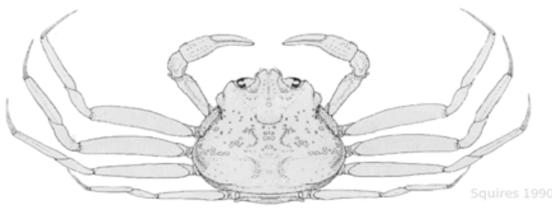
ASSESSMENT OF EASTERN NOVA SCOTIA (4VW) SNOW CRAB



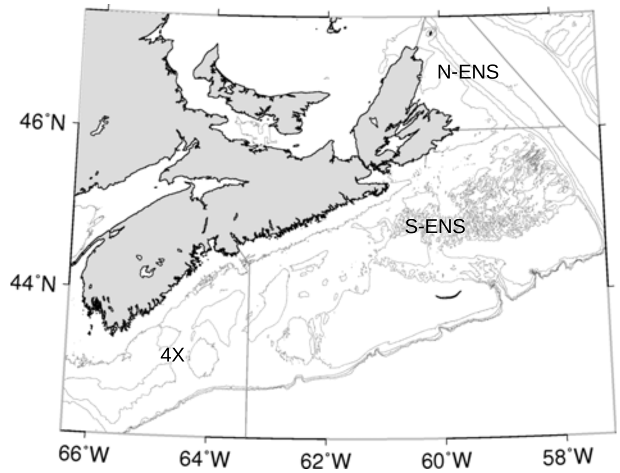


Figure 1: Map of the Scotian Shelf and Crab Fishing Areas (CFA).

Context

Since the demise of the groundfish, snow crab have become a dominant macro-invertebrate on the Scotian Shelf. They are observed in large numbers in deep, soft-bottom substrates ranging from 60 to 280m and at temperatures generally less than 6°C. The ENS snow crab are on the southern-most extreme of their spatial distribution in the Northwest Atlantic. In most exploited areas, a general decline in the abundance of snow crab has been observed on the Scotian Shelf since their peak abundance in the late-1990s. Recruitment patterns of this long-lived species (up to 18 year life span) have also been severely depressed since 2001.

The fishery has been in existence since the late 1970s in Nova Scotia. It exploits the whole spatial extent of the species on the Scotian Shelf. Since 1998, the fishing grounds have been subdivided into numerous management areas (Figure 1). The management of the snow crab fisheries on the Scotian Shelf was initially based on effort controls (season, license, trap limits) from 1982 to 1993 with harvesting during June-November of hard-shelled males larger than 95 mm CW (carapace width). Additional management measures were introduced from 1994 to 1999: IBQs (individual boat quotas), TACs (total allowable catches), 100% dockside monitoring, mandatory logbooks and at-sea monitoring by certified observers. More recently, vessel monitoring systems (VMS) have become a requirement in S-ENS.

In support of the fishery, DFO Maritimes Fisheries and Aquaculture Management requests from DFO Science an assessment of resource status and the consequences of various harvest levels for the coming fishing season. This document is a scientific overview of the assessment and projections undertaken in support of the fishery. Commercial catch rates and other fishery statistics are reported. An assessment of the status of ENS snow crab is made from fishery independent surveys using indicators of: abundance; reproductive potential; recruitment; and exploitation rates. Harvest advice for the next year is provided. Information for area 4X is presented where available but the assessment will not be undertaken until the completion of the fishery in May.

SUMMARY

- Landings in 2006 were 486 and 4,486 t, and within their respective TACs, in N-ENS and S-ENS, respectively – declines of 14 and 30% from 562 t and 6407 t in 2005. Average, non-standardized catch rates were 35.6 and 90.6 kg/trap in N- and S-ENS, respectively – representing a marginal increase in the north and a marginal decrease in the south.
- Soft-shelled crab incidence in the commercial catch of legal sized crab was estimated to be 4.1% in N-ENS (relative to 18% in 2005) and 6.2% in S-ENS (relative to 5.2% in 2005).
- The post-fishery fishable biomass of snow crab was estimated to be 720 and 25,400 t in N- and S-ENS, respectively. They represent a 50% decline in N-ENS and a 10% increase in S-ENS.
- By-catch levels are very low in this fishery.
- Throughout the shelf, pre-recruits near a 54 mm CW modal group (instars 9/10) have been found in large numbers. The leading edge of recruitment should enter in 2007 and full entry in 2010 to 2011.
- The reproductive potential of the Scotian Shelf population has increased with the substantial increase in berried female abundance in both areas. Larval production should continue for another 5 years. However, potential predators of (immature and soft shelled) snow crab have been found concentrated in areas with high densities of immature snow crab. This adds uncertainty to the potential strength of future recruitment to the fishable biomass.
- Increasing temperatures in ENS represent an additional source of uncertainty. The implications of this warming (N- and S-ENS) and shrinking of potential habitat (S-ENS) may be negative upon the ENS snow crab.
- The numerical abundance estimates of old males (CC5) are currently below the detection limit on the Scotian Shelf surveys and low as well in the at-sea-observed data (approximately 1% or less). This may be indicative of high exploitation rates.
- Exploitation rates (by biomass) in N-ENS were 43% in 2006, relative to 30% in 2005. Projections suggest that a 40% exploitation in N-ENS is not sustainable especially when recruitment is poor. A range between 10 to 30%, depending upon the strength of recruitment, may help ensure the long-term sustainability of this fishery.
- Exploitation rates (by biomass) in S-ENS were 15% in 2006, relative to 22% in 2005. This decrease was to meet the long-term concerns of conservation (reproductive output) and sustainability (fishable biomass). For S-ENS, projections suggest exploitation rates between 10 to 20% may ensure the longevity of the fishery, again depending upon the strength of recruitment.
- The N-ENS snow crab fishery did not succeed in bridging the gap between the past declines in fishable biomass/poor recruitment and the expected beginning of recovery in 2007. A decrease in TACs is recommended for N-ENS.
- The S-ENS snow crab fishery succeeded in bridging the gap between the past declines in fishable biomass/poor recruitment and the initiation of recovery in 2006. A status quo to marginal increase in TAC is recommended.
- The relative speed and strength of the recovery in each area will depend heavily upon how intensively the immature and soft-shell crab are fished out or harmed in the 2007 and 2008 seasons. Caution is still warranted for 2007.

BACKGROUND

Species Biology

Snow crab (*Chionoecetes opilio*, Brachyura, Majidae, O. Fabricius) is a subarctic species with a distribution from northern Labrador to near the Gulf of Maine. Habitat preferences are soft mud bottoms. Smaller crabs are found in more complex habitats with shelter. Commercial crab in large numbers are found at depths from 60 to 280 m and temperatures from -1 to 6 ° on the Scotian Shelf. Temperatures greater than 7 °C are known to be detrimental to snow crab. The primary food items of crab are shrimp, fish (capelin and lumpfish), starfish, sea urchins, worms, detritus, large zooplankton, other crabs, ocean quahaug, molluscs, sea snails, and sea anemones. Predators of snow crab are halibut, skates (especially thorny skate), cod, seals, American plaice, squids, and other crabs. Crab in the size range of 3 to 30 mm carapace width (CW) are particularly vulnerable to predation as are soft-shelled crab in the spring moulting season.

A female snow crab produces from 16,000 to 160,000 eggs in the spring which are brooded by the mothers for up to 2 years, depending upon ambient temperatures, food sources and maturity status. Eggs are hatched from late spring to early summer when they become pelagic (zoea stages 1 and 2 and the intermediate megalopea stage) feeding upon plankton. After 3 to 5 months in the pelagic stage, they settle to the bottom in late autumn and winter. In the early bottom dwelling postlarval stages ("instars"), crab moult approximately twice a year. Snow crab generally moult once a year from the 5th instar up to a terminal moult (instars 9 to 14 for males and 9 to 11 for females). Snow crab can become sexually mature by the 9th instar. Prior to the terminal moult, male crab may skip a moult in one year to moult in the next. Snow crab reach legal size by the 12th instar, representing an age of approximately 9 years since settlement to the bottom and 11 years since egg extrusion. Some males of instar 11 will also be within legal size.

