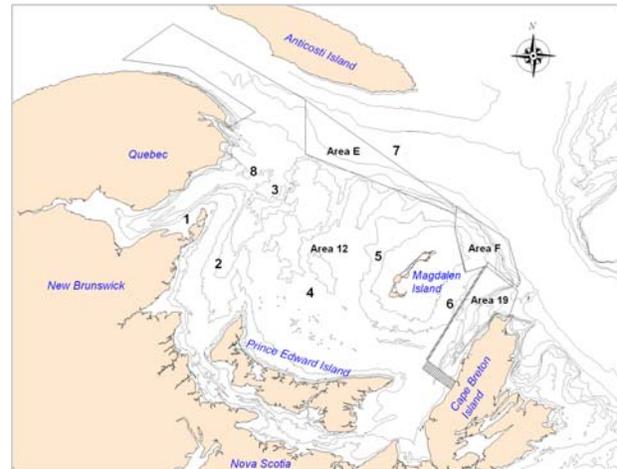




ASSESSMENT OF SNOW CRAB IN THE SOUTHERN GULF OF ST. LAWRENCE (AREAS 12, 19, E AND F)



- | | |
|----------------------|-------------------------|
| 1. Baie des Chaleurs | 5. Magdalen Channel |
| 2. Shediac Valley | 6. Cape Breton Corridor |
| 3. Orphan Bank | 7. Laurentian Channel |
| 4. Bradelle Bank | 8. American Bank |

Figure 1: Map of the southern Gulf of St. Lawrence showing the Crab Fishing Areas (CFAs), fishing grounds and management buffer zones (shaded area).

Context

Snow crab, *Chionoecetes opilio*, has been commercially exploited in the southern Gulf of St. Lawrence (sGSL) since the mid 1960s. There are four individually managed fishing areas among which Area 12 (Figure 1) is the largest fishery in terms of its fishable surface, number of participants, and landings. In Areas 12, E and F, the fishing season generally starts in April-May as soon as the Gulf is clear of ice and continues into early summer while in Area 19, the fishery opens after June 30 and usually ends in mid-September. The landing of females is prohibited and only hard-shelled males ≥ 95 mm of carapace width are commercially exploited.

This fishery grew quickly from 1966, peaking at 33,400 t in 1982 and dropped to 13,600 t in 1987 and then to the lowest catches level of 8,900 t in 1990. Landings have fluctuated since with peaks in 1995 of 22,750 t and in 2005 of 36,200 t. Landings were 24,890 t in 2008.

DFO Gulf Region Fisheries and Aquaculture Management requested an assessment of the resource status and catch advice for the 2009 fishery. This document is an overview of the assessment results and the advice provided. Catch rates and other fishery performance indicators are reported. The assessment of the status of the southern Gulf snow crab resource (Areas 12, 19, E and F) is based on fishery independent trawl surveys to develop indicators of : abundance (commercial biomass), reproductive potential (numerical abundance of mature females), recruitment, and to estimate exploitation rates in the fishery. A science peer review was conducted Feb. 25-26, 2009. Participants at the science review included DFO Science, DFO Fisheries and Aquaculture Management, from the fishing industry, provincial governments, aboriginal peoples and an external expert from the Alaska Department of Fish and Game.

SUMMARY

- Snow crab in management Areas 12, 19, E, and F comprise a single biological population and the southern Gulf of St. Lawrence stock is considered as one unit for assessment purposes.

Fishery

Area 12:

- The 2008 landings in Area 12 were 20,911 t (quota of 20,900 t).
- The CPUE decreased from 2007 but has remained high since 2003.
- The incidence of soft-shelled crab remained low at 3.0%.

Area 19:

- The 2008 landings in Area 19 were 2,929 t (quota of 3,002 t).
- The CPUE in 2008 was within the range of values from previous years.
- The incidence of white-crab in 2008 increased from 8.3% to 10.2%.
- All four sectors within Area 19 were closed during the fishing season due to high incidence of white-crab.

Area E:

- In Area E, the landings were 187 t, 47% of the 400 t quota.
- The CPUE decreased in 2008 to the lowest value of the time series (1995-2008)
- The incidence of soft-shelled crab in 2008 increased to 10.1%, the highest value since 2000.

Area F:

- In Area F, landings were 431 t representing 74% of the 585 t quota.
- The CPUE decreased in 2008 to the second lowest value of the time series (1995-2008).
- The incidence of soft-shelled crab increased to 7.3%, the highest value since 2000.

