



**Southern Gulf  
Snow Crab**

**Background**

*Snow crab (Chionoecetes opilio) are crustaceans (like lobster and shrimp), with a flat almost circular body and five pairs of spider-like legs. As crab grow, the hard outer shell is periodically shed in a process called molting. At this stage, crab have a soft shell for a period of time and are called soft crab (early postmolt stage) and white crab (all postmolt stages). Unlike lobster, male and female snow crab do not continue to molt throughout their lives. Females stop molting when they acquire a wide abdomen for carrying eggs, which occurs at shell widths less than 95 mm. Male snow crab stop molting when they acquire relatively large claws on the first pair of legs, which can occur at shell widths as small as 40 mm and is called the terminal molt. Female crab produce eggs that are carried beneath the abdomen for approximately 2 years. The eggs hatch in late spring or early summer and the tiny newly hatched crab larvae spend 12-15 weeks drifting freely in the water. At the end of this period they settle on the bottom. It then takes at least 8-9 years for snow crab males to reach legal size.*

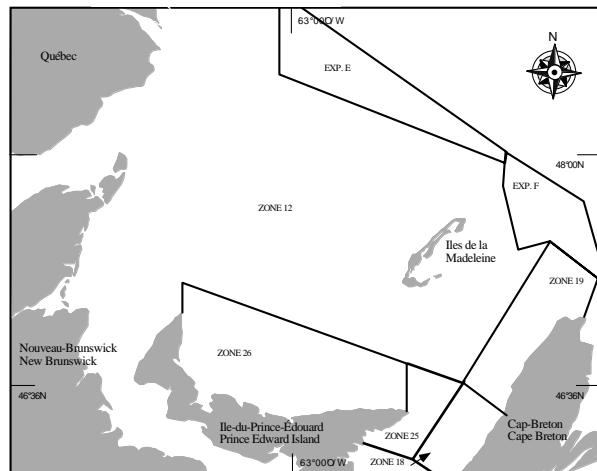
*The snow crab fishery in the southern Gulf began in the mid-1960s. There are four fishing zones: 12, 18, 19, 25/ 26, each with separate management schemes. It is considered that the entire southern Gulf is a single stock; zones have been established for management purposes, not on any biological basis.*

*The minimum legal carapace width is 95 mm, and female crab is not kept by industry. Fishing is by baited traps on muddy or sand-mud bottoms at temperatures ranging from -0.5 to 4.5 °C and depth ranging from 50 to 280 m. The fishery opens in spring in zones 12 and 25/26 and in summer in zones 18 and 19.*

*Management of these fisheries is based strictly on quotas, in recent years near 35% of the fishable biomass, and effort controls (number of licenses, trap limits and seasons). License number remained stable at about 260 permits until 1995 when over 400 temporary permits were added to the fishery.*

**The Fishery**

**Zone 12** - The largest snow crab fishery is zone 12, which is located in the midshore sector. It has been fished by 130 fishermen from New Brunswick, Quebec and Nova Scotia, with a trap limit of 150 per license. The fishery expanded rapidly, and landings peaked in 1982 at 31,500t



Landings then fluctuated around 25,000 t until 1986, falling to 11,700 t in 1987. Even lower catches were recorded in 1989 (7,882 t) when the fishery was closed due to a high incidence of soft crab. The quota was set at 7,000 t in 1990. In 1995, landings increased to 19,944 t (quota of 20,000t). A total of 4,500t was allocated for the first time to 320 temporary permit holders. In addition, exploratory fisheries were conducted for the first time in zone E (4 vessels and a quota of 217t) and zone F (7 vessels and a quota of 317t).

**Quota (t), landings (t), CPUE (kg/trap haul) and % soft crab in zone 12**

|           | 80-89  | 90    | 91     | 92     | 93     | 94     | 95     |
|-----------|--------|-------|--------|--------|--------|--------|--------|
| Quota     | -      | 7,000 | 10,000 | 11,200 | 14,500 | 20,000 | 20,000 |
| Landings  | 20,016 | 6,950 | 10,019 | 11,235 | 14,336 | 19,995 | 19,944 |
| CPUE      | 36.3   | 27.3  | 30.7   | 31.0   | 41.6   | 51.2   | 47.8   |
| Soft crab | 15.1   | 16.8  | 11.5   | 8.6    | 6.1    | 5.6    | 2.5    |

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

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

were converted into permanent fishing licenses and nine supplementary licenses were issued to explore fishing grounds further offshore. Midshore vessels fished these same grounds until 1982. In 1984, zone 18 was reserved exclusively for inshore fishermen. The overall quota, which had initially been set at 835 t in 1981, was reduced to 626 t in 1986 and then increased to 674 t in 1988 and remained until the 1990 season. In the spring of 1991, a quota of 200 t was set to promote a spring fishery in the area. Later that year, a quota of 674 t was set for the 1991 fall fishery and 1992 spring fishery. The quota was raised to 749 t for 1992-93, and remained at that level for 1993-94 and 1994-95. Since 1992-93, 30 fishers have participated in this fishery. In 1995, temporary permits were given to 30 fishers with an allocation of 109 t. The quota, which decreased by 5% from 1994, was reached with much more effort compared to the previous seasons. CPUE decreased by 44% compared to the 1994 season and the percentage of soft crab was relatively high (8.2%). The spring fishery was abolished after the 1995 season.

