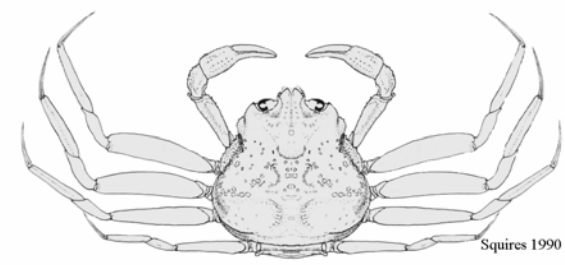
Fisheries and Oceans Canada | Pêches et Océans Canada
Science | Sciences
Gulf Region
Canadian Science Advisory Secretariat
Science Advisory Report 2007/022

ASSESSMENT OF SNOW CRAB IN THE WESTERN GULF OF ST. LAWRENCE (AREA 19)



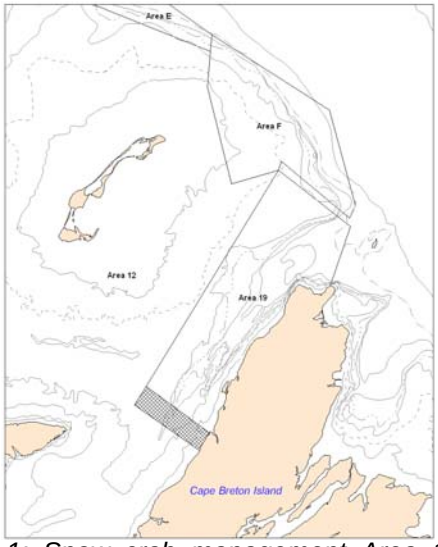


Figure 1: Snow crab management Area 19, the southeastern part of Area 12 and the 5-mile buffer zone (shaded area).

Context

Snow crab, Chionoecetes opilio, has been commercially exploited in the southern Gulf of St. Lawrence (sGSL) since the mid 1960s. In 1978, Area 19 (Figure 1) was established for the exclusive use of Cape Breton inshore fishermen with vessels less than 13.7 m (45 feet) in length. The number of permanent license holders increased throughout the years from 14 in 1978 to 74 in 1995.

Landings, controlled by annual quota, ranged from 900 to 1,390 t between 1979 and 1991. The quotas from 1992 to 1994 were set at 1,686 t. In 1995, 37 temporary (one year) license holders using 25 inshore vessels fished 134 t of the total quota of 1,577 t. In 1996, the 37 temporary license holders were converted into permanent licenses and the 111 permanent license holders fished a quota of 1,343 t. The landings then gradually increased to reach 3,279 t in 2002. In 2004, despite the highest commercial biomass index observed in Area 19 from the 2003 fall trawl survey, the 2004 landings did not reach the quota (landings of 3,894 t representing 76.5% of the total quota). Since 2005, the quota in Area 19 is allocated based on the commercial biomass index estimated from the June trawl survey. Landings reached 2,827 t. and 1,989 t in 2005 and 2006, respectively.

In support of the fishery, DFO Gulf Region Fisheries and Aquaculture Management requests from DFO Science an assessment of the resource status and the consequences of various harvest levels for the coming fishing season. This document is a scientific overview of the assessment undertaken in support of the 2007 fishery. Commercial catch rates and other fishery statistics in the 2006 fishery are reported. An assessment of the status of Area 19 snow crab up to the end of the 2006 is made from fishery independent surveys using indicators of : abundance (fishable biomass index); reproductive potential (numerical abundance of mature females); recruitment; and exploitation rates (relative biomass exploitation rates and empirical exploitation rates).

