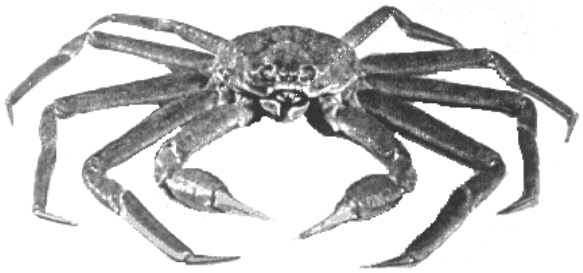

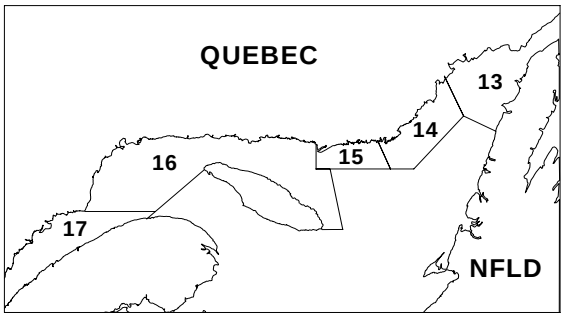

Snow Crab of the Estuary and Northern Gulf of St. Lawrence (Areas 13 to 17)

Background

The commercial snow crab fishery in the Estuary and northern Gulf of St. Lawrence began in the late 1970s. The northern Gulf is divided into five management areas, numbered from 13 to 17 from east to west. TAC-based management was gradually introduced in the region between 1985 and 1994. The fishery is directed exclusively at males with a carapace width over 95 mm.

Recruitment in snow crab varies over an intrinsic cycle of about eight years, generally characterized by five years of moderate-to-high recruitment (recruitment wave) followed by three years of low recruitment (recruitment trough). Males reach commercial size at an age of about nine years. The 1985-1987 age classes, which are currently being harvested, form a recruitment trough. The biomass, and hence catches and yields, are lower than the values observed between 1991 and 1995, when the last recruitment wave occurred. This situation should persist until 1998-1999 in areas 17 and 16, and until 2000-2001 in areas 14 and 13, when the 1988-1992 age classes which will make up the next recruitment wavewill be fully recruited to the fishery.

Summary

- The westernmost management areas (16 and 17) are more productive than the easterly ones (15, 14 and 13); recruitment waves appear sooner and last longer than in the east.
- **In areas 16 and 17,** crabs of the recruitment wave consisting of the 1988 to 1992 age classes are reaching commercial size; this will entail a decline in the average size of crabs taken.
- In 1998, the 1988 age class should be fully recruited to the fishery, but its abundance at commercial size is not enough to provide any significant increase in harvestable biomass, given the small residual biomass now on the seabed.
- The subsequent age classes (1989-1992) are more abundant and should allow the harvestable biomass to grow starting in 1999. Meanwhile, recruitment of the harvestable population of the 1989 age class will bring an abundance of white crab in 1998.
- The next recruitment trough, which will hit the fishery as of 2003-2004, is now well formed.
- **In areas 15, 14 and 13,** commercial catch rates have plummeted, indicating a drop in harvestable biomass.
- Crab size grew slightly in 1997 relative to the previous year, and the proportion of adolescents was very low (3–4 %), suggesting low recruitment.
- No recovery is expected in these areas until 2000-2001.

Overview

Biological context

The snow crab (*Chionoecetes opilio*) is a crustacean species that prefers saltwater environments with temperatures below 3°C. Like other crustaceans, snow crabs increase their size in a discontinuous fashion through moulting. During this process, they shed their old shells and take up water, which causes them to swell and grow into a new, larger carapace. The reference measure used in this document to describe the size of snow crabs is carapace width expressed in millimetres. As a rule, snow crabs larger than 30 mm moult every year, females between December and April and males between April and June. Immediately after moulting, the crab's shell is very soft, making it vulnerable to predators and damage from handling. As the shell hardens, a process which takes about three to six months, the crab's water content decreases and is largely replaced by meat. Recently moulted snow crabs are called "white crab" because of their spotless white abdominal surface.

In both sexes of snow crab, growth ceases after the "terminal" moult, with females reaching a final size of 35 to 95 mm and males 38 to 165 mm. Hence, not all males in a population reach the minimum legal size of 95 mm. Males over 38 mm which have not undergone their terminal moult can be recognized by their smaller claws and are called "adolescents." Those that have moulted and have proportionately larger claws are called "adults." Females and males do not live much longer than five to six years after their terminal moult; by the fourth year, their appearance and physiological condition have deteriorated quite rapidly. Among males, this deterioration is accompanied by changes in spatial distribution, with older crabs tending to congregate at shallow depths or at other marginal sites. Their catchability also declines owing to their reduced mobility. Given this ageing process and the time required for the shell to harden and meat content to increase after moulting, legal-size males are fully available to the fishery for a period of only three years or so after the terminal moult.

Females mate in late winter or in spring and carry the fertilized eggs under the abdomen for one to two years, depending on the ambient water temperature. After hatching in spring, the larvae go through a planktonic stage for three to five months, and then metamorphose into small crabs and settle on the sea bottom in the fall. It takes a male crab at least nine years after hatching to reach the legal size of 95 mm. Since moulting occurs in spring, the quality males available to the spring fishery are at least ten years old, whereas those available to the fall fishery may be only nine.