Stock status in the Southern Gulf of St. Lawrence

- The 2008 survey biomass of commercial-sized adult crabs was estimated at 48,000 t (43,800 t – 52,400 t), 16% lower than in 2007.
- Fifty six percent (56%) of the 2008 survey biomass, available for the 2009 fishery, is composed of new recruitment (27,100 t). The recruitment to the fishery decreased by 13% relative to 2007.
- The residual biomass (20,700 t) decreased by 20% compared to 2007 but it has been maintained at 20,000 to 26,000 t since 2003.
- The recruitment to the fishery is expected to remain low into 2010. An increase in the abundance of prerecruits (R-4) was observed in 2008, which may indicate a potential upward phase in recruitment starting in 2011.
- The abundance of males smaller than 56 mm CW observed in the trawl surveys from 2002 to 2008 has increased but is lower than the previous recruitment waves observed from 1993 to 1998.
- The abundance of mature females has declined since 1990 and reached the lowest observed level in 2006 to 2008.

- The exploitation rate in the southern Gulf of St. Lawrence in 2008, corrected for non-directed fishing losses, was 50%. Exploitation rates varied between 41% and 62% during 2000 to 2008 compared to 17% and 33% during 1990 to 1999.
- A risk analysis of consequences to biomass indicators relative to catch options for the 2009 fishery is provided. The choice of biomass indicator to use and the risk level (probability of the event happening) to apply are the decision of management and the stakeholders.

BACKGROUND

Species Biology

Snow crab (*Chionoecetes opilio*) is a crustacean like lobster and shrimp, with a flat, almost circular, body and five pairs of spider-like legs. The hard outer shell is periodically shed in a process called moulting. After moulting, crabs have a soft shell for a period of 8 to 10 months. Soft-shelled crab is defined by shell hardness (<68 durometer units) and includes both new-soft (condition 1) and clean hard-shelled crab (condition 2). The term white-crab is used in the summer fishery of Area 19 because the newly-molted crabs have reached a relatively harder carapace than those observed during the spring fishery (Areas 12, E and F). White-crab is defined by shell hardness (<78 durometer units) and includes both new-soft (condition 1) and clean hard-shelled crab (condition 2).

Unlike lobsters, snow crabs do not continue to moult throughout their lives. Females stop growing when they acquire a wide abdomen for carrying eggs, which occurs at shell widths less than 95mm. Males stop growing when they acquire large claws on the first pair of legs, which can occur at shell widths between 40 and 150 mm. Females produce eggs that are carried beneath the abdomen for approximately 2 years. The eggs hatch in late spring or early summer and the newly-hatched crab larvae spend 12-15 weeks floating freely in the water column. At the end of this period, they settle on the bottom. It takes at least 8-9 years (post-settlement) for males to reach legal size.

Fishery

Until 1997, the snow crab fishery in Area 12 (Figure 1) was exploited by 130 mid-shore fish harvesters from New Brunswick, Quebec and Nova Scotia. Since 1997, the PEI coastal fishery, (formally Areas 25/26) has been integrated into Area 12. In 2003, a portion of the coastal fishery off Cape Breton (formally Area 18) was also integrated into Area 12. For the purpose of this assessment, Area 12 refers to the new management unit (Figure 1). The number of licences in Area 12 was 274 in 2008.

In 1978, Area 19 (Figure 1) was established for the exclusive use of Cape Breton inshore fish harvesters with vessels less than 13.7 m (45 feet) in length. There were 175 licences in Area 19 in 2008.

Areas E and F were introduced in 1995 as exploratory fisheries. In 2002, the status of Areas E and F was changed from exploratory to commercial fishing areas. There are 8 and 18 permanent fish harvesters in Areas E and F, respectively. In 2008, 7 temporary licences were allocated in Area F for a total of 25 licences.

The minimum legal carapace width is 95 mm, females are not harvested and soft-shell and white-crab is not targeted by the fishery. Baited traps, constructed of wire or tubular steel, are

used to catch crab, mainly on mud or sand-mud bottoms at temperatures ranging from -0.5 to 4.5°C, and depths ranging from 50 to 280m. The fishery takes place in spring and early summer in Areas 12, E and F but after June 30 in Area 19.

