

Southwestern Gulf of St. Lawrence Snow Crab

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 Southwestern Gulf of St. Lawrence snow crab fisheries (Area 12 and the two exploratory Areas E and F). These are part of a larger biological unit namely Area 12+E and Areas 18,19+F.



Southern Gulf of St. Lawrence snow crab management zones.

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 crab 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 1999. In 1999, landings were 12,682 t (quota of 12,686 t) in Area 12.

Summary

- Landings in 1999 were 12,682 t (quota of 12,686 t). This level is still below the average of the last ten years (13,289 t). Catch rates (adjusted for soak time) increased by 15 % to 33 kg per trap haul; and the percentage of soft-shelled crab remained low, around 5 %.
- The 1999 trawl survey estimated that the exploitable biomass for year 2000 is 31,000 t, an increase from 1998.
- About 2,500 t of very old crab (category 5) will die or not be available and are not included in the exploitable biomass for the 2000 fishing season.
- The survey also estimated that recruitment was 16,500 t and would comprise over 50 % of the exploitable biomass in the 2000 fishery.
- Maintaining the current exploitation rate of 45 % would not exceed the predicted recruitment and would ensure growth of biomass.
- An increase in the amount of soft-shelled crab is expected in the next two years.
- There is no biological basis for Areas E and F, and in future assessments, they will be included within Areas 12, 18 and 19.
- The quota in Area E was 163 t with 159 t landed. The catch rates in 1999 (29 kg/th) remained similar to 1998, but represent a 50 % decrease from 1996.
- The quota in Area F was 288 t with 290 t landed. The catch rates in 1999 (57 kg/th) were 50 % higher compared to 1995 (27 kg/trap).

The Fishery

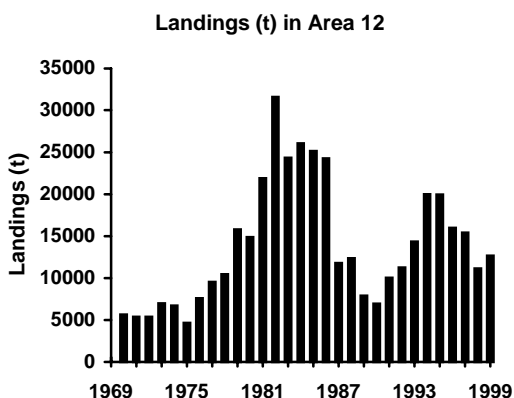
Area 12, Southwestern Gulf of St. Lawrence

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 11,700t in 1987. In 1989, the fishery was closed early due to a high incidence of soft-shelled crab. In 1990, an observer program and dockside monitoring were introduced to obtain good quality information on the fishing activities. The quota was set at 7,000t in 1990. In 1995, landings were 19,944 t (quota of 20,000 t) and 4,500 t was allocated for the first time for one year 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 P.E.I. (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 landings were 11,136 t (quota of 11,125 t). Given lower abundance and the lower market value of snow crab, no temporary licenses were allowed in 1998. In 1999, landings were 12,682 t (quota of 12,686t). Based on management considerations and resource availability, no temporary licenses were allowed in 1999.

Quota (t) and landings (t) in Area 12.

	1995	1996	1997	1998	1999
Quota	20,000	16,100	15,400	11,125	12,686
Landings	19,944	15,978	15,413	11,136	12,682
CPUE	47.8	50.1	50.8	45.8	43.9
Adj. CPUE*	40.5	41.2	34.5	27.8	32.6
Soft crab (%) in catches	2.5	4.2	5.0	2.8	4.9

* CPUE adjusted for soak time



Despite the fact that parts of these areas had been fished in the past by the traditional fleet, temporary **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) and landings (t) in Area E.

