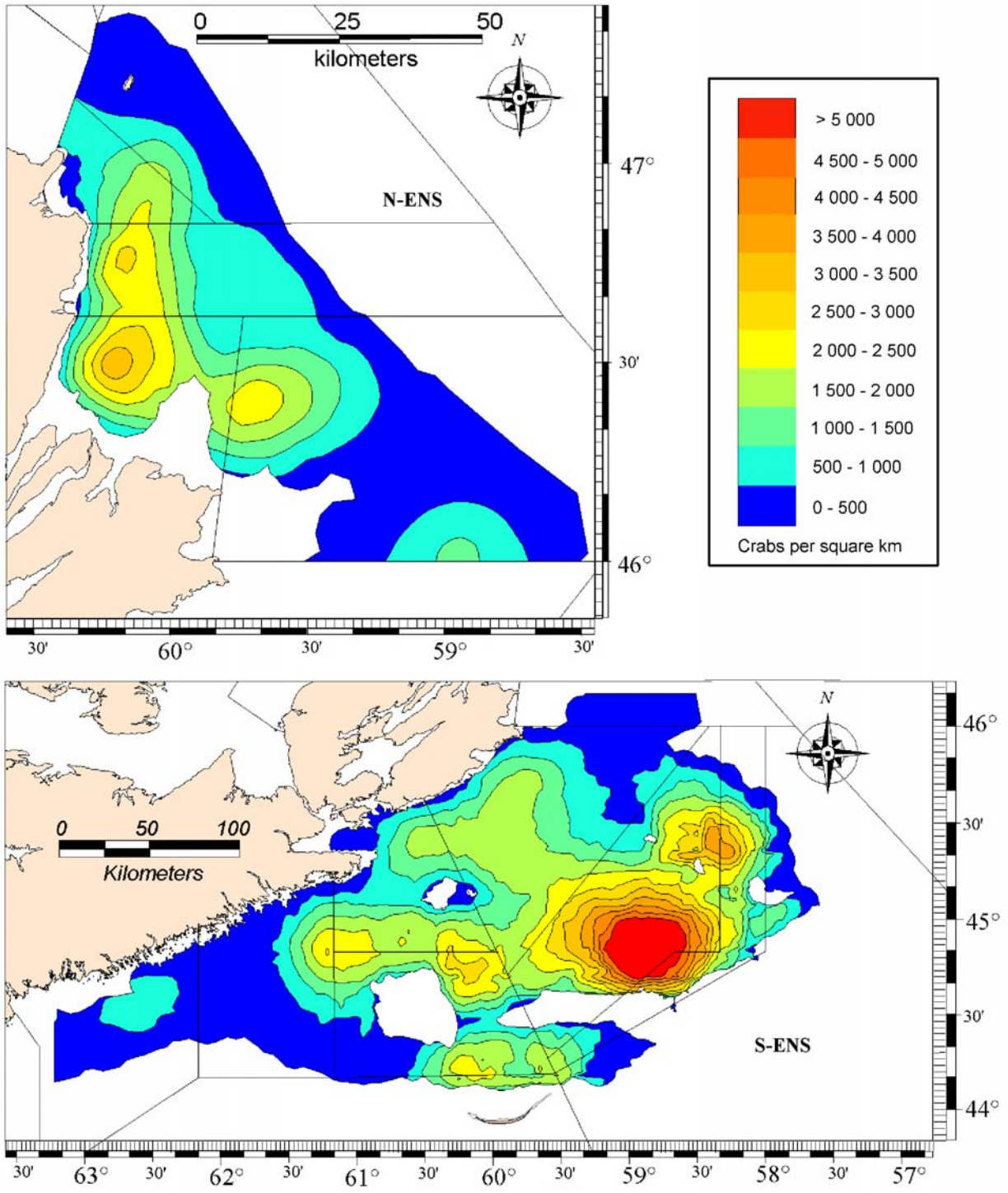


Snow crab of carapace condition 5 (very old crab) is not expected to contribute to the 2003 fishery due to high natural mortality. In 2002, the amount of old category 5 crabs has been estimated at 13 ± 41t in N-ENS and 99 ± 83t in S-ENS.

Assuming no other losses than category-5 crab in the mean time, the biomass index for the 2003 fishery is 2,800t (2,820t –13t of category-5) in N-ENS and 24,350t (24,454t –92t of category-5) in S-ENS.

In general, the fishable biomass index in the originally surveyed areas has been declining, which is expected to accelerate in all areas if recruitment does not improve.

