STOCK STATUS REPORT

LAURENTIAN REGION

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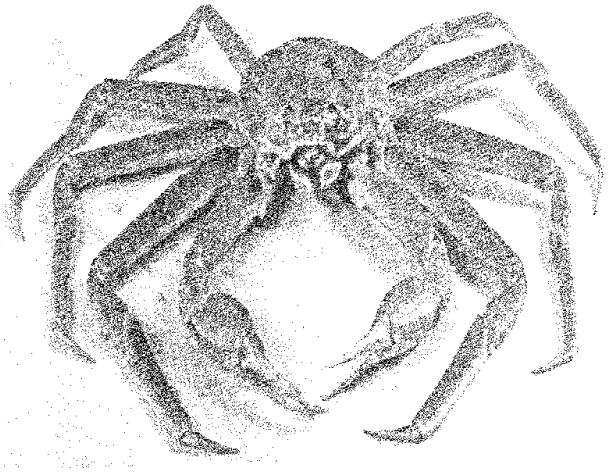
SNOW CRAB OF THE ESTUARY AND NORTHERN GULF OF ST. LAWRENCE (AREAS 13 TO 17)



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 year-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, when the 1988-1992 year-classes which will make up the next recruitment wave are fully recruited to the fishery.

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OVERVIEW OF SNOW CRAB

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 36 to 92 mm and males 40 to 165 mm. Hence not all males in a population reach the minimum legal size of 95 mm. Males over 40 mm which have not undergone their terminal moult can be recognized by their smaller claws and are called "adolescents". Those that have terminally moulted and have proportionally larger claws are called "adults." Females and males do not live much longer than five years after their terminal moult; by the fourth year, their appearance and physiological condition has 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 months 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 year-classes that are smaller, collectively designated as

"recruitment troughs," and up to five consecutive year-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 year-classes constitute a recruitment trough, and the 1988-1992 year-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, accompanied by 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 year-classes.

The nature of recruitment cycles and conservation concerns

The main theory put forward to explain abundance cycles relates to a periodic change in the survival rate of individuals during the initial benthic stages crabs ranging in size from 3 to roughly 20 mm caused by strong competition for space and food in the confined habitat of young snow crabs. After the larval stages, young crabs generally settle on specific bottom areas at intermediate depths (40-80 metres), and do not leave those sites for good until they reach age five approximately. According to this hypothesis, nursery grounds may become overcrowded due to the influx of young snow crabs from successive year-classes, to the point that the establishment and survival of the newcomers are compromised until the nurseries nearly empty out when the snow crabs begin to disperse over the much broader territory occupied by adults as they reach the age of about five. The main mortality factor affecting newcomers is cannibalism, the extent of which has been demonstrated by a recent field investigation.

