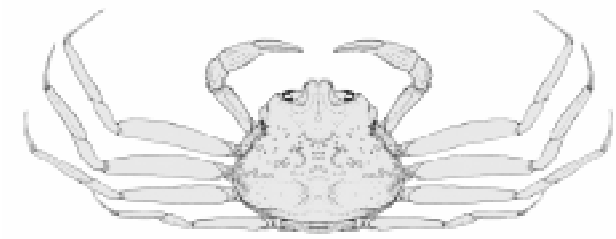
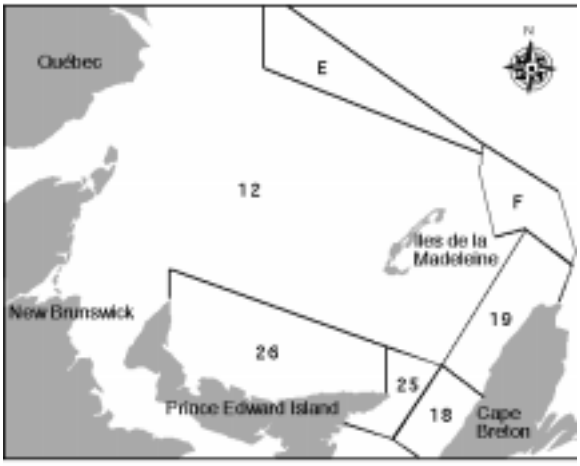




Southern Gulf of St. Lawrence Snow Crab

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).

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.

The snow crab fishery in the southern Gulf began in the mid-1960s. Currently, there are three fishing Areas: 12/25/26, 18 and 19, and two exploratory

areas (E and F) each with separate management schemes. Since 1997, 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 areas, and for assessment purposes, the southern Gulf is considered one stock.

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 Area 12 and Areas E and F and in late summer in Areas 18 and 19. Neither soft-shelled nor white crab are harvested.

Management of these fisheries is based strictly on quotas and effort controls (number of licenses, trap limits and seasons). In 1998, landings were 11,136t (quota of 11,125 t). Given lower abundance and the lower value of snow crab, no temporary permits were allowed in 1998.

Summary

Area 12

- Landings and quota in 1998 declined to 11,000t. The catch rates adjusted for soak time have declined since 1995. In 1998, the percentage of soft-shelled crab declined to about 3 percent from 5 percent in previous year.
- The 1998 survey indicates a decline in the biomass to 28,000t. The recruitment also declined to 15,000t.
- There will be an increase in the amount of soft-shelled crab and recruitment in the near future.
- A harvest at an exploitation rate of 45% would not exceed the predicted recruitment for 1999 and thus would not result in any change of the exploitable biomass.

Area 18

- Only 70 percent of the quota was caught because of high percentage of soft-shelled crab and poor quality of landed crab. Catch rates were at the lowest level on record. There was an increased proportion of sub-legal adult males in commercial catches in the 1998 fishery.
- There was no biomass and recruitment estimates because the survey was not conducted in 1998.

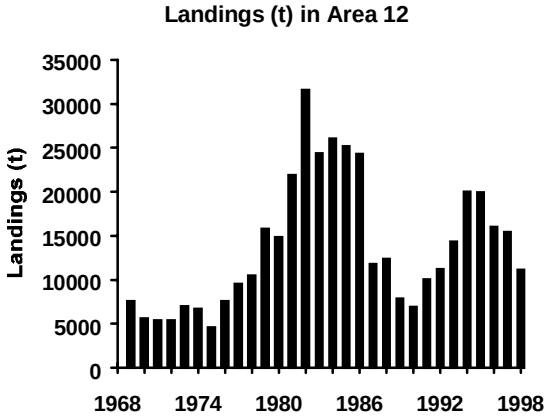
Area 19

- The 1998 landings and catch rates were high.
- The projected exploitable biomass for 1999 is 3,150t. The recruitment within Area 19 is projected to be 1,900t.
- There was no reason to change the exploitation rate for 1999.

The Fishery

Area 12, Southwestern Gulf of St. Lawrence

Prior to 1995, Area 12 was traditionally 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 1970s, and **reported landings** peaked in 1982 at 31,500 t. Landings then fluctuated around 25,000t until 1986, falling to 11,700t in 1987. In 1989, the fishery was closed early due to a high incidence of soft-shelled crab. The quota was set at 7,000t in 1990. In 1995, landings were 19,944t (quota of 20,000 t) of which 4,500t was allocated for the first time for one year to 131 non-traditional vessels (temporary license holders). In 1996, the quota was set at 16,100t of which 3,508t 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 license. In 1997, the 160 traditional fishers were allowed a total quota of 13,110t of which 2,290t was allocated to 93 non-traditional vessels. The 1998 landings were 11,136t (quota of 11,125 t). Given lower abundance and the lower value of snow crab, no temporary licenses were allowed in 1998.



