STOCK STATUS REPORT

LAURENTIAN REGION

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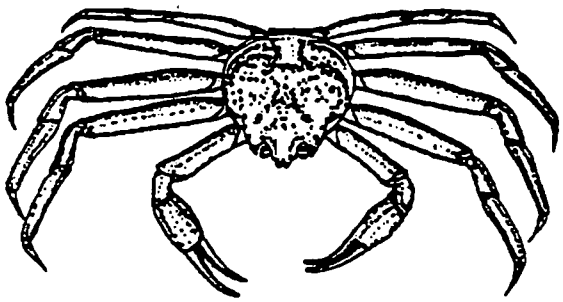
DFO, Atlantic Fisheries, Stock Status Report 96/6 March 1996

SNOW CRAB OF THE ESTUARY AND NORTHERN GULF OF ST. LAWRENCE



OVERVIEW OF SNOW CRAB

Biological context

The snow crab (*Chionoecetes opilio*) is a crustacean that prefers salty waters under 3°C. As for all crustaceans, the snow crab's growth in size is discontinuous, and is achieved by means of a molt, in the course of which an individual sheds its old shell and absorbs water in order to lend volume to its new shell. Snow crabs of over 30 mm in carapace width (CW) generally molt from April to June each year. Immediately after molting, the snow crab has a very soft shell and is vulnerable to predators and handling. Following the annual molt, 3 to 6 months are needed for a snow crab's shell to harden and for its water content to diminish and be largely replaced by meat. Newly molted snow crabs are called "white crab" because of the spotless whiteness of their abdominal surface.

In both sexes of snow crab, growth ceases after the so-called "terminal" molt. The ultimate size of females varies from 39 to 95 mm in carapace width, and of males from 40 to 165 mm. Hence not all males in a population reach the minimum legal size of 95 mm CW. Males over 40 mm which have not yet gone through their terminal molt can be recognized by their relatively small claws, and are termed "adolescents", whereas those which have experienced their terminal molt can be recognized by their relatively large claws, and are called "adults". Males and females do not live much longer than 5 years after

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their terminal molt; following the third year, their appearance and physiological condition deteriorate fairly quickly. Given the initial time required for the shell to harden and the meat to develop, males of legal size are available to the fishery only for a period of about 3 years after the terminal molt.

The female snow crab mates in the spring and subsequently incubates her eggs under her abdomen for 1 or 2 years, depending on the surrounding temperature. The larvae hatch in the spring, remain in the plankton for 3 to 5 months, and then metamorphose into small crabs and settle on the bottom in the fall. One must expect at least 9 years from the hatching of the larva before a male crab reaches the legal size of 95 mm carapace width. Since molting occurs in spring, the quality males available to the spring fisheries are at least 10 years old, whereas those available to the fall fisheries may be only 9.

The snow crab stocks in the estuary and northwest Gulf of St. Lawrence show abundance fluctuations which suggest a cycle of about 8 years. Each cycle includes at least 3 consecutive year-classes that are smaller in numbers, collectively designated "recruitment troughs", and at most 5 consecutive year-classes of moderate to large numbers, collectively designated "recruitment waves". The size distribution of the crabs observed in St. Marguerite Bay (near Sept-Îles) during research surveys provides a good illustration of the action of recruitment waves and troughs (Figure