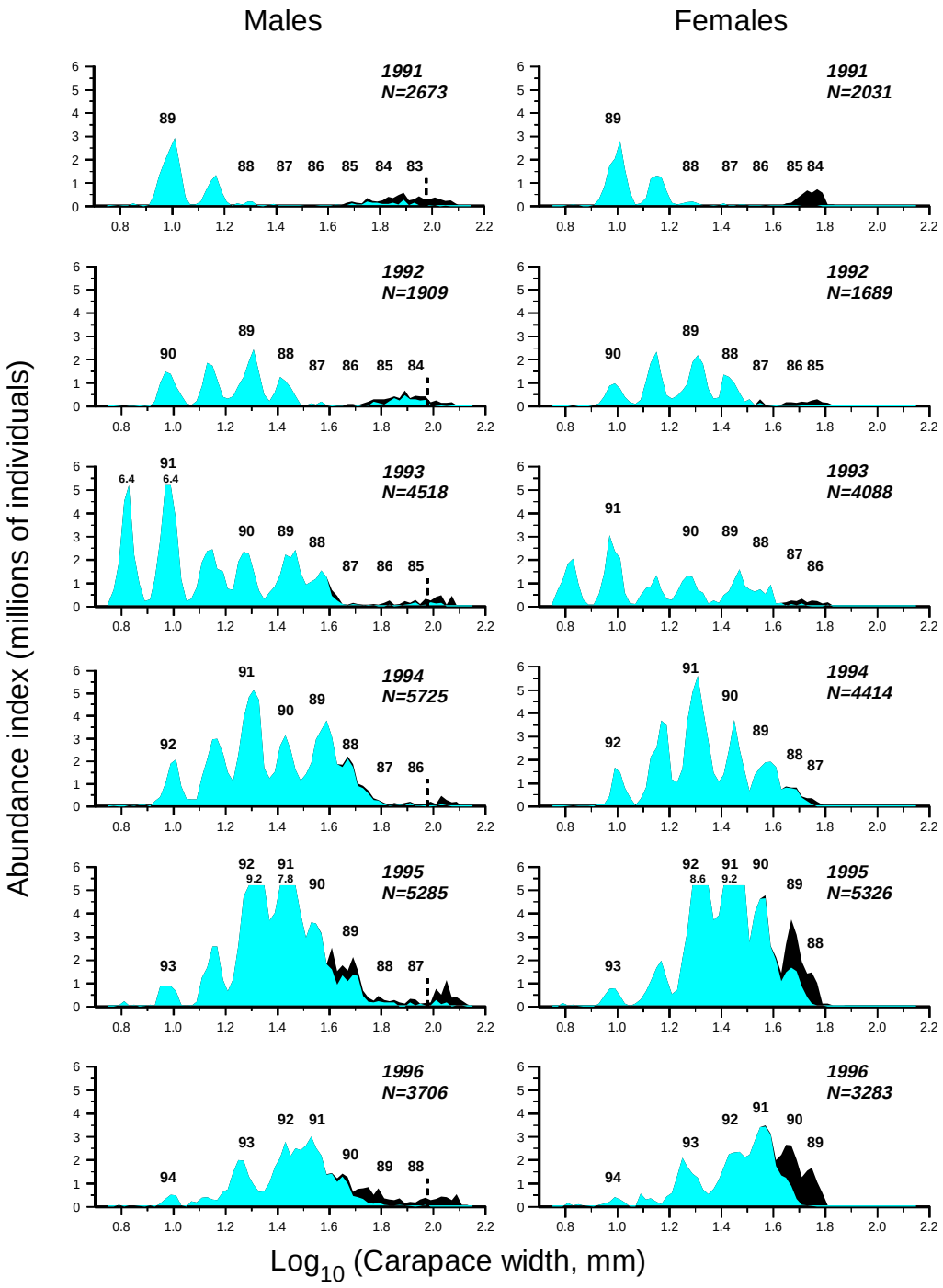

Figure 1 Size structure of snow crab caught in St Marguerite Bay during research surveys from 1991-96. Immature and adolescent males and immature and prepubescent females are shown in grey, whereas male and female adults are shown in black. The horizontal axis illustrates size, and the vertical axis abundance. The year of birth of the crabs is shown above each of the modes (peaks). The broken vertical line indicates the legal size of 95 mm.

Biologists are also studying the magnitude and impact of variations in the abundance and quality of females during an abundance cycle. It has been shown that the number of females releasing eggs in a given area can vary over the years by a factor of about ten, depending on the passage of recruitment waves or troughs. In addition, the population of adult females is dominated either by primiparous (first-time spawners) or by multiparous (second- or third-time spawners), which exhibit different fecundity and behavioural characteristics. It is conceivable that large fluctuations in egg and larval production, especially in the largest snow crab populations, play some role in maintaining abundance cycles or inducing them in adjoining populations.

Abundance cycles also cause wide fluctuations in the number and size of males, given that the male population is dominated numerically either by small males or large males. Since females recruit to adult age across a narrow range of sizes and ages (with the average age being six years), whereas males reach adult size across a wide range of sizes and at a markedly higher average age (eight years), abundance cycles induce large variations in the sex ratio of abundance. In the past two years, there has been a massive recruitment of female adults to the populations, whereas the abundance of large males has declined (Figure 1). Although the fishery is not to blame for abundance cycles, it can influence them, possibly having an adverse impact by reducing the reproductive potential of females. Indeed, the fishery selectively removes the large males in a population and accentuates natural variations in the sex ratio, giving rise to a predominance of females. However, one or two years from now, when the huge number of primiparous females recruited in 1996 and 1997 reproduce again and become multiparous, the abundance of the large adult males with which they can mate will have fallen to a minimal level. There will likely be a shortage of large adult males, and hence a considerable reduction in egg and larval production, with consequences that are difficult to predict at this time. Some major studies are currently being carried out on this topic, and a more in-depth discussion and preliminary results will be provided in the complementary report by Sainte-Marie and Sévigny (in preparation).

THE FISHERY

Location and historical context

Snow crab stocks in the estuary and northern Gulf of St. Lawrence have been the responsibility of DFO since 1983. The territory is divided into five management areas (Figure 2), corresponding to three broad geographic regions: the Upper North Shore (Area 17) including the estuary, the Middle North Shore (areas 16 and 15) and the Lower North Shore (areas 14 and 13).