Quota (t) and landings (t) in Area 12, excluding Areas E and F.

	1994	1995	1996	1997	1998
Quota	20,000	20,000	16,100	15,400	11,125
Landings	19,995	19,944	15,978	15,413	11,136
CPUE	51.2	47.8	50.1	50.8	45.8
Adj. CPUE*	48.7	40.5	42.2	39.5	30.4
Soft crab (%)	5.6	2.5	4.2	5.0	2.8

* CPUE adjusted for soak time

In 1995, **exploratory fisheries** were conducted for the first time in Area E (4 vessels and a quota of 217 t) and Area 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 163t and 238t, shared with 8 and 14 vessels respectively. Since 1997, the quotas have been 163t for Area E and 288t for Area F shared amongst 8 and 16 vessels respectively.

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

	1995	1996	1997	1998
Quota	217	163	163	163
Landings	217	163	163	161
CPUE	53.8	60.3	34.7	28.6
Soft crab (%)	0.6	4.6	4.3	2.9

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

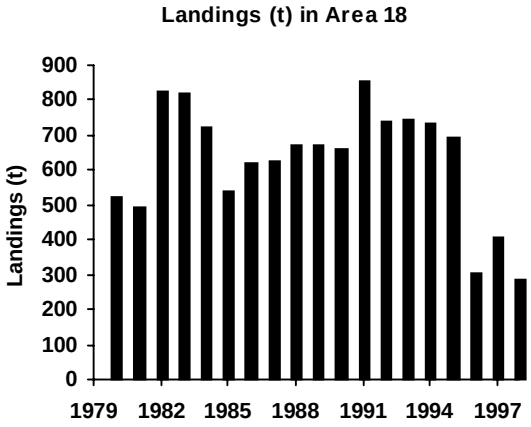
	1995	1996	1997	1998
Quota	317	238	288	288
Landings	317	238	287	290
CPUE	27.4	42.4	44.9	48.1
Soft crab (%)	11.8	5.3	1.5	1.1

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, fishers 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. In 1984, Area 18 was reserved exclusively for inshore fishers. The overall quota, which had initially been set at 835t in 1981, was reduced to 626t in 1986 and then increased to 674t in 1988, where it remained until 1990. In the spring of 1991, a quota of 200t was set to promote a spring fishery in the area. Later that year, a quota of 674t was set for the 1991 fall fishery and 1992 spring fishery. The quota was raised to 749t 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, the quota was 705t of which 109t were allocated to 30 temporary license holders. In 1996, no temporary licenses were issued and a quota of 340t was allocated to 30 fishers. In 1997, the quota was set at 580 t. Landings were 406t which correspond to 70 percent of the total quota. In 1998, landings were 289 t, which correspond to 70 percent of the total quota of 411 t.

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

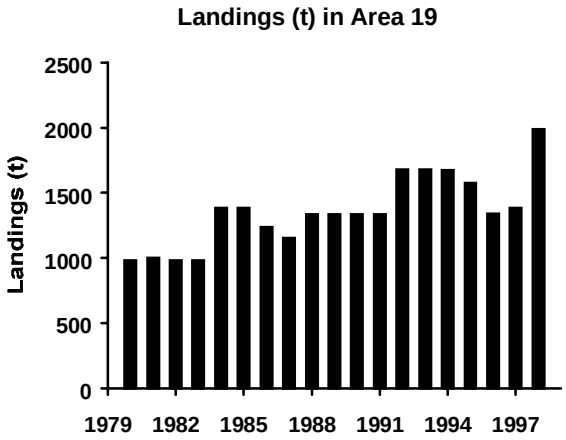
	Average 1990-94	1995	1996	1997	1998
Quota	759	705	340	580	411
Landings	748	693	306	406	289
CPUE	51.7	33.5	21.2	18.1	18.0
Soft crab (%)	10.4	8.2	20.5	13.1	17.1