SUMMARY

- Final advice will be provided following the June trawl survey (prior to the opening of the fishing season).
- Crabs in management Areas 12, E, F and 19 are part of a larger biological population and the southern Gulf has to be considered as one unit for biological and assessment purposes.
- The 2006 landings in Area 19 were 1,989 t (quota of 2,000 t).
- The partially standardized CPUE increased from 68.7 kilograms per trap haul (kg/th) in 2005 to 84.4 kg/th in 2006.
- The 2006 fall survey biomass index of commercial-sized crabs was 4,285 t (2,910 t – 6,090 t), which represents an increase of 13% compared to the 2005 fall estimate of 3,802 t (2,890 t – 4,912 t).
- The recruitment to the fishery estimated at 2,519 t (1,443 t – 4,096 t) represents 59% of the 2006 fall survey commercial biomass index.
- The prerecruits ≥ 56 mm CW (R-4, R-3 and R-2) observed in the 2006 trawl survey increased in Area 19 compared to 2005, which may indicate an increase in the commercial biomass index in the near future if these crabs stay within the zone after reaching the legal size.
- The commercial biomass index estimates based on the fall trawl survey may not reflect the fishable stock at the time of the fishery 8-10 months later; movement of commercial-sized adult males occurs between Areas 12 and F to Area 19 such that in some years the biomass supporting the fishery in the year after the survey was much larger than estimated by the survey, and in other years, it was smaller. The June survey, immediately prior to the July fishery provides a more reliable biomass estimate.
- Empirical exploitation rates were calculated based on the ratio between the landings during the year and the sum of the landings and the residual biomass of the same year. Since 2000, exploitation rates calculated this way varied between 43 and 62% and are considered high compared to other snow crab fishery.
- Limits and target reference points and comprehensive harvest control rules need to be developed and tested jointly by scientists, fishery managers and the fishing industry for the biological unit in the southern Gulf in the context of existing management areas.

BACKGROUND

Species Biology

Snow crab (*Chionoecetes opilio*) is a crustacean 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 8 to 10 months. ‘White-crab’ is defined by shell hardness (<78 durometer units). The term ‘white crab’ describes both new-soft (condition 1) and clean hard-shelled crab (condition 2).

Unlike lobsters, snow crabs do not continue to moult throughout their lives. Females stop growing when they acquire a wide abdomen for carrying eggs, which occurs at shell widths less than 95mm. Males stop growing when they acquire large claws on the first pair of legs, which can occur at shell widths between 40 and 150 mm. Females produce eggs that are carried beneath the abdomen for approximately 2 years. The eggs hatch in late spring or early summer and the newly-hatched crab larvae spend 12-15 weeks floating freely in the water column. At the end of this period, they settle on the bottom. It takes at least 8-9 years for males to reach legal size.

Fishery

The minimum legal shell carapace width (CW) is 95 mm, and females are not kept by industry. Baited traps, constructed of wire or tubular steel, are used to catch crab, mainly on mud or sand-mud bottoms at temperatures ranging from -0.5 to 4.5°C and depths ranging from 50 to 280m. The fishery takes place in late summer in Area 19. 'White-crabs' are not harvested.

In 2003, Area 18 was integrated to Area 12 and a 5 nautical miles no fish buffer zone was implemented between Area 18 and Area 19 (Figure 1). Management of this fishery is based on quotas and effort controls (number of licenses, trap limits and seasons).

The 2006 regular fishing season opened on July 10 and ended on August 21 with reported landings of 1,989 t (quota of 2,000 t) (Figure 2). This quota was set from a pre-season trawl survey conducted in June 2006 based on a 45% exploitation rate of a commercial biomass index estimated at 4,443 t (3,565 t – 5,471 t).

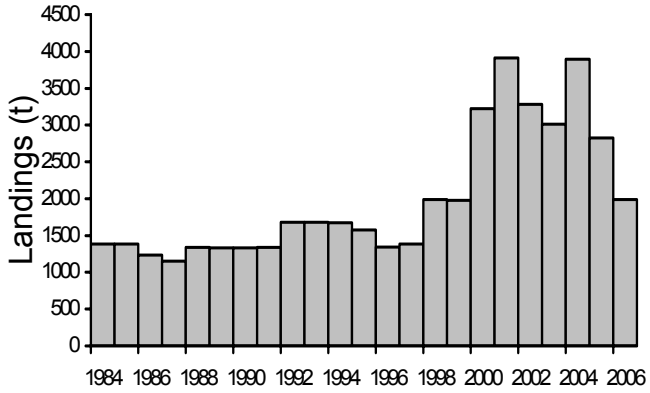


Figure 2: Landings (t) in Area 19 snow crab fishery.