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

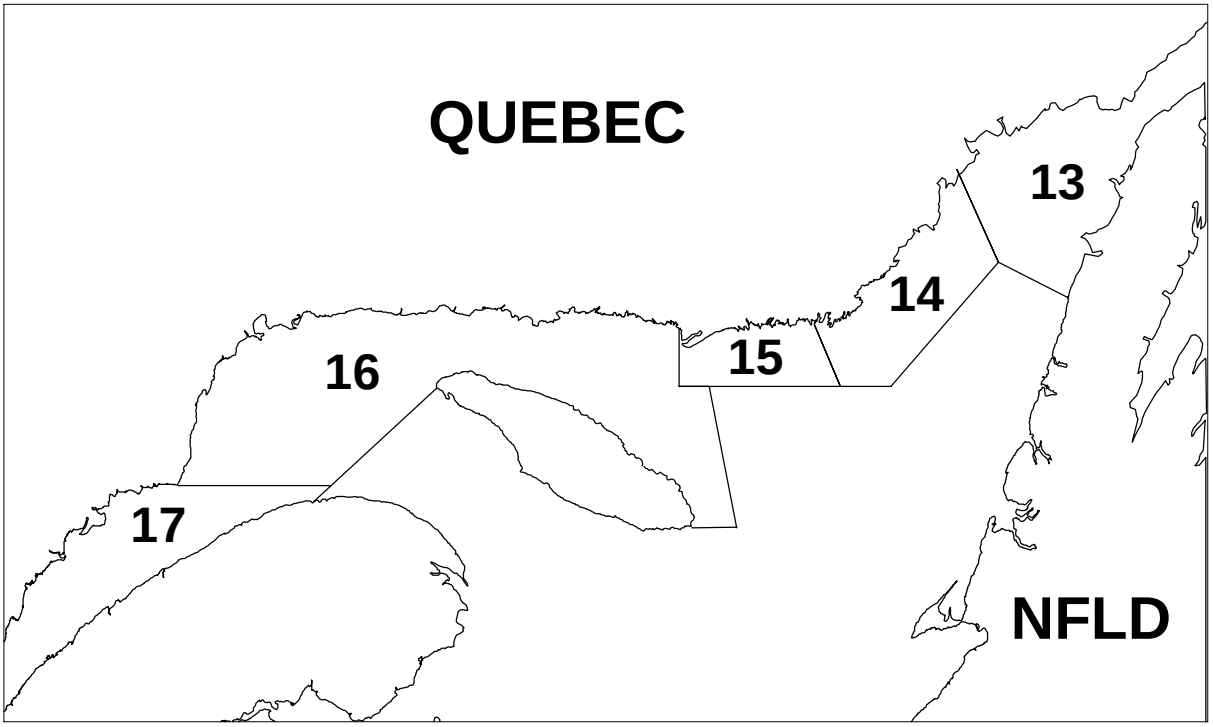

Figure 2 Snow crab management areas in the northern Gulf of St. Lawrence.

the Middle North Shore has begun at ice break-up (March-April) and generally closed after 10 to 14 weeks of activity (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 between October and 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 Quebec 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 catches of white crab, as a direct result of a recruitment trough affecting the 1977-1979 year-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 year-

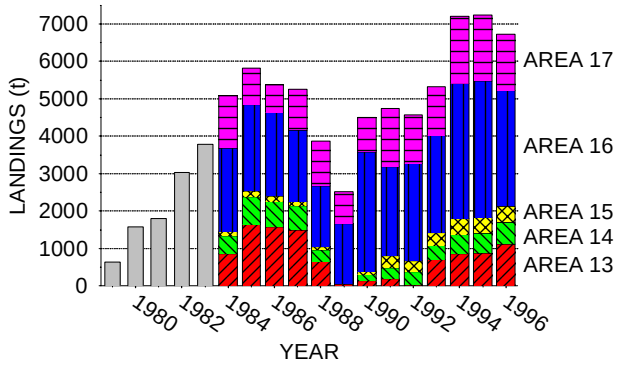

Figure 3 Snow crab landings in the northern Gulf of St. Lawrence.

classes. In 1996, landings declined slightly (6 718 t as at December 6), primarily because the total allowable catch was reduced in areas 16 and 17.

The main indices for the 1989 to 1996 fishing seasons landings, fishing effort and catches per unit of effort (CPUE) have been updated by using the database of final statistics to derive a clearer picture of the fishery results for each of those years. In terms of the CPUE, a more detailed review of fishing practices over the eight years in question showed that, over the last two years, the percentage of traps kept in the water for more than a day (up to over three days) rose steadily in most fishing areas. Since the trap yield usually increases with the soak time unless the holding capacity is reached, this practice results in an overestimation of the CPUE based on fishing data, because a unit of effort corresponds to a single trap haul regardless of soak time. At present, the CPUEs for different traps cannot be standardized in relation to soak time, because catches do not increase in proportion with soak time due to complex factors which vary both temporally and spatially, such as exhaustion of the bait supply, resource abundance levels and attainment of the trap holding capacity. For example, in 1996 the yields of traps that had fished for over three days were 5% (Area 17) to 22% (Area 14) higher on average than those of traps deployed for only one day. Consequently, it is likely that in most areas the CPUEs calculated for 1995 and especially for 1996 are overestimated compared to those for the period before 1995. As well, it has been noted that a larger-volume trap, the conical type with a 2-m-diameter base, has been gaining popularity in areas 16 and 17 since 1994.

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).

Like 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 these very fragile individuals. Recent data show that white crabs can survive fishing operations pro-

Table 1 Catches and fishing effort in Area 17.

Year		1983 to 1989[4]	1990	1991	1992	1993	1994	1995	1996
TAC		-	-	-	1 300	1 300	1 820	1 820[5]	1547[5]
Catches[1]		1 022	910	1 562	1 289	1 305	1 788	1 774	1503
Effort[2]		121.8	137.9	173.6	107.4	90.6	124.2	155.6	153.4
CPUE[3]:	North shore	8.4	7.7	10.0	12.4	15.2	15.7	11.7	10.3
	South shore	7.4	5.3	7.8	11.5	13.2	11.4	9.7	9.3

1 Landings in metric tonnes as at December 18, 1996
2 Standardized effort in thousands of Japanese traps hauled
3 Catches per unit of effort in kilograms per Japanese trap
4 Average for the period
5 Including special allocations

vided they are handled carefully, which is especially important in the summer when fishing mortality can be very high.

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. In 1996, the fishery opened on April 1 and closed on July 31. The global quota for 1996 stood at 1 547 t, with 1 462 t for regular fishermen and 85 t in special allocations, down 15% from 1995. As at December 18, 1996, landings were 45 t short of the TAC.

State of the resource in 1996

The average trap yield continued to fall on both shores in 1996. The average CPUE showed an overall drop of 14% for the entire area compared to 1995. Yields fell more sharply on the north shore (12.0%) than on the south shore (4.1%) (Table 1). Although total fishing effort for the area declined only slightly (1%) from 1995, the distribution of effort between the two sides of the estuary changed completely. Landings on the north shore plummeted 44% in 1996 (807 t) from 1995 (1 455 t), whereas the south shore's catch was one and a half times greater than in 1995 (694 t versus 283 t). Since the average annual catch recorded for the north shore since 1990 was 480 t, it can be concluded that the south shore was fished only lightly in 1995 and its exceptional share of 1996 landings results from a substantial increase in fishing mortality between 1995 and 1996.

