

## Southern Gulf of St. Lawrence Snow Crab



Southern Gulf of St. Lawrence snow crab management zones.

### **Background**

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 molting. After molting, crab have a soft shell for a period of time. Soft-shelled crab is defined by shell hardness (<68 durometer units). The term white crab describes both new-soft and clean hard-shelled crab (categories 1 and 2 respectively).

Unlike lobster, snow crab do not continue to molt throughout their lives. Females stop growing after the molt in which they acquire a wider abdomen for carrying eggs, which occurs at shell widths less than 95 mm. Male snow crab stop growing after the molt, in which they acquire large claws on the first pair of legs, and which can occur at shell widths as small as 40 mm. Female crab 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 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 snow crab males to reach legal size.

This report deals with the Southern Gulf of St. Lawrence snow crab fisheries (Area 12 and the two exploratory Areas E and F).

The snow crab fishery in Area 12 has been exploited by 130 mid-shore fishermen from New Brunswick, Quebec and Nova Scotia. Area 12 and exploratory Areas (E and F) each have separate management schemes. Since 1997, the PEI coastal fishery, Area 25/26 have been integrated into Area 12 to form one management unit. For the purpose of this assessment, Area 12 refers to the new management unit. There is no biological basis for these management areas.

The minimum legal shell width is 95 mm, and female crabs 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 280 m. The fishery takes place in spring and early summer in Areas 12, E and F. Neither soft-shelled nor white crabs are harvested.

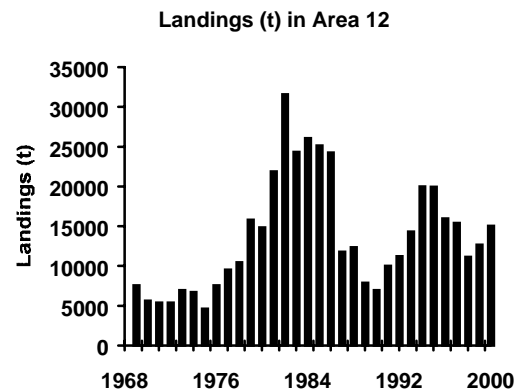
Management of these fisheries is based strictly on quotas and effort controls (number of licenses, trap limits and seasons). Based on management considerations and resource availability, no temporary licenses were issued in 2000. In 2000, an allocation of 1,060 t was given to aboriginal communities. The 2000 landings were 15,046 t (quota of 15,500 t) in Area 12.

## Summary

- In Area 12, landings were 15,046 t in 2000, which represent 97 % of the quota (15,500 t). The 2000 fishing season was closed on July 23 because of the high incidence of soft-shelled crab in catches and low CPUE. CPUE decreased by 27 % to 34.5 kg per trap haul and the percentage of soft-shelled crab increased to 12.5 % from 4.9 % in 1999.
- The 2000 biomass estimate from the 1999 trawl survey is not considered to be reliable.
- The exploitable biomass for year 2001 is 25,900 t (exclusive of very old crab).
- The recruitment biomass is 22,900 t and comprises 88 % of the exploitable biomass in the 2001 fishery.
- The biomass estimate in 2001 may not be comparable with the estimates prior to 1999. Further research is required to properly assess the gear efficiency between the two vessels.
- The exploitation rate should not exceed 50 % of the exploitable biomass (25,900 t) considering the uncertainties in the biomass estimates and the expected high incidence of soft-shelled crab.
- The quota in Area E was 163 t with 150 t landed. The CPUE in 2000 (22.9 kg/trap haul) decreased by 60 % from 1996 (60.3 kg/trap haul).
- The quota in Area F was 288 t with 291 t landed. The CPUE in 2000 (57 kg/trap haul) was similar to 1999, but 50 % higher compared to 1995 (27 kg/trap haul).

## The Fishery

Prior to 1995, **Area 12** was fished by 130 fishers from New Brunswick, Quebec and Nova Scotia, with a trap limit of 150 per license. The fishery expanded rapidly in late 1970's, and reported landings peaked in 1982 at 31,500 t. Landings then fluctuated around 25,000 t until 1986, falling to 11,700 t in 1987.



