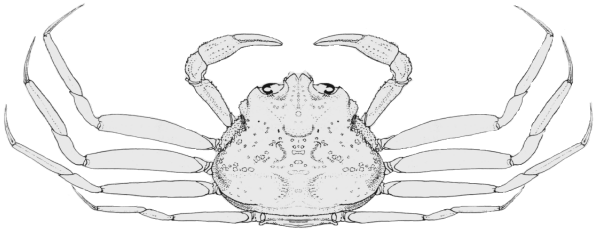
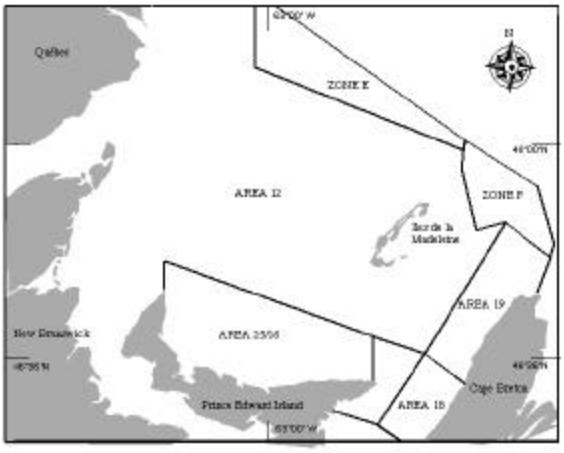


Southern Gulf Snow Crab



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 and are called white crab. 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, 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. There is no biological basis for these areas, and for assessment purposes the southern Gulf is considered as one stock.

The snow crab fishery in the southern Gulf began in the mid-1960s. There are three fishing Areas: 12/25/26, 18 and 19, and two exploratory zones (E and F) each with separate management schemes. In 1997, the southern Gulf portion of Area 12 and Area 25/26 were integrated 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 areas, and for assessment purposes the southern Gulf is considered as one stock. The minimum legal shell width is 95 mm, and female crab is 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 Area 12 and Zones E and F and in late summer in Areas 18 and 19. Neither soft-shelled crab nor white crab are harvested. 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).

Management of these fisheries is based strictly on quotas and effort controls (number of licenses, trap limits and seasons). In 1997, 93 vessels have access on a temporary basis to Area 12. Although the number of participants in Area 12 increased in 1995-97, the increase in total effort or trap hauls over previous years was less than 10%.

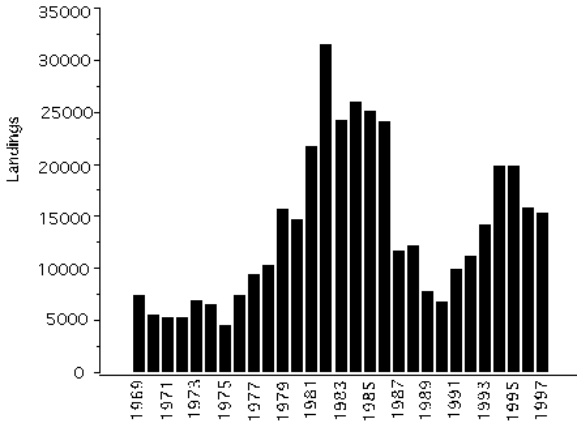
The Fishery

Area 12 Southern Gulf of St. Lawrence-
Area 12 was traditionally fished by 130 fishermen from New Brunswick, Quebec and Nova Scotia, with a trap limit of 150 per license. The fishery expanded rapidly, and 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 due to a high incidence of soft-shelled crab. 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 for one year to 131 non-traditional vessels. In 1996, the quota was set at 16,100 t of which 3,508 t was allocated to 123 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 licence. In 1997, the 160 traditional fishers were allowed a total quota of 13,110 t and 2,290 t was allocated to 93 non-traditional vessels.

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

	1970-79	1980-89	1990-94	1995	1996	1997
Quota	-	-	12,540	20,000	16,100	15,400
Landings	6,985	19,598	12,507	19,944	15,978	15,413
CPUE	-	-	36.4	47.8	50.1	50.8
Soft crab (%)	-	-	9.7	2.5	4.2	5.0

Landings (t) in Area 12



In 1995, exploratory fisheries were conducted for the first time in Zone E (4 vessels and a quota of 217 t) and Zone F (7 vessels and a quota of 317 t). Parts of these areas had been fished in the past by the traditional fleet. These fisheries were maintained in 1996 with lower quotas of 164 t and 238 t shared with 8 and 14 vessels respectively. In 1997, the quotas were 163 t for Zone E and 288 t for Zone F shared with 8 and 16 vessels respectively.

Areas 18 and 19, Cape Breton Island -
The fishing grounds along the west coast of Cape Breton Island were initially fished by a group of fishers based in Cheticamp. Subsequently, fishermen from Quebec and New Brunswick sporadically fished in the area. With the increase in the commercial value of snow crab in the late 1970s, the fishery gradually expanded to cover all fishing grounds along the west coast of Cape Breton Island.