Females begin to moult to maturity at an average size of approximately 55 mm CW and mate between winter/spring while the carapace is still soft (prior to the prosecution of the fishery in ENS). Complex behavioural patterns have been observed: the male helps the female remove her shell during her moult, protects her from other males and predators and even feeds her (indirectly). Pair formations (mating embrace where the male holds the female) have been seen to occur up to 3 weeks prior to mating. Upon larval release, males have been seen to wave the females about to help disperse the larvae. Females are selective in their mate choice and may die in the process of resisting mating attempts from unsolicited males. Males compete heavily for females and often injure themselves (losing appendages) while contesting over a female. Once terminally moulted, snow crab can live up to 6 years under optimal conditions. This means that females generally reproduce twice although a third cycle is possible under very good environmental conditions. The condition of the male deteriorates in the last two years of its life, a stage that is generally associated with a mossy and decalcified carapace.

Natural mortality rates of snow crab on the Scotian Shelf have not been estimated. However, mortality rates (including by-catch, illegal landings, soft-shell handling mortality, predation, agonistic behaviour, disease, old-age) for legal sized crab resident in the southern Gulf of St. Lawrence have been estimated to be within the range of 26 to 48 percent per annum. This may be an overestimate for the Scotian Shelf as very few natural predators for large snow crabs currently exist; soft-shell incidence is generally lower; and the number of mature females is lower resulting in reduced agonistic behaviour.

Fishery

The snow crab fishery in eastern Canada began in 1960 with incidental by-catches by groundfish draggers near Gaspé, Quebec. Its development was slow until the 1980s when it began expanding rapidly to become one of the largest fisheries in Canada (93,000 t in 2001).

On the Scotian Shelf, the fishery has been in existence since the late 1970s with landings at levels of less than 1,000 t. By 1979, this rose to 1,500 t subsequent to which the fishery declined substantially in the mid-1980s. A large pulse of recruitment to the fishery was observed in 1986. Landings increased to record-levels of approximately 10,000 t each year in the early 2000s (Figure 2). The spatial distribution of total landings has shifted from being mostly derived from inshore areas in the past (2000-2002) to presently being derived mostly from the offshore areas (Map 1). In 2006, total landings were 486 and 4,486 t in N-ENS and S-ENS, respectively (Tables 1 and 2). Relative to 2005 levels, this represents a decline of 14 and 30%, respectively. Both management areas reached their respective TACs.

Table 1: Summary of snow crab fisheries activity of N-ENS.

Year	Licenses	TAC (t)	Landings (t)	CPUE (kg/trap haul)	Effort (x1000 trap hauls)
1997	74	540	534	23.3	22.9
1998	74	660	657	41.6	15.8
1999	78	900	899	54.8	16.4
2000	79	1,015	1,017	68.3	14.9
2001	80	1,065	1,066	94.3	11.3
2002	80	1,493	1,495	101.0	14.8
2003	80	1,493	1,492	76.8	19.4
2004	79	1,416	1,418	60.6	23.4
2005	78	566	562	30.6	18.4
2006	78	487	486	35.6	13.7

Table 2: Summary of snow crab fisheries activity of S-ENS. Catch rates and trap hauls for 2001 to 2004 are calculated excluding slope area landings and effort as they were design-constrained trap surveys, however these landings are included in total landings and TACs. These slope allocations were for 200 t in 2001-2002 and 300 t in 2003-2004.

Year	Licenses	TAC (t)	Landings (t)	CPUE (kg/trap haul)	Effort (x1000 trap hauls)
1997	59	1,163	1,157	50.9	22.7
1998	67	1,671	1,558	68.9	22.6
1999	-	2,700	2,700	71.1	38.0
2000	158	8,799	8,701	85.0	102.4
2001	163	9,023	9,048	87.8	103.1
2002	149	9,022	8,891	111.7	79.6
2003	145	9,113	8,836	98.6	89.6
2004	130	8,241	8,022	105.6	76.0
2005	118.5	6,353	6,407	109.4	58.6
2006	111.2	4,510	4,486	90.6	49.4

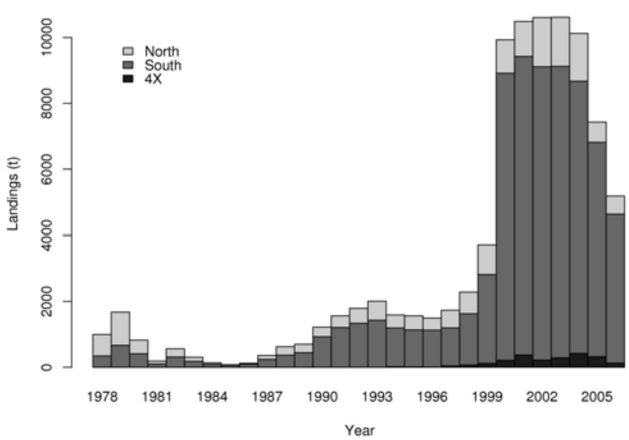


Figure 2: Temporal variations in the landings (t) of snow crab on the Scotian Shelf. Note the sharp increase in landings associated with large increases to TACs and a doubling of fishing effort in the year 2000. The landings follow the TACs with little deviation (and so are not shown).

The spatial distribution of fishing effort continued to increase in offshore areas and decline in inshore areas (Map 2). The effort on the offshore slope areas was minimal in 2006. In 2006, a total of 13,700 and 49,400 trap hauls were applied in N- and S-ENS, respectively. This represents declines of 26 and 15% respectively from 2005 (Tables 1, 2; Figure 3).

The catch rate for N-ENS was 35.6 kg/trap, a 16% increase from 30.6 kg/trap in 2005 (Table 1; Figure 4). In S-ENS, catch rates were 90.6 kg/trap, a 17% decline from 109.4 kg/trap in 2005 (Table 2; Figure 4). Catch rates declined in most areas, especially the near-shore areas (Map 3).

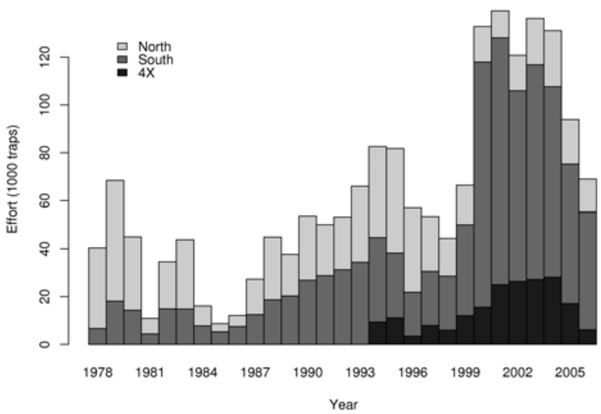


Figure 3: Temporal variations in the fishing effort, expressed as the number of trap hauls. Note the doubling of effort in the year 2000.

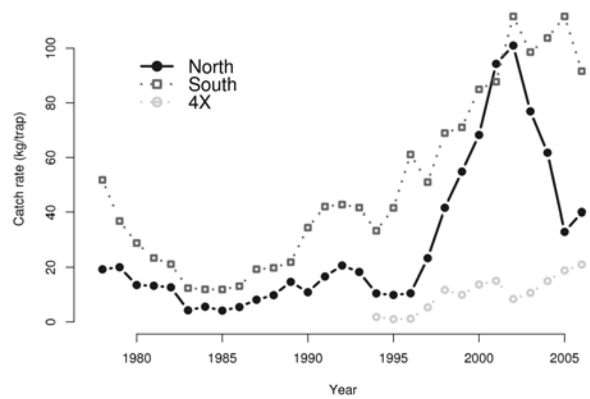


Figure 4: Temporal variations in catch rates of snow crab on the Scotian Shelf, expressed as kg per trap haul. Trap design and size have changed over time. No corrections for these varying trap-types nor soak time and bait-type have been attempted.