In 1989, the fishery was closed early due to a high incidence of soft-shelled crab. In 1990, at-sea observer and dockside monitoring programs were introduced to obtain good quality information on the fishing activities. The quota was set at 7,000 t in 1990. In 1995, landings were 19,944 t (quota of 20,000 t) and 4,500 t was allocated for the first time to 131 non-traditional vessels (temporary license holders). In 1996, the quota was set at 16,100 t of which 3,508 t was allocated to 137 non-traditional vessels. In 1997, the 30 traditional fishers from PEI (Area 25/26) were given access to Area 12, using a maximum of 50 traps per license. In 1997, the 160 traditional fishers were allowed a total quota of 13,110 t and an additional 2,290 t was allocated to 93 non-traditional vessels. The 1998 and 1999 landings were 11,136 t (quota of 11,125 t) and 12,682 t (quota of 12,686 t), respectively. In 2000, an allocation of 1,060 t was given to aboriginal communities (500 t in NB, 500 t

in QC, and 60 t in PEI). The 2000 landings were 15,046 t, which represent 97 % of the total quota (15,500 t). Based on co-management agreement, no temporary licenses were allowed since 1998.

**Quota (t), landings (t) and catch performance in Area 12.**

	1995	1996	1997	1998	1999	2000
Quota	20,000	16,100	15,400	11,125	12,686	15,500
Landings	19,944	15,978	15,413	11,136	12,682	15,046
CPUE	47.8	50.1	50.8	45.8	43.9	34.5
Mean size (mm)	112.2	113.1	114.5	114.4	112.7	109.1
Soft crab (%) in catches	2.5	4.2	5.0	2.8	4.9	12.5

Although parts of these areas had been fished in the past by the traditional fleet, **exploratory fishing** licenses were issued for the first time in 1995 in **Area E** (4 vessels and a quota of 217 t) and **Area F** (7 vessels and a quota of 317 t). These fisheries were maintained in 1996 with lower quotas of 163 t and 238 t, shared with 8 and 14 vessels, respectively. Since 1997, the quotas have been 163 t for Area E and 288 t for Area F shared amongst 8 and 16 vessels, respectively.

**Quota (t), landings (t) and catch performance in Area E.**

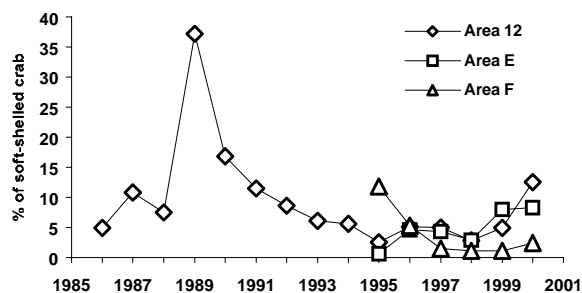
	1995	1996	1997	1998	1999	2000
Quota	217	163	163	163	163	163
Landings	217	163	163	161	159	150
CPUE	53.8	60.3	34.7	28.6	29.4	22.9
Mean size (mm)	112.2	115.1	114.1	111.5	109.6	105.8
Soft crab (%) in catches	0.6	4.6	4.3	2.9	8.0	8.3

**Quota (t), landings (t) and catch performance in Area F.**

	1995	1996	1997	1998	1999	2000
Quota	317	238	288	288	288	288
Landings	317	238	287	290	290	291
CPUE	27.4	42.4	44.9	48.1	57.2	56.7
Mean size (mm)	112.2	114.7	113.9	110.6	108.5	107.9
Soft crab (%) in catches	11.8	5.3	1.5	1.1	1.1	2.4

In **Area 12**, the fishery was closed on July 23, before the quota was reached because of the high incidence of soft-shelled crab in catches and low CPUE. The percentage of **soft-shelled crab** in the catches increased in 2000 (12.5 %) compared to the previous year (4.9 %). The application of the 2000 soft-shelled crab protocol, by asking fishermen to move out of areas where the percentage of soft-shelled crab exceeded 20 %, had the effect of: 1) decreasing fishing effort in areas of high concentration of soft-shelled crab and thus, minimized the catch of these crabs and 2) increasing the catch performance by moving the effort to areas with lower concentration of soft-shelled crab. The application of the soft-shelled crab protocol since 1997 has been a success and industry's collaboration has generally been good. The mean size of commercial adult crabs has been decreasing since 1997.