The snow crab populations of the Estuary and northwestern Gulf of St. Lawrence exhibit abundance fluctuations which suggests an eight-year cycle. Each cycle includes at least three consecutive age classes that are smaller, collectively designated as "recruitment troughs," and up to five consecutive age classes consisting of a moderate-to-large number of crabs, collectively called "recruitment waves." The size distribution of crabs, as measured in St. Marguerite Bay (near Sept-Îles) during research surveys, provides a good illustration of the effect of recruitment waves and troughs (Figure 1). St. Marguerite Bay is considered representative of the situation in the northern Gulf.

In the Estuary and northwestern Gulf of St. Lawrence, the 1985-1987 age classes constitute a recruitment trough, and the 1988-1992 age classes a recruitment wave. In previous snow crab stock assessments, it was predicted that the 1985-87 recruitment trough would show the following characteristics for

the period 1995 to 1997, possibly persisting until 1998:

- first, a general aging of the population of legal-size males between 1995 and 1996;
- then, a decline in the number and average size of males available to the fishery, leading to a major decrease in catches per unit of effort;
- and finally, a gradual increase in the percentage of white crab in catches at sea because of the reduction in the exploitable biomass of hard-shell males and the attainment of legal size by the first two cohorts of the recruitment wave comprising the 1988-92 age classes.

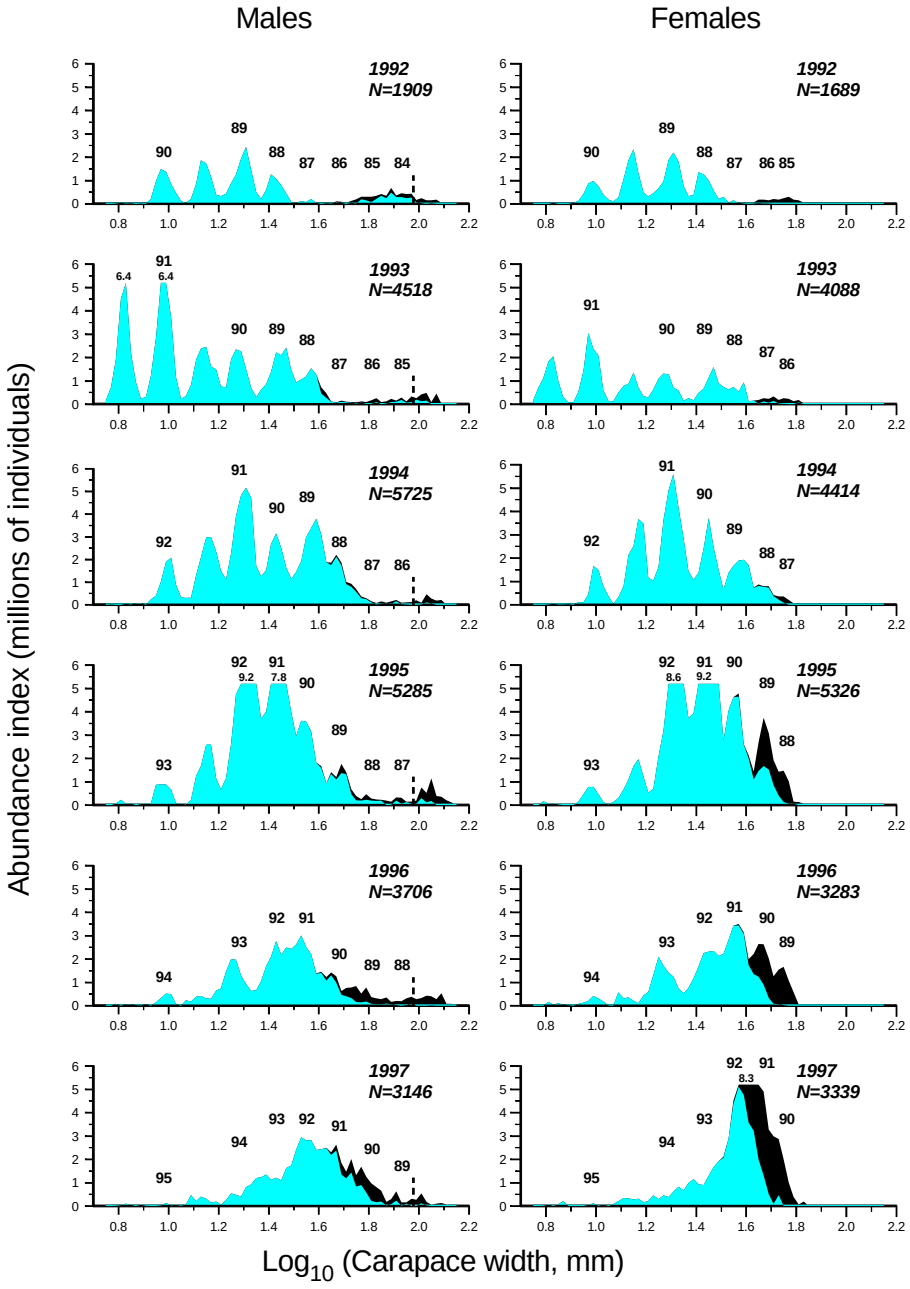

Figure 1. Size structure of snow crab captured in St Marguerite Bay during research surveys in 1992-97. Grey indicates immature and adolescent males and immature and prepubescent females. Black indicates adult males and females. The horizontal axis represents size and the vertical one abundance. Birth years are shown above each of the columns (peaks). The broken vertical line represents the legal limit of 95 mm.