In N-ENS, the moult structure of legal-sized snow crab observed at sea was dominated by CC3 crab (71%). CC4 crab (14%) has been declining in relative abundance since 2004 (20%) indicating elevated exploitation rates in the area. CC5 crab increased in relative numbers marginally (from 0.8 in 2005 to 1.6% in 2006), however due to the low fishable biomass, the significance of this increase is likely minimal. With the decline in the fishable biomass, CC2 crab, has become an increasingly important component for N-ENS (Figure 5). That is, N-ENS is increasingly reliant upon new recruitment.

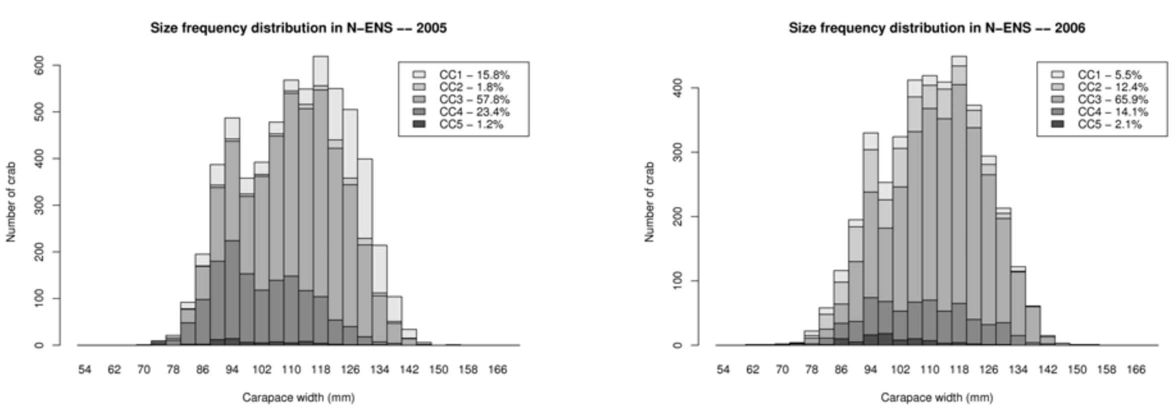


Figure 5: Size frequency distribution of at-sea-observer monitored male snow crab broken down by carapace condition in N-ENS.

In S-ENS, the moult structure of legal-sized snow crab observed at sea was also comparable between 2005 to 2006 (Figure 6). However, an increase in the proportion of CC2 males was found (from 4% to 17%) likely associated with the expected recruitment pulse. Hard-shelled crab dominated the catch: 69% CC3 and 7% CC4. However, the reduction in CC4 (18% in 2004 to 7.2% in 2006) and CC5 (0.7% in 2004 to 0.3% in 2006) suggests that exploitation rates may still be high in S-ENS.

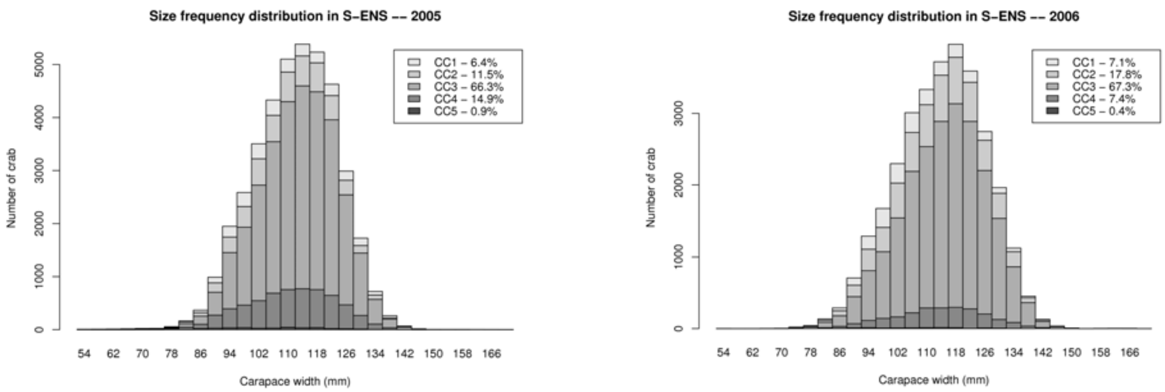


Figure 6: Size frequency distribution of at-sea-observer monitored male snow crab broken down by carapace condition in S-ENS.

Observed discard rates of sub-legal sized crab was 17.7% and 8% in N- and S-ENS, respectively. They represent improvements relative to the higher rates observed in 2005 of 34 and 21% in N- and S-ENS, respectively. The occurrence of soft-shelled crab (Figure 7) declined in N-ENS in 2006 (4.1%, relative to 18% in 2005). In S-ENS, soft-shelled crab incidence increased marginally to 6.2% (from 5.2% in 2005). The soft-shelled crab discard represents up to 20 t and 278 t being potentially killed from handling mortality alone in N- and S-ENS, respectively.

By-catch levels are very low in this fishery (0.025% of the TAC over the past three years), being primarily represented by other crab species (Northern Stone, Jonah, Toad) as well as some demersal fish such as wolffish and halibut. Leatherback turtle entanglement on buoy lines has been observed on occasion (3 cases in 3 years), but in all cases, they were released with little to no visible harm.

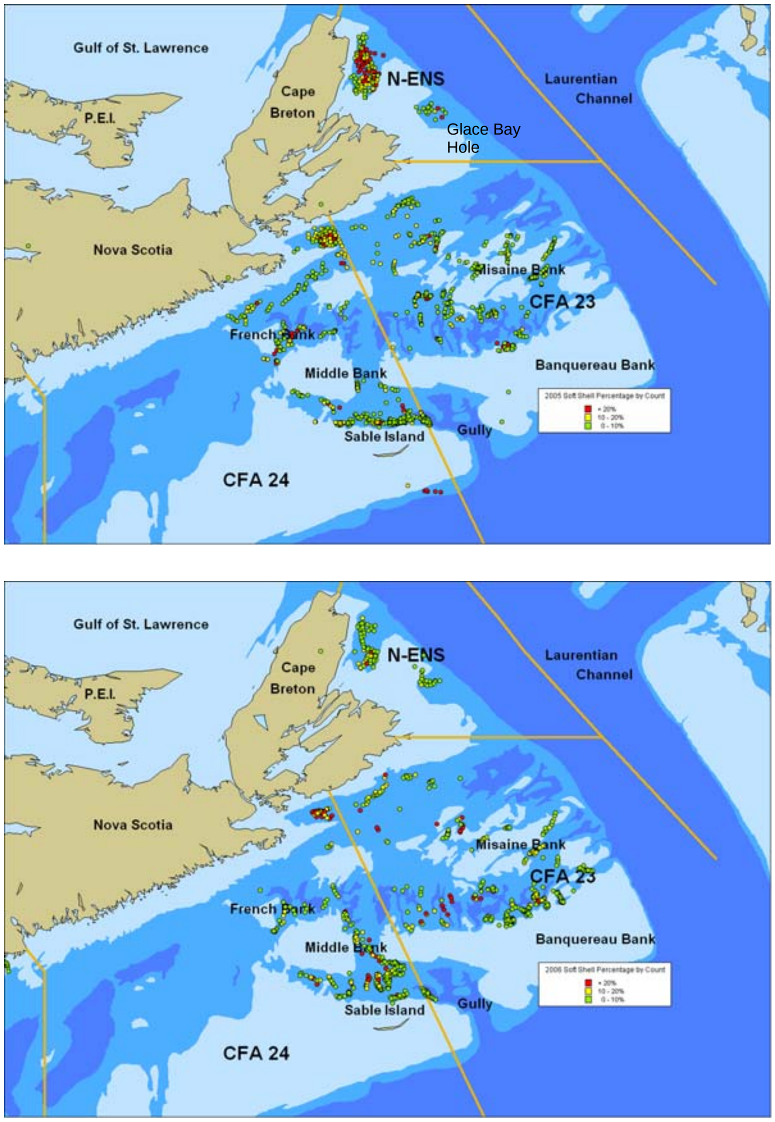


Figure 7. The occurrence of soft-shell crab in observed catches in 2005 (top) and 2006 (bottom).

ASSESSMENT

Stock Trends and Current Status

Fishable Biomass

In N-ENS, the recalculated 2006 post-fishery fishable biomass of snow crab (recalculated with new methods in 2007) was estimated to be 720 t (with a 95% confidence range of 580 to 880 t; Figure 8; Map 4); a 50% decline relative to the 2005 estimate of 1460 t. The declines were observed in all areas of N-ENS.