Management of these fisheries is based on quotas and effort controls (number of licenses, trap allocations, trap dimensions, and seasons). Soft-shelled and white-crab are not targeted. There are soft-shelled and white-crab protocols which allow for closure of portions of the fishing areas when the proportion of the catch comprised of these exceeds 20%. The protocols are in place to maximize the yield and the reproductive potential of the resource.

Table 1. Number of licenses, boats, traps, quota and opening and closing dates in snow crab fishery by management area in the southern Gulf in 2008.

| | Area | | | | Southern Gulf |
|--------------------|---------|---------|----------|----------|---------------|
| | 12 | E | F | 19 | |
| Number of licenses | 274 | 8 | 25 | 175 | 482 |
| Number of boats | 378 | 8 | 25 | 104 | 515 |
| Total traps | 40,100 | 1,200 | 1,700 | 1,699 | 44,699 |
| Opening date | May 10 | May 10 | April 30 | July 14 | |
| Closing date | July 20 | July 19 | July 16 | Sept. 15 | |
| Quota | 20,900 | 400 | 585 | 3,002 | 24,887 |

The fishery harvests from the southern Gulf of St. Lawrence increased from 1969 to the present with three periods of high landings: 1981-1986, 1994-1995, and more recently 2002 to 2008 (Figure 2). Peak landing was reported in 2005 (36,118 t) while the lowest landing was reported in 1975 (4,632 t).

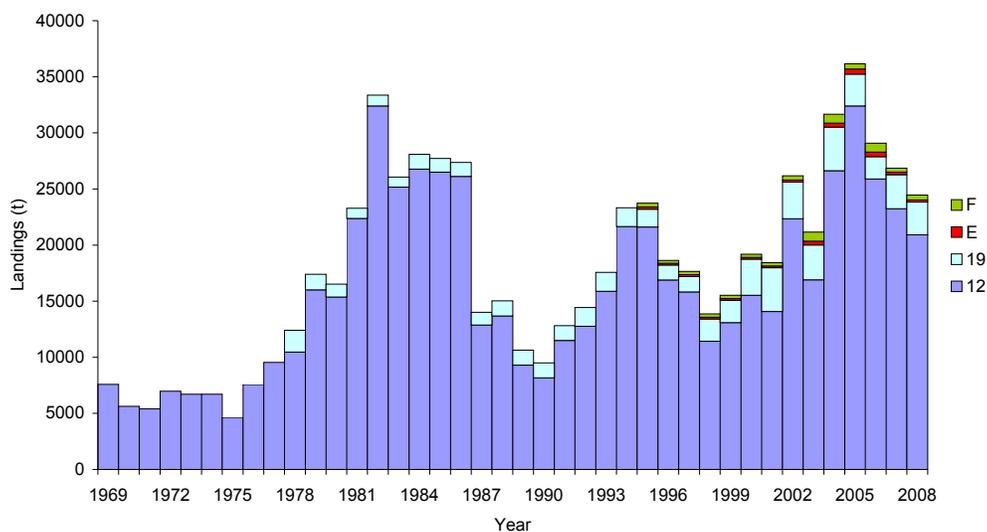


Figure 2: Landings in the southern Gulf of St. Lawrence snow crab fishery.

The 2008 fishing season in Area 12 opened on May 10 and closed on July 20 with reported **landings** of 20,911 t (quota of 20,900 t) (Tables 1, 2; Figure 2). In accordance with the soft-shelled crab protocol, three grid areas were closed during the 2008 fishing season. The fishing effort estimated from logbooks decreased from 508,053 to 353,775 trap hauls from 2005 to 2007 but has increased to 370,762 trap hauls in 2008 (Table 2).

Table 2. Quota, landings, fishing effort and catch performance for the snow crab fishery in Area 12.