The nature of recruitment cycles and conservation concerns

Abundance cycles cause major variations in the size and abundance of adult crab. As females go through their terminal moult 2 to 3 years earlier than males on average, abundance peaks for adult male and female crabs do not coincide. Thus, for the last three years female crabs have been very abundant in the population, while male abundance is only just starting to climb, and abundance of large males is still falling (Figure 1).

Fishing selectively removes large males and accentuates the divergence between adult females and large males. At certain times, there are not enough males to provide adequate fertilization for all the adult females. Findings in St Marguerite Bay show a marked drop in the fertilization rate for females since 1991, reflecting an increasingly pronounced imbalance in the abundance of adult males and females. A significant proportion of the females reaching sexual maturity in 1996 and 1997 may have trouble mating because of the shortage of large males. Egg production will likely decline, with consequences that are as yet hard to foresee.

Environmental context

Since the mid 1980s, the waters where snow crab are found have been colder than usual and have covered a larger part of the Gulf seabed. Growth is slower and terminal moulting occurs later in crabs exposed to colder water than in those exposed to warmer temperatures (2–3°C). On the other hand, in cold periods areas suitable for crab are more extensive, since cold water is in contact with a larger part of the seabed.

The 1980-1984 age classes, which contributed heavily to the fishery between 1990 and 1994, were born in a period when the water was relatively warm and thus enjoyed good growth, then benefited from the extensive habitat made available as the Gulf cooled. This may explain their productiveness.

In contrast, the 1988-92 age classes, which will contribute to landings as of 1998, were spawned in very cold conditions, and many of the males in the 1988-89 age classes have undergone their terminal moult at a very small size (Figure 1), so that there will be relatively few males of commercial size. Since 1995, the Gulf waters have been steadily warming. If this warming trend in the Estuary and Gulf continues, the habitat available to prerecruits and adults will shrink in area, leading to greater concentration and greater intraspecific competition. Fishery conditions in the next few years may therefore be quite different from those of the 1990-95 period.

Previous reports have stressed the fact that the productivity of snow crab populations seems to tail off from west to east along the north shore of the Estuary and Gulf. This shows up as lower catches per unit effort and smaller landed crab size in areas 14 and 13 than in 17 and 16. This downward productivity gradient is partly due to the smaller scale of recruitment waves in the east, with fewer large age classes, than in the western reaches of this huge expanse. The waters of areas 14 and 13 also seem to have been much colder than those of 17 and 16 in recent years. This environmental factor, combined with the impact of a fall harvest targeting both adolescent and legal-size adult males, may account for the small size of the crabs available for fishing in areas 14 and 13.

The fishery

Location and historical context

The territory is divided into five management areas (Figure 2), corresponding to three broad geographic regions: the Upper North Shore (Area 17) meaning the Estuary, the Middle North Shore (areas 16 and 15) and the Lower North Shore (areas 14 and 13). However, since snow crab demography and fishing patterns in Area 15 have more in common with those of areas 14 and 13, that Area was grouped with the latter two in 1997.

Snow crab is fished with baited traps, most often conical steel models, such as the Japanese trap with a 1.2-m-diameter base. Since 1990, the fishery in the Estuary and the Middle North Shore has begun at ice breakup (March-April) and generally closed after 10 to 14 weeks (June-July). On the Lower North Shore, the opening of the fishery is often delayed because the ice cover stays longer, and the season generally does not begin until June, ending in the fall in October or November.

The snow crab fishery in the Estuary and northern Gulf of St. Lawrence began in the late 1960s. From 1968 to 1971, vessels from Québec and New Brunswick reported catches of about 1,000 t from around the Port Cartier sector of the Middle North Shore. Subsequently, a limited inshore fishery took place, with annual landings of roughly 200-300 t until the late 1970s. The fishery experienced a boom from 1979 to 1985, when the number of participants, fishing effort, geographic extent and landings increased substantially.

Between 1987 and 1989, landings for the entire region of the Estuary and northern Gulf of St. Lawrence plummeted from 5,255 t to 2,622 t (Figure 3). This drop was accompanied by marked decreases in catches per unit of effort and ever greater