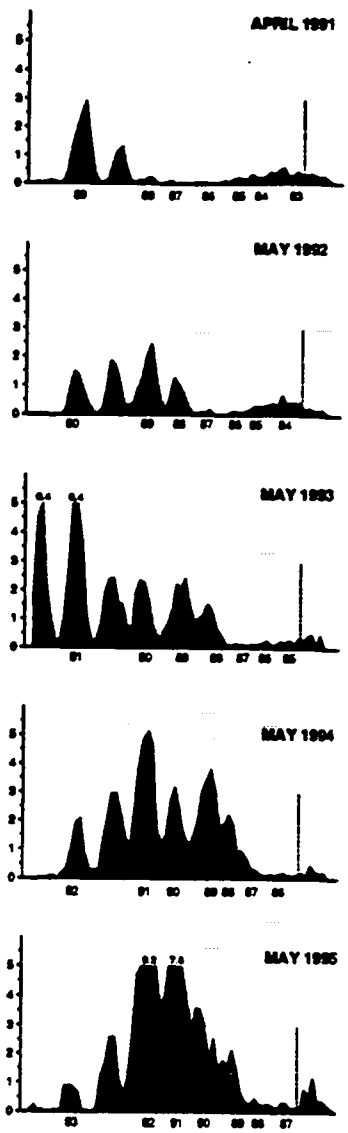

Figure 1. Size structure of snow crab caught in St. Marguerite Bay during 1991-1995 research surveys. Grey represents immature males and adolescents, and black, adult males. The horizontal axis represents size and the vertical axis abundance. The year of birth corresponding to each mode (peak) is indicated under each panel. The dotted line represents the minimum legal size of 95 mm. One can clearly see the annual displacement of the recruitment trough formed by the 1985 to 1987 year-classes and the recruitment wave represented by the 1988 to 1992 year-classes as they grow.

1). St. Marguerite Bay is considered representative of the situation in the northern Gulf. Work to clarify the causes of the abundance cycle is under way, but it already seems that fishing is not the primary cause. This cycle could be explained by:

- a periodic change in the survival rate of individuals in year-class one, on account of strong competition for space and food in the restricted habitat of very young snow crab;

- or a periodic variation in larvae production.

In the estuary and northwest of the Gulf of St. Lawrence, the 1985 to 1987 year-classes form a recruitment trough, and the 1988 to 1992 year-classes form a recruitment wave. In previous snow crab stock assessments, we predicted that the 1985-87 recruitment trough would result in the following for 1995 to 1997:

- a significant decline in catches per unit effort;

- a general ageing of the population of legal-size males, followed by a gradual increase in the percentage of white crab in catches at sea as a result of the reduction of the exploitable biomass of hard-shell males;

- a decrease in the average size of males in catches at sea and catches landed.

The fishery data and research surveys confirm that snow crab populations are organized from west to east on a declining gradient of abundance and size upon harvesting. The populations in Areas 17 and 16 are already experiencing the effects of a recruitment trough, as shown in the decline in catches per unit effort, the drop in recruitment to legal size and the ageing of the exploitable biomass. Areas 15, 14 and 13 seem to have enjoyed one year's respite compared with the areas further to the west, but the inevitable decrease in the exploitable biomass which will begin in 1996 could be felt over a longer period than in Areas 17 and 16.

THE FISHERY

Location and historical context

Snow crab stocks in the estuary and northern Gulf have been the direct responsibility of DFO since 1983. The territory is divided into 5 management areas (Figure 2), which can be organized into three major geographic regions: the estuary including the Upper North Shore (Area 17), the Middle North Shore (Areas 16 and 15) and the Lower North Shore (Areas 14 and 13).

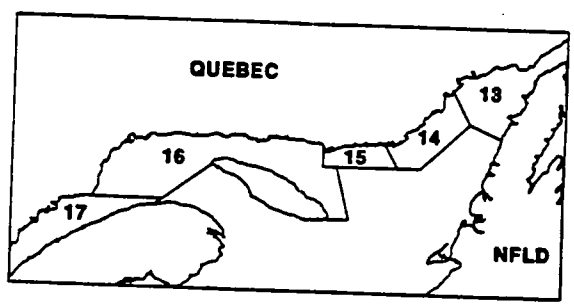

Figure 2. Snow crab management areas in the northern Gulf of St. Lawrence.

Snow crab is fished with baited traps, most often conical steel models, such as the Japanese trap of 1.2 m in diameter at the base. Since 1990, the fishery has begun at ice break-up (March-April) and generally closed after 10 to 14 weeks of activity (June-July) in the estuary and on the Middle North Shore. The opening of the fishery is often delayed because ice on the Lower North Shore is slow to disappear, and the season generally does not begin before June, ending in the fall in October-November.