#### Quota (t), landings (t), CPUE (kg/trap haul) and % soft crab in zone 18

|           | 80-89 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|-----------|-------|------|------|------|------|------|------|
| Quota     | 753   | 674  | 874  | 749  | 749  | 749  | 709  |
| Landings  | 650   | 662  | 855  | 741  | 748  | 734  | 693  |
| CPUE      | 56.8  | 42.2 | 72.2 | 50.0 | 55.5 | 59.4 | 33.5 |
| Soft crab | n/a   | 24.8 | 5.7  | 5.6  | 10.4 | 7.2  | 8.2  |

In 1978, zone 19 was established as an inshore area reserved exclusively for inshore fishers using vessels under 13.7 m (45 feet) in length. Landings, regulated by quotas, fluctuated between 900 t and 1,390 t from 1979 to 1991. In 1995, 74 fishermen participated in this fishery, with a trap limit of 20 per license. The 1995 quota was decreased by 9% compared to 1994. A total of 134 t was allocated to an additional 37 temporary permit holders. From 1992-94, quotas were set at 1,686 t and were always caught. A slight decrease in CPUE was recorded in 1995. No problem of soft crab was observed (3.5 %).

#### Quota (t), landings (t), CPUE (kg/trap haul) and % soft crab in zone 19

|           | 80-89 | 1990  | 1991  | 1992  | 1993  | 1994  | 1995  |
|-----------|-------|-------|-------|-------|-------|-------|-------|
| Quota     | 1,217 | 1,338 | 1,338 | 1,686 | 1,686 | 1,686 | 1,575 |
| Landings  | 1,154 | 1,333 | 1,337 | 1,678 | 1,678 | 1,672 | 1,575 |
| CPUE      | 44.5  | 46.9  | 79.9  | 97.9  | 92.2  | 68.3  | 63.4  |
| Soft crab | n/a   | 19.4  | 5.1   | 6.6   | 1.9   | 5.5   | 3.5   |

**Zone 25/26 of Prince Edward Island** - The Prince Edward Island snow crab fishery, which comprises zones 25 and 26, began as an exploratory fishery in 1986. In 1986, the number of licenses issued was increased to 30. Since 1989, this fishery has been open only in the spring. In 1990, the two areas in question were reserved exclusively for fishers from Prince Edward Island. Each of the 30 fishers can use 50 traps. The largest total catch recorded to date was 1,239 t in 1986. Since 1990, this fishery has been subject to a quota, which progressively increased from 500 t in 1990 to 1,000 t in 1994. The quotas have been reached every year except 1994, when the fishery was closed early due to a high incidence of soft crab in the catches. Early closure was not necessary in 1995. An additional 22 temporary permits with an allocation of 200 t were issued for the 1995 fishery.

#### Quota (t), landings (t), CPUE (kg/trap haul) and % soft crab in zone 25/26

|           | 80-89 | 1990 | 1991 | 1992 | 1993 | 1994  | 1995  |
|-----------|-------|------|------|------|------|-------|-------|
| Quota     | -     | 500  | 600  | 800  | 800  | 1,000 | 1,000 |
| Landings  | 782   | 546  | 615  | 783  | 800  | 923   | 981   |
| CPUE      | 35.8  | 24.8 | 33.4 | 44.4 | 63.0 | 31.5  | 23.9  |
| Soft crab | n/a   | 55.3 | 36.4 | 10.1 | n/a  | 12.4  | 8.7   |

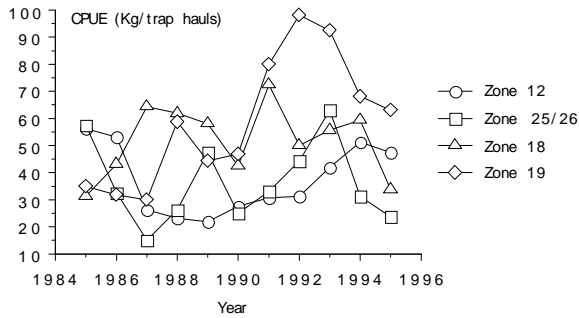
#### Resource Status

The current management zones do not necessarily correspond to biological units and in order to facilitate the interpretation of crab abundance data, an overall assessment is presented for the entire southern Gulf of St. Lawrence. The overall assessment was conducted on the basis of fisheries and trawl survey data from 1989 to 1995. The trawl survey provides estimates of uncaught, exploitable biomass immediately following the fishery and estimates of large-clawed, soft-shell males larger than 95mm that will be part of the exploitable biomass in the following year as new recruits. Abundance is also estimated for smaller size intervals or pre-recruits.