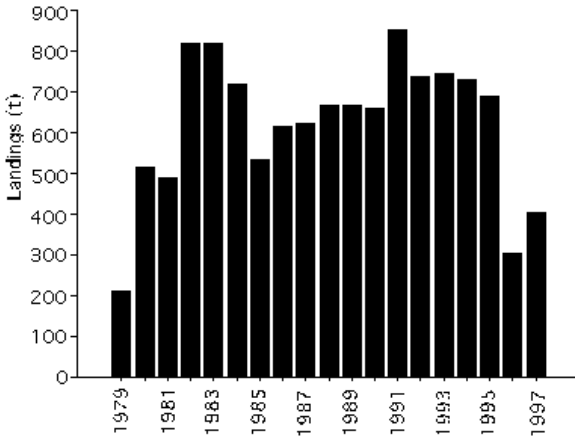
Area 18 was fished for the first time in 1979 by 14 inshore vessels with exploratory licenses and a trap limit of 30 traps per license. The following year, the licenses were converted into permanent fishing licenses

and nine supplementary licenses were issued to explore fishing grounds further offshore. Midshore vessels fished these same grounds until 1982. In 1984, Area 18 was reserved exclusively for inshore fishermen. The overall quota, which had initially been set at 835 t in 1981, was reduced to 626 t in 1986 and then increased to 674 t in 1988, where it remained for the 1990 season. In the spring of 1991, a quota of 200 t was set to promote a spring fishery in the area. Later that year, a quota of 674 t was set for the 1991 fall fishery and 1992 spring fishery. The quota was raised to 749 t for 1992-93, and remained at that level for 1993-94 and 1994-95. Since 1992-93, 30 fishers have participated in this fishery. In 1995, temporary licences were given to 30 fishers with a total quota of 109 t. The spring fishery was abolished after the 1995 season. In 1996, no temporary licences were issued and a quota of 340 t was allocated to 30 fishers. The season was closed early due to a high incidence of soft-shelled crab and because of low catch rates. In 1997, the quota was set at 580 t. The fishing season was prematurely closed for a second consecutive year due to the high incidence of soft-shelled crab and low catch rates. The landings were 406 t which correspond to 70 % of the total quota.

Quota (t) and landings (t) in Area 18

	1980-89	1990-94	1995	1996	1997
Quota	678	759	705	340	580
Landings	650	748	693	306	406
CPUE	-	51.7	33.5	21.2	18.1
Soft crab (%)	-	10.4	8.2	20.5	13.1

Landings (t) in Area 18

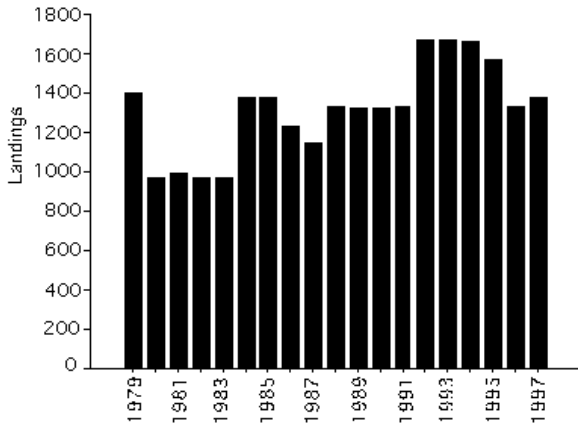


In 1978, Area 19 was established as an inshore area reserved exclusively for inshore fishers using vessels under 13.7 m (45 feet) in length. During 1992-94, quotas were set at 1,686 t. Landings, regulated by quotas, fluctuated between 900 t and 1,390 t from 1979 to 1991. In 1995, 74 fishermen participated in this fishery, with a trap limit of 20 per license. The quota of 134 t was allocated to 37 temporary licence holders. In 1996, a 5-year co-management agreement was signed between DFO and Area 19 snow crab fishermen's association and a quota of 1,343 t was allocated to 111 licenses holders. In 1997, the global quota was set at 1,386 t for the 111 licenses holders.

Quota (t) and landings (t) in Area 19

	1980-89	1990-94	1995	1996	1997
Quota	1,217	1,546	1,575	1,343	1,386
Landings	1,177	1,540	1,575	1,343	1,386
CPUE	-	77.0	63.4	54.6	63.2
Soft crab (%)	-	7.7	3.5	10.8	10.7