The snow crab fishery in the estuary and northern Gulf of St. Lawrence began in the late 1960s. Vessels from Québec and New Brunswick brought in catches of around 1,000 t from the Port Cartier sector on the Middle North Shore from 1968 to 1971. Subsequently there was a limited inshore fishery, with landings of around 200-300 t annually, until the late 1970s. The fishery experienced a boom from 1979 to 1985, when the number of participants, effort, geographic extent and landings increased substantially (Figure 3).

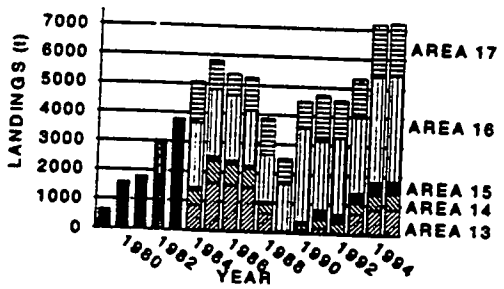

Figure 3. Snow crab landings in the northern Gulf of St. Lawrence.

From 1987 to 1989, landings for the entire territory of the estuary and the northern Gulf of St. Lawrence plummeted from 5,255 t to 2,622 t. This reduction was accompanied by marked decreases in catches per unit effort and increasingly large catches of white crab. We now know that this temporary decline in the status of the resource was caused by a recruitment trough affecting the 1977 to 1979 year-classes. Starting in 1990-91, the white crab problem gradually went away, catches per unit effort increased, and landings rose to a record 7,245 t in 1995 thanks to the maturation of the 1980-84 recruitment wave.

Fishery management

The fishery was initially managed by controlling effort, but between 1985 and 1994 total allowable catches (TAC) were gradually introduced in each of these areas. The number of traps authorized per licence is limited to 150 Japanese traps, but fishermen may use an equivalence of 1 regular trap (maximum volume of 2.1 m^3) for 2 Japanese traps (maximum volume of 0.44 m^3).

As everywhere else in Canada, minimum legal size is set at 95 mm carapace width, and the landing of females is prohibited. Since 1985, exceeding the limit of 20% white crab in catches at sea results in automatic closure of the fishery in the area concerned, in order to minimize the mortality of these very fragile crabs.

SNOW CRAB IN THE ESTUARY (AREA 17)

There are 22 licence holders active in Area 17. The first total allowable catch was set in 1992 at 1,300 t. In 1995, the fishery opened on April 12 and closed on September 1, and the global quota of 1,820 t was almost met. The late closure of the area was due to a special allocation of 100 t to non-crabbers after the regular fishing season.

Status of the resource in 1995

An overall decline of 21% in catches per unit effort compared with 1994 (24% and 18% on the north and south shores, respectively) and the early abandonment of the fishery on the south shore indicate that the exploitable biomass of snow crab decreased substantially in the estuary in 1995 (Table 1). Catches on the south shore dropped by over half, from 653 t in 1994 to 297 t in 1995, forcing the 22 fishermen in this area to increase their geographic distribution and fishing pressure on the north shore, where catches were up 25% (1,111 t to 1,476 t) over 1994.

Table 1. Catch and fishing effort in Area 17

Year	1983-1989[4]	1990	1991	1992	1993	1994	1995
TAC	-	-	-	1 300	1 300	1 820	1 820
Catches[1]	1 022	910	1 562	1 289	1 305	1 788	1 774
Effort[2]	122.1	137.9	182.0	113.1	88.2	125.0	157.0
CPUE[3]							
N. Shore	8.6	7.7	10.1	11.8	15.7	15.2	11.5
S. Shore	7.3	5.5	7.4	11.0	13.5	12.1	9.9

1. Weight in tonnes
2. Standardized effort in thousands of Japanese traps hauled
3. Catches per unit effort in kilograms per Japanese trap
4. Calculation of the average for these years

The condition of the legal-size snow crab on the fishing grounds deteriorated significantly in 1995 (Table 2). First, the percentage of recently molted crabs (carapace conditions 1 and 2) declined from 43.6% in 1994 to 7.9% in 1995; second, the percentage of old crabs (carapace conditions 4 and 5) doubled in 1995 compared with 1994, rising from 14.8% to 30.8%.