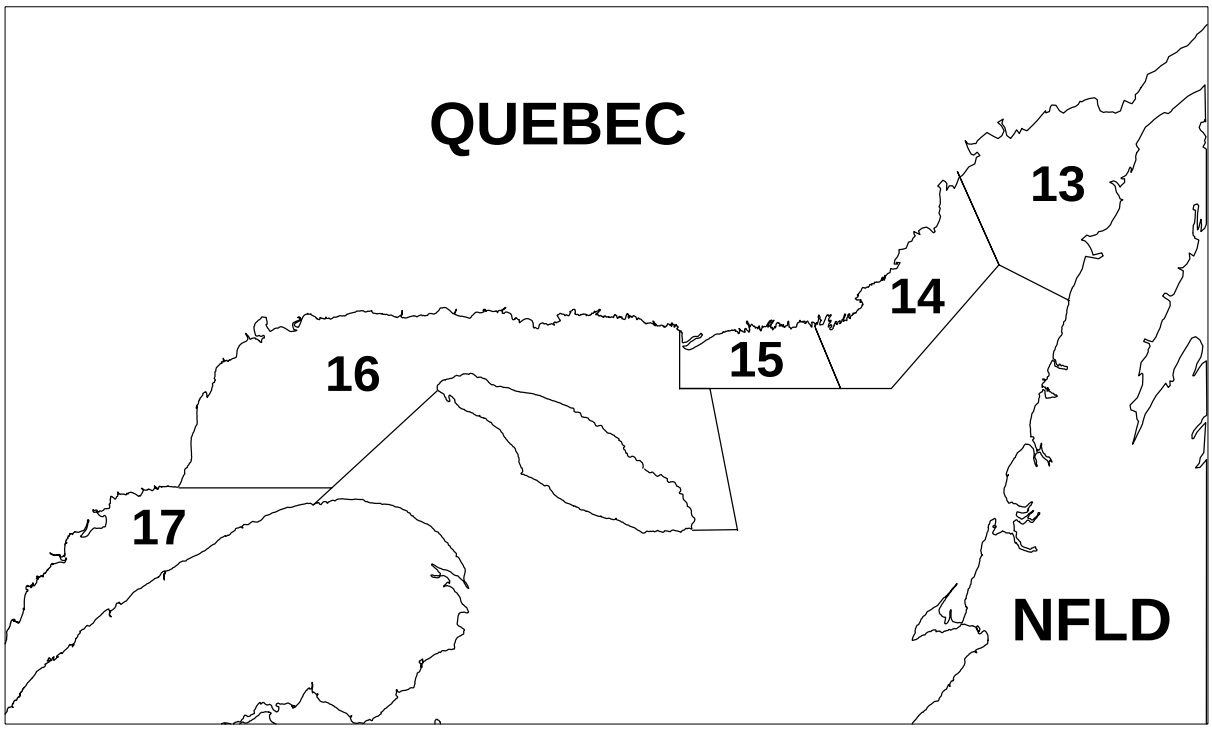

Figure 2. Snow crab management areas in the northern Gulf of St Lawrence.

catches of white crab, as a direct result of a recruitment trough affecting the 1977-1979 age classes. Beginning in 1990-91, the white crab problem gradually disappeared, catches per unit of effort rose, and landings increased to a record level of 7,245 t in 1995, thanks to the advent of the recruitment wave made up of the 1980-84 age classes. Landings slipped somewhat in 1996 (6,716 t) and 1997 (5,499 t as of December 12) as a result of the drop in overall allowable catches in all areas and the inability of some fishermen to reach their 1997 quota.

Fishery management

Although the fishery was originally managed by controlling fishing effort, total allowable catches (TACs) were gradually introduced in the different fishing areas between 1985 and 1994. The number of traps authorized per licence is limited to 150 Japanese traps; however, fishermen may substitute one regular trap (maximum volume 2.1 m^3) for two Japanese traps (maximum volume 0.44 m^3).

As elsewhere in Canada, the minimum legal size is set at 95 mm, and the landing of females is prohibited. Since 1985, once the limit of 20 % of white crab in catches at sea has been exceeded, the fishery is automatically closed in the area concerned to minimize the mortality of the very fragile individuals needed for the next year's fishery

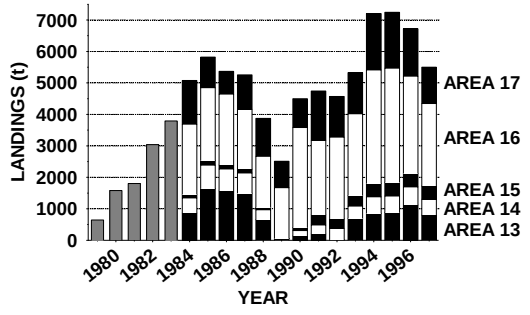

Figure 3. Snow crab landings in the northern Gulf.

State of the resource

The status of snow crab populations in areas 17 (Estuary) and 16 (Middle North Shore) is established yearly on the basis of statistical analyses, fishery sampling and research surveys using either a beam trawl or traps. The status of crab populations in areas 15, 14 and 13 is determined solely from fishing data, though a research survey was conducted in the last two areas in 1994-95.

Snow crab in the Estuary (Area 17)

There are 22 holders of active licences in Area 17. The total allowable catch was originally set at 1,300 t in 1992 (Table 1). In 1997, the fishery opened on March 28 and closed on June 29, about a month earlier than in 1996. The global quota for 1997 stood at 1,315 t, with 1,243 t for regular fishermen and 72 t in special allocations, down 15 % from 1996. As at December 12, 1997, landings were 159 t short of the TAC.

State of the resource in 1997

In 1997, average yields on both shores continued the decline that had begun in 1995. The overall drop in yields from 1996 to 1997 was 16 % and was more pronounced on the north shore (–25 %) than on the south (-9 %). Overall average yield for the year (8.2 kg per Japanese trap) was the lowest recorded since 1991 (9.0 kg). Trap immersion times have been rising since 1995, often staying down for 2 and 3 days.