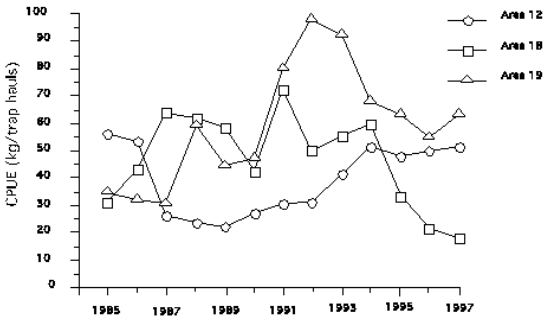
Landings (t) in Area 19



Resource Status

Catch rates are calculated from logbooks and are generally viewed with caution because fishers are provided with maps of crab concentrations before the opening of their fishery. Also catch rates are affected by socio-economic factors. Historically, there has been a good relationship between catch rates and the biomass survey but in 1996 and 1997 industry noted that there was a large increase in the soak time of traps in most areas and catch rates were considered to be inflated and not comparable to previous years, particularly in Area 12. In all areas, the daily monitoring of soft-shelled crab was introduced for the 1997 fishery and fishers were asked to move out from spots where the percentage of soft-shelled crab exceeded 20 %. This measure had the effect of: 1) decreasing the fishing effort in spots of high concentration of soft-shelled crab and thus, minimized the catch of these crabs and 2) increasing the catch rates by moving the effort in spots of higher concentration of hard-shelled crab.

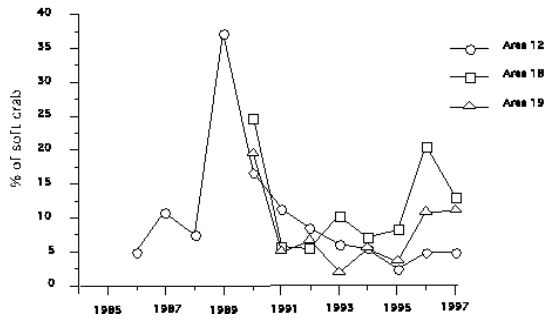
CPUE (kg per trap hauls) in Areas 12, 18 and 19



Nominal catch rates have increased in Area 19 and Zone F. A decrease in catch rates was observed in Area 18 and Zone E. Logbook data were also used to describe the general distribution of fishing effort per section (10 by 10 minutes). In 1997, the catches in the exploratory Zones E and F were located only at the boundaries and catch rates would not reflect abundance throughout the zone.

In Area 12, the percentage of **soft-shelled crab** increased slightly compared to the previous year. Although the fishery in Area 18 is restricted to the northern part of the area, the percentage of soft-shelled crab was high enough to result in closure of the fishery on August 16, before the quota was caught. In Area 19, the percentage of soft-shelled crab increased slightly compared to the previous year.

Percentage of soft-shelled crab in Areas 12, 18 and 19



Carapace condition was estimated from sea samples taken from the 1997 fishery. It is clear that crab with carapace category 3-5 comprised the bulk of the fishery.

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

Category	Description	Area 12	Area 18	Area 19	Zone E	Zone F
1-2	White crab	9.1	19.1	18.3	14.2	15.8
3	Intermediate	48.1	53.1	52.4	59.0	51.1
4	Old crab	34.9	21.8	26.7	24.2	31.8
5	Very old crab	7.9	5.8	2.6	2.5	1.3

The assessment is based on a trawl survey which provides estimates of uncaught, 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 be part of the exploitable biomass in the following year as new recruits. 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 crab with a very old carapace at the time of the survey. Abundance is also estimated for smaller size crab or pre-recruits. The survey should be viewed as an estimate of the population at the time of the sampling.

The stock assessment in Areas 12 and 19 and Zones E and F was based on a 1997 trawl survey. In Area 18, there was no survey in 1997.

Harvestable biomass estimates (t) in the southern Gulf of St. Lawrence

Year	Southern Gulf	Area 12	Area 18	Area 19
1989	-	8,700 (± 42 %)	-	-
1990	-	21,700 (± 53 %)	-	-
1991	-	23,400 (± 53 %)	-	-
1992	-	29,400 (± 50 %)	-	5,500 (± 36 %)
1993	46,500 (± 42 %)	37,800 (± 38 %)	1,300 (± 92 %)	5,200 (± 42 %)
1994	68,800 (± 16 %)	61,900 (± 13 %)	1,300 (± 83 %)	2,300 (± 27 %)
1995	66,100 (± 14 %)	58,700 (± 12 %)	1,200 (± 89 %)	2,600 (± 40 %)
1996	57,200 (± 17 %)	49,500 (± 16 %)	600 (± 39 %)	1,800 (± 21 %)
1997*	47,200 (± 33 %)	43,600 (± 54 %)	1,000 (± 54 %)	2,200 (± 27 %)
1998	36,245 (± 25 %)	33,085 (± 25 %)	-	3,160 (± 24 %)

*No survey in 1996. Estimates for Southern Gulf and Area 12 were based on the 1995 trawl survey.

Area 12:

Landings controlled by quota are down. There was an increase in the percentage of soft-shelled crab, especially in Baie des Chaleurs.

The survey indicates a decline in biomass to 33,000 t 25% (95 % confidence limits). Recruitment to the commercial fishery is expected to decline in 1999. A new wave of recruitment is expected to enter the fishery in the near future. The incidence of soft-shelled crab is expected to increase in 1998. A continuous decrease of the commercial biomass has been observed since 1994. It was considered that a part of the 1998 biomass, 1,300 tonnes of very old crab will not be available for the next fishing season.

No concentration of that biomass was observed by the 1997 survey.