**Percentage of soft-shelled crab in Areas 12, E and F.**



In Area E, the percentage of soft-shelled crab in 2000 (8.3 %) remained at the same level as the 1999 fishing season. The CPUE

has been decreasing since 1996, from 60.3 to 22.9 kg/trap haul. The mean size of commercial adult crabs has been decreasing since 1996. In Area F, the percentage of soft-shelled crab in 2000 slightly increased (2.4 %) compared to the previous year (1.1 %). The CPUE in 2000 (57 kg/trap haul) remained at the same level as the 1999 fishing season. The mean size of commercial adult crabs has been decreasing since 1996.

**Carapace condition** was estimated from sea samples taken from the 2000 fishery. Crabs with carapace categories 3 and 4 comprised the bulk of the fishery in all areas.

**Percentage of the catch of commercial-sized adult crab by carapace condition**

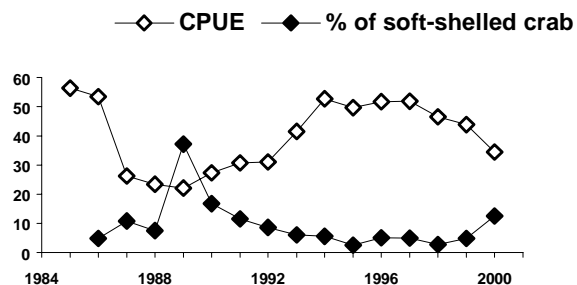
Category	Description	12	E	F
1-2	White crab	11.6	4.3	6.5
3	Intermediate	26.9	51.7	63.6
4	Old crab	56.7	39.3	28.8
5	Very old crab	4.8	4.8	1.0

**Resource Status**

**Catch rates (CPUE)** are calculated from logbooks and must be viewed with caution because (1) fishers are provided with maps showing crab concentrations before the opening of the fishery, (2) CPUE are affected by socio-economic factors, and (3) the soft-shelled crab protocol may have an impact on the fishing performance due to the movement of fishing effort from areas of high concentrations of soft-shelled crab.

The average CPUE in Area 12 decreased from 43.9 in 1999 to 34.5 kg/trap haul in 2000. The average CPUE has been decreasing since 1997.

**CPUE (kg per trap haul) and soft-shelled crab percentage in Area 12**



The evaluation of stock status is based on a **trawl survey**, which provides estimates of exploitable biomass (hard-shelled adult males of legal size) immediately following the fishery, plus estimates of soft-shelled adult males larger than 95 mm that will recruit to the fishery in the following year. The method assumes that there is no natural mortality between the time of the survey and the beginning of the fishery nine months later, except for very old crab. Abundance is also estimated for smaller size crab or pre-recruits.

In Area 12, the survey was conducted every year since 1989, except in 1996. The trawl survey in Areas E and F was conducted since 1997. From 1989 to 1998, the “Emy-Serge”, (65 feet, side-trawl, wooden boat with 375 HP), was used to conduct the trawl surveys. In 1999, the “Emy-Serge” was sold and the “Den C. Martin”, (65 feet, stern-trawl, steel boat with 402 HP), was chosen to continue the surveys. Without a comparative study between the two survey vessels, which was not possible at this time, the biomass estimation from the time series cannot be compared.

**Biomass estimates (t) including very old crab in the southern Gulf of St. Lawrence (with 95 % confidence intervals)**

Survey Year	12	E	F
1988	8,700 (± 42 %)	-	-
1989	21,700 (± 53 %)	-	-
1990	23,400 (± 53 %)	-	-
1991	29,400 (± 50 %)	-	-
1992	37,800 (± 38 %)	-	-
1993	62,000 (± 13 %)	-	-
1994	56,700 (± 12 %)	-	-
1995	49,500 (± 16 %)	-	-
1996 <sup>1</sup>	43,600 (± 54 %)	-	-
1997	33,000 (± 25 %)	1,460 (56%)	510 (65%)
1998	28,200 (± 20 %)	220 (±125%)	900 (±99%)
1999 <sup>2</sup>	-	-	-
2000 <sup>3</sup>	26,500 (± 19 %)	160 (± 401 %)	1,510 (± 57 %)

<sup>1</sup> No survey in Area 12 in 1996.

<sup>2</sup> Not available at the moment due to ongoing study regarding the vessel change.