The fishery indicators were generally good during the 2006 fishing season. The partially standardized mean catch-per-unit-of-effort (CPUE) (soak time is not taken into account) increased from 68.7 kg/trap haul (kg/th), in 2005 to 84.4 kg/th in 2006 while the fishing effort decreased from 41,892 trap hauls (th) in 2005 to 23,566 th in 2006 (Table 1). The annual percentage of 'white-crabs' slightly decreased in 2006 (8.3%) compared to 2005 (9.8%) (Table 1). Two sectors were closed within Area 19 on July 28 due to high incidences of 'white-crabs' in catches during the 2006 fishery. The mean size of commercial adult males increased from 114.0 mm CW in 2003 to 116.5 mm CW in 2006 (Table 1).

Table 1. Quota, Landings, Fishing Effort and Catch Performance in Area 19.

	2002	2003	2004	2005	2006
Quota (t)	3,285	3,106	5,092	2,878	2,000
Landings (t)	3,279	3,103	3,894	2,827	1989
CPUE (kg/trap haul)	43,662	29,952	56,517	41,512	23,566
Effort (# of trap hauls)	72.3	103.6	68.9	68.7	84.4
Mean size (mm)	110.0	114.0	113.9	116.1	116.5
'White-crab' (%) in catches	3.5	3.7	7.1	9.8	8.3

The fishing effort during the 2006 season was concentrated mostly in the southern and central parts of Area 19 where the highest CPUE were observed.

Carapace condition (Table 2) was estimated from sea samples taken from the 2006 fishery. The percentage of commercial-sized adult males with carapace conditions 1 and 2 in commercial catches has continuously decreased from 2000 (16.6%) to 2003 (4.9%), but has increased to around 15.0 % in 2004 and 2005. The percentage of these crabs decreased to 11.1% in 2006. The percentage of crabs with carapace condition 3 has increased from 26.9% in 2000 to 80.4% in 2003, decreased to 69.5% in 2004 but increased to 83.8% in 2006. Conditions 3 and 4 combined, represented 88.7% of the catches in 2006. The percentage of commercial-sized adult males with carapace condition 5 remained low in 2006.

Table 2. Composition (%) of the catch of commercial-sized adult crabs by carapace condition for Area 19.

Condition	1 & 2	3	4	5
Description	'White-crab'	Intermediate	Old	Very Old
2000	16.5	26.9	55.8	0.8
2001	8.3	31.3	60.1	0.3
2002	8.7	70.2	20.6	0.5
2003	4.9	80.4	14.5	0.2
2004	15.7	69.5	14.3	0.5
2005	15.2	73.9	10.6	0.3
2006	11.1	83.8	4.9	0.2

ASSESSMENT

Stock Trends and Current Status

Fishable Biomass

Conclusions about stock status are primarily based on annual trawl surveys conducted during July to October, which provide an index of commercially exploitable biomass (hard-shelled adult males of legal size) remaining immediately after the fishery. They also provide estimates of soft-shelled adult males larger than 95 mm CW (R-1) that will be new recruits to the fishery the following fishing season. Abundance indices are estimated for future male recruitment to the fishery (prerecruits defined as R-4, R-3 and R-2). The prerecruits R-4, R-3 and R-2 represent male crabs with a carapace width range of 56-68, 69-83, and larger than 83 mm CW, respectively. A portion of these crabs could be available to the fishery in 4, 3 and 2 years, respectively. An abundance index of total adolescent males larger than 56 mm CW (R-4, R-3 and R-2 combined) is also estimated and used as an index of the incidence of white crabs that may enter commercial traps the following fishing season.

Indices of future and current spawning stock abundance are estimated using female abundance estimates (pubescent and mature). The term pubescent refers to females with a narrow abdomen and orange gonads that will molt to maturity and mate the following year and become primiparous females (first brood). The term 'multiparous' refers to females which are carrying a brood for the second time or more. The term 'mature female', includes primiparous and multiparous females (excluding senile females).

The 2006 fall trawl survey indicates a commercial biomass index at the time of the survey of 4,285 t (2,910 t – 6,090 t) (Figure 3), which represents an increase of 13% compared to the

2005 fall trawl survey estimate of 3,802 t (2,890 t – 4,912 t). The recruitment to the fishery at the time of the 2006 fall survey estimated at 2,519 t (1,443 t – 4,096 t) represents 59% of the commercial biomass index. The concentrations of the fall 2006 trawl survey commercial biomass were located in the middle and the southern part of the area (Figure 4).