Area 18:

In 1997, the fishery had the lowest catch rate on record although it took place only in the northern part of the area. In addition , there was a high incidence of soft-shelled crab. There was no survey in 1997. The 1997 fishery suggested that the availability of the resource was less than indicated by the 1996 survey. Fishers believed that newly-molted, commercial-sized crab, moved towards the outside of the Area in the early part of the season. The 1996 survey indicated an increase in pre-recruits which could indicate an increase of recruitment to the fishery in 1998, but only if crab remain within the area after their terminal molt.

Area 19:

There were a number of indicators of the healthy status of crab in this Area. Landings and catch rates increased in 1997. Catch rates tended to remain high throughout the fishing season. Soft-shelled crab remained steady at 10%. The survey indicated an exploitable biomass of 3,160 t, which is an increase of 44% over the previous year. There has been an increasing trend in biomass and recruitment since 1996. In addition there is a high concentration of crab >56mm that indicates future recruitment. The recruitment to the fishery within the bounds of Area 19 represents 62 % of the available biomass for the 1998 fishing season. There has been no calculation of the impact of removals in Area 19 on the status of stocks in Area 12, but it is assumed to be minimal.

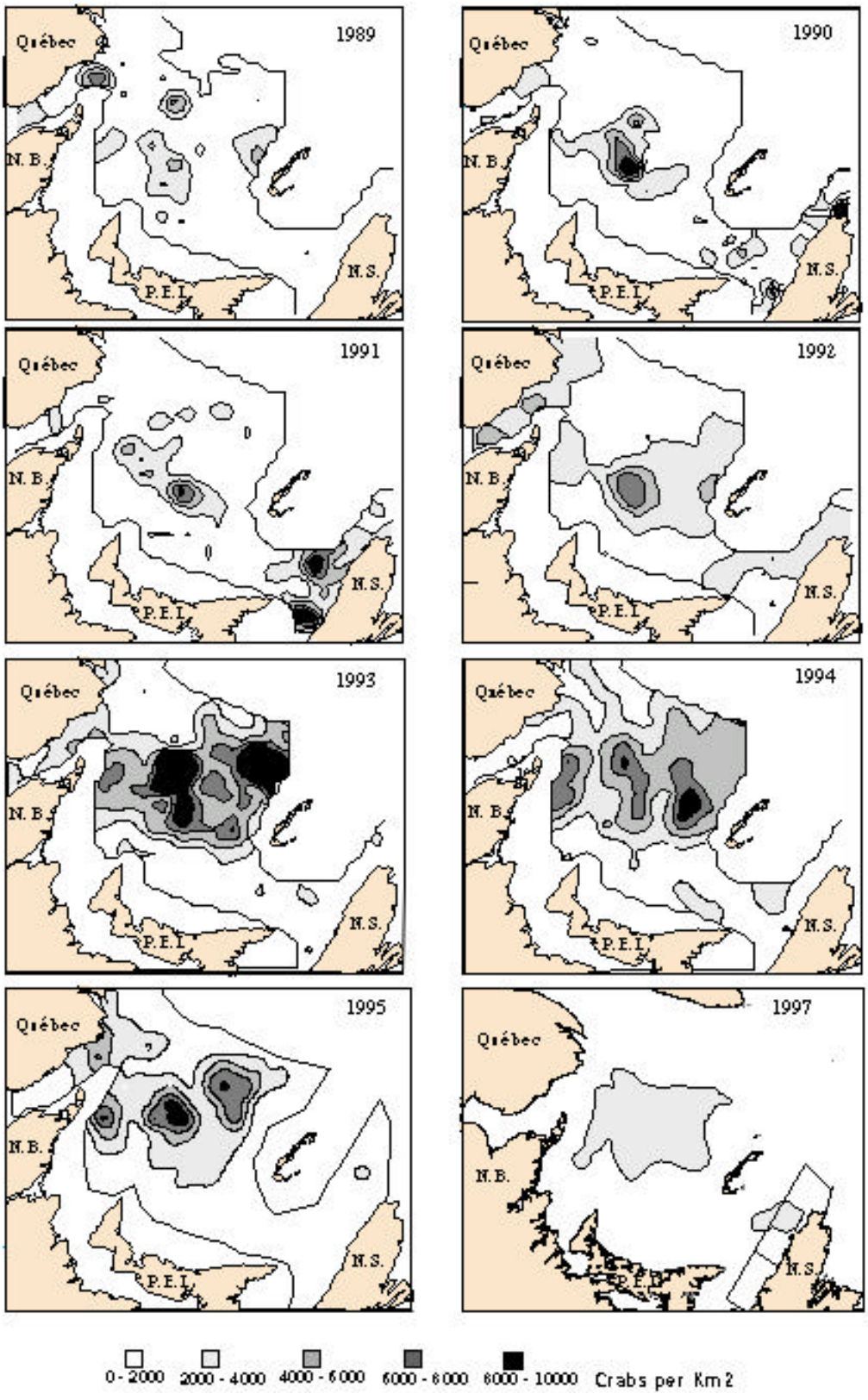
Zone E:

The exploitable biomass for the 1998 fishing season was estimated at 1,456 t ± 821 t. The recruitment to the fishery was estimated at 567 t ± 630 t. The biomass level (1,456 t ± 821 t) should be interpreted carefully because the crab concentrations are situated at the boundaries of the area sampled and have wide confidence intervals. The results of the 1997 trawl survey shows a trough in the abundance of pre-recruits in that zone.