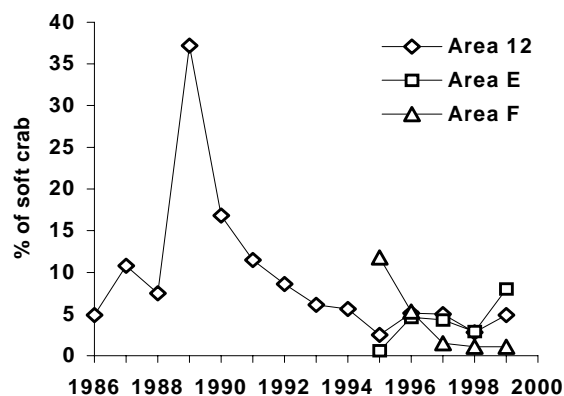
	1995	1996	1997	1998	1999
Quota	217	163	163	163	163
Landings	217	163	163	161	159
CPUE	53.8	60.3	34.7	28.6	29.4
Soft crab (%) in catches	0.6	4.6	4.3	2.9	8.0

Quota (t) and landings (t) in Area F.

	1995	1996	1997	1998	1999
Quota	317	238	288	288	288
Landings	317	238	287	290	290
CPUE	27.4	42.4	44.9	48.1	57.2
Soft crab (%) in catches	11.8	5.3	1.5	1.1	1.1

In **Area 12**, the percentage of **soft-shelled crab** in the catches increased slightly in 1999 (5 %) compared to the previous year (3 %). The relatively low percentage of soft-shelled crab reflects how effective management measures have been since 1997, when daily monitoring of soft-shelled crab was introduced. Fishers volunteered not to fish in areas where the percentage of soft-shelled crab exceeded 20 %. In the 1999 fishing season, 17 grids of 10 minutes latitude by 10 minutes longitude were closed because of the high percentage of soft-shelled crab in catches. This measure 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 catch performance by moving the effort to areas with higher concentrations of hard-shelled crab. The application of the soft-shelled crab protocol since 1997 has been a success and fisher's collaboration has generally been good.

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



In Area E, the percentage of soft-shelled crab was 8.0 % for the 1999 fishing season compared to 2.9 % in 1998. In Area F, the percentage of soft-shelled crab in 1999 was low and comparable to that in the previous year (1.1 %).

Carapace condition was estimated from sea samples taken from the 1999 fishery. Crab with carapace category 3 and 4 comprised the bulk of the fishery in all areas.

Carapace condition of commercial-sized adult crab in the catch (%)

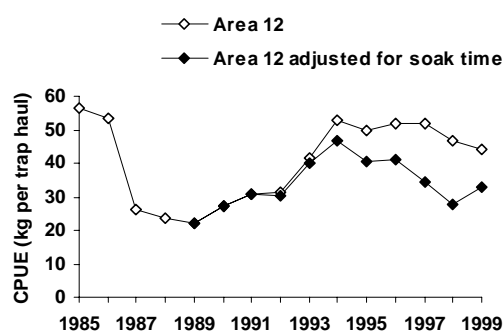
Category	Description	12	E	F
1-2	White crab	7.3	10.5	5.6
3	Intermediate	49.1	39.3	68.9
4	Old crab	37.3	48.1	24.9
5	Very old crab	6.3	2.1	0.6

Resource Status

Catch rates (CPUE) are calculated from logbooks and must be viewed with caution because fishers are provided with maps of crab concentrations before the opening of the fishery. Also CPUE is affected by socio-economic factors. Up to 1997, there has been a good relationship between CPUE and the exploitable biomass estimates from the trawl survey. However, since 1997, industry noted that there has been a large increase in the soak time of traps in most areas. The unadjusted logbook-derived CPUE is not comparable to previous years, particularly in Area 12, because processing plants imposed weekly trip limits which increased soak time. Increased soak time has an important impact on the estimated CPUE. As a result, CPUE from fishers' logbook data between 1989 and 1999 were adjusted to compensate for change in soak time.

The mean annual adjusted CPUE gradually increased between 1989 (22.1 kg/trap haul) and 1994 (46.8 kg/trap haul) and has gradually decreased to 27.8 kg/trap haul in 1998. In 1999, the adjusted CPUEs have increased slightly (32.6 kg/trap haul). The relationship between CPUE and the estimates of exploitable biomass improved when the adjusted CPUE was used to plot the linear regression. Logbook data were also used to describe the general distribution of fishing effort per section (10 by 10 minutes).

CPUE (kg per trap haul) in Areas 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 95mm 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.

The stock assessment in Areas 12, E and F was based on the 1999 trawl survey.