The percentage of adolescent crab in catches at sea remained stable but very low at around 6% in 1995, this being far below the values of 12-18% recorded in 1992-93. Average carapace width of male snow crabs in at-sea sampling, which had risen gradually from 102.2 mm in 1989 to 115.7 mm in 1994, dropped off slightly in 1995 to 113.4 mm. Also observed was a slight decline in the average carapace width of landed males, from 116.5 mm in 1994 to 115.3 mm in 1995.

Table 2. Carapace condition in Area 17

CARAPACE	1994		1995	
CONDITION	AT SEA	DOCK-SIDE	AT SEA	DOCK-SIDE
1	0.5	2.3	0.3	0.1
2	43.1	76.4	7.6	29.9
3	41.6	16.3	61.3	48.5
4	12.0	4.2	29.2	20.3
5	2.8	0.8	1.6	1.2

The research survey done on the Upper North Shore (north shore of the estuary) using a beam trawl, from late July until early August, at a time when 95% of catches had already been made, confirms the indices and trends derived from the fishery. The abundance of males left by the fishery in 1995, of males recruited to the fishery in 1995, and of adolescent males with a carapace width of 78 to 95 mm which will be recruited to legal size in 1996, has been in decline since 1992-93, and continued to drop in 1995 (Figure 4).

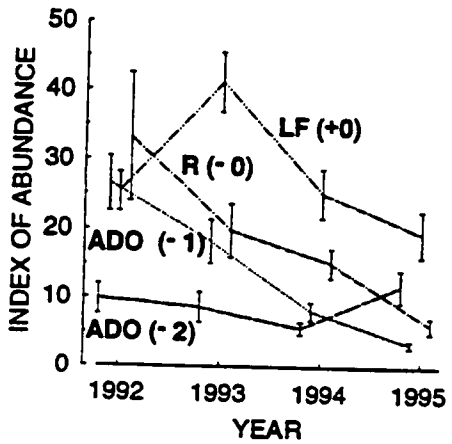

Figure 4. Abundance of male snow crabs caught in research surveys between 1992 and 1995 in the estuary. LF(+0) = males left by the fishery in the year of the survey; R(-0) = males recruited to the fishery; ADO(-1) = adolescent males between 78 and 95 mm carapace width; ADO (-2) = adolescent males between 62 and 78 mm carapace width.

The group of crabs left by the fishery fell 37% from 1994, and the maximum abundance of males that will be available to the fishery in 1996 will be at least half that of 1993. However, in 1995 the downward trend observed since 1992 in the abundance of adolescent males of 62-78 mm CW was reversed.

These crabs might reach legal size in 2 years. The survey also confirms the ageing of the population of adult males of legal size.

Prospects for Area 17 in 1996

The fall in catches per unit effort in Area 17 is expected to continue and intensify in 1996-97 because of the following factors:

- the weakness of legal-size recruitment in 1995;
- the exploitable biomass left after the 1995 fishing season was low; 31% of it consisted of old males, some of which will not have survived the winter or will be less catchable in 1996;
- the legal-size recruitment anticipated in 1996 will be even lower than in 1995.

It seems likely that catches per unit effort in 1997 will post low values similar to those recorded in the late 1980's.

The reduction of the exploitable biomass will result in white crab problems, especially in 1997 and probably in 1998 when the first two year-classes in the recruitment wave of 1988-1992 reach legal size. The average size of males will continue to diminish until 1997, before stabilizing and commencing a slight recovery in 1998-99.

At present, the abundance of adult males of legal size is low, and we have some

degree of concern for the reproductive potential of this population (see conservation measures, below). A significant reduction in catches in 1996 or any other measure that might reduce the harvesting rate would help maintain an acceptable level of good-size male spawners.