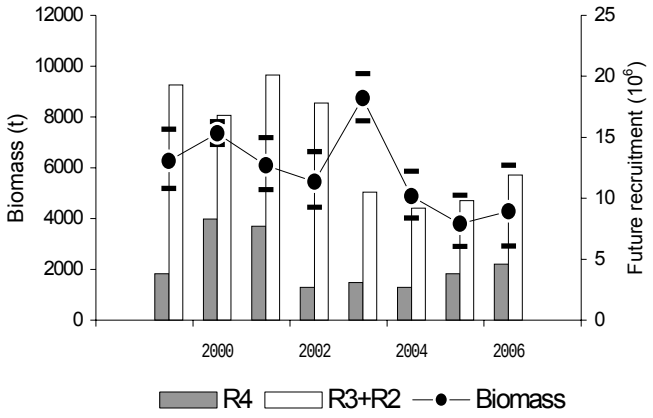


Figure 3: Survey biomass index (t) with a 95% confidence interval and abundance of future recruitment in Area 19.

An increase in abundances of prerecruits R-4 and R-2 and a decrease in abundance of R-3 were observed from the 2006 trawl survey (Figure 3). The increase in abundance of prerecruits R-4, R-3 and R-2 could be an indicator of high incidences of soft-shelled crabs in catches if the fishing effort is too high next year (Figure 5).

However, the commercial biomass index estimates based on the fall trawl survey may not reflect the fishable stock at the time of the fishery 8-10 months later. Movement of commercial-sized adult males occurs between Areas 12 and F to Area 19 (with relatively small fishing surface) such that in some years the biomass supporting the fishery in the year after the survey was much larger than estimated by the survey, and in other years, it was smaller.

In 2004, the fishery was prematurely closed with reported landings of 3,894 t (77% of the quota of 5,092 t), despite the fact that the 2003 fall survey estimated the highest commercial biomass index (8,083 t) ever recorded in that zone. However, towards the end of the fishing season, catch rates were declining, the incidence of 'white-crab' in catches was increasing, and there was uncertainty about possible emigration out of Area 19 by biomass that had contributed to the survey estimate the preceding fall. By comparing the commercial biomass index from the 2003 fall survey done after the fishing season and the 2004 June trawl survey conducted few days before the regular fishing season, the commercial biomass index decreased by 42% from 8,083 t in fall 2003 to 4,712 t in June 2004. In contrast, a 45% increase in the commercial biomass index was observed between the 2004 fall survey estimates (4,113 t) and the 2005 June survey (5,981 t). These differences in commercial biomass indices between the fall (after the fishery) and spring (just few days before the fishery) trawl surveys show the difficulty in estimating adequately the commercial biomass index for the July fishery based on the fall survey.

Given the size frequency distribution observed in survey catches for Area 12 a decline in commercial biomass index is expected in Area 12 until 2011. Consequently, the abundance of commercial-sized adult males in Area 19 may be negatively affected to the extent that commercial crab show a net migration from Area 12 to 19 when densities are higher in Area 12, or from Area 19 to 12, when densities are higher in Area 19.