**Catch rates:** For all areas, fishermen's logbook catch/effort data were used to describe the general

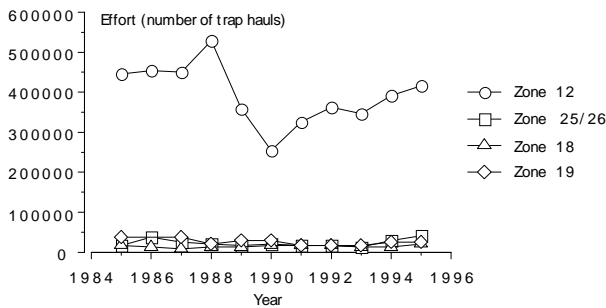
distribution of fishing effort per section (10 minute grid of latitude and longitude). Fishermen's logs were also used to obtain data on catch per unit of effort. In general, catch rates declined in all zones from 1994 to 1995. The highest catch rates were in zone 19, but 1995 was the third consecutive year of decline in this zone. Catch rates peaked in 1991 for zone 18, in 1993 for zones 25/26, and in 1994 for zone 12.

**CPUE (kg/trap haul) in the southern Gulf**



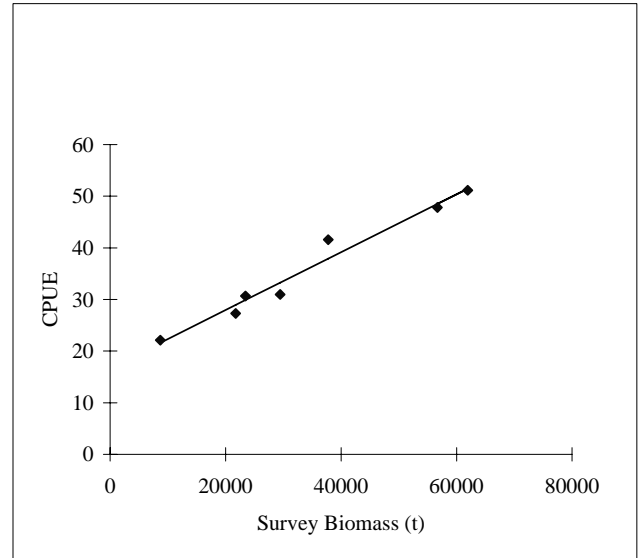
Although the number of participants doubled in 1995, estimates of trap hauls increased by only 10% over the 1994 fishery. In general, analyses revealed no consistent differences between catch rates of traditional fishermen and temporary permit holders.

**Effort in number of trap hauls**



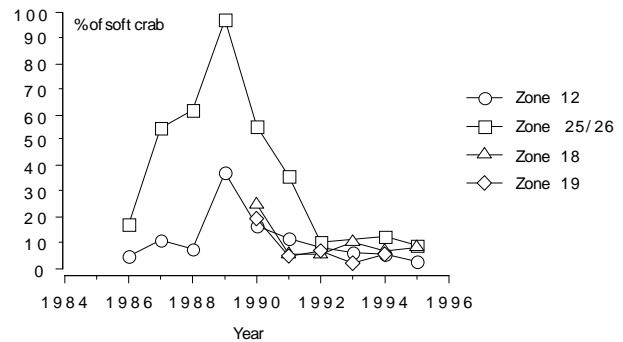
Catch rate data are generally viewed with caution partly because they are affected by socio-economic factors. In addition, because fishermen are provided with maps of crab concentrations before the opening of their fishery, it was felt that catch rates would overestimate abundance. Despite these qualifications, there was a strong correlation between catch rate and the survey estimates of fishable biomass in zone 12, indicating that the catch-rate data for southern Gulf snow crab are of sufficient quality to reflect changes in stock abundance. It is also worth noting that the relationship suggests that catch rates will tend to overestimate abundance at low levels of stock biomass.

**Relationship between catch rate and biomass, zone 12**



The percent soft crab is summarized in the figure below. The percent of soft crab has remained low for the past 4 years.