Table 1. Catches and fishing effort in Area 17.

Year		1983 to 1989[4]	1990	1991	1992	1993	1994	1995	1996	1997
TAC		-	-	-	1 300	1 300	1 820	1 820[5]	1547[5]	1315[5]
Catches[1]		1 022	910	1 562	1 289	1 305	1 788	1 774	1502	1156
Effort[2]		121.8	137.9	173.6	107.4	90.6	124.2	155.6	153.3	141.0
CPUE[3:]	**North shore**	8.4	7.7	10.0	12.4	15.2	15.7	11.7	10.3	7.7
	South shore	7.4	5.3	7.8	11.5	13.2	11.4	9.7	9.3	8.5

1 Landings in metric tonnes as at December 12, 1997

1 Standardized effort in thousands of Japanese traps hauled

1 Catches per unit of effort in kilograms per Japanese trap

1 Average for the period

1 Including special allocations.

White crab dominated catches in the late 1997 season, leading to closure of the Area in mid June. The proportion of male crabs with a clean soft shell (condition 1) or a clean hard shell (condition 2) was up slightly from 1996, reaching 14.3 % of 1997 sea samples. The proportion of old crabs on the seabed (conditions 4 and 5) stayed the same as in 1996, namely 18.9 % of crabs sampled at sea. For the first time since the early 1980s, most of the crabs landed came from the south shore, and 70 % of landings were intermediate shell specimens (condition 3).

Commercial crab size, declining since 1995, continued to fall in 1997 in Area 17. The average size of commercial-size crabs sampled at sea fell from 113.4 mm in 1995 to 107.3 mm in 1997, a decline of 5 % over 2 years. Average size of landed crabs also shrank.

Results of DFO research surveys in the Estuary from late July to early August 1997 indicate that abundance of commercial-size snow crab, in decline since 1993, stabilized at or near 1996 levels in 1997 (Figure 4). This was because the 1988 age class, the first of the 1988-92 recruitment wave, was reaching commercial size. The contribution of the 1988 age class offset the shrinking numbers (–39 %) of residual crabs on the seabed in 1997. The arrival of the 1988 age class at commercial size had the effect of reducing the average size of commercial crabs. Adolescents of the 1989 age class, set to reach commercial size next year and be recruited in 1999, are about 2.5 times as numerous as those of the class of 1988. Adolescents of the 1990 age class (ADO^{-2}) are very abundant, but an unknown proportion of them will undergo terminal moult before reaching commercial size.

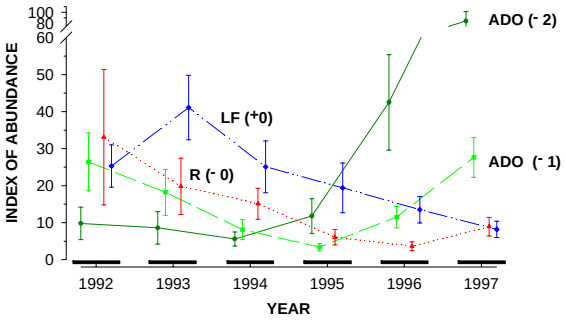

Figure 4. Abundance of male snow crab taken in research surveys of the Estuary between 1992 and 1997. LP(+0): males left by fishing in the survey year; R(-0): males recruited for fishing; ADO(-1): adolescent males 78 to 95 mm; ADO(-2): adolescent males 62 to 78 mm.

Trawl survey data also show a significant increase in females over the last 3 years. On the other hand, since large males capable of breeding are currently scarce on the seabed, this creates a serious imbalance between the sexes, with a preponderance of receptive females, possibly resulting in a fall in individual fertility within the population. 1998 will be the last year with a steep increase in abundance of adult females before the next recruitment wave.

The results of trap surveys (done by fishermen in co-operation with DFO) after the fishing season confirm the trends evident in the fishery and in trawl surveys in the last 2 years. Arrival of new recruits (conditions 1 and 2) from the 1988 age class and declining abundance of old crabs (conditions 4 and 5) reduced average size among commercial crabs in 1997. However, in contrast to trawl data, trap surveys point to a slight upturn in yields early in the 1998 fishing season (Figure 5): 10.5 kg per conical trap at the start of the season, compared to the 7.4 kg per trap expected for 1997. These figures, diverging somewhat as they do from trawl data for the same years, may be explained by a difference in the effectiveness with which the two devices used capture commercial males.

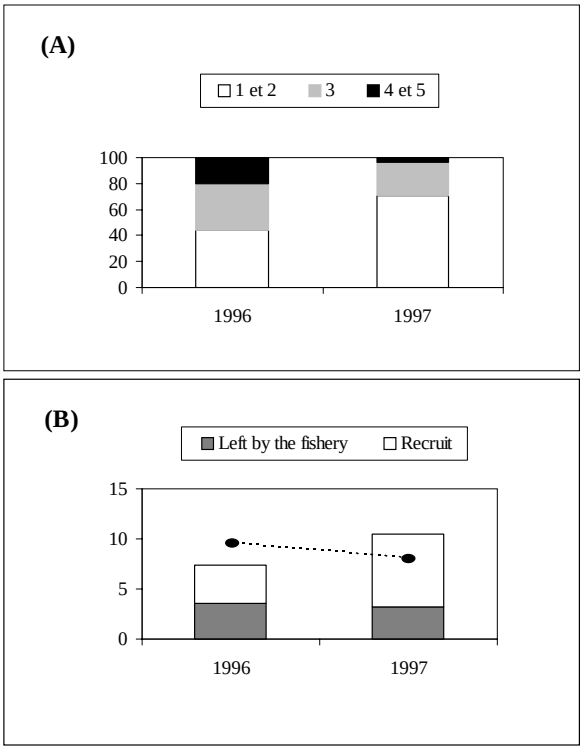

Figure 5. Shell condition (A, %) and yield (B, kg per conical trap) of crabs taken in post-season surveys in Area 17 in 1996 and 1997. The black dots show the corresponding year's fishing yield in kg per Japanese trap.