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

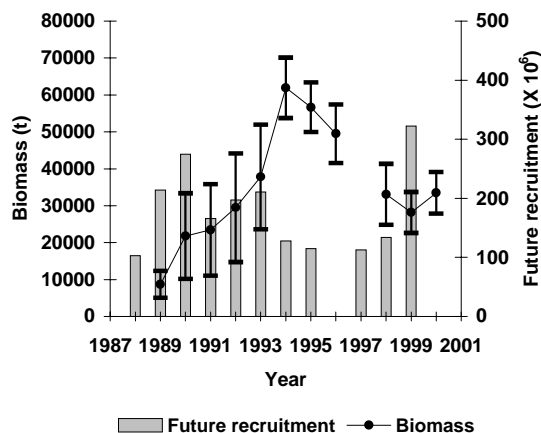
Survey Year	12	E	F
1988	8,700 (± 42 %)	-	-
1989	21,700 (± 53 %)	-	-
1990	23,400 (± 53 %)	-	-
1991	29,400 (± 50 %)	-	-
1992	37,800 (± 38 %)	-	-
1993	61,900 (± 13 %)	-	-
1994	58,700 (± 12 %)	-	-
1995	49,500 (± 16 %)	-	-
1996*	-	-	-
1997	33,100 (± 25 %)	1,460 (56%)	580 (65%)
1998	28,200 (± 20 %)	220 (±125%)	970 (±99%)
1999	33,500 (± 17 %)	240 (±678%)	1,050 (±144%)

*No survey in Area 12 in 1996.

Area 12:

The 1999 survey indicates an increase in **exploitable biomass** to 33,500 t ± 17% (95 % confidence limits). However, part of this biomass is very old crab (2,500 t ± 28%) that will mate and die and not be available for the 2000 fishing season. The recruitment to the fishery (16,500 t ± 21 %) represents 53 % of the exploitable biomass for the 2000 fishing season. An increase of pre-recruits was observed in the 1999 trawl survey and could increase the level of recruitment to the fishery. An increase of the harvestable biomass is expected starting in 2000. The surface of high crab density zone expanded in 1999 compared to 1998 for both adult and adolescent categories. The size frequency distributions showed a wave of recruitment growing towards harvestable size between 1997 and 1999.