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

There are 36 and 8 active regular licences in Areas 16 and 15, respectively. The total allowable catch was set at 2,596 t in 1992 in Area 16, and at 435 t in 1994 in Area 15. In 1995 the fishery took place from April 18 to August 8 in Area 16, and from May 16 to September 1 in Area 15. Special allocations of 204 t and 25 t, from the achieved global quotas of 3,635 t and 435 t, were granted to non-crabbers in Areas 16 and 15, respectively. The late closure of the fishery in Area 15 could be the result of the delay required to catch the special allocations in this area.

Status of the resource in 1995

The fishery did not perform in a uniform manner throughout Area 16. In the western part of Area 16 adjacent to Area 17, from Pointe des Monts to Rivière au Tonnerre (excluded), the fishery showed clear signs of decline in 1995. In 1995, catches per unit effort were down 18% from 1994 (Table 3). On the other hand, they remained stable in the centre of Area 16 (Rivière au Tonnerre) and rose 3% in the east of Area 16 (Mingan to Natashquan).

Table 3. Catch and fishing effort in Areas 16 and 15

Year	1983 1989[4]	1990	1991	1992	1993	1994	1995
TAC							
area 16	2 500[5]	-	2 368	2 596	2 596	3 636	3 636
area 15	-	-	-	-	-	435	435
Catches[1]	2 093	3 274	2 692	2 897	2 934	4 034	4 064
Effort[2]	248.3	266.2	164.1	158.7	148.1	191.2	191.2
CPUE[3]							
16 West	6.0	8.8	13.6	17.4	18.6	22.4	18.4
16 Centre	7.7	12.3	18.4	21.9	23.3	21.2	21.9
16 East	10.0[6]	15.2	18.6	17.5	20.0	19.5	20.1
area 15	-	6.6	14.3	14.2	15.8	21.1	27.7

1. Weight in tonnes
2. Standardized effort in thousands of Japanese traps hauled
3. Catches per unit effort in kilograms per Japanese trap
4. Calculation of the average for these years
5. In effect from 1986 to 1987
6. Prior to 1990, CPUEs for the East 16 sector and Area 15 were combined

For all of Area 16, one notes a pronounced ageing of legal-size adult males: recently molted crabs (carapace conditions 1 and 2) make up only 6.9% of catches in 1995 versus 33.1% in 1994, while old crabs (carapace conditions 4 and 5) account for 20.8% of catches in 1995 versus 11.7% in 1994.

Table 4. Carapace condition in Areas 16 and 15.

Area 16

CARAPACE	1994		1995	
CONDITION	AT SEA	DOCK-SIDE	AT SEA	DOCK-SIDE
1	2.5	1.7	0.9	0.3
2	30.6	36.9	6.0	2.5
3	55.2	35.3	72.3	48.6
4	10.0	25.6	19.3	48.2
5	1.7	0.5	1.5	0.4

Area 15

CARAPACE	1994		1995	
CONDITION	AT SEA	DOCK-SIDE	AT SEA	DOCK-SIDE
1	0.1	0.7	1.5	0
2	17.2	68.2	16.7	8.7
3	63.0	27.9	64.4	56.6
4	15.2	1.4	15.8	33.0
5	4.5	1.8	1.6	1.7

The percentage of adolescent crabs in catches at sea remained stable but low in 1995 at 8%, well below the values of 13-14% recorded in 1992-93. The average carapace width of males caught at sea, which had been rising steadily from 99.3 mm in 1990 to 111.8 mm in 1994, saw a very slight decline to 111.2 mm in 1995. But the average carapace width of males landed saw a modest increase from 112.5 mm in 1994 to 113.3 mm in 1995. The annual research surveys begun in 1988 in St. Marguerite Bay in the vicinity of Sept Îles, also using a beam trawl, confirm that the behavior of the population in the west part of Area 16 is similar to that of the populations in the estuary, and that legal-size recruitment will be very low in 1996. A modest recovery in legal-size recruitment is expected in 1997, followed by a substantial increase in such recruitment in 1998.