Density Contours of Commercial-sized Adult Males in Eastern Nova Scotia from the 2002 Trawl Survey



Sources of Uncertainty

The current biomass estimates provided should not be considered as absolute because the natural mortality (e.g. predation, diseases, etc.) of commercially exploitable crab between the time of survey and the fishing season has not been taken into account. The estimation of "biomass" was based on the assumption that the catchability of commercial sized male crab in front of trawl net foot rope was 100%. Until these uncertainties are assessed, the estimates are considered as relative.

The current post-season trawl survey makes comparison with previous pre-season estimates more uncertain. In addition, the effect of change from 3 survey vessels in 2001 to 1 vessel in 2002 could not be assessed. The extensive trawl survey in 2002 covered all the major fishing grounds, but not necessarily all of the snow crab habitat.

Movement of crab amongst CFAs is assumed but was not explicitly considered in this assessment. Some areas such as Glace Bay Hole seemed to be more dynamic in their movement pattern. However, the accuracy of the trawl survey method becomes limited when dealing with small areas.

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.

For the Scotian Shelf stock assessment, no monitoring of reproductive output has been done and the reaction of the snow crab population against the current exploitation level is unknown. We, at least, found that the abundance of adult females decreased significantly through the last 2-3 years and currently their abundance has reached the lowest level ever since the trawl survey has begun. If the Scotian Shelf is self-reproducing system, this decline of female spawning stock may result in a serious stock decline in the future.

Although some of these uncertainties may have lead to an underestimation of the snow crab population in 2002, the fact that data on carapace condition (e.g. at-sea observer, trawl survey) showed no accumulation of older crab proved that the stock was not being grossly underestimated.

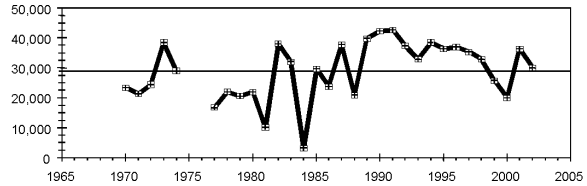
Ecosystem Considerations

Cold bottom temperatures (<4°C) typically 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 surveys in 2002, the coldest bottom temperatures (less than 2°C) were found near shore off eastern Cape Breton and near eastern Banquereau Bank. Temperatures gradually increased from these regions to 4°-5°C towards the east in Laurentian Channel and to 4°-6°C on the shallow areas of Banquereau, Sable Island and Middle Banks to the south and west. The warmest temperatures in 2002 (7° to greater than 9°C) were in the southwestern portion of CFA 24 (Emerald Basin, Western Bank and

Middle Bank). This spatial pattern in near-bottom temperatures is typical of that seen in most years.

Bottom temperatures in the northeastern Scotian Shelf were typically warmer-than-average during the late'-1970s and early 1980s. In the mid-1980s they declined reaching a minimum in the early 1990s. Temperatures then rose gradually until by the late 1990s, they rose above average values for the first extended period since the mid-1980s. Temperatures continued to rise through to 2000 but dropped below average in 2001. During 2002, temperatures in the northeast were generally near to or slightly warmer than the long-term average (1971-2000) having warned relative to observation in 2001. The snow crab habitat index, defined by the area of the bottom with temperatures of -1° to 3°C, decreased to a near average value from the relatively high value in 2001. This is consistent with the observed warmer temperatures in 2002. Given that colder conditions in this region are considered to be advantageous for snow crab, the lower snow crab habitat index and the near-average bottom temperatures indicate that bottom conditions were slightly less favorable for the adult snow crab in 2002 compared to conditions observed during 2001.

Snow Crab Habitat Index



Outlook

Estimates of fishable biomass index for the 2003 fishery are 2,800t for N-ENS and 24,350t for S-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.

Management Considerations

Due to the uncertainty described above together with negative signs of recruitment, fishable biomass and reproductive potential, it is strongly recommended not to increase the current harvesting level in 2003. Harvesting levels should also respect current effort distribution strategies in effect in ENS.

Protocols to control the capture of soft or white crab, comparable to those applied in the southern Gulf of St. Lawrence are required in order to minimize the mortality of these crabs and to protect future recruitment to the fishery.

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ISSN 1480-4913

La version française est disponible à l'adresse ci-dessus.

Correct citation for this publication:

DFO, 2003. Eastern Nova Scotia Snow Crab. DFO Science Stock Status Report 2003/029.