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|-----------------------------------|---------|---------|---------|----------------|---------|---------|---------|---------|---------|
| Quota (t) | 15,500 | 13,819 | 22,000 | 17,148 | 26,600 | 32,336 | 25,869 | 23,207 | 20,900 |
| Landings (t) | 15,046 | 13,819 | 21,869 | 16,898 | 26,626 | 32,363 | 25,889 | 23,243 | 20,911 |
| CPUE (kg/trap-haul) | 34.5 | 42.3 | 40.2 | 50.0 | 54.9 | 63.7 | 64.4 | 65.7 | 56.4 |
| Effort (trap hauls) | 436,782 | 326,382 | 544,454 | 337,960 | 484,991 | 508,053 | 402,702 | 353,775 | 370,762 |
| Soft-shell crab (%) in catches | 12.5 | 6.2 | 4.6 | 3.3 | 3.0 | 3.9 | 3.1 | 2.0 | 3.0 |
| Grids closed (total of 323) | 323 | 60 | 100 | 0 ¹ | 17 | 68 | 11 | 5 | 3 |

¹ In 2003, the area was divided into four sectors and none of the sectors were closed

The 2008 fishing season in Area 19 opened on July 14 and ended on September 15 with reported landings of 2,929 t (quota of 3,002 t) (Tables 1, 3; Figure 2).

The fishing effort in Area 19 decreased from 42,553 trap hauls in 2007 to 38,388 trap hauls in 2008. All four sectors within Area 19 were closed during the 2008 fishing season due to high incidence of white crabs in the catches. One sector (the northern part of the area) was re-opened at the end of the fishing season with 100% at-sea observer coverage.

Table 3. Quota, landings, fishing effort and catch performance for the snow crab fishery in Area 19.

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|--------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Quota (t) | 3,370 | 3,912 | 3,285 | 3,106 | 5,092 | 2,878 | 2,000 | 3,074 | 3,002 |
| Landings (t) | 3,225 | 3,910 | 3,279 | 3,103 | 3,894 | 2,827 | 1,989 | 3,034 | 2,929 |
| CPUE (kg/trap-haul) | 64.1 | 88.5 | 72.3 | 103.6 | 68.9 | 68.1 | 84.4 | 71.3 | 76.3 |
| Effort (trap hauls) | 55,977 | 46,251 | 43,662 | 29,952 | 56,517 | 41,512 | 23,566 | 42,553 | 38,388 |
| White-crab (%) in catches | 5.6 | 6.5 | 3.5 | 3.7 | 7.1 | 9.8 | 8.3 | 8.3 | 10.2 |
| Sectors closed (total of 4) | 0 | 0 | 0 | 0 | 4 | 0 | 2 | 0 | 4 |

The fishing season in Area E began on May 10 and ended July 19 with reported landings of 187 t, 47% of the 400 t quota (Tables 1, 4; Figure 2). The fishing effort in Area E decreased from 10,074 trap hauls in 2006 to 5,914 trap hauls in 2007 but increased to 9,232 trap hauls in 2008.

Table 4. Quota, landings, fishing effort and catch performance for the snow crab fishery in Area E.

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|------------------------------|-------|-------|-------|-------|-------|-------|--------|-------|-------|
| Quota (t) | 163 | 163 | 163 | 350 | 350 | 450 | 550 | 221 | 400 |
| Landings (t) | 150 | 155 | 165 | 345 | 349 | 449 | 411 | 220 | 187 |
| CPUE (kg/trap-haul) | 22.9 | 23.2 | 56.6 | 63.1 | 55.6 | 80.6 | 40.8 | 37.2 | 20.3 |
| Effort (trap hauls) | 6,528 | 6,700 | 2,916 | 5,471 | 6,277 | 5,571 | 10,074 | 5,914 | 9,232 |
| Soft-crab (%) in catches | 8.3 | 0.7 | 0.3 | 1.2 | 1.5 | 2.9 | 7.8 | 1.3 | 10.1 |
| Grids closed (total of 8) | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |

In Area F, the fishery opened on April 30 and closed on July 16 with reported landings of 431 t representing 73.7% of the 585 t quota (Tables 1, 5; Figure 2). The fishing effort decreased from 14,079 trap hauls in 2006 to 12,252 trap hauls in 2007 but has increased to 15,504 trap hauls in 2008.

Table 5. Quota, landings, fishing effort and catch performance for the snow crab fishery in Area F.