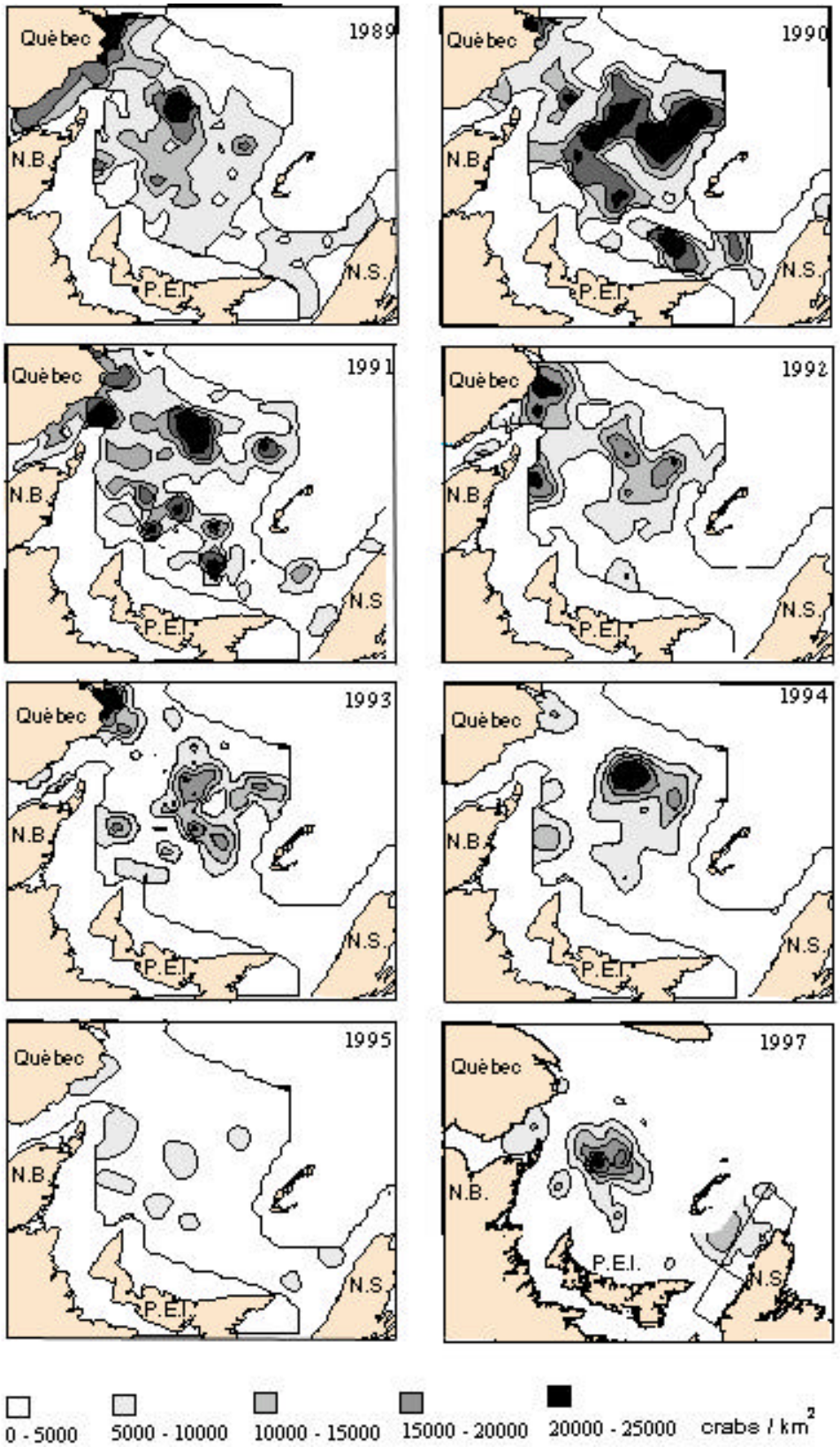
Zone F:

The results of the 1997 trawl survey does not shown abundance of pre-recruits as indicated in the surveys for Areas 12 and 19. The fishers of Zone F, as observed during the 1996 fishing season, have concentrated their fishing effort in two distinct areas: the northwestern part adjacent to Area 12, and in the southeastern part adjacent to the northern boundary of Area 19. It is not known whether recruitment into Zone F can sustain a fishery over the long term, or whether it can simply support fisheries during population pulses related to trends in Areas 12 and 19. The increase of the harvestable biomass in Area 19 could have a positive effect on this zone.