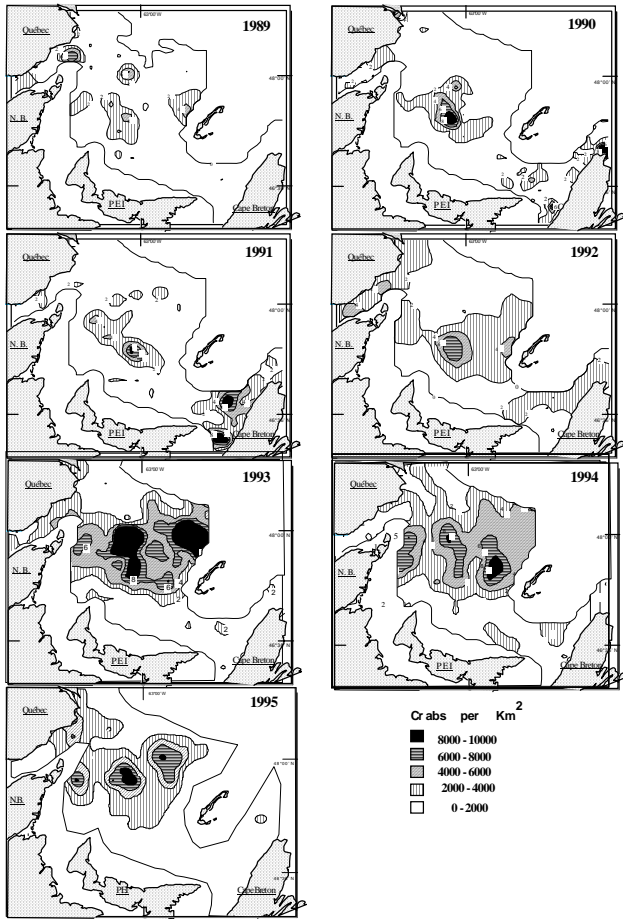
**Percent soft crab in the southern Gulf**



**Surveys:** A bottom trawl survey was conducted for the first time in 1988 in zones 12 and 25/26. Beginning in 1990, the survey was conducted in the entire southern Gulf area. Sampling is carried out after the spring fishery in areas 12 and 25/26. Prior to 1992, sampling was carried out between the spring and fall fisheries in zones 18 and 19. Sampling in zones 18 and 19 after the fall fishery was not started until 1992. Catch data were standardized for a sampled area of 0.8 km<sup>2</sup>. Numbers and biomass were estimated by kriging. Density contour maps for the different classes of crab are provided below. The survey should be viewed as a snapshot that provides an estimate of the true population.

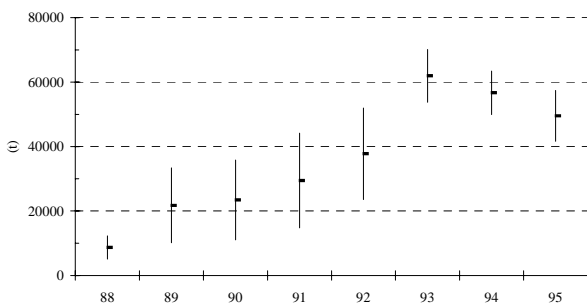
**Population abundance:** Maps of large-clawed male snow crab >95 mm clearly illustrate the increase in snow crab abundance between 1989 and 1993. The area of high concentrations declined in 1994 and 1995 compared to 1993.

**Density contours of snow crab (>95mm) abundance**



The survey in zone 12 indicates that the estimated, exploitable biomass remaining after the fishery has peaked and has decreased for a second consecutive year.

**Estimated exploitable biomass (mean and 95% confidence limits)**



There has been an increase in the number of mossy crab including stages IV and V. These old crab are currently 35% of the survey biomass, a doubling since 1994.

**% old-carapace crab from the trawl survey in zone 12**

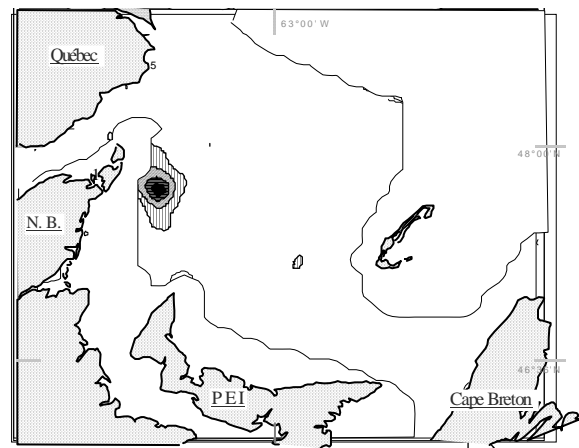
| Stage        | I+II<br>(soft and new) | III<br>(inter-mediate) | IV<br>(old**) | V<br>(very old**) |
|--------------|------------------------|------------------------|---------------|-------------------|
| Age (month)* | 0 - 12                 | 8 - 36                 | 24 - 60       | 48 - 72           |
| 1992         | 60.7                   | 36.2                   |               | 3.1               |
| 1993         | 57.2                   | 27.9                   | 9.8           | 5.1               |
| 1994         | 46.5                   | 37.3                   | 14.9          | 1.3               |
| 1995         | 36.0                   | 29.2                   | 24.9          | 9.8               |

\* Age: Approximate age of crab after terminal molt.