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

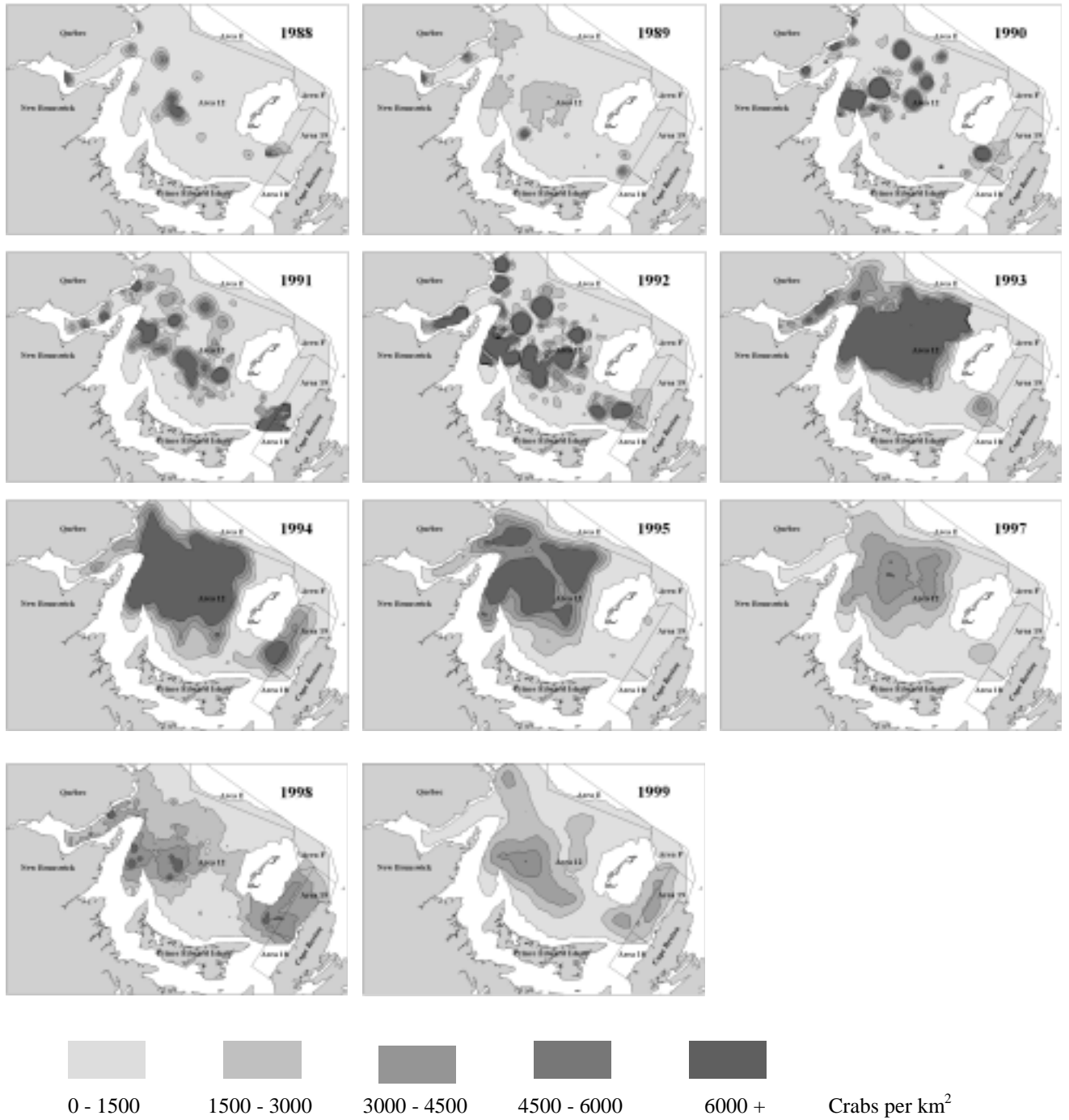


Areas E and F:

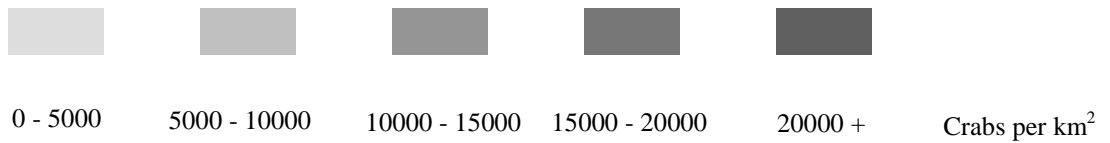
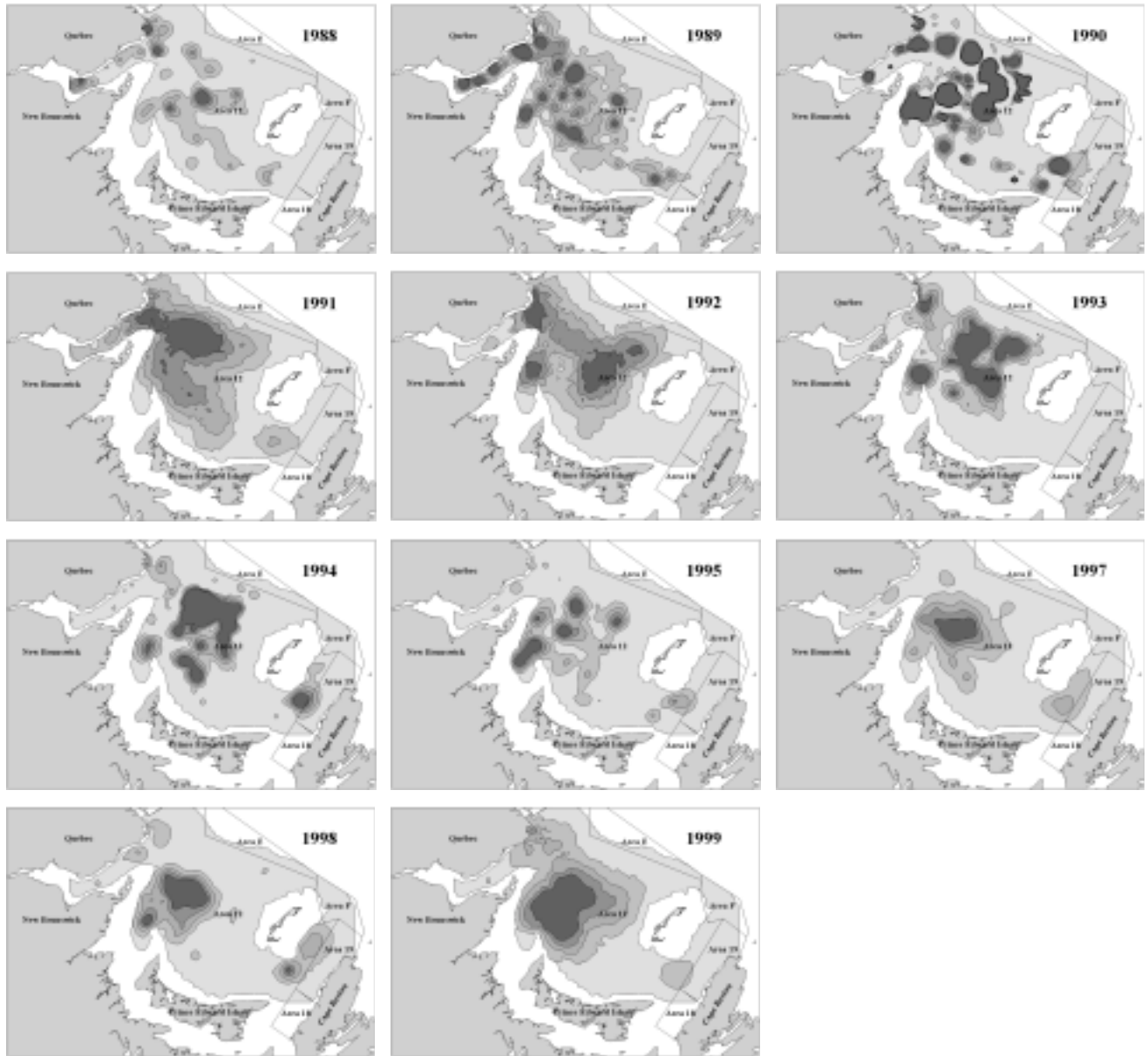
Because it was noted that there is movement of crab in and out of these areas within a given year, the estimates of exploitable biomass in these two areas are not considered reliable. Area E is not biologically distinct from Area 12. Area F is not biologically distinct from Area 12 (the part east of Magdalen Islands) and Area 19.