The condition of legal-size snow crabs on fishing grounds during the season was comparable to that observed in 1995 (Table 2). The percentage of recently moulted crabs (shell conditions 1 and 2) rose slightly, to 10.1% in 1996 from 7.9% in 1995. Conversely, the percentage of old crabs (shell conditions 4 and 5) declined moderately to 21.6% in 1996 from 30.8% in 1995. These results suggest a decline in the older segment of the population due to natural mortality of the oldest males and to depletion

Table 2 Shell condition (%) in Area 17

SHELL	1995		1996	
CONDITION	SEA	DOCK	SEA	DOCK
1	0.3	0.1	1.1	1.1
2	7.6	29.9	9.0	42.3
3	61.3	48.5	68.3	34.0
4	29.2	20.3	20.4	22.1
5	1.6	1.2	1.2	0.5

of the residual biomass of crabs on fishing grounds by the fishery.

The percentage of adolescent crabs in catches at sea climbed from 6% in 1995 to 9% in 1996. However, the percentage of legal-size adolescents remained very low (5%), at a level comparable to 1994-95, but well below the range of 12-18% recorded in 1992-93 when the exploitable biomass was expanding dramatically. The average carapace width of male snow crabs sampled at sea, which had increased gradually from 102.2 mm in 1989 to 115.7 mm in 1994, and then declined to 113.4 mm in 1995, fell further in 1996, to 111.3 mm. By contrast, the average size of landed males rose from 115.3 mm in 1995 to 117.8 mm in 1996.

The beam trawl research survey done on the north shore of the estuary in Area 17 between late July and early August 1996, when the fishery was virtually finished, confirmed the trends observed in the fishery and those identified in earlier surveys. The abundance of males left by the fishery (LF) and males recruited to the fishery (R), which had been declining since 1993, declined again in 1996 (Figure 4). In contrast, adolescent males between 78 and

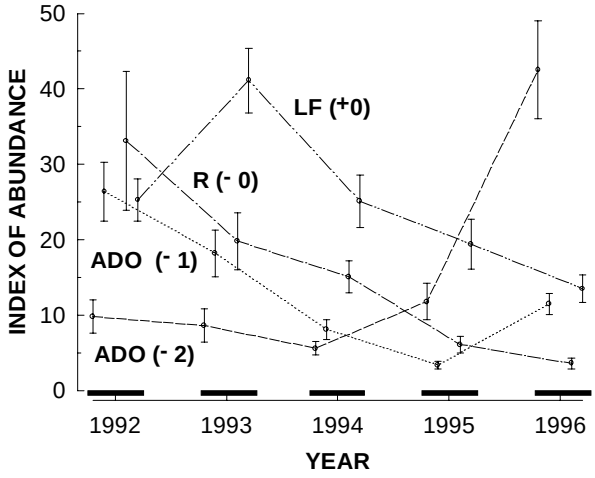

Figure 4 Abundance of male snow crabs caught during research surveys in the estuary between 1992 and 1996. LF(+0): males left by the fishery during the survey year; R(-0): males recruited to the fishery; ADO(-1): adolescent males from 78 to 95 mm; ADO(-2) adolescent males from 62 to 78 mm.

95 mm (ADO^{-1}), whose abundance had been decreasing since 1992, were almost four times more numerous in 1996 than in 1995. They will reach legal size in 1997, but will not be fully available to the fishery until 1998. However, since they are fairly abundant compared to the total number of males recruited to the fishery and left by the fishery in 1996, white crab problems can be anticipated in 1997. The upward trend observed in the number of adolescent males from 62-78 mm (ADO^{-2}) in 1995 continued in 1996.

The group of crabs left by the fishery, which consists primarily of adult males and which will essentially make up the 1997 harvest, shrank by 30% compared to 1995, given the poor recruitment in 1996. Males recruited to the fishery were five times less abundant in 1996 than in 1993 and reached

the lowest level in five years. The survey results indicate a drop in the average size of adolescent and adult males that have reached commercial size recently.

In 1996, the first postseason survey was conducted by Area 17 fishermen concurrently with the trawl survey and at the same sites, using traps. The abundance of recruits and males left by the fishery was very low, approximately 3 kg/trap. In general, the CPUEs were almost nil for the region to the east of Baie Comeau and increased slightly toward the west. This observation is consistent with the results of the commercial fishery, as fishermen from the Baie Comeau area reported very low catch rates in this North Shore sector. Whereas the average size of males caught at sea (103.7 mm) was much smaller than in the fishery (111.3 mm), the percentage of undersize and legal-size adolescents was slightly higher (12.5%) than in the fishery. The crabs' condition was similar to that observed in the trawl survey, but the relative abundance of recently moulted crabs (shell conditions 1 and 2) was three times higher (32.9%) than in the fishery (10.1%). The number of older crabs (conditions 3, 4 and 5) also appeared to be slightly higher (10%).

Outlook for Area 17 in 1997

The recruitment trough made up of the 1985-87 year-classes will take an ever greater toll on Area 17, as reflected in the steady decline in CPUEs since 1995 and the major changes in the distribution of fishing effort over the last two years. The short-term outlook for this area is not good, with a sharp drop in the CPUE anticipated in 1997. Following the 1996 fishing season, the exploitable biomass shrank by 30% on the north shore, which generally accounts for two-thirds of the landings; the biomass was composed of 32% old crabs, some of which will die over the winter or will not be catchable next year. Owing to the strong fishing pressure exerted on the north shore in 1995 and on the south shore in 1996, the residual biomass is expected to decline considerably throughout the region. In all likelihood, catches per unit of effort will continue to drop, reaching values in 1997 comparable to those of the late 1980s.