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|--------------------------------|-------|-------|-------|--------|--------|-------|--------|--------|--------|
| Quota (t) | 288 | 377 | 378 | 808 | 808 | 480 | 815 | 408 | 585 |
| Landings (t) | 291 | 378 | 378 | 817 | 806 | 479 | 787 | 370 | 431 |
| CPUE (kg/trap-haul) | 56.7 | 63.0 | 85.2 | 78.1 | 74.8 | 93.7 | 55.9 | 30.2 | 27.8 |
| Effort (trap hauls) | 5,136 | 5,736 | 4,437 | 10,460 | 10,775 | 5,112 | 14,079 | 12,252 | 15,504 |
| Soft-crab (%) in catches | 2.4 | 1.3 | 0.5 | 0.4 | 0.6 | 0.8 | 3.5 | 2.4 | 7.3 |
| Sectors closed (total of 3) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 |

Catch per unit of effort (CPUE) is calculated from logbook data. In Area 12, the annual unadjusted mean CPUE (landings / effort) remained high in 2005 to 2008 (Table 2; Figure 3). In Area 19, the CPUE increased in 2008 compared to 2007 (Table 3, Figure 3). The CPUE in Area E decreased in 2008 to the lowest value ever recorded as did the CPUE in Area F which was the lowest since 1995 (Tables 4, 5; Figure 3).

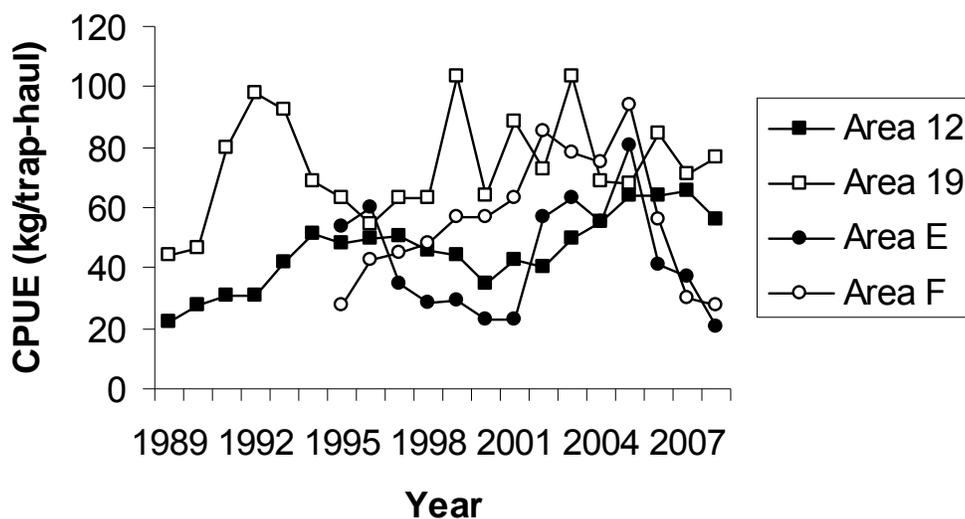


Figure 3: Catch rates in the southern Gulf snow crab fishery, Areas 12, 19, E and F.

The **percentage of soft-shelled crabs and white-crab** is calculated using data collected from the at-sea observer program. The incidence of soft-shelled crab and white-crab in catches is strongly influenced by the fishing strategy used by harvesters during the season, as well as crab abundance in the area.

The percentage of soft-shelled crab in Area 12 has remained low since 2000 and was at 3.0% in 2008 (Table 2). In Area 19, the percentage of white-crab increased from 8.3% in 2007 to 10.2% in 2008 (Table 3). The percentage of soft-shelled crabs in Area E increased from 1.3% in 2007

to 10.1% in 2008 (Table 4). In Area F, the percentage of soft-shelled crabs also increased from 2.4% in 2007 to 7.3% in 2008 (Table 5).

ASSESSMENT

Snow crab in management Areas 12, 19, E, and F comprise a single biological population and the southern Gulf of St. Lawrence stock is considered as one unit for assessment purposes.

Stock Trends and Current Status in the Southern Gulf

Statements of stock status are based on inferences from abundance data from annual trawl surveys conducted during July to October, over the entire area of snow crab distribution in the southern Gulf. This provides estimates of commercial biomass (hard-shelled adult males of legal size remaining after the fishery and soft-shelled adult males larger than 95 mm CW (R-1) that will be available to the fishery the following fishing season) and future male recruitment to the fishery (prerecruits defined as R-4, R-3 and R-2). The prerecruits R-4, R-3 and R-2 represent adolescent male crabs with a carapace width range of 56-68, 69-83, and larger than 83 mm, respectively. A portion of these crabs could be available to the fishery in 4, 3 and 2 years, respectively.

Future and current spawning stock abundance consists of females (pubescent and mature). The term pubescent refers to females that will molt to maturity and mate the following year and become primiparous females (first brood). The term 'multiparous' refers to females which are carrying a brood for the second time or more. The term 'mature female', includes primiparous and multiparous females.