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

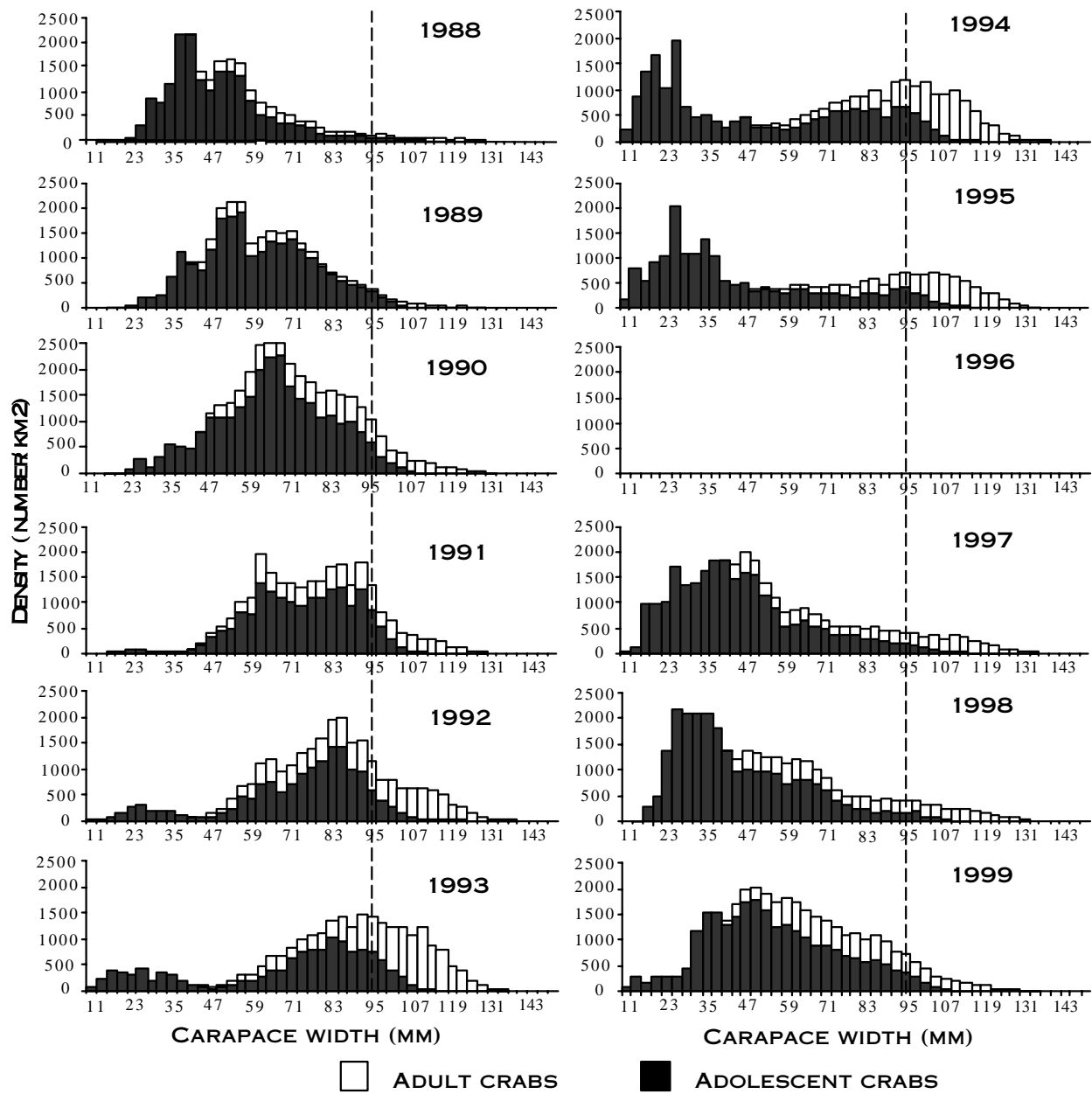
Density contours of adult male crab ≥ 95 mm CW



Density contours of adolescent male crab ≥ 56 mm CW



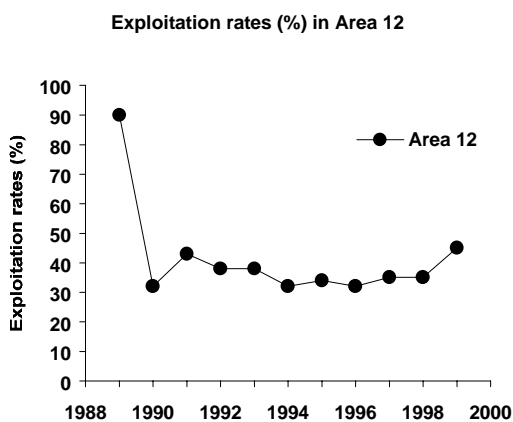
Size frequency distributions (number per km²) of male crab sampled during the trawl survey in Area 12 after the fishing season



In Area E, the exploitable biomass for the 2000 fishing season was estimated at 237 t \pm 678 % and recruitment to the fishery was estimated at 54 t \pm 2,276 %.

In Area F, the exploitable biomass for the 2000 fishing season was estimated at 1,050 t \pm 144 % and recruitment to the fishery was estimated at 477 t \pm 208 %. The pattern of the seasonal effort concentration showed that fishing effort was well distributed into the whole area compared to previous years.

Exploitation rate in 1999 for Area 12 was estimated at 45 %, which was the target for that year.



Sources of Uncertainty

The current evaluation has a number of uncertainties listed below.

The lack of knowledge on the growth of the pre-recruits is a source of uncertainty of this assessment. The size at which skip molting occurs as well as its causes are not understood. Therefore, any prediction of the timing of arrival of recruitment into the fishery should be interpreted with caution.

Estimates of exploitable biomass have been biased since 1995. The bias occurred in both directions. First there was a tendency

towards under-estimating recruitment and over-estimating the remaining biomass. This bias occurred because **natural mortality** of adult crabs was assumed to be negligible. We knew that old carapace crabs (category 5) were certainly dying, but the magnitude by shell condition was unknown. A natural mortality coefficient of 0.034/month was found to substantially reduce this bias. More work is required.