White crab problems are anticipated in 1997 and probably 1998, when the first two cohorts of the recruitment wave made up of the 1988-1992 year-classes reach legal size. Although recruitment to commercial size will definitely pick up as of 1997, the exploitable biomass will remain low until 1998 since the abundance of pre-recruits (ADO^{-1}) in 1996 was not high enough to offset the observed decline in biomass. It is therefore highly likely that the expected upturn in recruitment will not be noticeable until 1999. The average size of males should decrease in 1997-98 and then begin edging up in 1999. To maintain an exploitation rate comparable to that of 1996, estimated at 45-50% of the exploitable biomass on the north shore of the estuary, 1997 catches should be reduced by about 30% in line with the lower abundance of

Table 3 Catches per unit of effort in areas 16 and 15.

Year		1983 to 1989[4]	1990	1991	1992	1993	1994	1995	1996
TAC	Area 16	2 500[5]	-	2 368	2 596	2 596	3 636	3 636[7]	3 090[7]
	Area 15	–	–	–	–	–	435	435	435
Catches[1]		2 093	3 274	2 692	2 897	2 934	4 034	4 065	3 520
Effort[2]		249.1	264.0	161.2	159.2	148..2	199.7	189.9	169.2
CPUE[3]	16 West	6.0	8.9	14.1	17.4	18.4	21.5	19.8	20.9
	16 Centre	7.7	12.4	18.2	22.0	23.3	19.7	21.7	18.5
	16 East	10.1[6]	15.2	18.7	17.4	19.9	18.5	19.9	21.2
	Area 15	-	6.1	14.0	13.6	15.2	20.1	25.5	24.1

1 Landings in metric tonnes as at December 18, 1996
2 Standardized effort in thousands of Japanese traps hauled
3 Catches per unit of effort in kilograms per Japanese trap
4 Average for the period
5 In effect from 1986 to 1987
6 The CPUEs for sector 16 East and Area 15 were combined prior to 1990
7 Including special allocations

harvestable crabs as revealed by trawl surveys between 1995 and 1996.

SNOW CRAB ON THE MIDDLE NORTH SHORE (AREAS 16 AND 15)

There are 36 and 8 regular active licences in areas 16 and 15, respectively. The total allowable catch in Area 16, originally set in 1992, was cut by 15% in 1996 and currently stands at 3 090 t. The TAC for Area 15, first set in 1994, remained unchanged at 435 t in 1996. In 1996, the fishery took place from April 15 to July 31 in Area 16 and from May 15 to September 15 in Area 15. Special allocations of 177 t and 25 t, included in the global quotas, were granted to non-crabbers in areas 16 and 15 respectively. The quotas were attained in both areas in 1996.

State of the resource in 1996

As in 1995, the trends apparent from fishery data were not uniform throughout the region; however, signs of a levelling off of the main abundance indices were evident almost everywhere. Between 1995 and 1996, the CPUEs declined slightly in the middle of Area 16 (Rivière au Tonnerre) and in Area 15, from 21.7 to 18.5 kg/Japanese trap and from 25.5 to 24.1 kg/Japanese trap (Table 3) respectively. In addition, beginning in late May the CPUEs dropped sharply in the western part of Area 16 (excluding Pointe des Monts to Rivière au Tonnerre) from about 25 kg/Japanese trap to 13 kg/Japanese trap in early July, and catches in this sector decreased by 16% in 1996 compared to 1995. Only the eastern part of Area 16 showed no sign of a decrease; however, longer trap soak times and the use of larger-volume traps in this region since 1994 may have

helped keep yields at what appear to be high levels.

A review of the condition of commercial-size males caught at sea indicated that the relative abundance of old crabs in both areas had stabilized or declined (Table 4), which suggests that the aging of the population stopped in 1996. Although the abundance of old crabs (shell conditions 4 and 5) was on a par with the 1995 level in Area 16 (21.5% versus 20.8%), it declined by half in Area 15, from 17.4% in 1995 to 7.4% in 1996. In contrast, recently moulted crabs (conditions 1 and 2) were four times and twice as numerous in areas 16 and 15 respectively in 1996.

Table 4 Shell condition (%) in areas 16 and 15.

Area 16

SHELL CONDITION	1995		1996	
	SEA	DOCK	SEA	DOCK
1	0.9	0.3	0.8	0.3
2	6.0	2.5	25.4	32.0
3	72.3	48.6	52.3	58.0
4	19.3	48.2	19.0	9.7
5	1.5	0.4	2.5	0

Area 15

SHELL CONDITION	1995		1996	
	SEA	DOCK	SEA	DOCK
1	1.5	0	0.9	0.3
2	16.7	8.7	41.2	48.2
3	64.4	56.6	50.5	50.9
4	15.8	33.0	7.2	0.6
5	1.6	1.7	0.2	0

The percentage of undersize and legal-size adolescents caught at sea moved up slightly in both areas in 1996. Whereas the average size of crabs caught at sea levelled off at 111.2 mm in Area 16, the average size of landed crabs increased from 113.3 to 115.4 mm. In Area 15, average carapace width rose both at sea (105.7 to 108.4 mm) and at dockside (109.6 to 110.4 mm) between 1995 and 1996.