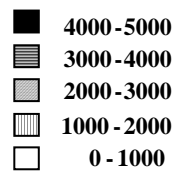
\*\*Stages IV and V: mossy crab

The main concentration of very old crab (stage V) was found in Miscou Bank (see map below).

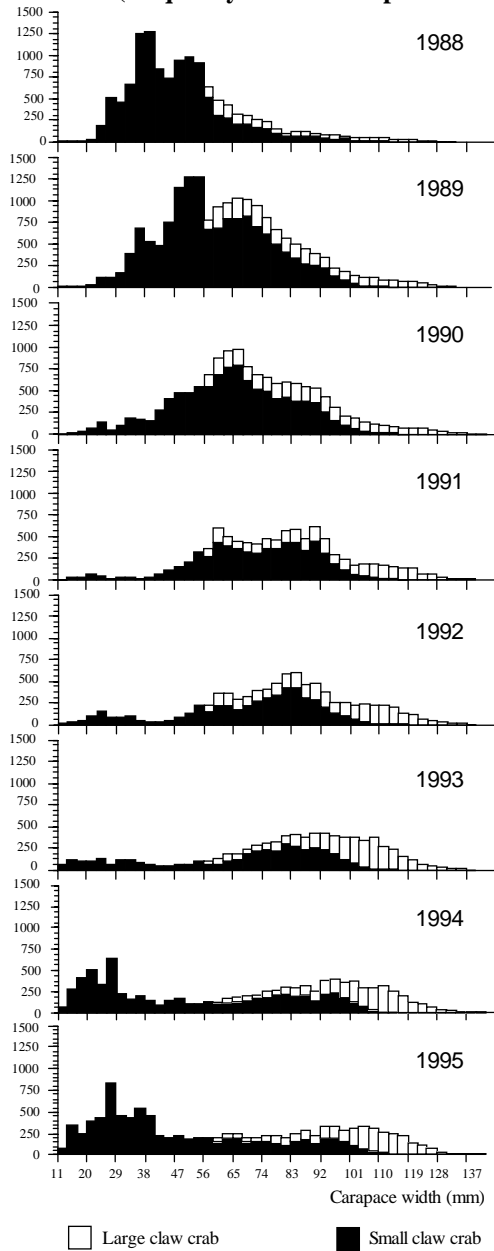
**Distribution of old mossy crab in 1995**



Crabs per km<sup>2</sup>



**Size distribution of snow crab in southern Gulf  
(frequency in numbers per 0.8 km<sup>2</sup>)**

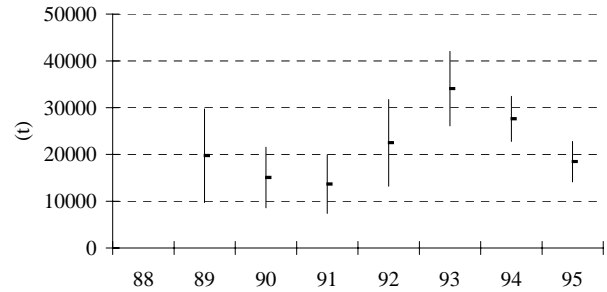


Size frequencies for the southern Gulf in 1995 were similar to the previous two years, except that in 1994 there was greatly increased abundance of small crab, 15 - 28 mm, and in 1995 there was greater abundance of crab between 15mm and 40mm. The modes seen in 1988 (27 mm, 38 mm and 52 mm) began to enter the fishery in 1991, resulting in an increase in biomass to the current level.

**Recruitment:** The survey indicates that we are at the end of a wave of recruitment: the survey estimate of the biomass of the recruitment to the fishery ( R ) based on