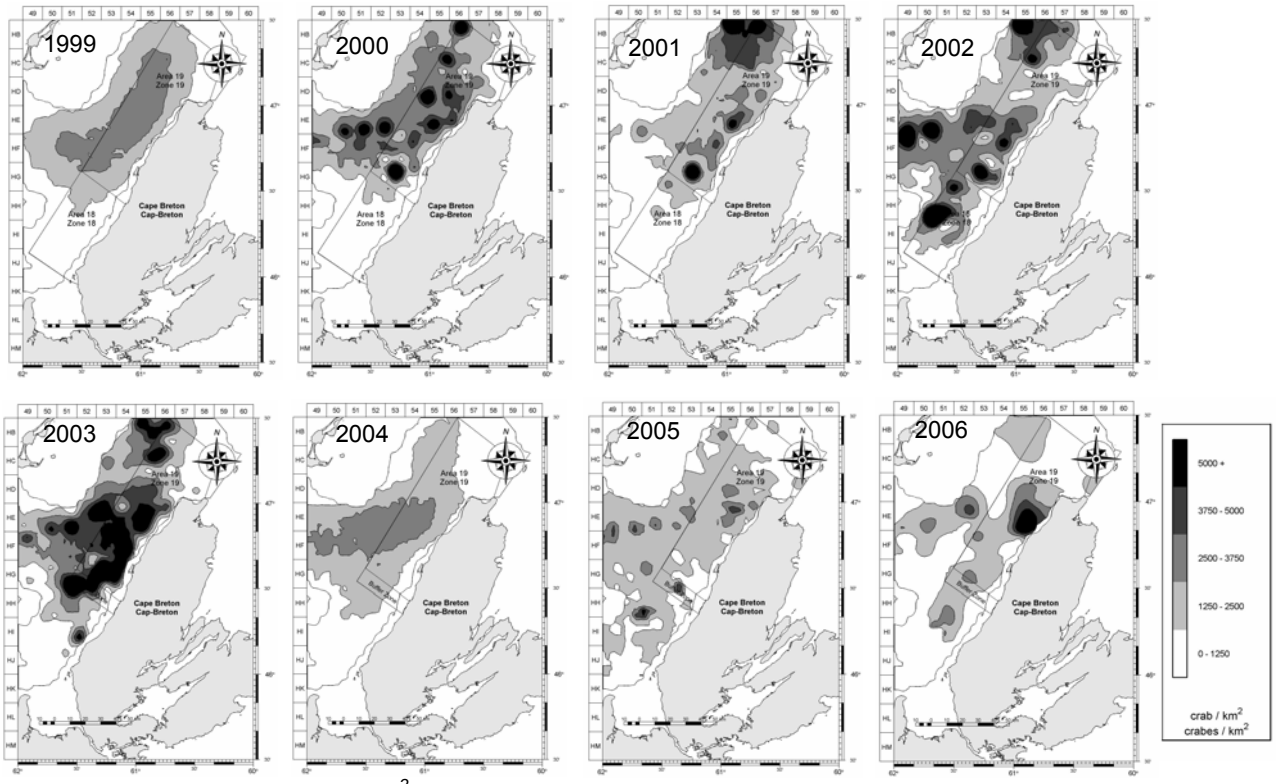


Figure 4: Density (number per km^2) contours of adult male crab ≥95 mm CW based on the trawl survey between 1999 and 2006 in the southeastern Gulf of St. Lawrence.