Three research surveys were conducted in this region in 1996. Monitoring of the snow crab population in St. Marguerite Bay was continued in 1996 through an underwater diving survey in March and a beam trawl survey in April-May. Adult males with shell conditions 4 and 5 were observed to have moved en masse toward shallow depths, congregating there in order to mate with the abundant primiparous females. Due to this migration, large adult males with old shells were not well represented on the fishing grounds in April-May. Furthermore, the beam trawl survey indicated a steady increase in the 1988-1992 year-classes and the near-disappearance of adolesent males greater than 90 mm (Figure 1). The expected recruitment to adult size will be very low in spring 1997 and rise in 1998; however, the exploitable biomass will not increase until 1999. A beam trawl survey was carried out from July 20 to 28 in the Natashquan region. The size structure of captured males was similar to that for St. Marguerite Bay and the estuary, but the strength of the 1986-1989 year-classes exhibited a declining pattern.

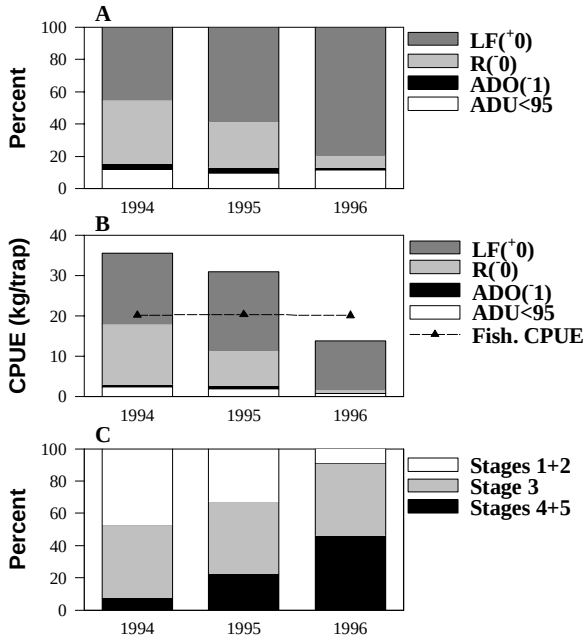

Figure 5 Results of the postseason surveys done in Area 16 since 1994. (A) Distribution of the different groups of males: ***LF(+0)****: left by the fishery;* ***R(-0)*** *recruited to the fishery;* ***ADO(-1)****: adolescent males between 78 and 95 mm;* ***ADU<95****: adult males under 95 mm. (B) Trap yields during the surveys for the different groups of males and the commercial fishing yield (CPUE Fishery) in the same year. (C) Shell condition of the crabs.*

In 1996, for the third consecutive year, a fall (postseason) survey was done in Area 16 by fishermen using traps. A synthesis of the results for the three years shows that the relative abundance of recently moulted crabs (conditions 1 and 2) has declined since 1994, with an opposite trend noted for older males (conditions 3, 4 and 5) left by the fishery (Figure 5). The percentage of newly recruited crabs (R) slid from 40% in 1994 to 10% in 1996, whereas the percentage of older males (LF) rose by 40% during the same period. CPUEs declined slightly between 1994 and 1995, from about 36 to 31 kg/trap, but dropped by half in 1996 to 14 kg/trap. The fall catches comprised 46% old crabs (conditions 4 and 5) in 1996.

The gradient in abundance, availability and condition of the resource noted between the eastern and western part of the region in 1995 appears to have disappeared in 1996. CPUEs declined in both sectors and probably would have fallen throughout the region had the trap soak time not been increased in an effort to boost catches. Furthermore, the findings of the fall trap surveys carried out since 1994 in Area 16 contrast with those of the fishery and indicate that the ageing of the commercial population was further accentuated in 1996. The apparent contradiction between these two information sources may be due to fishing directed at males with shell conditions 2 and 3, as shown in Table 4, or to the non-availability of old-shell males in the early part of the fishing season when they were cohabiting shallow depths with the abundant primparous females. If the results of the 1996 postseason survey reflect the real situation, old males (conditions 3+, 4 and 5) will make up over 90% of the biomass available in the area in 1997. The abundance and condition of the resource available in Area 15 in 1997 are not known; however, the levelling off of yields and the condition of males caught in the fishery suggest a scenario similar to that for Area 16.

Outlook for 1997

The effects of the recruitment trough formed by the 1985-87 year-classes are now

noticeable throughout the region, and the fishing situation is expected to deteriorate appreciably in 1997 because of the following factors:

- Increased and generalized aging of the biomass of commercial size crabs left on the fishing grounds after the 1996 season;
- Poor recruitment, with 1996 marking an all-time low since the early 1990s, as confirmed by the different surveys.

It is clear that CPUEs will fall sharply throughout the region in 1997, and the crabs caught will be either large but of poor quality, or small and recently moulted. White crab problems will occur in 1997 and 1998, when the 1988 and 1989 year-classes reach legal size. There is likely to be a displacement of fishing effort toward the eastern sector, where the CPUEs appear to be holding steady. A strong recovery should be seen in 1999.

SNOW CRAB ON THE LOWER NORTH SHORE (AREAS 14 AND 13)

There are 21 and 49 active licences in areas 14 and 13, respectively. A total allowable catch has been in effect in areas 14 and 13 since 1986 (Table 5). In 1996, the TACs were set at 576 t and 1 241 t in areas 14 and 13, up 10% and 40% respectively from 1995. In 1996, the fishery took place from June 30 to October 9 in Area 14, and until October 20 in Area 13. Special allocations of 33 t for Area 14 and 130 t for Area 13 were granted to non-crabbers from Quebec and Newfoundland. As at December 18, 1996, 3 t of the Area 14 quota and 71 t of the Area 13 quota were uncaught.