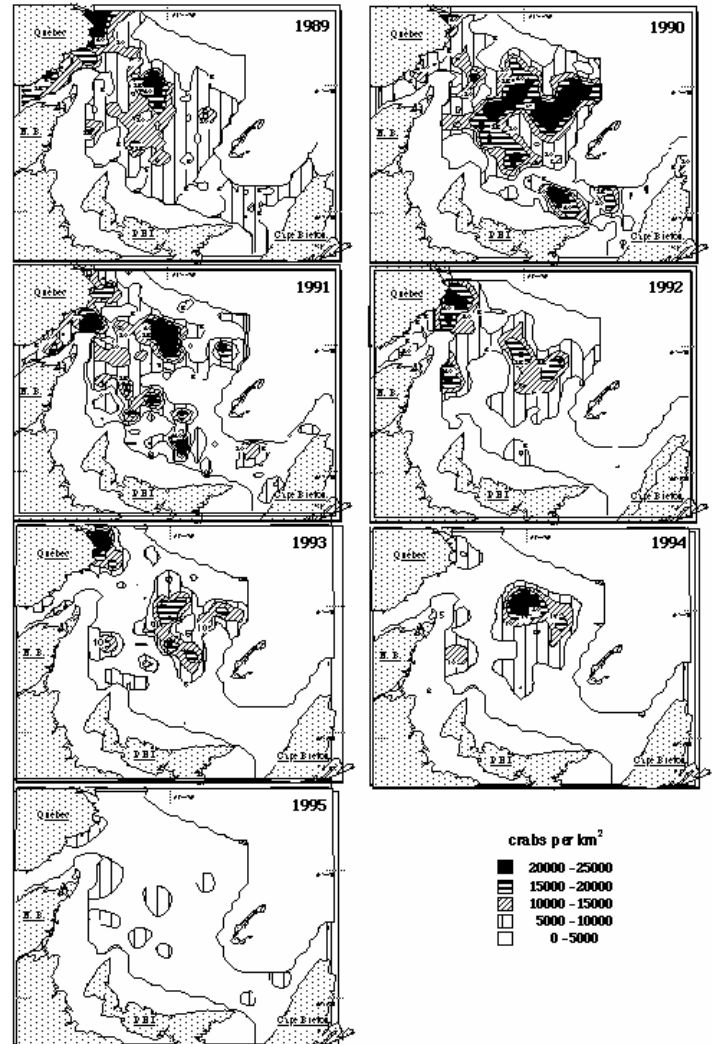
the abundance of large-clawed, soft-shell males,  $\geq 95$ mm, (R-1) has decreased for the second consecutive year.

**Estimated new recruitment to fishery, zone 12  
(mean and 95% confidence limits)**



In addition, the area of distribution of small-claw crabs of carapace width  $\geq 56$  mm has declined continuously since 1990.

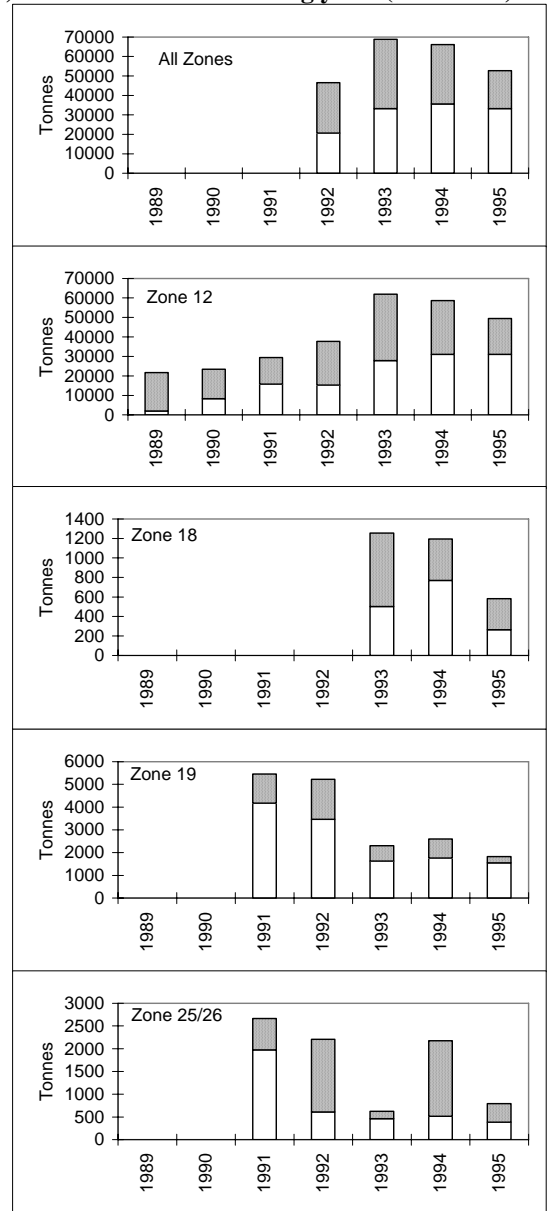
**Density contours of snow crab (>56 mm) abundance**



Recruitment can be inferred from the numbers of small crab in the frequency distributions of carapace size. There are large numbers of crab between 15-50mm. Based on past experience, these animals would be expected to recruit in 5 to 7 years. If historical patterns persist, recruitment appears to be slightly earlier in zones 18, 25/26 than the other zones.

The figures in the opposite column summarize the uncaught, exploitable, post-fishery biomass (white bars) and new recruits to the fishery (R) (dark bars). New recruits have become a less important component of the fishable biomass, particularly in zones 12 and 19.

**Estimated biomass of uncaught, fishable crab (white bars) and recruits the following year (dark bars)**



**Exploitation rate:** An estimate of exploitation rate for the whole southern Gulf of St. Lawrence was calculated as the ratio of catch to the survey estimate of fishable biomass. The value for all zones in 1995 was 35%. Historically, the estimated exploitation rate has been higher in inshore zones than in zone 12, but these values should be interpreted with caution because during the time period between the survey and the fishery there may be movement of crab among zones.