The commercial biomass in the fall of 2008 was 48,000 t with 95% confidence limits (95% CL) range of 43,800 t to 52,400 t, a decrease of 16% compared to the 2007 value (Table 6; Figure 4). The commercial biomass in the southern Gulf has been decreasing since 2004. In 2008, 93% of the commercial biomass was within management Area 12, 6% in Area 19, and 1% or less in Areas E and F (Table 6).

The residual (carapace conditions 3 to 5) biomass of commercial sized male crab after the 2008 fishery was 20,700 t (95% CL 17,900 t – 23,800 t), a decrease of 20% compared to 2007 (Figure 5; Table 7). The recruitment to the fishery at the time of the survey was 27,100 t (95% CL 24,100 t – 30,300 t) comprising 56% of the commercial biomass (Figure 5; Table 7). The recruitment decreased by 13% relative to 2007. Commercial biomass as well as recruitment and residual biomass by management areas in the southern Gulf for 2007 and 2008 are provided in Table 7.

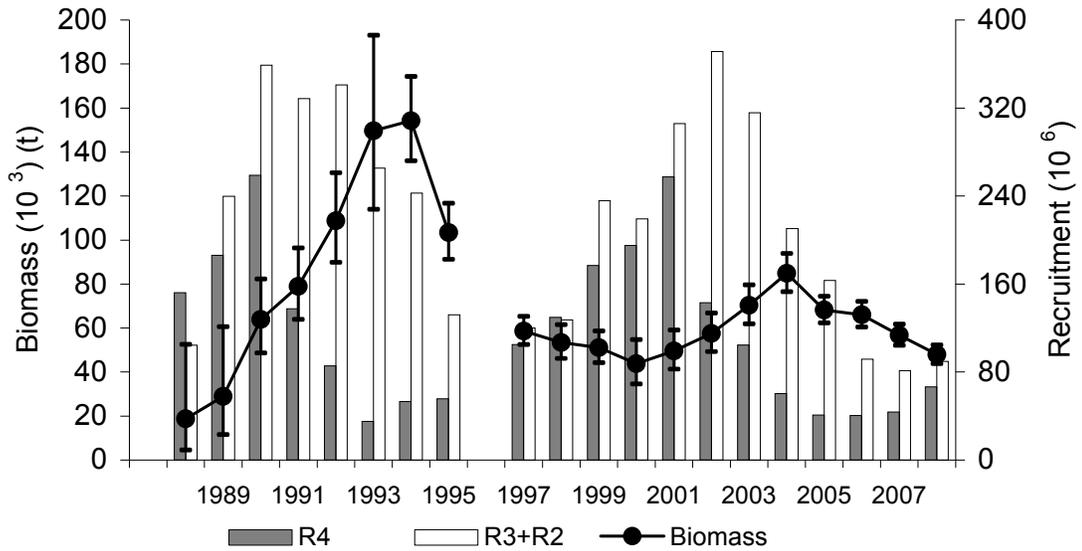


Figure 4: Survey biomass (commercial sized males; with 95% confidence intervals) and abundance of future recruitment in the southern Gulf of St. Lawrence.