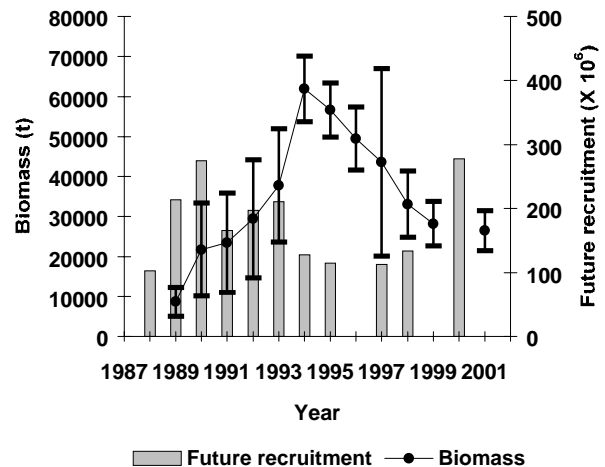
<sup>3</sup> Biomass estimates with “Den C. Martin” without adjustment of the net efficiency change.

Area 12:

The 2000 survey indicates a **total biomass** of 26,500 t ± 19% (95 % confidence limits). However, part of this biomass is very old crab (600 t ± 48%) that will mate and die and not be available for the 2001 fishing season. The recruitment to the fishery (22,900 t ± 19 %) represents 88 % of the exploitable biomass for the 2001 fishing season. The abundance of pre-recruits was high in the 2000 trawl survey and could increase the level of recruitment to the fishery. An increase of the recruitment to the fishery is now expected. The biomass estimates for 2001 season cannot be comparable with the estimates prior to 1999

if the catch efficiency with the new vessel is different than the former vessel. The size frequency distributions showed a wave of recruitment growing towards commercial size since 1997.