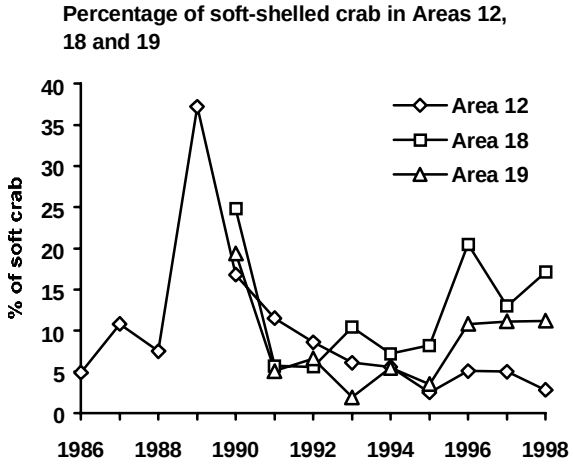
In 1978, **Area 19** was established as an inshore area reserved exclusively for inshore fishers using vessels under 13.7 m (45 feet) in length. Landings, regulated by quotas, fluctuated between 900t and 1,390t from 1979 to 1991. During 1992-94, quotas were set at 1,686 t. In 1995, there were 74 permanent and 37 temporary license holders participated in the fishery with a global quota of 1,575 t. Since 1996, the 37 temporary licenses have become permanent. In 1996, the quota was 1,343t for the 111 permanent license holders. In 1997, the quota was set at 1,386 t. In 1998, the quota increased to 1,991t (landings of 1,988 t).

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

	Average				
	1990-94	**1995**	**1996**	**1997**	**1998**
Quota	1,546	1,575	1,343	1,386	1,991
Landings	1,540	1,575	1,343	1,386	1,988
CPUE	77.0	63.4	54.6	63.2	63.7
Soft crab (%)	7.7	3.5	10.8	10.7	11.2



In **Area 12**, the percentage of **soft-shelled crab** in the catch decreased slightly in 1998 compared to the previous year. This change reflects how effective management measures have been since 1997, when daily monitoring of soft-shelled crab was introduced. Fishers were asked not to fish in areas where the percentage of soft-shelled crab exceeded 20 %. This measure had the effect of: 1) decreasing fishing effort in spots 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 spots with higher concentrations of hard-shelled crab. The percentage of soft-shelled crab was particularly high in Baie des Chaleurs and a part of the bay had to be closed during the 1998 fishing season. In Area 18, the percentage of soft-shelled crab in 1998 was also high but during the whole season. The fishery was prematurely closed and re-opened twice due to a high incidence of soft-shelled crab and poor quality of landed crab. In Area 19, the percentage of soft-shelled crab in 1998 was comparable to that in the previous year (11 %).



Carapace condition was estimated from sea samples taken from the 1998 fishery. Crab with carapace category 3-5 comprised the bulk of the fishery in all areas.

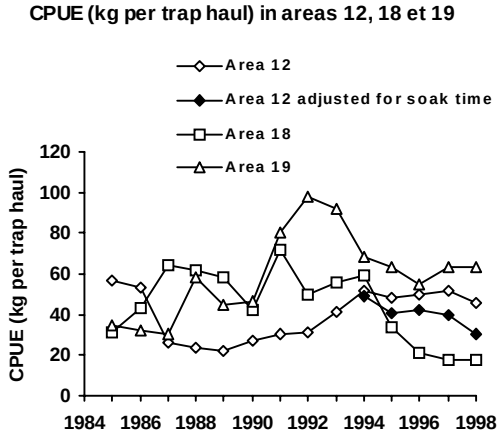
Carapace condition of commercial-sized adult crab in the catch (%)

Category	Description	12	18	19	E	F
1-2	White crab	4	19	14	10	6
3	Intermediate	40	54	44	43	68
4	Old crab	37	24	41	38	25
5	Very old crab	9	3	1	9	1

Resource Status

Catch rates (CPUE) are calculated from logbooks and are 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. Historically, there has been a good relationship between CPUE and the exploitable biomass estimates from the trawl survey. However, since 1996, industry noted that there has been a large increase in the soak time of traps in most areas. The CPUE is not comparable to previous years, particularly in Area 12, because processing plant 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 1994 and 1998 were adjusted to compensate for change in soak time.

The adjusted CPUE series indicated a decreasing trend since 1994. The adjusted CPUE has decreased from 1994 (48.7 kg/trap haul) to 1998 (30.4 kg/trap haul). Logbook data were also used to describe the general distribution of fishing effort per section (10 by 10 minutes).



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 be new recruits 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 and 19 and Zones E and F was based on a 1998 trawl

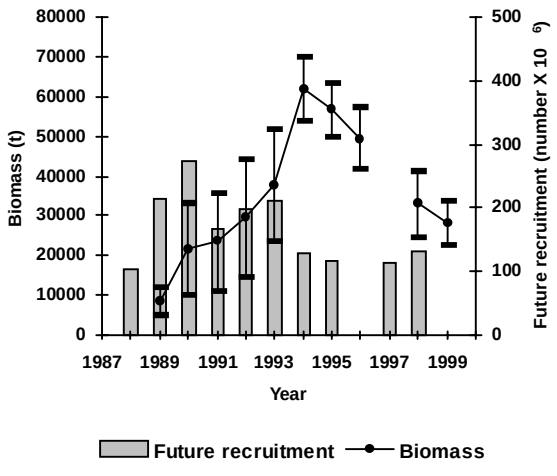
survey. In Area 18, there was no survey in 1998.