**Exploitation rates (%) in zones 12, 25/26, 18 and 19**

|      | Southern Gulf | Zone 12 | Zone 18 | Zone 19 | Zone 25/26 |
|------|---------------|---------|---------|---------|------------|
| 1990 | -             | 31.9    | -       | -       | 42.1       |
| 1991 | -             | 42.7    | -       | -       | 46.4       |
| 1992 | -             | 38.2    | -       | -       | 29.4       |
| 1993 | 37.8          | 38.0    | 58.5    | 32.1    | 36.2       |
| 1994 | 33.9          | 32.3    | 58.4    | 72.7    | -          |
| 1995 | 35.1          | 34.0    | 58.0    | 60.6    | 45.1       |

**Uncertainty:** There are some uncertainties that would tend to result in an overestimate of stock biomass. Most important, the methods assume that there is no natural mortality between the time of the survey and the start of the fishery 9 months later. It is quite likely that there is increased natural mortality on old-shelled crabs, but estimates have not been made for the southern Gulf. By contrast, it is unlikely that the survey is 100% efficient at covering the entire distribution of snow crab. This uncertainty would result in an underestimate of biomass. Finally there are a number of technical uncertainties which are as yet unquantified. These uncertainties would include the catchability of smaller-sized crab by the trawl net, the estimated area of bottom swept by the trawl, the classification of older age groups as mossy crab, the approach to analysis of survey data, mean weights used to estimate biomass from abundance of different size categories, and the inability to compare expected and observed estimates of biomass using a formal modeling structure.

**Environment:** It is known that snow crab prefer water temperatures between -1°C and 3 °C and the increased extent of cold water may mean that there has been more habitat suitable for adult crab over the past 6 years. Bottom water temperatures were unusually cold relative to the average in the southern Gulf during 1995: 40% of the southern Gulf was less than 1°C; and 1995 had the greatest extent of subzero water in the past 25 years. The past 6 years have had consistently large amounts of cold bottom water. This colder water may be conducive to snow crab abundance.

**Exploratory fisheries:** The potential for new fisheries was examined in zones E and F. Zone E should be included in Zone 12. Exploratory fishing in the outer half of zone E did not appear to find any crab. The survey covered the inside half of zone E which is included in the projected biomass estimated for the 1996 fishery.

The affinity of crab in zone F is unknown. There is some evidence of crab movement between zone 19 and zone F, but until the tagging data are examined, we do not know the extent of this affinity relative to zone 12. The

incidence of a higher soft-shelled crab (13.7%) in zone F may indicate that the abundance of hard-shelled crabs is low.

**Outlook**

**Projection:** Estimates of the biomass of commercial-sized male crab that will be available to the 1996 fishery are provided in the following table. As noted on the previous maps, the distribution of biomass in 1996 is expected to be in locations similar to 1995 but less extensive. For inshore zones, these figures are considered relatively accurate at the time of the survey, but actual abundance on fishing grounds the following spring may be affected by several factors, including the movement of crab between zones. The numbers in parentheses indicate the value that must be added and subtracted to obtain the upper and lower 95% confidence intervals.

The biomass of snow crab in the southern Gulf apparently peaked in 1994-1995 and has started to decrease. The life expectancy of terminal molt crab rarely exceeds 5-6 years. On average, crab become dirty in less than 3 years after their terminal molt and the appearance of the carapace continues to deteriorate. In the Gulf, there is clear evidence of population aging and an increase in natural mortality among very old crabs (stage V) is possible in the near future.

**Projected estimates of exploitable biomass (t)**

| Zone | Southern Gulf    | 12               | 18             | 19             | 25/26          |
|------|------------------|------------------|----------------|----------------|----------------|
| 1989 | -                | 8,676 (±3,635)   | -              | -              | 472 (±570)     |
| 1990 | -                | 21,748 (±11,614) | -              | -              | 1,298 (±1,274) |
| 1991 | -                | 23,444 (±12,402) | -              | -              | 1,325 (±950)   |
| 1992 | -                | 29,443 (±14,714) | -              | 5,459 (±1,942) | 2,665 (±1,661) |
| 1993 | 46,483 (±19,338) | 37,771 (±14,175) | 1,278 (±1,171) | 5,226 (±2,205) | 2,208 (±1,787) |
| 1994 | 68,832 (±10,710) | 61,936 (±8,176)  | 1,256 (±1,043) | 2,300 (±621)   | 623 (±455)*    |
| 1995 | 66,145 (±9,092)  | 58,682 (±6,748)  | 1,195 (±1,060) | 2,598 (±1,045) | 2,175 (±840)   |
| 1996 | 52,719 (±8,894)  | 49,517 (±7,923)  | 582 (±229)     | 1,825 (±376)   | 795 (±366)     |

\* Caution must be exercised in the use and interpretation of the values for zone 25/26 in 1994 because the survey was not completed in this zone in 1993.