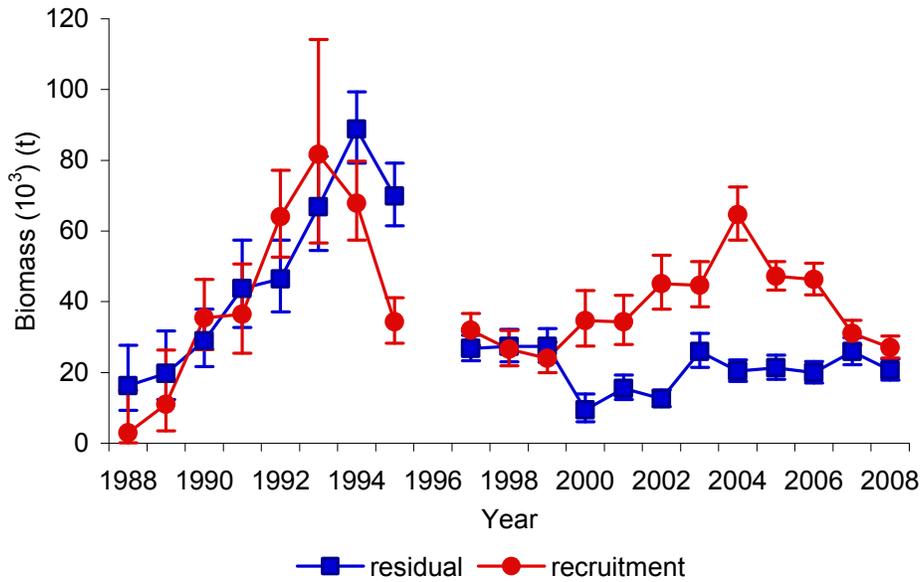


Figure 5: Recruitment (R1) and residual biomass (with 95% confidence intervals) in the southern Gulf of St. Lawrence.

Table 6. Biomass (t; with 95 % confidence intervals) post-fishery of adult commercial sized males (carapace conditions 1, 2, 3, 4 and 5) by management areas and overall in the southern Gulf of St. Lawrence.

| Year | Southern Gulf | 12 | 19 | E | F |
|------|-----------------------------------|-----------------------------------|------------------------------|-----------------------------|-----------------------------|
| 1988 | 18,800 4,500-52,500 | 14,200 4,300-35,100 | | | |
| 1989 | 29,000 11,600-60,600 | 25,100 13,000-44,100 | | | |
| 1990 | 63,900 48,700-82,300 | 42,400 31,800-55,400 | | | |
| 1991 | 78,900 63,900-96,400 | 50,800 39,400-64,400 | | | |
| 1992 | 108,800 89,800-130,600 | 82,700 68,400-99,100 | | | |
| 1993 | 149,700 114,000-193,000 | 126,700 98,700-160,100 | 6,100 1,600-16,400 | | |
| 1994 | 154,300 136,000-174,300 | 121,900 107,500-137,600 | 7,900 4,600-12,700 | | |
| 1995 | 103,420 91,200-116,800 | 90,200 80,800-100,300 | 5,000 2,400-9,200 | | |
| 1996 | N/A | N/A | 4,100 3,100-5,200 | | |
| 1997 | 58,600 52,500-65,200 | 49,300 44,200-54,800 | 4,700 3,700-5,900 | 1,500 640-2,300 | 510 180-850 |
| 1998 | 53,500 46,200-61,600 | 44,600 38,500-51,300 | 6,000 4,800-7,500 | 3,000 1,900-4,400 | 1,700 370-5,200 |
| 1999 | 51,100 44,300-58,600 | 41,500 36,000-47,600 | 5,800 4,600-7,300 | 1,200 650-2,150 | 1,800 600-4,200 |
| 2000 | 43,800 34,600-54,700 | 34,200 26,900-42,900 | 7,200 6,000-8,600 | 550 250-1,100 | 2,800 2,200-3,500 |
| 2001 | 49,600 41,300-59,100 | 40,600 34,000-48,200 | 6,000 4,800-7,300 | 750 300-1,600 | 3,800 2,800-5,100 |
| 2002 | 57,600 49,300-66,800 | 48,400 41,900-55,700 | 5,400 4,400-6,600 | 920 460-1,700 | 3,900 3,000-5,100 |
| 2003 | 70,400 62,000-80,000 | 59,400 52,500-66,900 | 8,600 7,500-9,900 | 860 440-1,500 | 3,100 2,100-4,300 |
| 2004 | 84,900 76,500-94,000 | 77,300 70,300-84,900 | 4,800 3,600-6,400 | 870 460-1,500 | 2,100 1,270-3,400 |
| 2005 | 68,200 62,300-74,000 | 63,000 57,700-68,600 | 3,800 2,700-5,300 | 850 420-1,500 | 1,900 1,000-3,300 |
| 2006 | 66,000 60,400-72,100 | 61,900 56,900-67,200 | 4,400 3,000-6,200 | 370 45-1,400 | 560 75-2,100 |
| 2007 | 56,800 52,000-61,800 | 50,600 46,500-55,100 | 5,500 4,300-7,000 | 600 200-1,300 | 1,300 600-2,500 |
| 2008 | 48,000 43,800-52,400 | 44,700 41,100-48,600 | 3,100 2,300-4,200 | 230 30-830 | 650 180-1,700 |

Table 7. Commercial biomass (t; with 95 % confidence intervals), recruitment biomass (t) and residual biomass (t) in the southern Gulf of St. Lawrence and for each management area, 2007 and 2008.