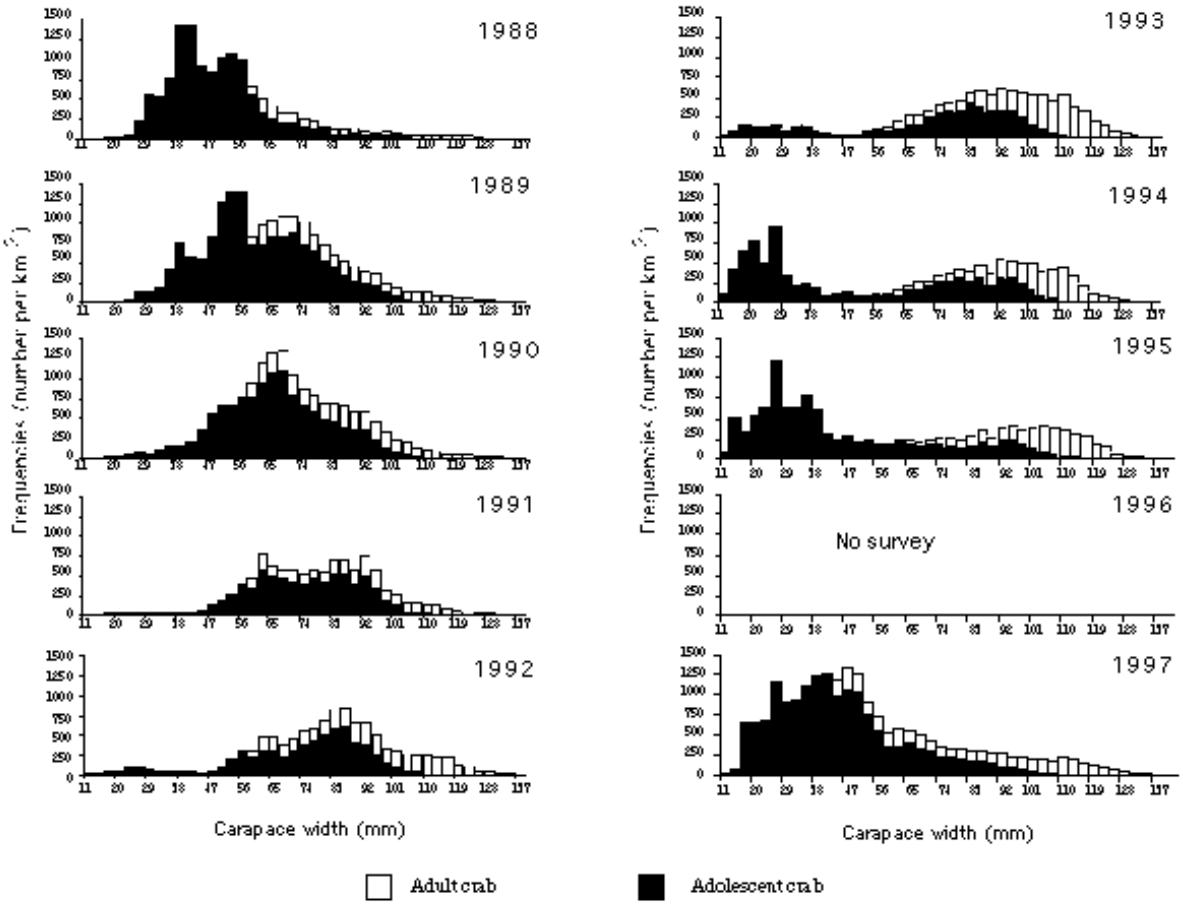
Projected density contours of adult male crab 95 mm CW