In S-ENS, the recalculated 2005 fishable biomass of snow crab was estimated to be 25,400 t (with a 95% confidence range of 23,400 to 27,500 t; Figure 8; Map 4); a 10% increase relative to the 2005 estimate of 23,100 t.

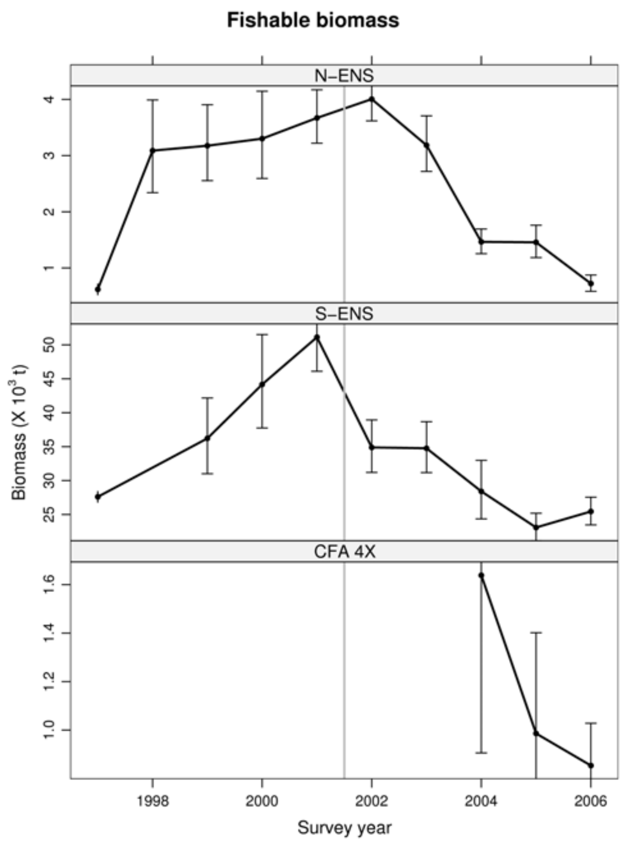


Figure 8. Fishable biomass over time from kriged estimates. Vertical line represents the shift in survey timing from spring to autumn.

Recruitment

The pulse of immature male crab detected in 2003 and 2004 continue to grow and propagate through the system (Figures 9 and 10a; Map 5). They are currently in the size class centered over the 54 mm CW mode (instars 9/10) which can be expected to fully enter the fishable biomass in 2010/2011. The leading edge of this mode has begun to enter into the fishable component, however the strength of this entry is stronger in S-ENS relative to N-ENS.

Low numbers of immature crab in size classes just prior to entry into the fishable biomass have been observed in most areas since 2000 (N-ENS) and 2002 (S-ENS). This recruitment bottleneck has dissipated in S-ENS. Currently, immature crab are observed spanning all size ranges from 40 to 110 mm CW. This is a positive sign for the S-ENS, in that a steady recruitment to the fishery is possible into the next five years. In N-ENS, the recruitment bottleneck continues to persist. However a very large abundance of immature crab exists that should begin a strong entry into the fishable biomass in 2008.

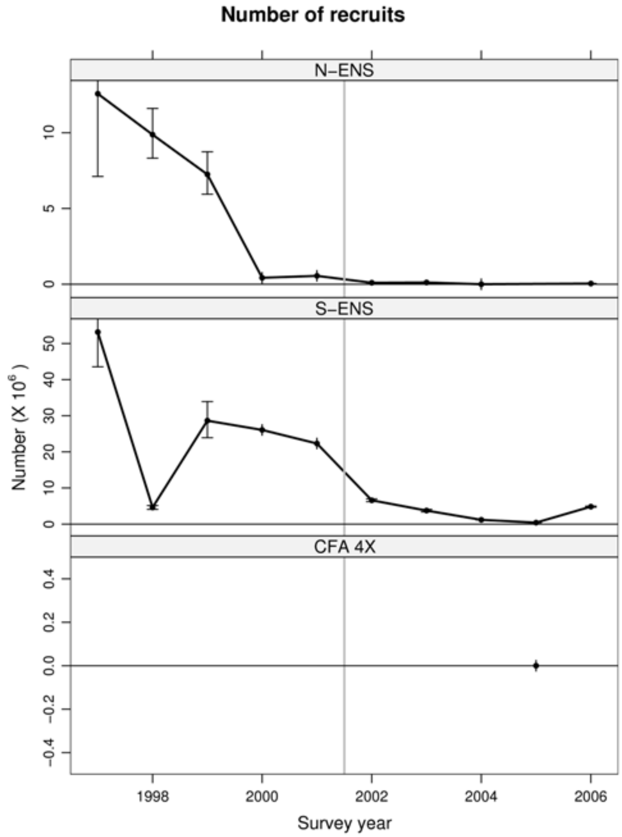


Figure 9. Recruitment (males larger than 95 mm CW and soft-shelled) expected into the mature stage in the next year. This expectation does not include immature males that will moult into the fishable sizes in the spring moult. As this recruitment has been low for the last 4 to 5 years, the fishery has been increasingly dependent upon immature males. Vertical line represents the shift in survey timing from spring to autumn.

Reproduction

The strong year-classes of immature females detected in 2003 in N-ENS and 2004 in S-ENS continued to grow and intensify in 2006 (Figure 10b). Large scale maturation of the female snow crab population was detected in 2005 and 2006. This trend should continue for another 4 to 6 years as the snow crab population has entered a very important reproductive mode. An increase in the number of berried females has also continued (Figure 11; Map 6). Larval production should therefore continue for at least another 5 years.

For the first time since the late 1990s, a more heterogeneous (mixed) distribution of sexes was observed: pockets of male dominated areas were mixed with pockets of female dominated areas (Figure 12, Map 7). During mating periods, mature crab would therefore be able find the other sex with minimal movement. Unfortunately, one reason for the increase in sex ratios in N-ENS is due to a decline in the number of *large mature* males, a situation that can have numerous negative consequences upon the future reproduction of the N-ENS snow crab population.