**Exploitable biomass (t) and future recruitment index (adolescent crabs ≥ 56 mm) in Area 12.**

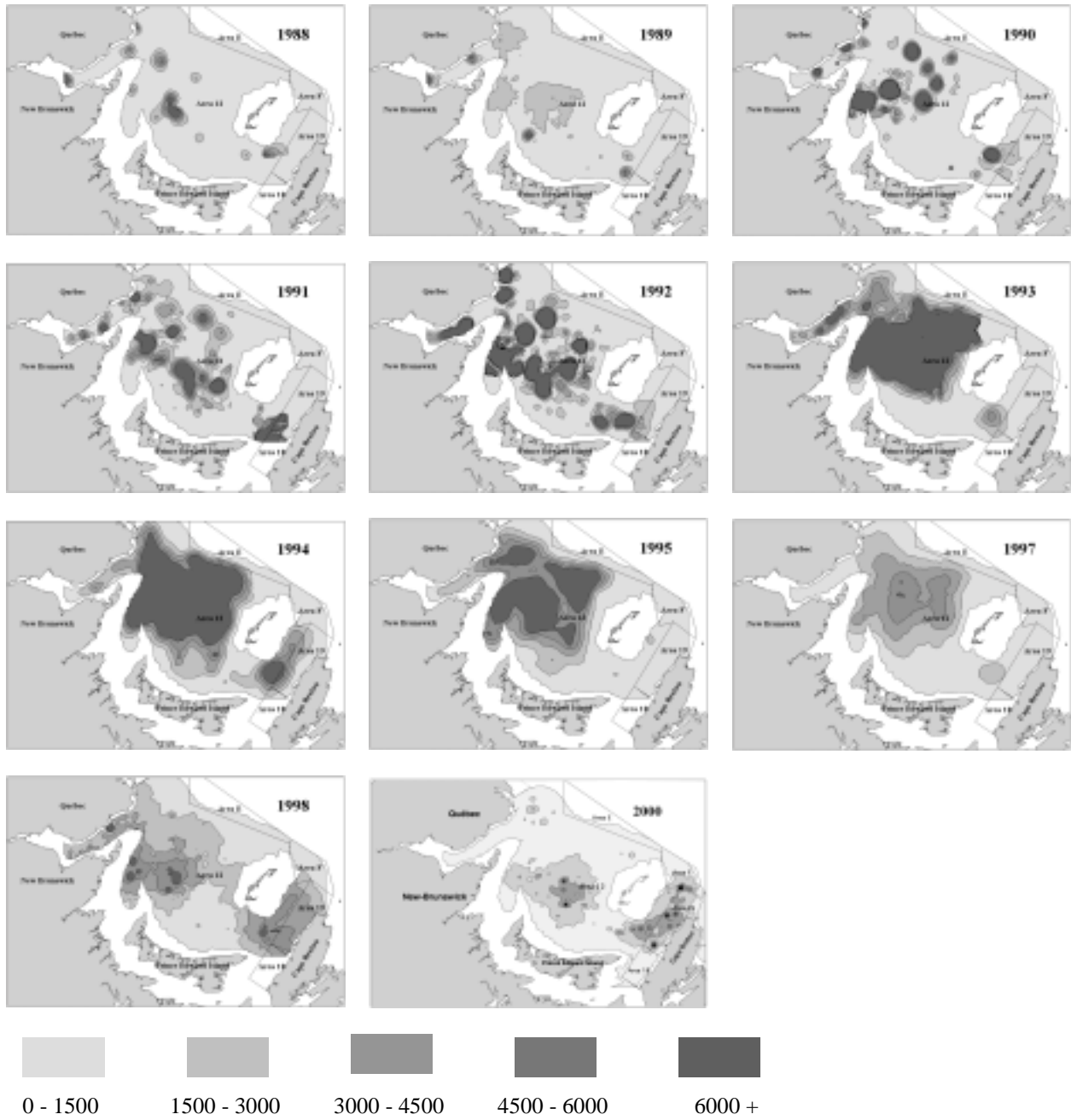


Areas E and F:

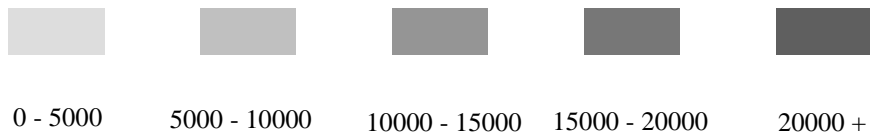
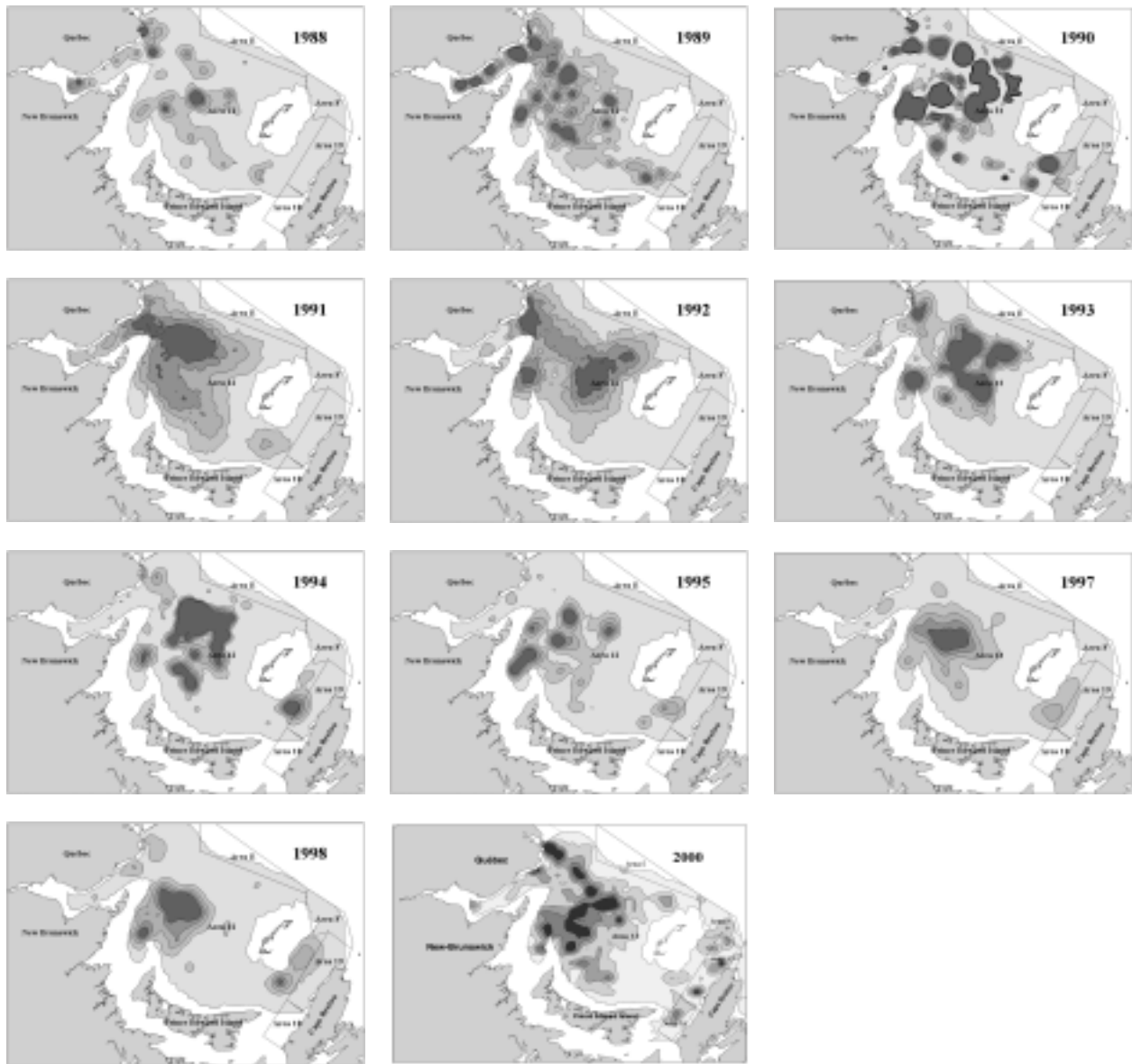
Because of the unknown amount of crab movement in and out of these areas within a given year, the estimates of exploitable biomass in these two areas may not necessarily reflect the biomass at the beginning of the following fishing season. In addition, the change of the survey vessel added to more uncertainty in the comparison of biomass estimates before and after 1999. Area E is not biologically distinct from Area 12, and Area F is not biologically distinct from Area 12 (the east part of Magdalen Islands) and Area 19.