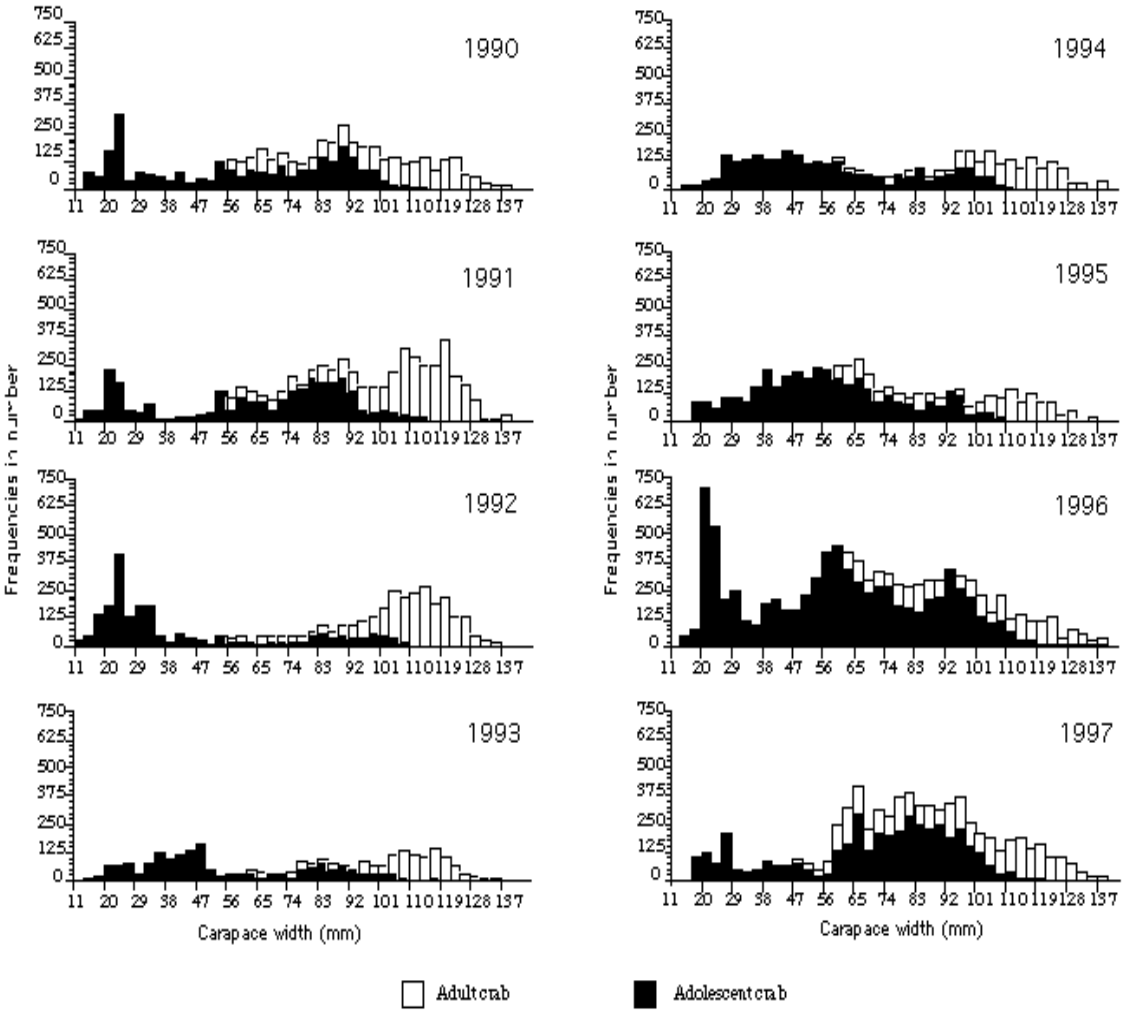
Projected density contours of adolescent male crab 56 mm CW



Size frequency distribution for male crab taken during the trawl survey in Area 12 after the fishing season



Size frequency distribution for male crab taken during the trawl survey in Area 19 after the fishing season



Exploitation rate for the combined southern Gulf of St. Lawrence fisheries was estimated at 37 % . However, the rate varied from area to area (35 % for Area 12, 42 % for Area 18 and 63 % for Area 19). Historically, the exploitation rate has been higher in inshore areas than in Area 12. It should be noted that the calculated exploitation rates in Areas 18 and 19 are influenced by the movements of crab into and out of these areas.

Exploitation rates (%) in Areas 12, 18 and 19

	Southern Gulf	Area 12	Area 18	Area 19
1990	-	32	-	-
1991	-	43	-	-
1992	-	38	-	-
1993	38	38	58	32
1994	34	32	58	73
1995	35	34	58	61
1996	35	32	53	74
1997	37	35	42	63

Sources of Uncertainty

The lack of knowledge on the growth of the pre-recruits is the major source of uncertainty of this assessment. The size at which skip molting occurs and its causes are not well known. Therefore, the forecast of the timing for the next recruitment to the fishery should be interpreted with caution.

Seasonal movement may occur (especially adult crabs of commercial size that have just molted) between the time of the trawl survey and the beginning of the subsequent fishing season. 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 Zone E in 1994 and 1995. By contrast, when biomass is decreasing, crab tend to be concentrated in a smaller area. We assume that there is movement of crab among Areas 12, 18 and 19.

The abundance estimates from the **trawl survey** include assumptions about the surface trawled by the gear being constant and that all crabs are equally catchable. Another source of uncertainty are errors in converting carapace size to biomass. The difficulty of classifying the shell condition of crab during the trawl survey is another source of uncertainty because the commercial biomass (B) is composed of the recruitment to the fishery (shell conditions 1 and 2) and residual biomass (shell conditions 3, 4 and 5). It is assumed that the survey gear catches 100% of crab > 30 mm, but this is unlikely to be always true and therefore the survey would tend to underestimate abundance and overestimate exploitation rate.

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 localized depletion. The result would be to underestimate abundance. This source of error would depend on how much crab redistributed themselves between surveys.

There were other uncertainties. First, it was not known if all **landings** are reported. Second, it was assumed there is no natural mortality except for crab in category 5 between the survey and the fishing season. Third, it was assumed that the mortality on discarding of soft-shelled crab during the fishery is negligeable. Finally, activities like

highgrading at sea of commercial-size crab could cause a certain mortality that is not taken into consideration in this assessment.