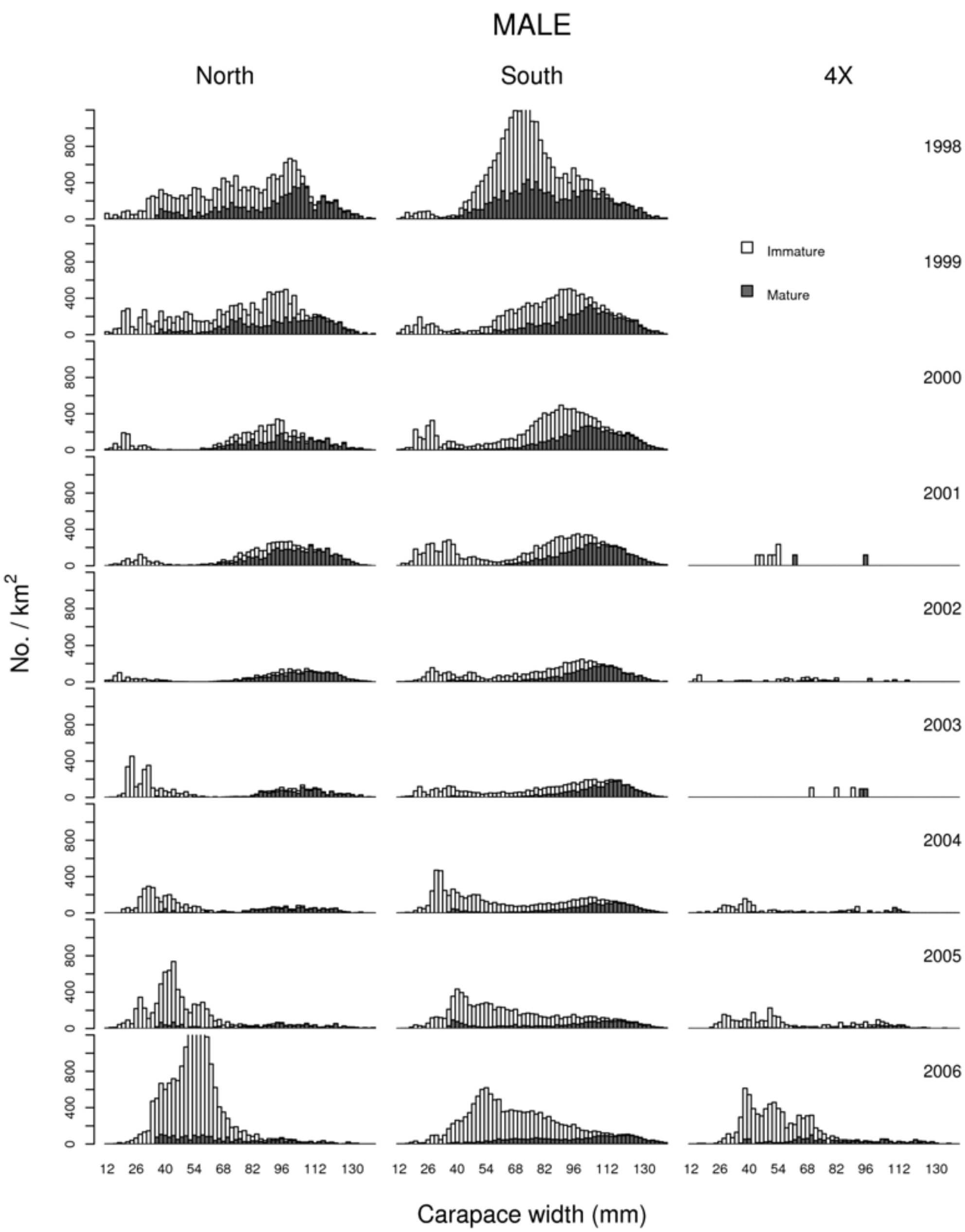


Figure 10a. Size-frequency histograms of carapace width of male snow crabs. Note the increasing numbers of juvenile crab, 2 to 4 years from entering morphometrically mature size classes. Note that for S-ENS and CFA 4X (but not N-ENS), the spatial extent of the surveys have changed over time, making a direct comparison of numerical density inappropriate. This figure provides information about the relative numbers within a given year.

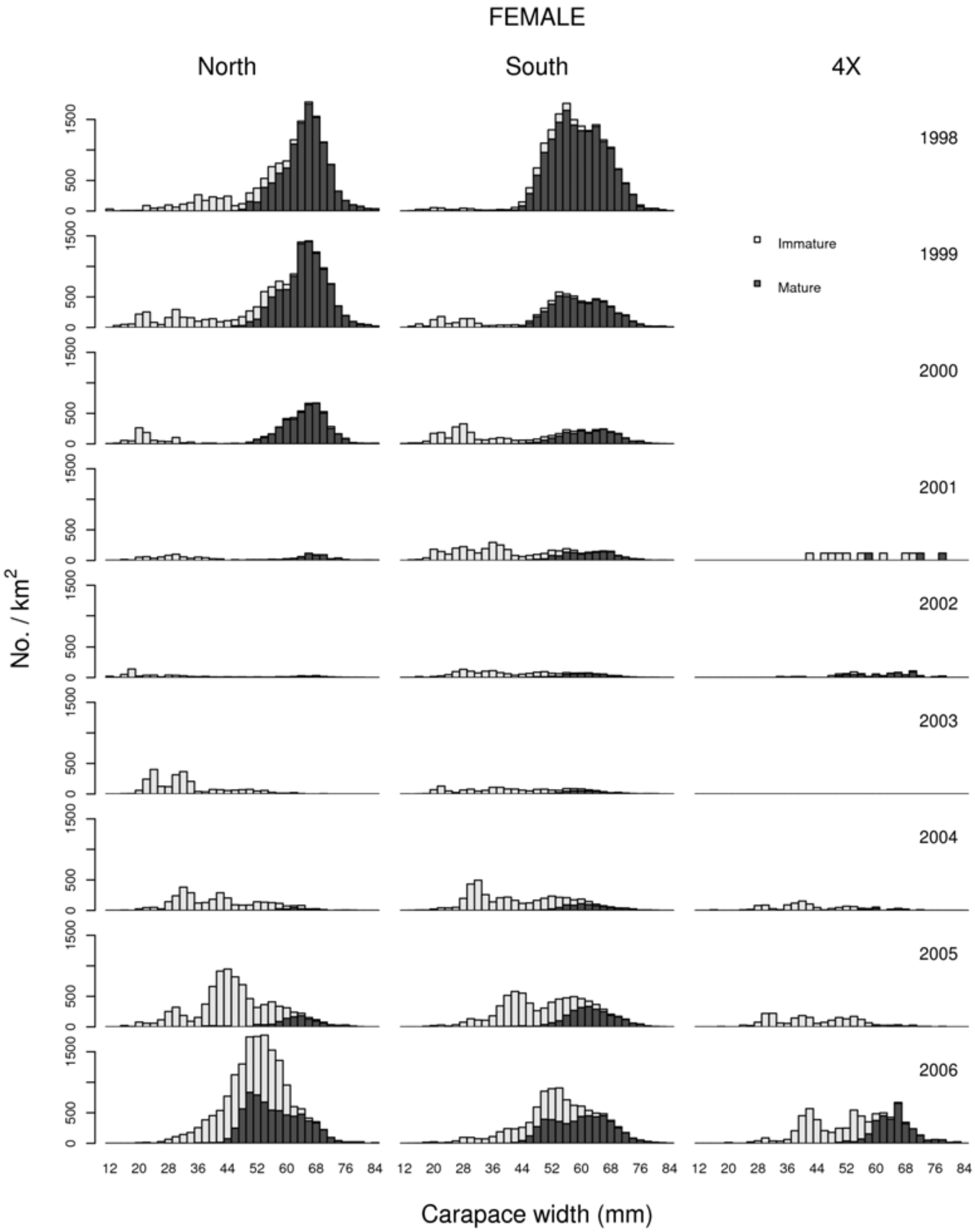


Figure 10b. Size-frequency histograms of carapace width of female snow crabs. Note that for S-ENS and CFA 4X (but not N-ENS), the spatial extent of the surveys have changed over time, making a direct comparison of numerical density inappropriate. This figure provides information about the relative numbers within a given year.

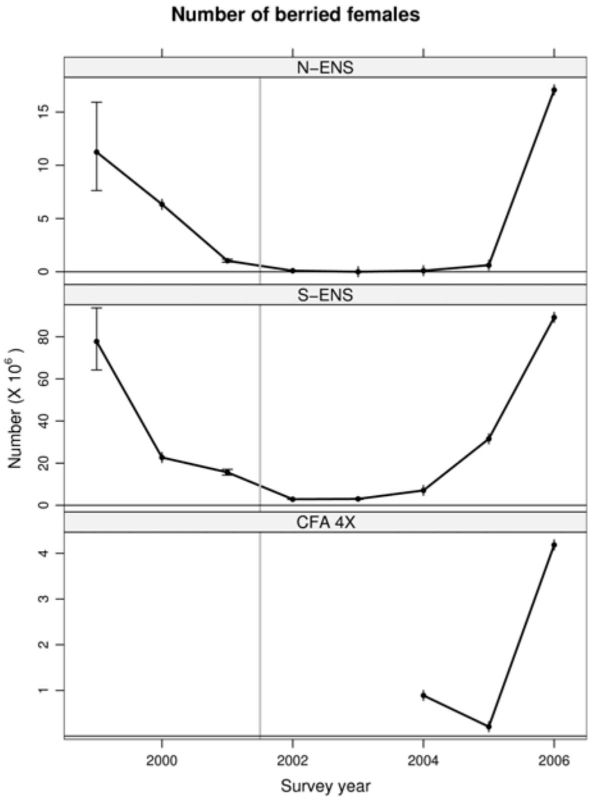


Figure 11. Numerical densities of the berried female snow crabs on the Scotian Shelf (number/km^2). Note the important increase seen since 2005 in all areas of the Scotian shelf. Vertical line represents the shift in survey timing from spring to autumn.