Exploitable biomass estimates (t) in the southern Gulf of St. Lawrence (with 95 % confidence intervals)

Year	Southern Gulf	12	18	19	E	F
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*	-	-	1,000 (± 54 %)	2,200 (± 27 %)	-	-
1998	36,245 (± 25 %)	33,085 (± 25 %)	-	3,160 (± 24 %)	1,456 (56%)	573 (65%)
1999	31,345 (± 21 %)	28,193 (± 20 %)	-	3,152 (± 35 %)	218 (±125%)	973 (±99%)

*No survey in Area 12 in 1996.

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



Area 12:

The survey indicates a decline in **exploitable biomass** to 28,193t ± 20% (95 % confidence limits) for 1999, which is the lowest level since 1992. One third of this biomass is composed of older crabs with carapace conditions 4 and 5 of which 2,200t are very old crab that will mate and die and not be available for the 1999 fishing season. However, an increase of recruitment to the fishery is expected in the near future (within a couple of years) and incidence of soft-shelled crab is expected to increase in 1999-2000.

Area 18:

The high percentages of soft-shelled crab and adult crab of sub-legal size (25 %) observed during the 1998 fishing season, as well as the decrease of the average CPUE, indicate that the 1998 exploitable biomass was very low. The trawl survey has not been conducted since 1996.

Area 19:

The survey indicated an exploitable biomass of 3,152t for the 1999 fishing season, which is comparable to that in 1998. Mortality of category 5 crab was not considered in the calculations of exploitable biomass. A slight decrease in the abundance of pre-recruits was observed from the 1998 trawl survey. However, the presence of pre-recruits in Area 12 adjacent to the Area 19 boundary could affect the level of recruitment to the fishery in Area 19 for the coming years. About 60 percent of the exploitable biomass for the 1999 fishing season will be new recruits. 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.

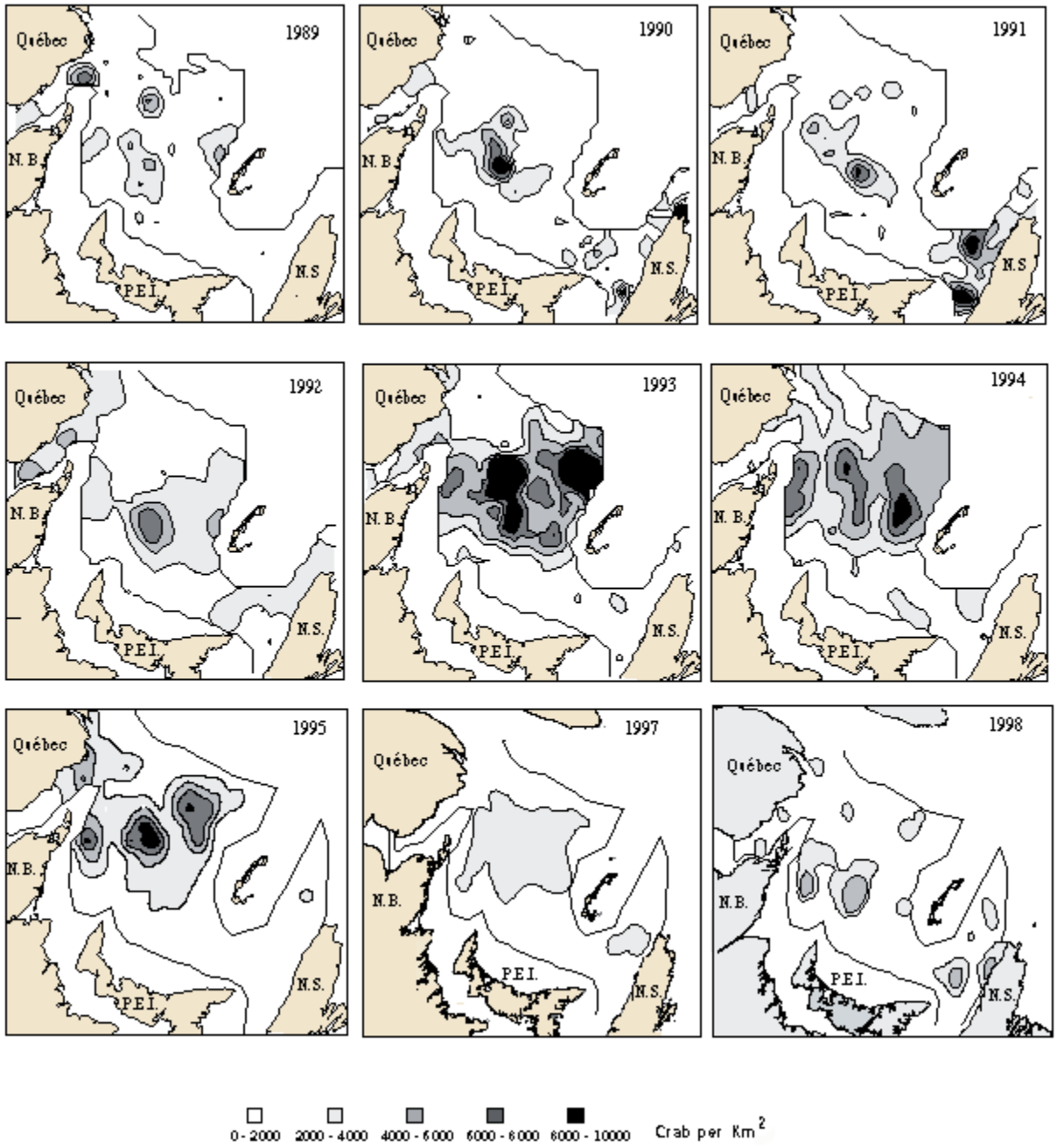
Area E:

The exploitable biomass for the 1999 fishing season was estimated at 218t ± 125 %. The recruitment to the fishery was estimated at 38t ± 132 %. The biomass level should be interpreted carefully because the crab concentrations are situated at the southern boundary and have wide confidence intervals.

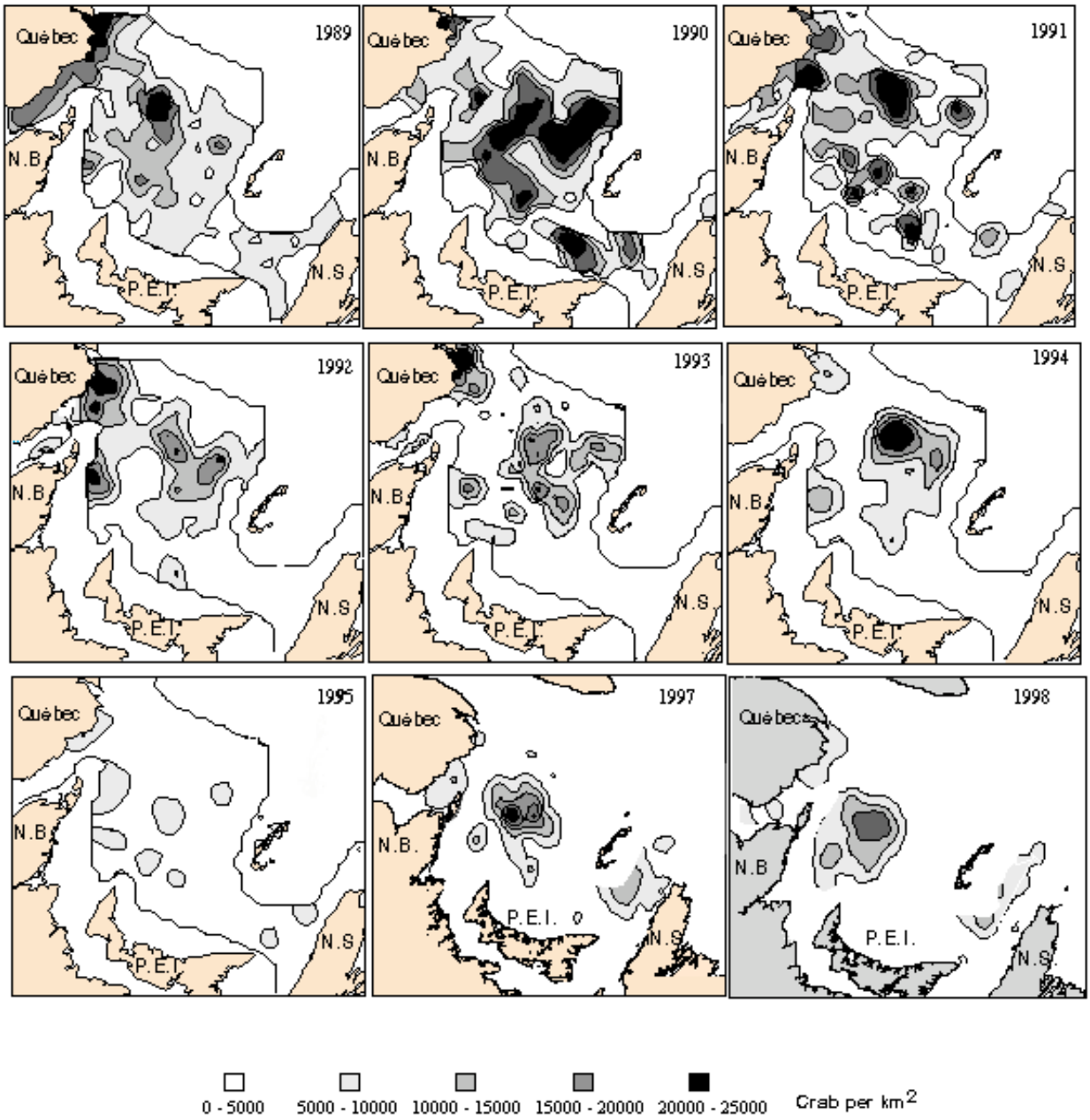
Area F:

The 1998 trawl survey shows a slight increase in the abundance of pre-recruits compared to the previous year. Fishers of Area F, as observed during the 1996 and 1997 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 within or outside Area F can sustain a fishery over the long term.

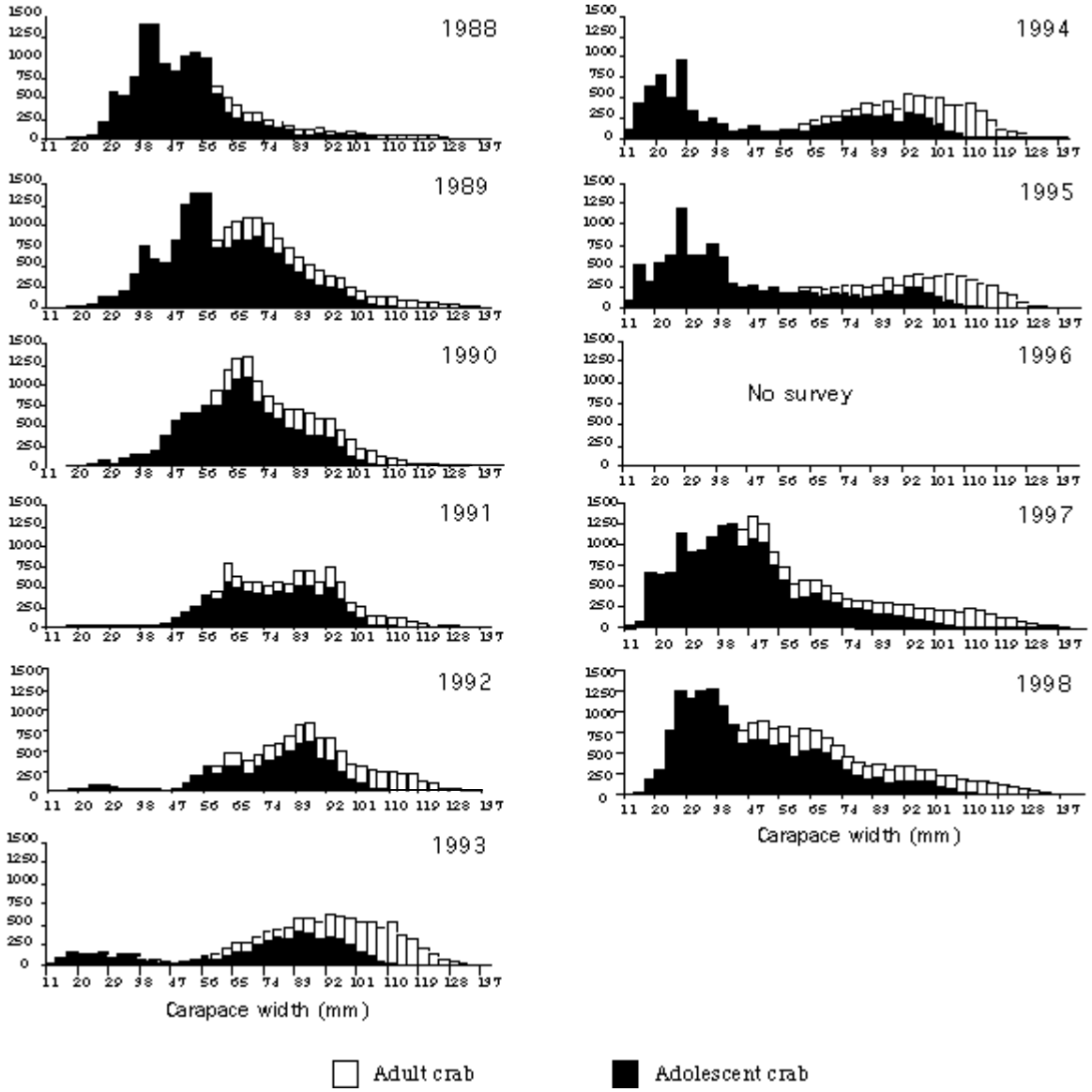
Projected density contours of adult male crab ≥ 95 mm CW