Ecosystem Considerations

Cold water temperatures are preferred by snow crab. Bottom water temperatures in the southern Gulf have been colder than the long-term average since the late 1980s. During 1995 and 1996 subzero bottom water was seen to be at its greatest extent since these measurements began in 1971. For southern Gulf, Areas 20-22, and south Cape Breton, 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 was used as an index of snow crab habitat, which for northeastern Scotian Shelf, Sydney Bight and southern Gulf has been high since late 1980s. Although, the western Gulf is colder than normal and the eastern Gulf is slightly warmer, bottom temperatures in both areas are warming up.

Outlook

In Area 12, an exploitation rate of 32 to 38 % has been used as a target rate since the stock collapsed in 1989. Since then, much knowledge on snow crab biology and population dynamics has been accumulated. The rapid stock recovery for Area 12 was mainly due to a timely arrival of strong recruitment waves. The stock decline in Area 12 may persist at least one or two more years. Based on the above exploitation rates and harvestable biomass, the available yield in 1998 would be between 10,175 t and 12,080 t.

Considering the current stock condition in Area 18, a cautious approch is suggested not to increase the level of exploitation and to close the fishery as soon as the catches of soft-shelled crab exceed 20 % in order to protect the future recruitment to the fishery.

In Area 19, it would be prudent to not increase the exploitation rate considering the presence of soft-shelled crab for the 1998 fishing season. Maintaining the 1997 exploitation rates would give an available yield in 1998 of 1,991 t. According to the trawl survey results, it was observed that the concentrations of harvestable crab have been located in the northern part of the Area for the last three years. Although the fishing effort has increased during the past few years in that part of the Area, fishers should continue to exploit this spot during the next years for the following reasons: 1) to prevent the accumulation of older crab and 2) to decrease the fishing effort in the southern part of the Area in order to minimize the catch of soft-shelled crab and protect the future recruitment to the fishery.

In Zone E, considering the decrease of the biomass in Area 12 and the lack of pre-recruits in that zone, it will be very difficult to maintain an exploitation rate and stabilize the fishery for a long-term period. Zone E is an area of overflow of harvestable crab coming from Area 12. This fishery is considered as a sporadic exploitation area and the stock condition of Area 12 can affect the abundance of commercial crab in that zone.

In Zone F, because of the low level of biomass (513 t ± 335 t) and the lack of pre-recruits, it will be difficult to maintain an exploitation rate and stable fishery. This fishery is considered as a sporadic exploitation area and the stock condition of Areas 12 and 19 can affect the abundance of commercial crab in that zone.

A harvest strategy is not yet in place at present time. Until the new wave of recruits reaches the exploitable population, the harvest level should be set by considering the timing and the strength of the next pulse of recruitment. When the recruitment pulse enters the fishery, a new exploitation strategy could be developed that would avoid losing yield of old-carapace crab; it would be based on linking harvest to the level of recruitment. Normally, harvest should not exceed recruitment. In addition, fishing locations could be rotated in relation to the quality and concentrations of exploitable crab. Further discussions would be required to consider the implications of the various options and develop an optimal harvesting strategy.

Management Considerations

An increase of soft-shelled crab is predicted starting in 1998 and for the next two or three years. This is mainly due to the arrival of strong waves of pre-recruits (R-3 and smaller sizes) observed during the 1997 trawl survey. It would be important to not concentrate the fishing effort in areas of high density of soft-shelled crab.

Throughout the history of this fishery, it is clear that the industry always has sought to protect the soft-shelled crab. Since the drastic decrease in biomass in 1989, a management measure was introduced in 1990 in Area 12: if the overall observed catch exceeded 20 % of soft-shelled crab, then the fishery would be closed. In 1997, a daily monitoring protocol of the soft-shelled crab was put in place for the southern Gulf. On a voluntary basis, vessels were invited to leave locations where catch of soft-shelled crab exceeded 20 %. The purpose of this protocol was to protect recruitment to the fishery and to decrease fishing effort in areas with a high percentage of soft-shelled crab without closing the whole fishery. A good strategy to add to the protocol for the following fishing seasons would be to adopt closures by sub-area.

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References

Hébert, M., M. Moriyasu, E. Wade, P. DeGrâce, A. Hébert, M. Biron. 1998. 1997 assessment of Snow crab (Chionoecetes opilio) stock in the southern Gulf of St.Lawrence (Areas 12, 18, 19 and Zones e and F). Canadian Stock Assessment Secretariat, Res. Doc. 98 1.

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Erratum

Please note the following corrections in regards to certain references in the Stock Status Report:

Document Referenced:

Hébert, M., M. Moriyasu, E. Wade, P. DeGrâce, A. Hébert, M. Biron. 1998. 1997 assessment of Snow crab (Chionoecetes opilio) stock in the southern Gulf of St.Lawrence (Areas 12, 18, 19 and Zones E and F). Canadian Stock Assessment Secretariat Res. Doc. ***98/1***.

Correction:

Document number should be ***98/95***.