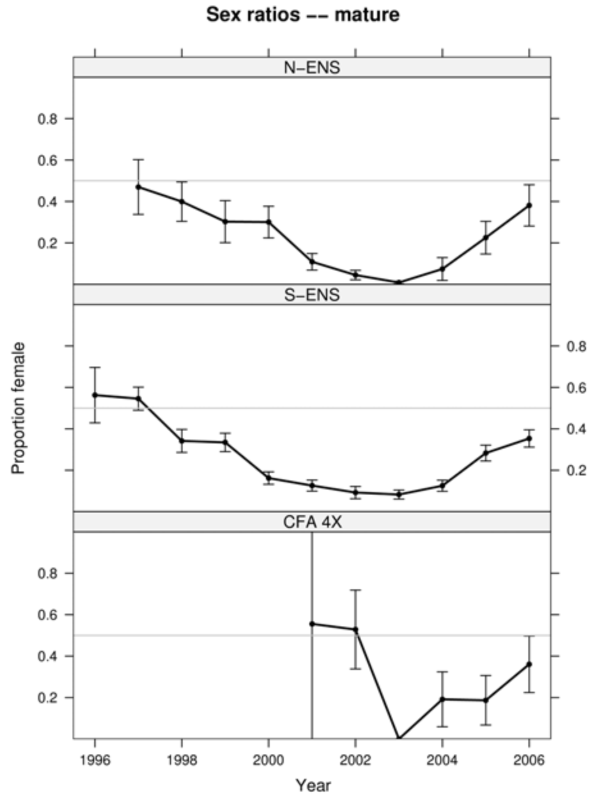


Figure 12. Sex ratios (% female) of mature snow crab. Since 2000, most of the Scotian Shelf was uniformly male dominated. A slight amelioration of the mature sex ratio was observed in 2004. This trend has continued and currently, the whole of the shelf can be seen to be entering a reproductive mode.

Exploitation Rate

The numerical abundance estimates of CC5 crab are currently below the detection limit on the Scotian Shelf. Their low representation in survey data and the fishery-observed data (generally less than 1%) may be indicative of high historical exploitation rates upon the hard-shelled phase.

Exploitation rates ($Landings_{(t)}$ / [$Landings_{(t)}$ + Fishable $biomass_{(t)}$]) in N-ENS increased to 43% from 30% in 2005. In S-ENS, exploitation rates have been stable between 15 to 20%; due to conservation concerns, the exploitation rate was reduced from 22% in 2005 to 15% in 2006 (Figure 13). This decrease in S-ENS was to meet the long-term concerns of conservation (reproductive output) and sustainability (fishable biomass).

Projections suggest that a 40% exploitation in N-ENS is not sustainable especially when recruitment is poor. A range between 10 to 30%, depending upon the strength of recruitment, may help ensure the longterm sustainability of this fishery. For S-ENS, projections suggest exploitation rates between 10 to 20% may ensure the longevity of the fishery, again depending upon the strength of recruitment.

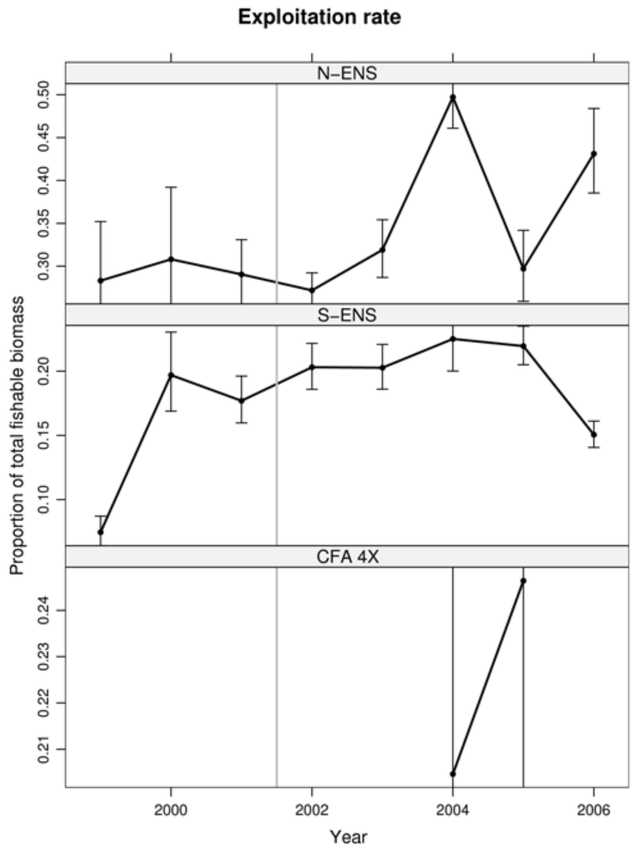


Figure 13. Relative exploitaiton rate (Landings$_{(t)}$ / [Landings$_{(t)}$ + Fishable biomass$_{(t)}$]) of snow crab. In S-ENS, exploitation rates have declines in 2006. Vertical line represents the shift in survey timing from spring to autumn.

Sources of Uncertainty

Environmental Variability

- The spatial extent of potential snow crab habitat based upon bottom temperature and depth preferences, has been stable in N-ENS (Figure 14). For S-ENS, the surface area of potential habitat in 2006 has declined to near the 36 year mean.

- An overall warming of the above habitat space has been occurring since the early 1990s in all areas. In 2006, mean average autumn bottom temperatures were above average in all areas: 3.6 and 3.8 °C in N- and S-ENS, respectively (Figure 15). Warm-water incursions into the offshore-slope areas were also marked, forcing most crab in the area to move or die. These temperature forcings were likely responsible for alterations in the life cycle of the crab in these areas, potentially accelerating their moult cycles and the capture of soft-shelled crab in these warmer areas.

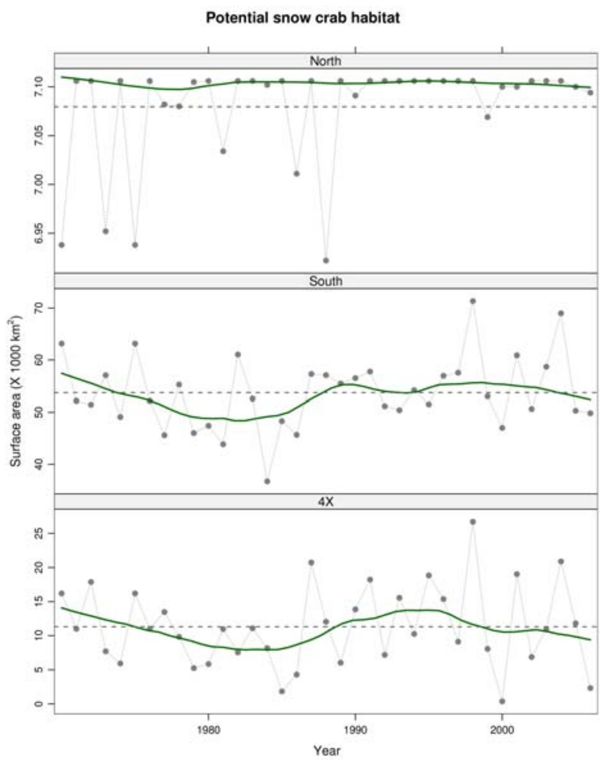


Figure 14. Total surface area of the potential habitat space of snow crab. Increased oscillations are evident since the late 1990s in S-ENS while in 4X, this increase is evident since the mid-1980s.