In both areas, the crab concentrations are found near the boundaries and the biomass estimates have large confidence intervals.

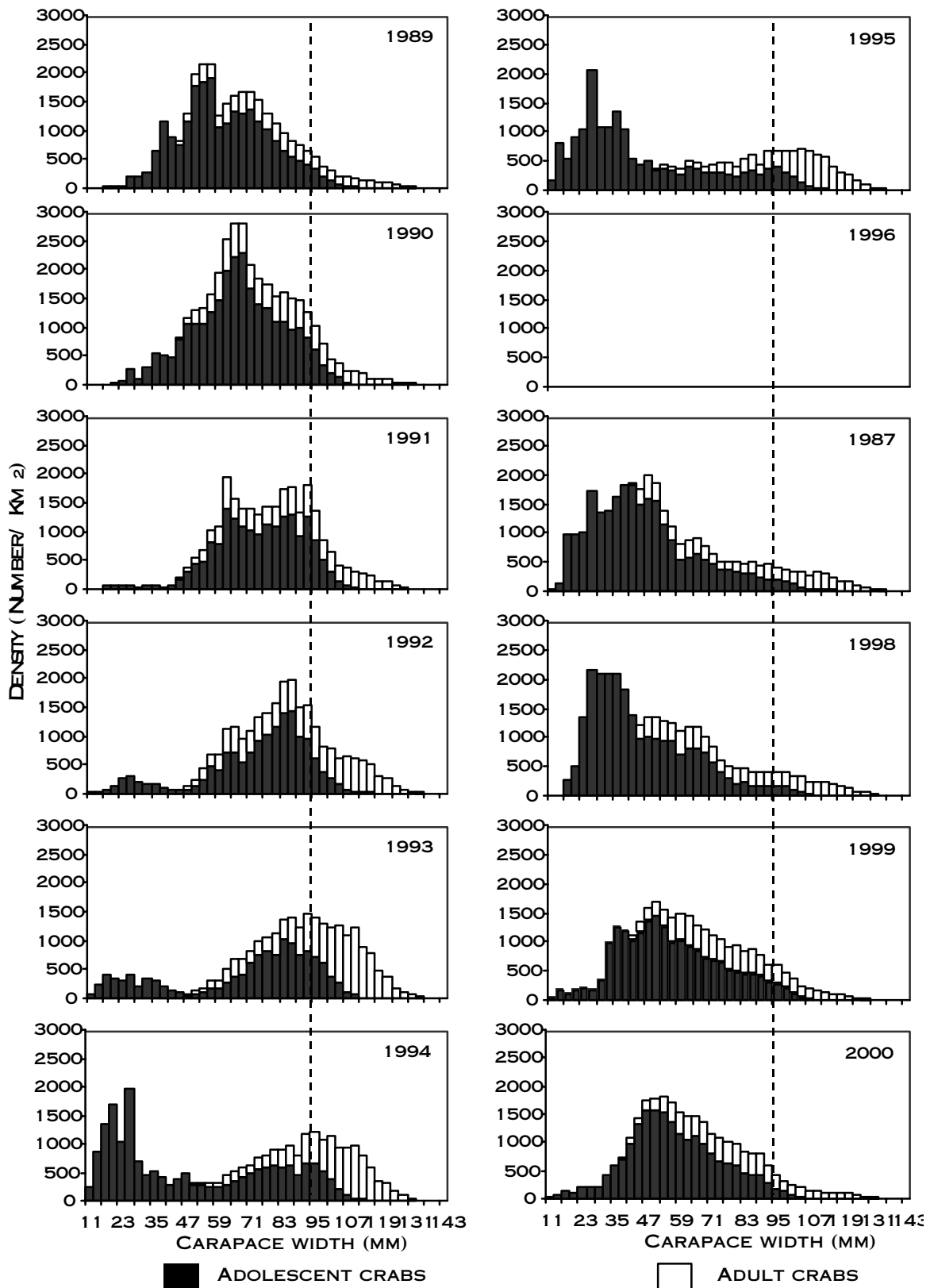
Density (crabs per km<sup>2</sup>) contours of adult male crab  $\geq 95$  mm CW