The fishery in Area 15 was very good in 1995, with catches per unit effort up 31% from 1994 (Table 3). Effort in this little area seems very localized, and is concentrated close to the boundary with Area 16. The results of the fishery seem similar to those in the eastern part of Area 16. No ageing of the population or change in recruitment levels between 1995 and 1994 is evident in the carapace conditions of males caught at sea (Table 4). The percentage of adolescent crabs remained stable but low in 1995 at 6%, versus 9-10% in 1992-93. The average carapace width of males caught at sea, which had risen constantly from 90.3 mm in 1990 to 107.5 mm in 1994, declined to 105.7 mm in 1995. However, this reduction is not reflected in the average carapace width of landed crabs, which rose from 107.8 mm in 1994 to 109.6 mm in 1995.

The increase in catches per unit effort in 1995 in the eastern part of Area 16 and in Area 15 might be attributable to an episode of strong recruitment in 1994. The abundance of adolescent males in the group of prerecruits with a CW of 78-95 mm was very high in the beam trawl survey done in the Natashquan region in August 1993. This group of adolescent males probably reached legal size in spring 1994 and became available to the fishery in 1995. In this survey, there were almost half as many pre-recruits of 62-78 mm CW as pre-recruits of 78-95 mm CW,

and adolescent males with a CW of 40-62 mm were very scarce, auguring low levels of legal-size recruitment in 1996-97. A research survey is planned in Area 15 in 1996; this will give us a clearer idea of the stock's status and refine our short- and medium-term projections.

Prospects for 1996

The western part of Area 16 performs like Area 17, and should experience difficulties of comparable magnitude, namely a marked drop in catches per unit effort, increasing white crab problems and a reduction in average carapace width at sea and dockside in 1996 and 1997, and possibly into 1998. However, this is a very large area, and the geographic extent of the fishery has been very restricted in recent years. We can therefore anticipate a displacement of fishing effort toward the eastern part of Area 16, where catches per unit effort seem to have been maintained or to have risen slightly in 1995, and especially toward the north shore of Anticosti Island, which has been neglected for a few years. This displacement of fishing effort could have a stabilizing effect on fishery indices in Area 16 in 1996, but would not be able to change a general downward trend for the next two years. A modest recovery of legal-size recruitment is expected in the western part of Area 16 in 1997; this should translate into an increase in catches per unit effort in 1998.

In Area 15, recruitment to legal size should be low in 1996 and 1997, and there will probably be a gradual decline in catches per unit effort until 1998.

The indices collected from the fishery and the research surveys do not allow us to recommend a reduced fishing effort at this time for the entirety of these two areas. However, an appreciable reduction in fishing pressure would help conserve the spawners at a level acceptable for maintaining these populations (see conservation measures, below).

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

There are 21 and 49 active licences in Areas 14 and 13, respectively. There has been a total allowable catch set in Areas 14 and 13 since 1986 (Table 5). In 1995, the TACs stood at 524 t and 889 t in Areas 14 and 13, respectively. The fishery took place from June 11 until September 15, 1995 in both areas. A special allocation of 30 t from the global quota of 524 t for Area 14 was granted to non-crabbers.

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

Year	1983-1989[4]	1990	1991	1992	1993	1994	1995
TAC							
area 14	667[3]	381	381	381	381	524	524
area 13	1 642	889	889	889	889	889	889
Catches[1]	1 428	312	489	380	1 086	1 381	1 407
Effort[2]	167.4	76.3	97.7	46.9	188.0	162.8	148.1
CPUE[3]							
area 14	5.1	4.5	4.7	8.2	10.2	10.5	11.7
area 13	5.1	3.6	3.1	4.6	4.3	4.4	8.4

1. Weight in tonnes
2. Standardized effort in thousands of Japanese traps hauled
3. Catches per unit effort in kilograms per Japanese trap; separation of CPUEs in the two areas only since 1987
4. Calculation of the average for these years
5. In effect only since 1986 in the two areas

Status of the resource in 1995

In 1995, catches per unit effort were up 11% in Area 14 and up 91% in Area 13 compared with 1994. In Area 13, CPUEs on the shores of Québec and Newfoundland were comparable. The two areas both show a marked reduction in the percentage of recently molted crabs (carapace conditions 1 and 2) caught at sea: from 35.3% in 1994 to 7.8% in 1995 in Area 14, and from 25.1% in 1994 to 8.6% in 1995 in Area 13 (Table 6). Paradoxically, there was also a marked decline in the percentage of old crabs (carapace conditions 4 and 5) in both areas. The percentage of adolescent crabs in catches continued to fall from the 1993 peaks of 13% and 37% recorded in Areas 14 and 13, respectively, standing in 1995 at the very low level of 3-4%.