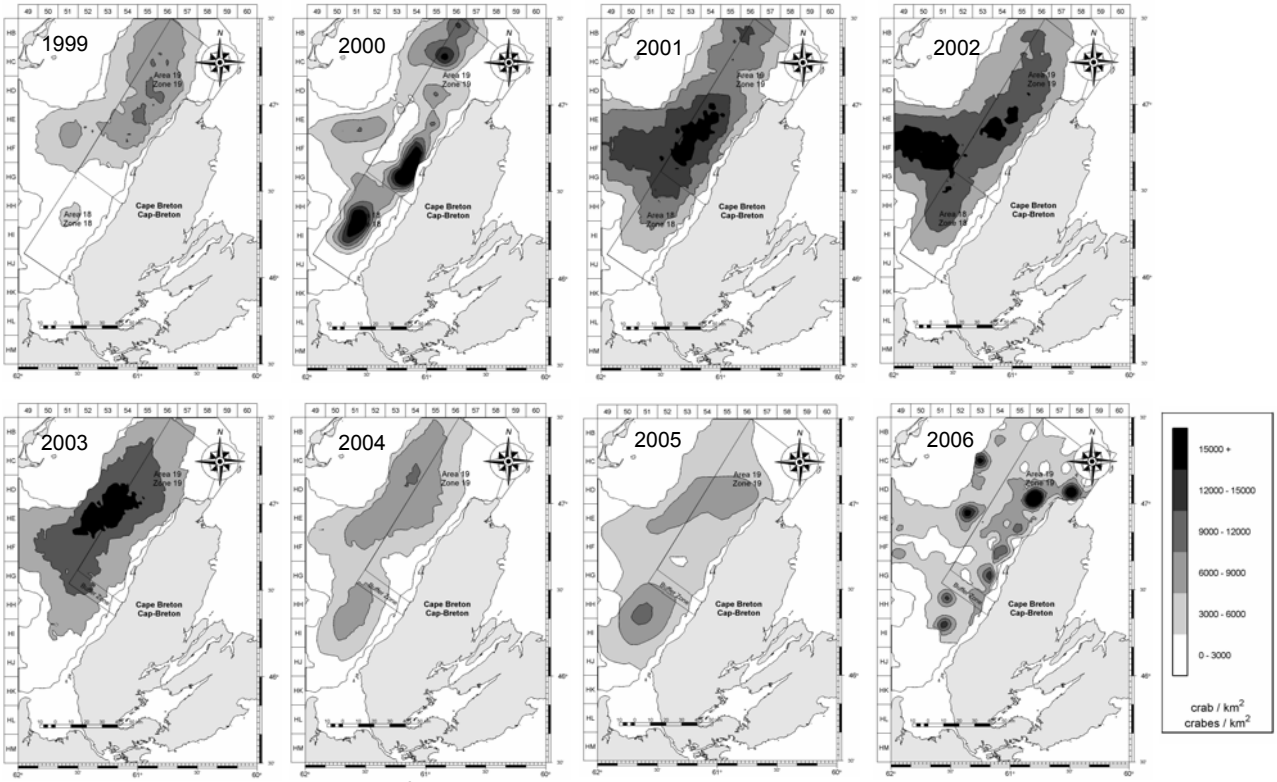


Figure 5: Density (number per km^2) contours of adolescent male crab ≥ 56mm CW based on the trawl survey between 1999 and 2006 in the southeastern Gulf of St. Lawrence.