The size-frequency distributions of males (pg. 5) show the progression of small crab that first appeared in 1988. Another increase in numbers of small males in the 15-28 mm size range was observed in the southern Gulf in the 1994 survey, an indication of future recruitment. This is the first time since 1988 that such a large number of small crab had been observed. Although this size class appeared again in the 1995 survey, it is still too early to compare its relative strength to the same size-classes found in 1988 and 1989.

The estimated abundance of recruits that will enter the fishery the following year has been declining for the past 3 years. Size frequencies indicate that the abundance of crab expected to recruit in 2 to 3 years is also at a low level. Given the decline in pre-recruit abundance since 1993, combined with aging of the population, it is likely that the abundance of the resource will continue to decline for a few more years. However, the presence of small crab (15 - 50 mm) in the 1994 and 1995 surveys suggests that recruitment may improve after the anticipated period of lower abundance.

**Uncertainty in forecast:** The principal source of uncertainty is the unknown extent and timing of loss of old-shelled crabs from the harvestable population to natural mortality. If losses occur soon, survey biomass estimates may represent an overestimate of the actual abundance at the start of the next fishing season. In addition, short and long-term forecasts may be biased by such factors as imprecisions in surveys and analyses. Crab concentrations are sometimes situated at the boundaries of the area sampled as noted in the 1993 and 1994 surveys, and there is the possibility of dispersion of crab between the time of the survey and the fishing season in the following year. Long-term forecasts are also affected by incomplete knowledge of crab growth patterns, which does not allow us to predict when specific size groups will molt. The current state of our knowledge does not allow us to make accurate forecasts more than one year in advance.

**Management considerations:** In the 1994 stock status report, two possible exploitation strategies were described: (1) maximize catches in the short term or (2) spread catches over a period of years to offset the anticipated decline in recruitment. The two strategies presented in 1994 and 1995 are still applicable today despite aging of the population:

*Maximize catches over the short term.* This approach would make it possible to take advantage, in the short term, of the accumulated snow crab biomass that is currently available and that will decline in quantity and quality in the near future due to aging of the population. The higher the quota and the lower the remaining biomass, the faster the available biomass will decline.

*Spread catches over a period of years.* By opting for smaller catches in 1996, it should be possible to maintain a population of commercially-sized males with a range of appearances and survival potentials. This approach could serve as a buffer over the anticipated several-year period of low recruitment. However, snow crab quality would deteriorate, natural mortality would likely increase and there would be wasted yield of crab that would otherwise die.

If the second strategy is adopted, it is critical that the industry does not only target high quality crab. If mossy crab (stages IV and V) is discarded, the exploitation rate on new recruits would be proportionally higher.

Four possible harvesting scenarios for the southern Gulf are presented below, based on the following criteria: (1) the same quota as in 1995; (2) the same exploitation rate as in 1994; (3) the same remaining biomass on the fishing grounds as after the 1994 fishery; (4) and the same biomass remaining on the fishing grounds as after the 1995 fishery.

#### Quota scenarios (t) in southern Gulf of St. Lawrence

| Criteria  | 1996 TAC    | 1996 exploitation rate | Remaining biomass after the 1996 season* |
|---|-------------|------------------------|--|
| 1996 quota similar to 1995 quota  | 23,286 t    | 44.2%                  | 29,433 t                                 |
| 1996 exploitation rate similar to 1995 rate                             | 18,557 t    | 35.2%                  | 34,162 t                                 |
| Remaining biomass after the 1996 season similar to (a) 1994 or (b) 1995 | (a) 7,211 t | (a) 13.7%              | (a) 45,508 t                             |
|   | (b) 9,860 t | (b) 18.7 %             | (b) 42,859 t                             |

\* Does not include the new recruitment

Although the crab population is aging, it is important to note that as new recruits enter the fishery, there is a possibility of increased incidence of soft crab, particularly if the commercial biomass is low. As a result, the industry must optimize catches in the short term and/or spread catches over a period of years in such a way as to maximize their income and taking into account the quantity and quality of available crab. Soft crab is the future recruitment to the fishery and should be protected. Returning soft shelled crab to the sea is highly recommended.

The build-up of mossy crab, now 35% of the exploitable biomass, could disappear from the fishery or die naturally within 1-4 years. Because it is difficult to distinguish among age groups within the same carapace stage, the timing of disappearance of stages IV and V cannot be predicted. The reproductive value of mossy crab and its importance to future recruitment is unknown. More knowledge is necessary before making any changes in the management approach. Nevertheless, it is important to avoid highgrading of these older crab. Such activity will result in excessive fishing mortality on recently molted large-clawed males, which are the future breeders and main component of good quality catches.



***For More Information***

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