A bias in the opposite direction would be caused by mis-classification of carapace condition during the trawl survey. Exploitable biomass is composed of recruitment to the fishery (shell conditions 1 and 2) and remaining biomass (shell conditions 3, 4 and 5). Uncertainty of carapace condition generally results in overestimation of recruitment biomass. Finally, it is assumed that the survey gear catches 100 percent of crab > 50 mm, but this is unlikely to be always true and therefore the survey would tend to underestimate abundance and overestimate exploitation rate.

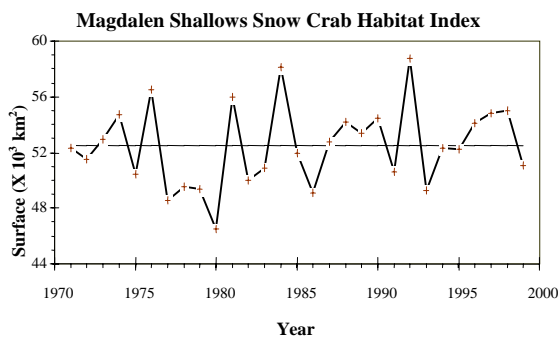
Seasonal movement between areas may occur between the time of the trawl survey and the beginning of the subsequent fishing season (especially adult crab of commercial size that have just molted). This movement is most apparent in the smaller areas. Another source of uncertainty is the movement of adult crab of commercial size when the biomass is increasing or decreasing. When the biomass is increasing, crab tend to spread over a larger surface and into peripheral areas like in Areas E and F. By contrast, when biomass is decreasing, crab tend to be concentrated in a smaller area. Movement of crab between Areas 12, 18 and 19 is assumed, but not explicitly taken into account in the assessment.

The survey sampling intensity and coverage have increased over time. The impact of this

is not yet known. There was some concern that the fixed station design could be affected by local depletion. The result would be to underestimate abundance. This source of error would depend on how crab redistributed themselves between surveys.

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 seen to be at the 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 degrees Celsius is an index of snow crab habitat, and was high since late 1980s to 1998. This index declined in 1999 to just below the long-term mean.



Outlook

The outlook for Area 12 snow crab is good. Based on the increase of pre-recruits observed in the 1999 trawl survey, the commercial crab biomass should continue to increase for at least another 3 years. In addition, an increase of the recruitment to the fishery is also anticipated. Thus, all indicators of stock health are very positive. We have just completed a decade, where

exploitation rates have been generally maintained around 35 %. At the moment, there is no long-term target exploitation rate and a harvest strategy needs to be developed over the next year. This strategy would ensure that the resource continues to be sustainable and yet would avoid any unnecessary wastage of yield. In the meantime, the 2000 fishery should ensure that the harvest does not exceed the biomass of incoming recruitment (16,500 t).

In Area E, there was a slight increase in catch rates and an increase of soft-shelled crab in catches in 1999. Projected harvestable biomass is 237 t. This fishery depends totally on Area 12.

In Area F, there was an increase in catch rate in 1999 and a low percentage of soft-shelled crab. Results of the 1999 trawl survey show an increase in the abundance of pre-recruits, which could increase the future recruitment to the fishery. In addition, 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 2000 and for the next two years. This is due to the arrival of strong waves of pre-recruits observed during the 1999 trawl survey. The application of the soft-shelled crab protocol since 1997 has been a success and fishers' collaboration has generally been good. Fishing activities should avoid areas of high concentrations of soft-shelled crab. Collaboration of fishers in following the daily soft-shelled crab monitoring protocol for the 2000 fishing season will be very important in minimizing the mortality of soft-shelled crab and protecting future recruitment to the fishery.

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References

Hébert, M., A. Hébert, E. Wade, T. Surette, D. Giard, P. DeGrâce, M. Biron and M. Moriyasu. 2000. The 1999 assessment of Snow crab, *Chionoecetes opilio*, stock in the southwestern Gulf of St. Lawrence (Areas 12, E and F). DFO Canadian Stock Assessment Secretariat, Res. Doc. 2000/014.

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