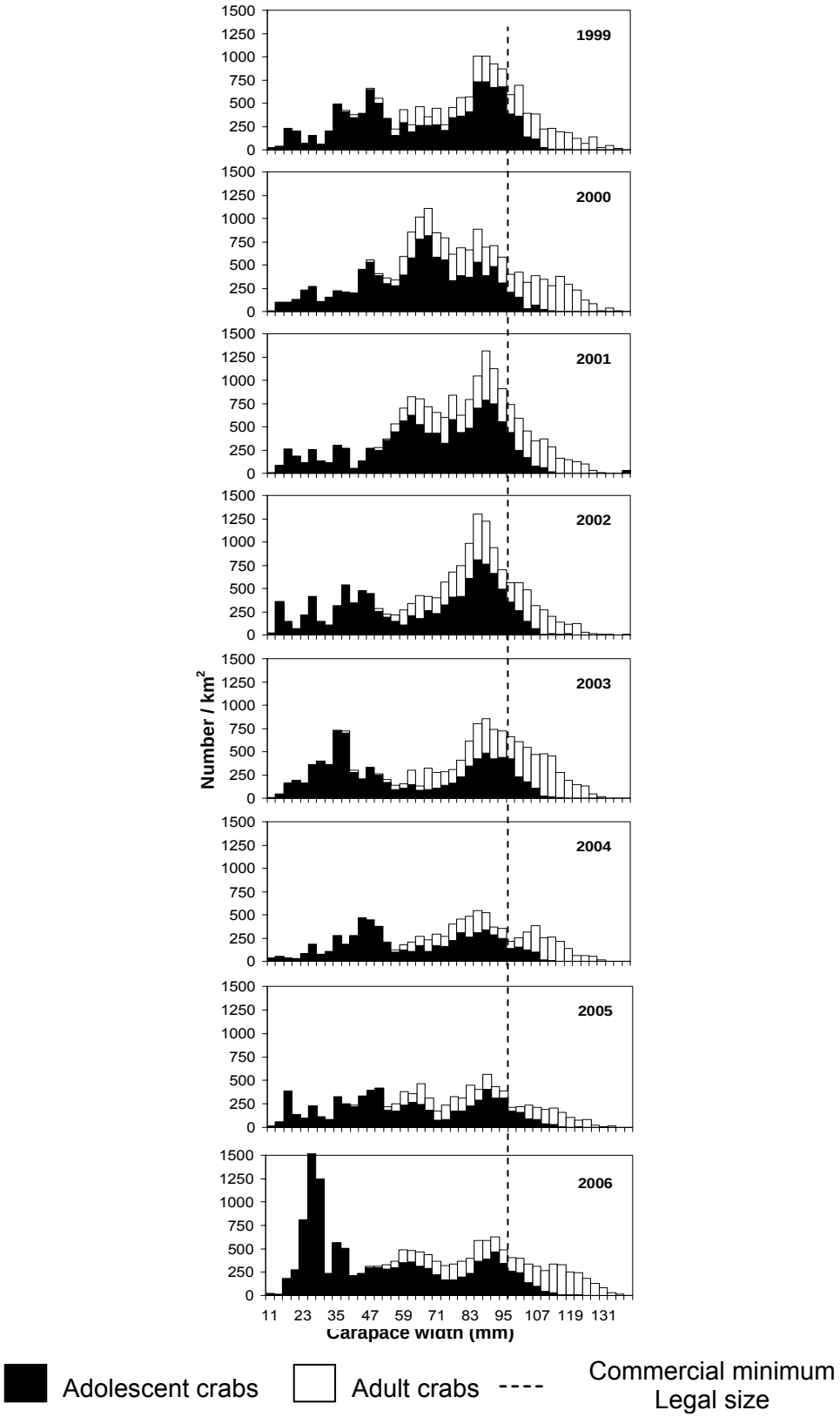


Figure 6: Size frequency distributions (number per km^2) of male crab sampled during the trawl survey in Area 19 after the fishing season.

Sources of Uncertainty

A change in the survey fishing vessels (FV) occurred from 1990 to 1998 (FV 'Emy-Serge D.'), from 1999 to 2002 (FV 'Den C. Martin') and since 2003 (FV 'Marco-Michel'). An increase in the number of sampling stations has occurred since 1998 and the trawl sampling protocols have changed. The commercial biomass index estimates prior to 1999 are currently under a thorough review.

The magnitude of unreported landing and handling mortality of 'white-crab' are unknown, and may be a source of uncertainty in reconciling survey and fishery results from one year to the next.

Research is needed to resolve uncertainties regarding many aspects of the snow crab biology such as growth pattern, skip molters, and reproductive output.

Movement of adult crab in and out of the surveyed areas is a major source of uncertainty in evaluating stock dynamics and managing the fishery. The role of environmental factors, density dependent processes in both Area 19 and adjacent areas (12 and F) needs to be better understood.

Two trawl surveys (the regular fall and a pre-fishery June surveys) will help to quantify the incoming or outgoing migration of commercial-sized adult males into Area 19 and reduce uncertainty about the appropriate exploitation rate for the portion of the biological unit that is supporting the fishery.

The relationships between the biomass of mature females, stock recruitment and the effect of the ratio of adult males for various ages to mature females on stock productivity needs further investigation.

Simulations of current and post-larvae distribution should be continued to determine the relationship between the spawning stock and the future recruitment to stock units in the periphery and outside the southern Gulf of St. Lawrence.

The trawl survey is an important tool to provide annual abundance and commercial biomass indices, detect any anomalies in reproductive potential of the stock and estimate the annual difference of commercial-sized crabs between the survey and the following fishing season. Without this tool, the uncertainty in the overall assessment will increase substantially.

CONCLUSIONS AND ADVICE

The prerecuits ≥ 56 mm CW (R-4, R-3 and R-2) from the 2006 fall survey increased in Area 19 compared to the 2005 fall estimates (Table 3; Figures 5 and 6). This may indicate an increase in the commercial biomass index for the coming years if these crabs stay within the zone upon reaching the legal-size. However, the commercial biomass index and the abundance of precrecruits ≥ 56 mm CW (R-4, R-3 and R-2) in Area 12 are decreasing. This may affect the migration of commercial-sized adult males between Areas 12 and 19.

The commercial biomass index estimated from the 2006 September trawl survey may not reflect the availability of commercial biomass at the beginning of the 2007 fishing season depending on the fishery and stock dynamics outside Area 19. It would be beneficial to continue the June trawl survey just before the opening of Area 19 fishery to estimate the commercial biomass prior

to the fishery and re-adjust the fishing strategy according to the biomass and proportion of carapace stages observed in that particular survey. Final advice will be provided following the June trawl survey (prior to the opening of the fishing season).

Empirical exploitation rates were calculated based on the ratio between the landings during the year and the sum of the landings and the residual biomass of the same year. Since 2000, exploitation rates calculated this way varied between 43 and 62% and are considered high compared to other snow crab fishery.