Prospects for Area 17 in 1998

The progress of the 1988-92 recruitment wave continued in 1997 as the 1988 age class reached commercial size; this arrested the decline in commercial crab abundance that had started in 1993. However, the arrival of new recruits also reduced the average size of commercial crab, whose biomass will therefore be lower (trawl) or slightly higher (traps) in 1998.

White crab will be numerous in 1998. The 1989 age class, the second in the recruitment wave, is relatively strong and will reach commercial size in the spring of 1998. Since it will consist of soft shell crabs of poor quality during the season, it will probably dominate 1998 catches, as the residual biomass of hard shell crabs will then be very low and rapidly taken. It should be remembered that the fishery was closed toward the end of the 1997 season in Area 17 because of the high proportion of white crab from the 1988 age class in catches.

An upturn is anticipated in 1999 following the entry into the fishery of the age class of 1989, more numerous than that of 1988. The beneficial effects of the recruitment wave should then be felt into the new millennium. The next recruitment trough, which will reach the fishery as of 2003-2004, is now well formed.

Snow crab in Area 16

There are 36 active licences in Area 16. Total allowable catches, first established in 1992, were down 15 % in 1997 and are now 2,627 t. The 1997 fishing season ran from April 14 to July 31. Special allocations of 151 t, included in overall quotas, were awarded to non-crabbers in 1997. Quotas were met.

State of the resource in 1997

Fishing yield dropped by between 24 and 38 % in 1997 from 1996 in Area 16, falling from 21.0 to 13.1 kg per Japanese trap in the West (Pointe des Monts to Rivière au Tonnerre), from 18.5 to 12.2 kg per trap in the Centre (Rivière au Tonnerre) and from 21.2 to 16.2 kg per trap in the East (Mingan to Natashquan) (Table 2). This decline in yield in 1997 led to a substantial increase (+27 %) and a general shift in fishing effort toward the eastern part of the territory, traditionally less heavily fished.

As forecast last year, the condition of crab stocks deteriorated markedly in 1997. Intermediate shell crabs (condition 3) and old crabs (conditions 4 and 5) were heavily represented on the seabed, and 86 % of crabs landed had intermediate shells.

The **size of crabs sampled at sea**, in decline since 1995, continued downward in 1997 from 111.0 mm (1996) to 110.0 mm. Average size of crabs landed, on the rise since 1992, maintained its progress in 1997, reaching 116.2 mm, as opposed to 115.2 mm in 1996.

Results of **beam trawl surveys** conducted by DFO in St Marguerite Bay, near Sept-Îles, over the last 10 years demonstrated the progress in 1997 of the 1988-92 recruitment wave, whose first age class (1988) attained commercial size in the course of the year. Abundance of commercial crab on the seabed was very low, and that of prerecruits between 78 and 95 mm (LC) increased relative to 1996 and 1995. The figures point to a decrease in the average size of the crabs constituting the commercial biomass, from about 108 mm in 1996 to 104 mm in 1997. There were also large numbers of adult females on the seabed.

Table 2. Catches per unit of effort in Area 16.

Year		1983 to 1989[4]	1990	1991	1992	1993	1994	1995	1996	1997
TAC		2,500[5]	-	2 ,368	2,596	2,596	3,636	3,636[7]	3,090[7]	2,627[7]
Catches[1]		1,984	3,181	2,371	2,597	2,595	3,608	3,629	3,085	2,623
Effort[2]		257.7	250.5	137.8	137.4	127.2	178.6	177.9	153.5	195.7
CPUE[3]	Total	7.7	12.7	17.2	18.9	20.4	20.2	20.4	20.1	13.4
	West	6.0	8.9	14.1	17.4	18.4	21.5	19.8	21.0	13.1
	Centre	7.7	12.4	18.2	22.0	23.3	19.7	21.7	18.5	12.2
	East	10.1[6]	15.2	18.7	17.4	19.9	18.5	19.9	21.2	16.2

1 Landings in metric tonnes as at December 12, 1997

1 Standardized effort in thousands of Japanese traps hauled

1 Catches per unit of effort in kilograms per Japanese trap

1 Average for the period

1 In effect from 1986 to 1987

1 The CPUEs for sector 16 East and Area 15 were combined prior to 1990

1 Including special allocations

Post-season trap survey indices, furnished by fishermen in co-operation with DFO for the fourth straight year in Area 16, agree with the findings of fishing and trawl surveys. The average size of commercial crabs was down in all areas from 110.1 mm in 1996 to 107.4 mm in 1997. The proportion of adolescents in traps rose slightly in 1997 (5.8 % in 1996, 7.1 % in 1997). Abundance of newly recruited crabs (conditions 1 and 2) more than doubled (8.8 % to 18.2 %) in 1997 at the expense of old crabs (conditions 4 and 5), which fell by about 8 % (46.3 % to 38.5 %) over the same period (Figure 6). However, yields grew in 1997, to 20.7 kg per trap from 16.0 kg per trap in 1996, suggesting the possibility that the fishery might be opened again in Area 16 in 1998.