Density (crabs per km<sup>2</sup>) contours of adolescent male crab  $\geq 56$  mm CW



Size frequency distributions (number per km<sup>2</sup>) of male crab sampled during the trawl survey in Area 12 after the fishing season

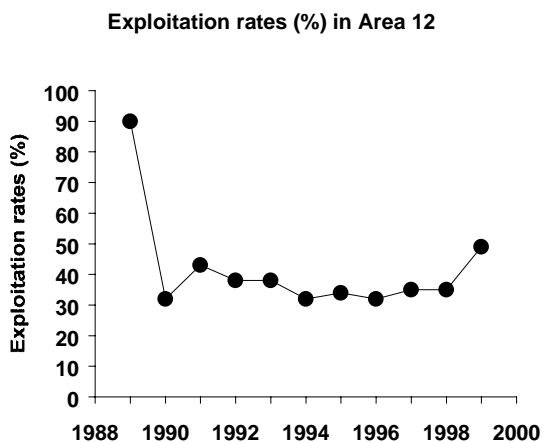




In Area E, the exploitable biomass for the 2001 fishing season was estimated at  $160 \text{ t} \pm 401 \%$  and recruitment to the fishery was estimated at  $50 \text{ t} \pm 2,414 \%$ .

In Area F, the exploitable biomass for the 2001 fishing season was estimated at  $1,510 \text{ t} \pm 57 \%$  and recruitment to the fishery was estimated at  $830 \text{ t} \pm 119 \%$ .

**The exploitation rate** in 2000 for Area 12 cannot be estimated because of concerns of the reliability of the 1999 trawl survey estimates. However, the facts that the quota was not taken, the decline in CPUE and the high incidence of soft-shelled crab during the 2000 fishing season indicate that the exploitation rate was higher than the previous year.



### *Sources of Uncertainty*

The effect of **changing the survey vessel** since 1999 on catch efficiency cannot be completely resolved until further study. However, the comparison of the values for the net width and tow distance, between the two vessels, revealed that these values were significantly different suggesting that the trawl net behaved differently with the new survey vessel. Consequently, the resulting biomass estimates with the new vessel may

not be comparable to the estimates from the former vessel. Until the catch efficiency of both vessels is properly assessed, the new biomass estimates have to be interpreted with caution.

The misclassification of carapace condition during the trawl survey is another source of uncertainty. Exploitable biomass is composed of the recruitment to the fishery (categories 1 and 2) and remaining biomass (categories 3 and 4).