State of the resource in 1996

Following a steady and fairly large increase in the CPUE in Area 14 from 1992 to 1994, the rate of increase slowed between 1994 and 1996, levelling off at about 11.9 kg/Japanese trap (Table 5). However, a detailed analysis of the fishing methods used since 1989 showed that the trap soak time has been rising since 1992, especially over the last two years. Seventy-seven per cent of the traps deployed in 1996 were kept in the water for at least two days, and 54% of them for more than three days. In 1996, the yields of Japanese traps used for three or more days were 22.5% higher on average than the yields for the same traps deployed for only one day of fishing. The inflationary effect that longer soak times have on CPUEs is thus especially marked in Area 14. The size of the crabs taken in Area 14 increased slightly in 1996, from 102.9 to 103.1 mm at sea and from 107.7 to 109.3 mm at dockside. The percentage of undersize and legal-size adolescents caught at sea rose moderately as well, from 4 to 5%. The condition of these crabs improved markedly in 1996 in Area 14, with recently moulted crabs (conditions 1 and 2) accounting for 32.5% of males in traps, compared with 7.8% in 1995 (Table 6).

Table 5 Catches and fishing effort in Areas 13 and 14.

Year		1983 to 1989[4]	1990	1991	1992	1993	1994	1995	1996
TAC:	Area 14	667[5]	381	381	381	381	524	524[6,7]	576[7]
	Area 13	1 642	889	889	889	889	889	889	1241[7]
Catches[1]		1 428	312	489	380	1 086	1 381	1 408	1 743
Effort[2]		165.6	76.1	116.4	53.5	193.9	212.5	154.7	281.1
CPUE[3]	Area 14	5.2	4.3	4.8	7.3	9.7	11.2	11.6	11.9
	Area 13	5.7	3.9	3.1	5.3	4.2	4.5	8.0	5.1

1 Landings in metric tonnes as at December 18, 1996
2 Standardized effort in thousands of Japanese traps hauled
3 Catches per unit of effort in kilograms per Japanese trap
4 The CPUEs for the two areas were calculated separately only as of 1987
5 Average for the period
6 In effect as of 1986 in both areas
7 Including special allocations

A steep drop of 36% in CPUEs was observed in Area 13 in 1996, with the average CPUE falling from 8.0 kg/Japanese trap in 1995 to 5.1 kg/Japanese trap in 1996. Moreover, CPUEs showed a steady downward trend during the fishing season from 10 kg/Japanese trap to about 3.7 kg/Japanese trap, which suggests that the resource was being fully exploited. The size of crabs caught at sea and those landed also declined, from 95.8 to 94.8 mm at sea and from 101.9 to 101.5 mm at dockside. Furthermore, the percentage of undersize and legal-size adolescents rose substantially in catches at sea, from 3% in 1995 to 9% in 1996. The condition of crabs taken at sea improved markedly in Area 13, with recently moulted crabs (conditions 1 and 2) comprising 42.3% of the catch in 1996, up from 8.6% a year earlier.

An initial postseason survey using traps was carried out by Area 14 fishermen in October 1996. The results show a declining gradient in abundance moving from west to east, based on CPUEs and the size of the hard-shell males that made up the biomass of crabs left on fishing grounds at the close of the fishery. The males sampled (97.3 mm) were smaller than those taken in the fishery (103.1 mm). Interestingly, the percentage of adolescents was very high, approximately 16%. Catches consisted primarily of clean, hard-shell males (condition 2) and dull, hard-shell males (condition 3), and the average CPUE stood at 7.2 crabs/trap (or about 3.5 kg/trap) for commercial-size crabs.

Outlook for 1997

Since Area 14 and 13 fishermen are active in the fall and harvest part of the current year's recruitment, the strong fishing pressure exerted in this region in 1996, particularly in Area 13, is thought to have greatly reduced the residual biomass that will be available in 1997. It should be kept in mind that the fragmentary research surveys conducted in this huge re-

Table 6 Shell condition (%) in areas 14 and 13.

Area 14

SHELL CONDITION	1995		1996	
	SEA	DOCK	SEA	DOCK
1	1.7	0	5.4	0.5
2	6.1	0	27.1	43.3
3	84.5	83.4	61.3	55.7
4	7.6	16.6	5.9	0.5
5	0.1	0	0.3	0

Area 13

SHELL	1995		1996	
CONDITION	DOCK	DOCK	SEA	DOCK
1	3.6	0	16.3	0
2	5.0	10.1	26.0	53.7
3	89.9	88.6	54.1	45.7
4	1.5	1.3	3.4	0.5
5	0	0	0.2	0

gion in 1994-95 revealed that a very small number of crabs would reach legal size between 1997 and 1999. CPUEs should start dropping in Area 14 in 1997 and continue to move downward in Area 13, with more marked declines in the east than the west.

GENERAL RECOMMENDATION

Scientific research surveys, postseason surveys by fishermen and fishery data from 1996 all showed that the exploitable biomass of snow crabs fell substantially in areas 13, 16 and 17, but peaked in areas 14 and 15 and is probably now declining. The only conflicting aspect of the data, namely the slight upturn observed in commercial CPUEs in Area 14 in 1996, must be interpreted cautiously, since the fishery data show a major increase in the average soak time for traps, a situation which has undoubtedly inflated yields.