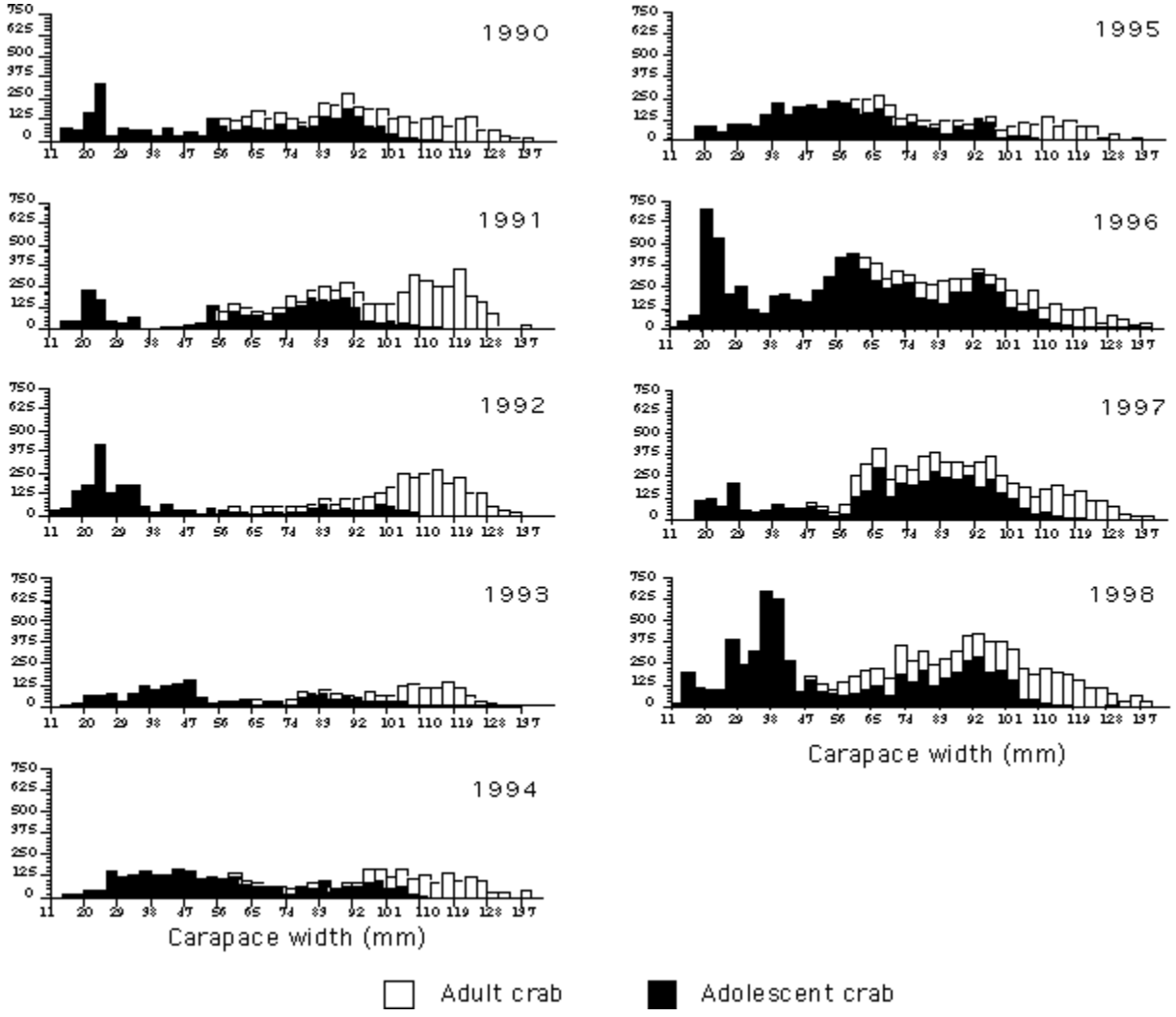
Projected density contours of adolescent male crab ≥ 56 mm CW



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



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



Exploitation rate for the combined southern Gulf of St. Lawrence fisheries in 1998 was estimated at 36 percent. However, the rate varied from area to area (35 % for Area 12, 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 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
1989	-	90	-	-
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
1998	36	35	-	63

Sources of Uncertainty

The current evaluation has a number of uncertainties listed below but notwithstanding, the stock assessment is considered valid.