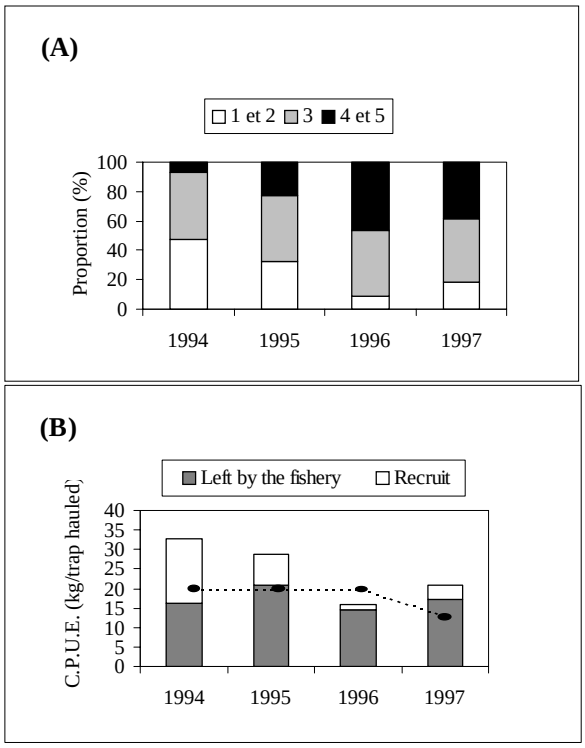

Figure 6. Shell condition (A) and yield (B, kg per conical trap) of crabs taken according to post-season surveys in Area 16 from 1994 to 1997. The black circles indicate fishing yields for the corresponding year in kg per Japanese trap.

Prospects for 1998

All indices used to document the state of the resource in Area 16 in 1997 concur and show that the commercial biomass on the seabed is small and composed largely of very old crabs. The arrival of the 1988 age class has reduced the mean size of commercial crabs. Consequently, the crabs taken in 1998 will be of smaller average size, and their abundance will depend in great part on the survival rate of the strong contingent of old crabs identified in 1997 trap surveys and how easy they are to catch. However, surveys show that the 1988-92 recruitment wave is advancing, with the first age class (1988) reaching commercial size in 1997, followed by others yet more abundant. This should result into an upturn in the fishery in 1999. Meanwhile, the 1998 spring moult of the 1989 age class is expected to create white crab problems in Area 16 for the next fishing season. As in the Estuary, the next recruitment trough, set to affect the fishery as of 2003-2004, is already well formed.

Snow crab in areas 15, 14 and 13

There are 8, 21 and 49 active licences for areas 15, 14 and 13 respectively. Total allowable catches have been established since 1986 for areas 14 and 13 and since 1994 for Area 15 (Table 3). In 1997, TACs were 413 t, 518 t and 931 t in areas 15, 14 and 13 respectively, representing a reduction of 5 %, 10 % and 25 % respectively from 1996. The 1997 fishing season ran from May 24 to September 26 in Area 15, from June 15 to September 26 in Area 14, and from July 12 to October 17 in Area 13. Special allocations of 20 t in Area 15 and 23.1 t in Area 14 were awarded to Québec non-crabbers. There were no special allocations in Area 13 in 1997. On December 12, 1997, catches in Area 13 fell 136 t short of the quota.

Table 3. Catches and fishing effort in Areas 15, 14 and 13

Year		1983 to 1989[4]	1990	1991	1992	1993	1994	1995	1996	1997
TAC:	**Area 15**						435	435	435	413
	Area 14	667[5]	381	381	381	381	524	524[6,7]	576[7]	518.4[7]
	Area 13	1.642	889	889	889	889	889	889	1,241[7]	931[7]
Catches[1]	**Area 15**	109.7	93	321	300	339	426	436	435	413
	Area 14	509.4	174	288	361	383	522	525	573	512
	Area 13	918.4	138	201	19	703	859	883	1,121	795
Effort[2]	**Area 15**		15.2	22.9	22.1	22.3	21.2	17.1	16.0	21.5
	Areas 13+14	165.6	76.1	116.4	53.5	193.9	212.5	154.7	281.1	242.0
CPUE[3]	**Area 15**		6.1	14.0	13.6	15.2	20.1	25.5	27.1	19.2
	Area 14	5.2	4.3	4.8	7.3	9.7	11.2	11.6	12.5	10.7
	Area 13	5.7	3.9	3.1	5.3	4.2	4.5	8.0	5.1	4.3

1 Landings in metric tonnes as at December 12, 1997

1 Standardized effort in thousands of Japanese traps hauled

1 Catches per unit of effort in kilograms per Japanese trap

1 The CPUEs for areas 14 and 13 were calculated separately only as of 1987

1 Average for the period

1 In effect as of 1986 in areas 14 and 13

1 Including special allocations

State of the resource in 1997

The northeastern Gulf was hit by a general fall in fishing yields in 1997. Catch rates fell by 14 and 16 % respectively in areas 14 and 13, going from 12.5 to 10.7 kg per Japanese trap in 14 and from 5.1 to 4.3 kg per trap in 13. The decline was even more pronounced in Area 15 (–29 %), with yields sliding from 27.1 kg per trap in 1996 to 19.2 kg per trap in 1997. Consequently, fishing effort grew by 4 and 34 % respectively in areas 14 and 15, notwithstanding lower TACs.