The abundant biomass which benefited the industry during the period 1992-95 stemmed from a recruitment wave made up of the 1981-84 year-classes. This wave affected all the fishing areas concurrently, as evidenced by the simultaneous increase in the percentage of adolescent males in the commercial fisheries in 1992 and 1993 (Figure 6). Since these predominantly legal-size adolescents moulted to adult size a year later and became available to the fishery two years later, they helped to sustain the fisheries right through 1995, thanks to

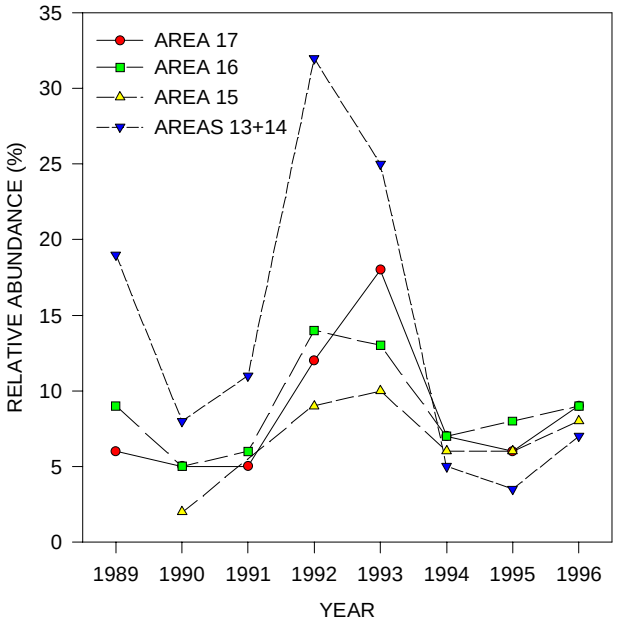

Figure 6 Abundance of undersize and legal-size adolescent males in samples taken at sea in each area since 1989.

their large size and individual biomass. However, the recruitment trough consisting of the 1985-87 year-classes caused a substantial decrease in the percentage of adolescents in commercial catches, affecting all areas simultaneously, so that commercial catches are now composed mainly of undersize adolescents. This declining percentage of adolescents in the commercial fisheries reflects the steep drop in recruitment to legal size, a situation which is borne out by all the scientific surveys and the postseason surveys by fishermen. The downturn in the number of adult males available to the fishery will be amplified by their smaller size, and the two factors combined spell a major decline in the exploitable biomass.

The broad population trends observed for snow crab appear to be affecting all the fishing areas uniformly, suggesting that the populations are probably interconnected or influenced by environmental factors common to all sectors, as discussed in earlier reports. Likewise, an west-east gradient of declining productivity in crab populations was previously identified on the basis of abundance indices compiled from fishery and research survey data and from the size structure of crab catches. Hence, fishermen in the east can be expected to achieve less promising yields than those in the western part of the region, which is not always the case. The discrepancies observed in fishery performance in the different areas, particularly the seemingly greater resilience of areas 15 and 14 during the 1985-87 recruitment trough, can be explained mainly by their differing exploitation rates.

Since it is very likely that the exploitable biomass is now declining in all fishing areas, with the situation worsening over a gradient from west to east, with the possible exception of a region centred around Area 15, and since the snow crab populations of the different areas are more or less interdependent or subject to similar environmental constraints, *it seems appropriate to make a general recommendation applying to the whole region encompassing Areas 13 to 17*. In view of the abiding concern about maintaining the reproductive potential of females over the coming two years, it is recommended that the total allowable catch be sharply reduced in all fishing areas. This measure is aimed at preserving large-size males so they can mate with multiparous females. The 30% reduction in catches estimated for Area 17 to keep 1997 exploitation rates on a par with those of 1996 could be applied to all the North Shore areas (13 to 17). However, in view of the gradient in productivity from west to east and the intensive harvesting done in Area 13 in 1996, a larger reduction in catches there is considered necessary to keep the exploitation rate fairly constant. By contrast, in areas 15 and 14, harvesting should be less intensive than in the other areas, and a smaller decrease in catches would make it possible to achieve the same objective. *At any rate, it is important to realise that even if exploitation rates are maintained at the 1996 level in 1997, this*

will not stop the decline in the population of large-size males. At the very most, this measure will prevent an acceleration in the rate of decline.

CONSERVATION MEASURES

Three key recommendations from the 1995 and 1996 reports on the state of snow crab populations in the estuary and northern Gulf of St. Lawrence are reiterated here briefly:

1. Adolescent males should not be landed, because when they moult they reach a much greater size and weight and can thereby help cushion the effect of a recruitment trough and ensure faster recovery. Harvesting males only after their terminal moult increases their chances of participating in reproduction and contributes to maximizing yield per recruit. Throughout the region, there will be a major increase in the percentage of adolescent males in catches over the coming years, due to the advent of a recruitment wave composed of the 1988-92 year-classes.

2. Obviously, if we are to preserve and, if necessary, re-establish a large exploitable biomass as quickly as possible, measures should continue to be implemented to protect white crabs. In 1997, returning white crabs to the water will be authorized throughout the region. This measure will be doubly beneficial, since it will also help to preserve most of the adolescent males, which moult in the spring. It will be particularly important during the 1997 and 1998 fishing seasons, which will be impacted by the presence of white crabs.

3. Harvesting old-shell males may also help cushion the effect of a recruitment trough, while maximizing the yield per recruit. Whereas the old-shell males will die naturally within a very short time if they are not harvested, clean-shell males may remain available to the fishery for another two or three years, although their appearance and condition will deteriorate. This recommendation will be less important over the coming years, because the population segment composed of legal-size individuals is expected to undergo a considerable rejuvenation.

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