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 and its causes are not well known. Therefore, the forecast of the timing for the next wave of recruitment into the fishery should be interpreted with caution.

Exploitable biomass has been **biased** since 1995. The tendency was towards under-estimating recruitment and over-estimating remaining biomass. The degree and nature of this bias requires further work. Several reasons for the bias include: movement, mortality and classification of carapace condition.

Seasonal movement between fished areas 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. Movement of crab among Areas 12, 18 and 19 is assumed.

Natural mortality of adult crabs was assumed to be negligible. However, the crab population is aging and old carapace crabs are most certainly dying. The magnitude of this mortality by shell condition is unknown.

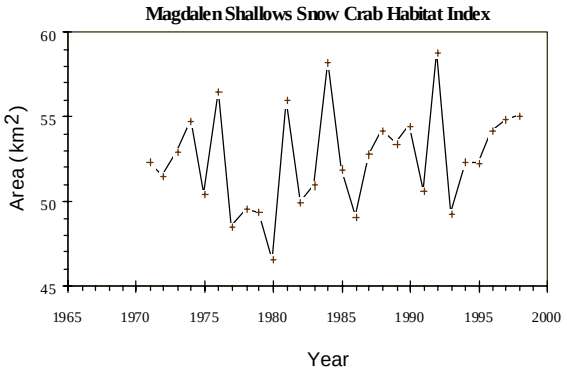
Classification of carapace condition during the trawl survey is another source of uncertainty. Exploitable biomass is composed of the recruitment to the fishery (shell conditions 1 and 2) and residual biomass (shell conditions 3, 4 and 5). Uncertainty of carapace condition may result in overestimation of recruitment biomass. Finally, it is assumed that the survey gear catches 100 percent 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 local depletion. The result would be to underestimate abundance. This source of error would depend on how much crab redistributed themselves between surveys.

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 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 has been high since late 1980s. This index remained high in 1998, for the southern Gulf of St. Lawrence, indicating that there is still a large amount of preferred thermal habitat for snow crab.



Outlook

We were unable to evaluate the long-term biological consequences of an increase in the exploitation rate to 45 percent for the 1999 fishery, which was an exploitation rate proposed by the snow crab industry for 1999. There was no biological basis for the current rate of 35 percent. The proposed rate of 45 percent was within the upper range of documented exploitation rates since 1989 and likely well below the exploitation rates estimated for the 1980s. A harvest at an exploitation rate of 45 percent would not exceed the predicted recruitment for 1999, and thus would not result in change in the exploitable biomass.

An increase of future recruitment is expected starting in year 2000-2001. An increase of soft-shelled crab in catches is expected for the next two or three fishing seasons.

In Area 18, considering the stock condition, it would be appropriate to decrease the level of harvesting 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, there was no reason to change the exploitation rate for the 1999 fishing season. According to the survey, concentrations of harvestable crab are located in the southern and central parts of the area. However, the presence of pre-recuits in Area 12, adjacent to Area 19, could affect the level of recruitment to the fishery in Area 19 for the coming years.

Management Considerations

An increase of soft-shelled crab in the catch is predicted starting in 1999 and for the next two or three years. This is due to the arrival of strong waves of pre-recruits observed during the 1998 trawl survey. The application of the soft-shelled crab protocol since 1997 has been a success and fishers' collaboration has been good. Fishing activities should be avoided in areas of high concentrations of soft-shelled crab, such as Baie des Chaleurs, the northern part of Bradelle Bank, Orphan Bank and the southern parts of the Magdalen Islands. Collaboration of fishers to follow the protocol of the daily soft-shelled crab monitoring for the 1999 fishing season will be very important in order to minimize the mortality of soft-shelled crab and protect future recruitment to the fishery.

In Area E, there was a decline in catch rates in 1998. Projected biomass is 200 t. This fishery depends totally on Area 12 and should be combined with this area. It will be difficult to maintain the same exploitation rate. There appears to be no reason to do a separate assessment for this area.

In Area F, there was an increase in catch rate in 1998 and a low percentage of soft-shelled crab. This area may be influenced to some extent by the stock conditions in Areas 12 and 19. We were unable to evaluate the uniqueness of this area.

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