Analysis of fishermen's log books for Area 14 also shows a systematic reversal of the trend toward mooring times conducive to longer trap immersion (two or three or more days) prevalent since 1992. The proportion of one-day moorings rose by 20 % in 1997 at the expense of moorings of three days or longer, perhaps signalling an active search for more productive beds.

Intermediate shell crabs (condition 3) dominated catches and landings at the expense of newly recruited crabs (conditions 1 and 2), which dropped sharply in 1997. Most crabs sampled at sea (65 to 73 %) and on landing (84 to 95 %) in all three areas had intermediate shells. Newly recruited crabs at sea were down 15 % (Area 14) to 28 % (Area 15) from 1996 to 1997, unlike old crabs (conditions 4 and 5), which were up by 3 % (Area 14) to 8 % (Area 13) at sea over the same period.

Average size of crabs in catches and landings grew in all three areas from 1996 to 1997. Size in catches, trending upward since 1990 in Area 15 and since 1993 in Area 14, grew from 108.1 to 109.1 mm in Area 15, from 102.6 to 105.4 mm in Area 14 and from 93.8 to 97.2 mm in Area 13 from 1996 to 1997. Size of crabs landed continued the climb begun in 1993 in Areas 15 and 14, reaching 112.2 and 110.4 mm respectively in 1997 from 110.3 and 109.2 mm in

1996. Conversely, the proportion of adolescents in traps fell in all three areas.

No improvement is anticipated before the end of the century. The results of research trawl surveys conducted in 1994-95 in areas 14 and 13 showed that the 1988 to 1990 age classes, which will be recruited to the fishery in 1997 to 1999, were poorly represented on the seabed, in contrast to the larger age classes of 1991 and 1992, which will be recruited in subsequent years.

Prospects for 1998

The commercial-size male biomass is still in decline in area 15, 14 and 13, as shown by (1) a distinct fall in catch rates in 1997, (2) increased fishing effort in areas 15 and 14 and more movement in Area 14 in spite of lower TACs and lastly (3) the difficulty fishermen in Area 13 had in meeting their 1997 quota. In addition, the size of crabs sampled at sea during fishing remained slightly above 1996 levels, and the proportion of adolescents was very low (3–4 %), unlike areas further west, suggesting little or no short-term recruitment in these areas. It will be remembered that the snow crab demographic structure in areas 14 and 13, as sampled in 1994 and 1995 by beam trawl, indicated no recovery before the end of the century.

A comparable situation was observed in areas 14 and 13 in the late 1980s at the time of the last recruitment trough. Yields and commercial biomass plummeted in 1989, and there was no solid recovery until 1993, three years later than in areas 17 and 16.

Area 15 is in a pivotal position and may present a pattern intermediate between those of areas 17/16 and 14/13.

General recommendations

For areas 17 and 16, since the commercial crab biomass available for fishing in 1998 will be stable but low, we reiterate our 1996 TAC recommendations for these areas: **in view of the abiding concern about maintaining the reproductive potential of females, over the short term at least, it is recommended that the total allowable catch be kept low in these areas, if not reduced, until there is a recovery**. The purpose of the measure is the same as before: to preserve enough large adult males to fertilize the multiparous females, which will be very numerous next year. The recruitment recovery for males expected in 1998 is a good sign and will help restore the balance between the sexes.

On the other hand, commercial biomass in areas 15, 14 and 13 is still in decline, and no short-term recovery is expected; ***lower fishing pressure on these populations is recommended to protect the reproductive biomass.***

Conservation measures

Three main recommendations from the 1995 and 1996 reports on the state of snow crab populations in the Estuary and northern Gulf are briefly reiterated here:

1. Adolescent males should not be landed, since after moulting they attain greater size and weight and may help speed up recovery of the biomass after a recruitment trough. Harvesting males only after their final moult increases their chances of participating in breeding and may help maximize yield per recruit. For the territory as a whole, there will be a much higher percentage of adolescent males in catches over the next few years as the recruitment wave formed by the 1988-92 age classes arrives.
2. Clearly, if a substantial harvestable biomass is to be preserved or even reconstituted as rapidly as possible, white crab must continue to be protected. This measure has the added benefit of pre-

serving most adolescent males, as they moult in the spring. This measure will be particularly important for the 1998 season, which will be characterized by large numbers of white crab in catches.

3. Harvesting of old-shell males may likewise help soften the impact of the recruitment trough, while maximizing yield per recruit. Old-shell males will in fact die off naturally in the very short term if not taken, whereas clean-shell males may remain available for fishing for another two or three years, though their appearance and condition will deteriorate. This recommendation will be less important in the following years because of the marked rejuvenation of the fraction of the population of legal size.

For more information:

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