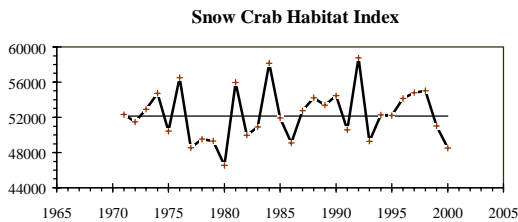
**Seasonal movement** between areas may occur from the time of the trawl survey and the beginning of the subsequent fishing season (especially adult crabs of commercial size that have recently molted). Movement of crabs between Areas 12, 18 and 19 is assumed, but not explicitly taken into account in the assessment.

**The natural mortality** of adult crabs was assumed to be negligible in this assessment. We know that old carapace crabs (category 5) are certainly dying, but the magnitude by shell condition is unknown. In addition, discarding soft-shelled crabs at sea during fishing activities could increase the mortality of these crabs. Minimizing the catch of soft-shelled crab during fishing is important in order to protect the reproductive potential of the stock and to achieve maximum yield per recruit.

### *Ecosystem Considerations*

Cold water **temperatures** are preferred by snow crab. Bottom water temperatures in the southern Gulf have generally been colder than the long-term average since the late 1980s. During 1995 and 1996, subzero bottom water temperatures were registered to be at their greatest extent since these measurements began in 1971. Southern Gulf waters at 50 to 150 m have been predominantly below normal in temperature

since the mid to late 1980s. The area of ocean bottom with water temperatures between -1 and 3 °C is an index of snow crab habitat, and was high since late 1980s to 1998. This index declined since 1999 below the long-term mean.



## Outlook

The stock status in Area 12 is generally positive for the near future. The 2001 commercial biomass is mainly composed of new recruitment (88 %) while the biomass of very old crabs is very low. Strong pulses of pre-recruits were observed in the 2000 trawl survey, which would increase the level of recruitment to the fishery for the next 3 to 4 years. The period of high abundance of the recruitment of new mature females (primiparous females) to the population was observed through 1996-98. A reasonable exploitation rate not exceeding 50 % for the 2001 fishing season would not have a negative impact on the reproductive potential of the stock since the abundance of mature females available to reproduce is decreasing. Other indicators, such as the annual CPUE and mean size of commercial adult crabs have been decreasing since 1998. A major concern for the 2001 fishing season is the high abundance of soft-shelled crabs expected in the catches. We have just completed a decade, where exploitation rates have been generally maintained between 32 and 50 %. This historical exploitation rate has to be re-evaluated to ensure that the resource continues to be sustainable while avoiding any unnecessary wastage of yield.

In Area E, all the indicators are negative and biomass is not expected to increase until the expanded biomass from Area 12 reaches this fishery ground. The CPUE and the mean size of commercial adult crabs have been decreasing since 1996. Projected exploitable biomass is 160 t, and has been declining since 1997. This fishery depends totally on Area 12.

In Area F, the current indicators are generally positive in the short term. The CPUE were high and remained stable and the percentage of soft-shelled crab was low in 2000. The exploitable biomass is 1,510 t, an increase compared to the 1997-1998 estimates. The mean size of commercial adult crabs has been declining since 1996. Results of the 2000 trawl survey show a decrease in the abundance of pre-recruits, which could decrease the future recruitment to the fishery. An increase of quota may be possible for the next season before the biomass starts to decrease in the near future. This area is influenced by the stock conditions in Areas 12 and 19.

## Management Considerations

An increase of soft-shelled crab in the catch is predicted for 2001 and 2002. This is due to the arrival of strong waves of pre-recruits observed during the 2000 trawl survey. The application of the soft-shelled crab protocol since 1997 has been a success and industry's collaboration has generally been good. Fishing activities should be limited in areas of high concentrations of soft-shelled crab. Respecting the daily soft-shelled crab monitoring protocol for the 2001 fishing season will be very important for minimizing the mortality of soft-shelled crab and protecting future recruitment to the fishery.

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***References***

Hébert, M., E. Wade, T. Surette and M. Moriyasu. 2001. The 2000 assessment of Snow crab, *Chionoecetes opilio*, stock in the southern Gulf of St. Lawrence (Areas 12, E and F). DFO Canadian Science Advisory Secretariat Res. Doc. 2001/015.

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