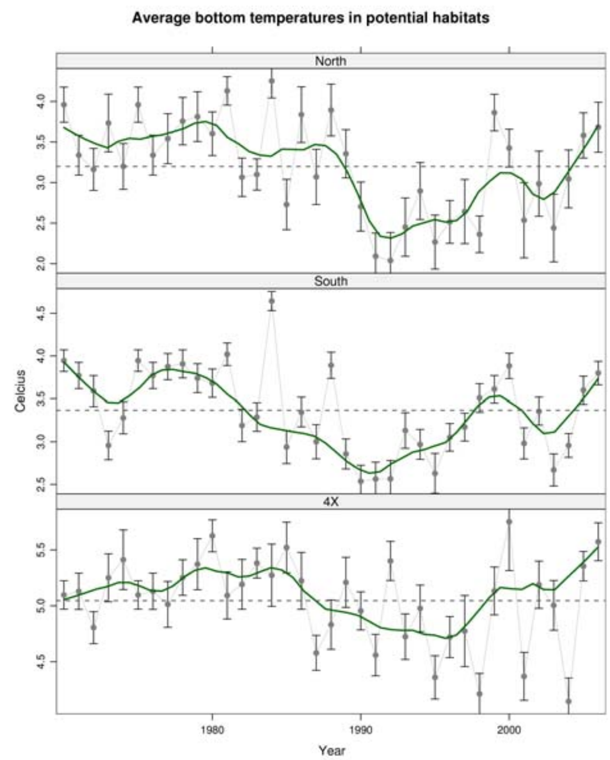


Figure 15. Mean summer/autumn bottom temperatures within the potential habitat space of snow crab. Mean temperatures seem to be increasing in ENS since the cool period of the 1990s. Note the extreme short-term fluctuations in mean temperatures in the 2000s in the 4X area.

<u>Bottom-up (resource limitation)</u>

- Food items such as northern shrimp are found in concentrations comparable to the historical average in most core areas (based on snow crab trawl survey; Map 8).

<u>Top-down (predation)</u>

- Potential predators of immature and soft-shelled crab have been found in high relative densities (based on snow crab trawl survey) in areas with high densities of immature snow crab (Map 9). This adds uncertainty to the strength of future recruitment into the fishable biomass.

<u>Lateral (competition)</u>

- Large mature males stabilize the snow crab population by maintaining and occupying prime crab habitats, which keep at bay potential competitors in the guise of other crabs or even groundfish and serve as large and strong mates and protectors of the smaller females. Their over-exploitation can have numerous negative biological consequences.

Internal (population dynamic)

- An important consequence of the extended period of very low sex ratios observed in the early-2000s throughout the Scotian Shelf is that very poor egg and larval production in the system likely occurred for at least a four to five year period. Poor recruitment into the fishable biomass may occur again in the early 2010s. Stabilisation of such strong oscillations in abundance into the future may be possible if reproduction of the currently available females is not hampered by a lack of large males.

- A recruitment bottleneck continues to persist in N-ENS. The cause is not known.

Human Influences

- Oil and gas development/exploitation on the Scotian Shelf near to or upstream of major crab fishing grounds and population centers (both N- and S-ENS) is a concern. The effects of seismic methods of exploration upon potentially vulnerable components of the snow crab population (eggs, larvae, soft-shelled crab) and the uncertainties associated with the long-term biological effects of development upon this long-lived species are still not known. In particular, seismic exploration occurred in November 2005 (Hunt Oil) immediately over the Glace Bay Hole and the shallows of Sydney Bight where immature and female crab are abundant, even after objections being presented against the proposal and urging of a precautionary approach from DFO snow crab science. The long-term consequences of this action are completely uncertain.

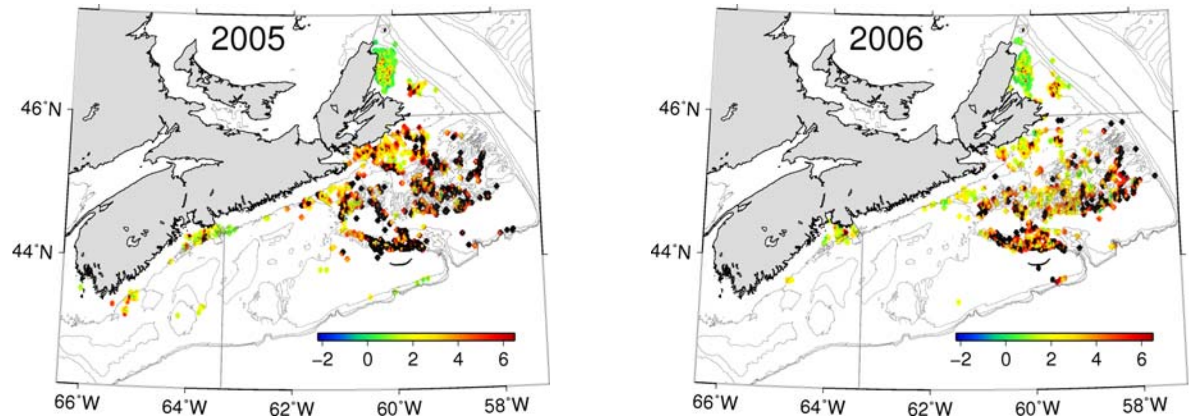
- By-catch from other fisheries is still not quantified. Damage from trawls, especially upon the soft-shelled phases of snow crab is potentially problematic.

CONCLUSIONS AND ADVICE

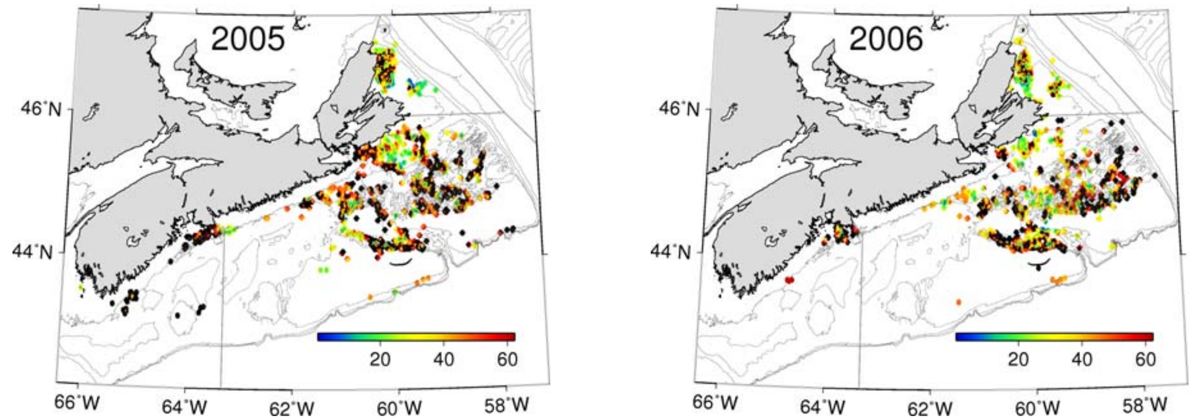
Soft-shelled crab catches and associated handling mortality are expected to be higher than the historical average until 2011. A rapid response by industry to the presence of high catches of soft-shelled crab is required. Continued refinement of the soft-shell protocol is suggested and adoption of the new approach by industry in essential.

The N-ENS fishable biomass continues to decline. The 2006 cuts in TAC were insufficient to bridge the gap between the past declines in fishable biomass/poor recruitment and the beginning of recovery that was expected in 2007. This expected initiation of recovery in 2007 is uncertain and will depend heavily upon how intensively the immature and soft-shell crab are fished out or killed in the 2007 season. Caution is warranted in 2007 for N-ENS. A decrease in TAC is recommended.