Substantial biological benefits are expected by the current 'white-crab' protocol. Revision of the 'white-crab' protocol may be an option to enhance the protection of the future recruitment to the fishery.

Limits and target reference points and comprehensive harvest control rules need to be developed and tested jointly by scientists, fishery managers and the fishing industry for the biological unit in the southern Gulf in the context of existing management areas.

Ecosystem Considerations

Environmental factors, such as water temperature, can affect the molting and reproductive dynamic as well as the movement of snow crab. Chassé et al. (2007) reported that the bottom temperatures over most of the southern Gulf of St. Lawrence are typically less than 3 °C, which is considered suitable thermal habitats for snow crab. Bottom temperatures in Area 19 are typically 1°-2 °C warmer than the traditional crab grounds in Area 12.

Near-bottom temperatures in Area 19, during 2006, were observed to be warmer than the long-term average (1971-2000). The central area was slightly cooler than in 2005. The snow crab habitat area index (total surface covered by bottom temperature between -1 and 3°C) was slightly below the long-term average and the mean bottom temperature within the habitat area was increased compared to 2005 (Figure 7). This temperature has shown an increasing trend since 1995. Snow crab occupies different depths in the water column at different life cycle stages. The temperature preference varies depending on the phase of the life cycle of snow crab, e.g. higher temperature may cause females change their reproductive cycle from two to one year in duration, lethal temperature for megalopae is known to be at around 18°C, immature crabs have a preference for colder temperatures while larger mature males have a tolerance to higher temperatures. However, the influence of habitat area and mean temperature on snow crab abundance and distribution is unknown.

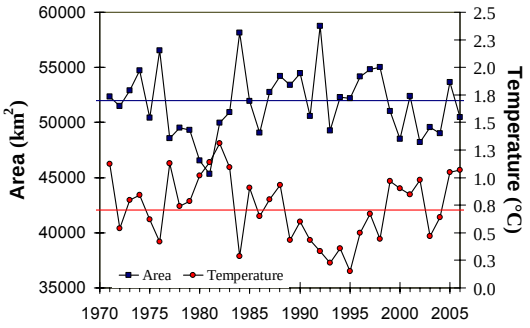


Figure 7: Snow crab habitat area and core temperature indices in the Southern Gulf of St. Lawrence.

Biological Considerations

Crabs in management Areas 12, E, F and 19 are part of a larger biological population and the southern Gulf has to be considered as one unit for biological and assessment purposes.

Close monitoring of the key events on population reproductive output (e.g., sex ratio, egg production (mating performance), is necessary to detect any anomalies on the quality and quantity of the spawning stock and subsequent recruitment.

SOURCES OF INFORMATION

Chassé, J., R.G. Pettipas, and W.M. Petrie. 2007. Temperature Conditions on the Scotian Shelf and in the Southern Gulf of St. Lawrence During 2006 Relevant to Snow Crab. DFO Can. Sci. Advis. Sec. Res. Doc. (in prep.).

Hébert, M., E. Wade, T. Surette, and M. Moriyasu. 2007. The 2006 Assessment of Snow Crab (Chionoecetes opilio) Stock in the Southern Gulf of St. Lawrence (Areas 12, 19, E, and F) / Évaluation de la pêcherie de crabe des neiges (Chionoecetes opilio) dans le sud du golfe du Saint-Laurent (zones 12, 19, E et F) en 2005. DFO Can. Sci. Advis. Sec. Res. Doc. (in prep.).

Squires, H. J. 1990. Decapod Crustacea of the Atlantic Coast of Canada. Can. Bull. Fish. Aquat. Sci. 221.

FOR MORE INFORMATION

Contact: Mikio Moriyasu
Oceans and Science Branch
Dept. of Fisheries and Oceans
Gulf Region
P.O. Box 5030
Moncton, N.B. E1C 9B6

Tel: (506) 851-6135
Fax: (506) 851-3062
E-Mail: moriyasum@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

ISSN 1480-4913 (Printed)

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

CORRECT CITATION FOR THIS PUBLICATION

DFO, 2007. Assessment of Snow Crab in the Western Gulf of St. Lawrence (Area 19). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2007/022.