The average carapace width of males caught at sea increased slightly from 102.3 mm in 1994 to 102.9 mm in 1995 in Area 14; in Area 13, it dropped from 97.0 mm in 1994 to 95.8 mm in 1995. However, the two areas recorded an increase in the average carapace width of landed males: from 104.9 mm in 1994 to 107.7 mm in 1995 in Area 14, and from 101.2 mm in 1994 to 101.9 mm in 1995 in Area 13.

Table 6. Carapace condition in Areas 14 and 13

Area 14

CARAPACE CONDITION	1994		1995	
	AT SEA	DOCK-SIDE	AT SEA	DOCK-SIDE
1	4.5	0	1.7	0
2	30.8	81.9	6.1	0
3	44.4	16.8	84.5	83.4
4	18.7	0	7.6	16.6
5	1.6	1.3	0.1	0

Area 13

CARAPACE CONDITION	1994		1995	
	AT SEA	DOCK-SIDE	AT SEA	DOCK - SIDE
1	14.3	1.9	3.6	0
2	10.8	67.9	5.0	10.1
3	59.5	29.2	89.9	88.6
4	11.3	0.6	1.5	1.3
5	4.1	0.4	0	0

The beam trawl survey done on the Lower North Shore in 1995 suggests that there might be some legal-size recruitment in 1996, but that recruitment will be very low from 1997 to 1999. It might recover in the year 2000.

Prospects for 1996

Areas 14 and 13 should enjoy a modest level of legal-size recruitment in 1996, but very few crabs will probably attain legal size from 1997 until 1999. Since the

fisheries in Areas 14 and 13 are active in the fall and exploit part of the current year's recruitment, the deficits in legal-size recruitment could be reflected in catches per unit effort in 1996 or 1997 at the latest. Areas 14 and 13 seem unlikely to experience a significant recruitment recovery before the end of the century.

CONSERVATION MEASURES

The abundance cycles of the snow crab entail significant variations in the ratio of abundance between the sexes, for females reach maturity at a lower average size and age than males. Hence, for example, when the population of legal-size adult males decreases over the next two years in the western part of the territory, the adult females will be reaching their abundance peaks. Intensive harvesting during a recruitment trough may exaggerate the natural fluctuations in the abundance ratio between the sexes. "Multiparous" females, that is those having laid eggs twice or more, will be particularly abundant in 1997-98, and require as sexual partners large, hard-shell adult males, which will be at a minimum in 1997-98. There is a great deal of uncertainty as to the consequences for a population's total fertility of a very pronounced demographic imbalance between the sexes. As a conservation measure, a reduction of global quotas or any other measures which may prevent excessive depletion of the legal-size adult male population would ensure that some degree of balance is maintained.

Here is a brief reminder of two main recommendations of the 1995 report on the status of the snow crab populations in the estuary and northern Gulf of St. Lawrence:

1. Adolescent males should not be landed, because when they molt they reach a much greater size and weight and can thereby help cushion the effect of a recruitment trough. Harvesting males only after their terminal molt increases their chances of participating in reproduction and contributes to maximizing yield per recruit.

2. Harvesting old-shell males may also help cushion the effect of a recruitment trough, while maximizing yield per recruit. Old-shell males will die naturally in the very short term if they are not harvested, while males with clean shells may remain available to the fishery for another 2 or 3 years, even though their appearance and condition will deteriorate.

Obviously, if we are to preserve and, if necessary, rebuild a large exploitable biomass as quickly as possible, it will be necessary to continue to protect white crab.

For further information:

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