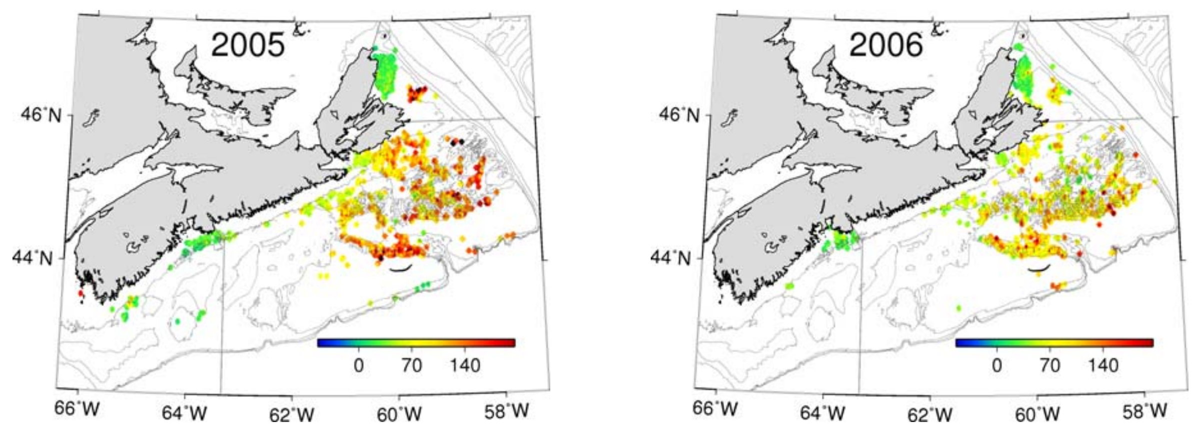
The S-ENS fishable biomass increased for the first time since the early 2000s. The 2006 TAC reductions were sufficient to bridge the gap between the past declines in fishable biomass/poor recruitment and the initiation of recovery in 2006. The expected initiation of recovery has begun and will continue more strongly into 2007. However, the danger of over-exploiting incoming recruits increases if TACs are set too high. Until all uncertainties associated with the predicted recruitment are resolved and the strength of the recruitment is actually seen, a continued conservative approach is recommended. A status quo to a marginal increase in TAC is recommended.



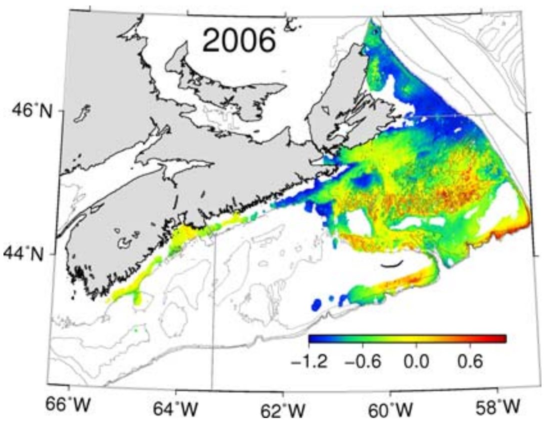
Map 1. Commercial landings (log10; metric tons) in the 2005 and 2006 fishing seasons. Areas in black are off the scale. Original figure in colour.



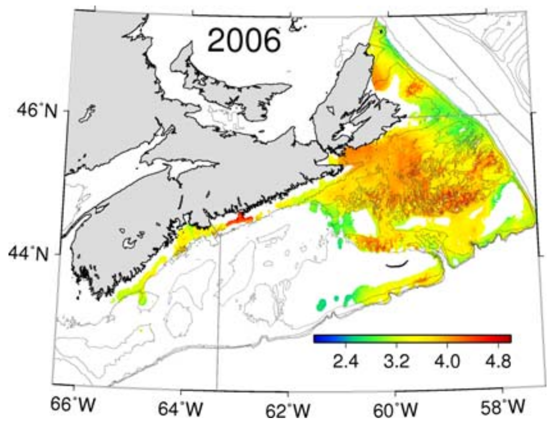
Map 2. Commercial fishing effort from reported logbook positions (total number of trap hauls) in the 2005 and 2006 fishing seasons. Note the reduction in effort in the offshore slope and the near shore in the former CFA 24E. Areas in black are off the scale. Original figure in colour.



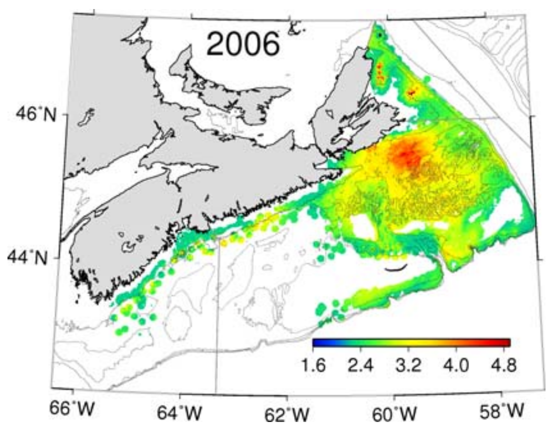
Map 3. Average catch rates (kg/trap haul) of snow crab on the Scotian Shelf in 2005 and 2006. Original figure in colour.



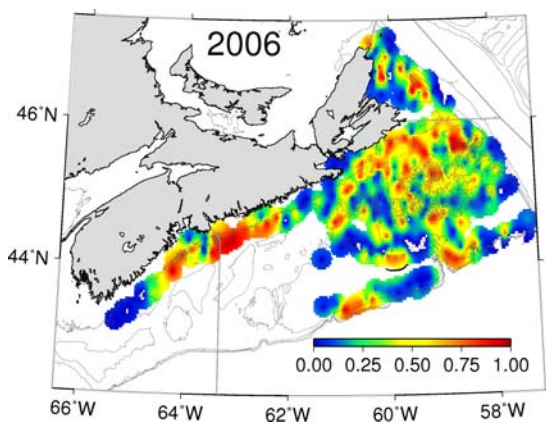
Map 4. Fishable biomass after the 2006 fishery. Log 10 scale. Original figure in colour.



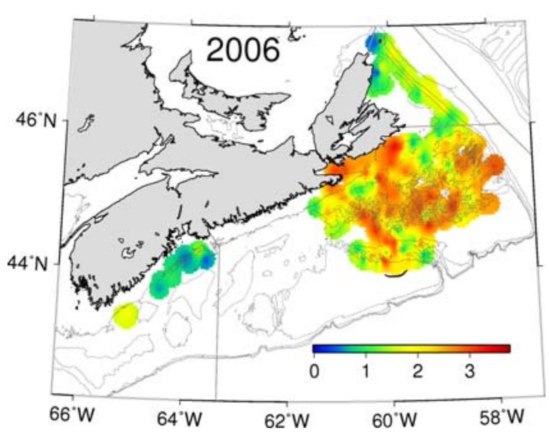
Map 5. Numerical abundance of immature male snow crab. Log 10 scale. Original figure in colour.



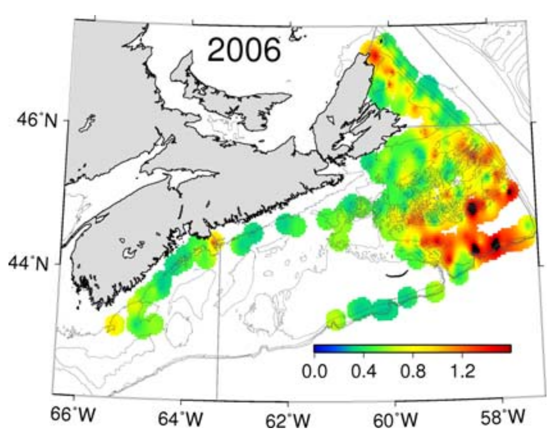
Map 6. Numerical abundance of berried female snow crab. Log 10 scale. Original figure in colour.



Map 7. Proportion female in the mature population. Note the heterogeneous distribution of sexes in all areas. Original figure in colour.



Map 8. Number of shrimp, a food item of snow crab. Log 10 scale. Original figure in colour.



Map 9. Number of thorny skate, a predator of snow crab. Log 10 scale. Original figure in colour.

SOURCES OF INFORMATION

Choi, J.S., and B.M. Zisserson. 2007. Assessment of the 2006 snow crab resident on the Eastern Nova Scotian Shelf. DFO Can. Sci. Advis. Sec. Res. Doc. 2007/017.

FOR MORE INFORMATION

Contact: Jae S. Choi / Ben M. Zisserson
Population Ecology Division
Bedford Institute of Oceanography
1 Challenger Drive, Dartmouth, N.S., B2Y4A2

Tel: (902) 426-1616 / 9325
Fax: (902) 426-1843
E-Mail: ChoiJ@mar.dfo-mpo.gc.ca / ZissersonB@mar.dfo-mpo.gc.ca

This report is available from the:

Centre for Science Advice,
Maritimes Region and Gulf Region
Department of Fisheries and Oceans
P.O. Box 1006, Stn. B203
Dartmouth, Nova Scotia
Canada B2Y 4A2

Phone number: 902-426-7070
Fax: 902-426-5435
e-mail address: XMARMRAP@mar.dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas

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