| Area | Year | Commercial biomass | Recruitment biomass | Residual biomass |
|---------------|------|--------------------------------|--------------------------------|--------------------------------|
| Southern Gulf | 2007 | 56,800 52,100-61,800 | 31,100 27,800-34,700 | 25,900 22,200-29,900 |
| | 2008 | 48,000 43,800-52,400 | 27,100 24,100-30,300 | 20,700 17,900-23,800 |
| Area 12 | 2007 | 50,600 46,400-55,100 | 27,000 24,000-30,300 | 23,700 20,700-27,000 |
| | 2008 | 44,700 41,100-48,600 | 25,500 22,800-28,400 | 18,900 16,500-21,400 |
| Area 19 | 2007 | 5,500 4,300-7,000 | 4,000 3,100-5,000 | 1,500 1,000-2,200 |
| | 2008 | 3,100 2,300-4,200 | 1,600 1,000-2,400 | 1,500 1,100-2,000 |
| Area E | 2007 | 590 210-1330 | 210 30-760 | 430 220-760 |
| | 2008 | 230 30-830 | 40 0-270 | 200 60-490 |
| Area F | 2007 | 1,310 6,10-2,490 | 1,040 520-1,880 | 300 70-860 |
| | 2008 | 650 180-1,670 | 410 90-1,210 | 330 100-820 |

In the 2008 trawl survey, snow crab concentrations were located in Chaleur Bay, Bradelle Bank, Shediac Valley, southern and northern parts of the Magdalen Channel and to a lesser extent in Area 19 (Figure 6). The biomass was fragmented spatially relative to distributions observed in the previous five years (Figure 7).

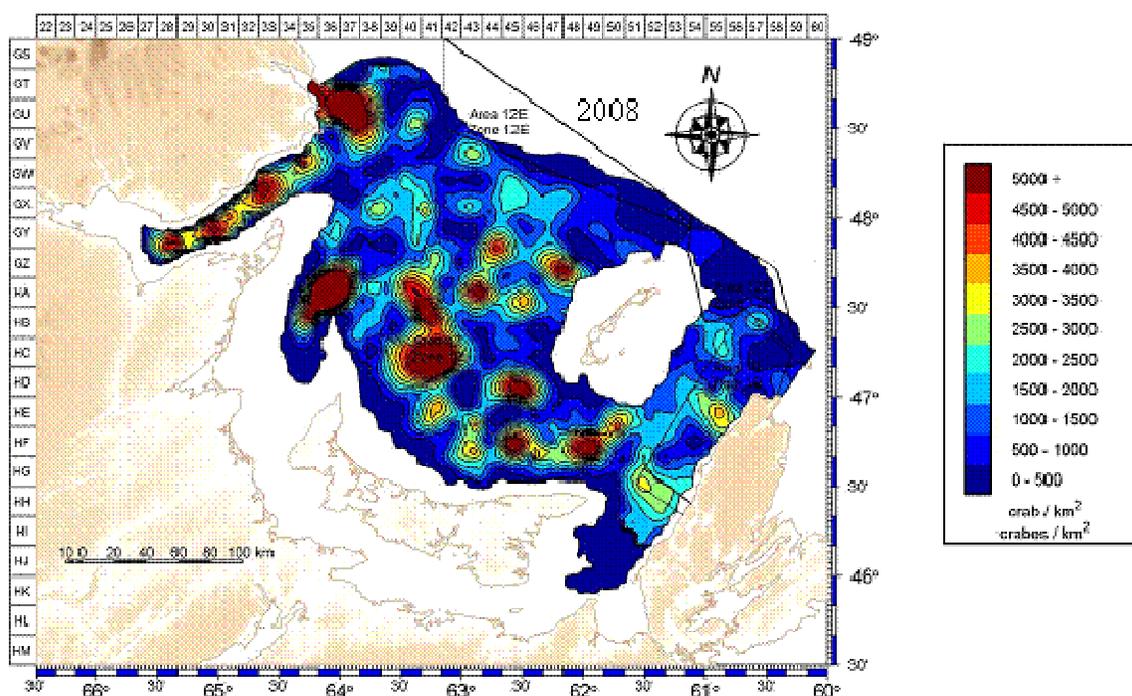


Figure 6: Density (number per km²) contours of adult male crab ≥ 95 mm CW in the southern Gulf of St. Lawrence in 2008.

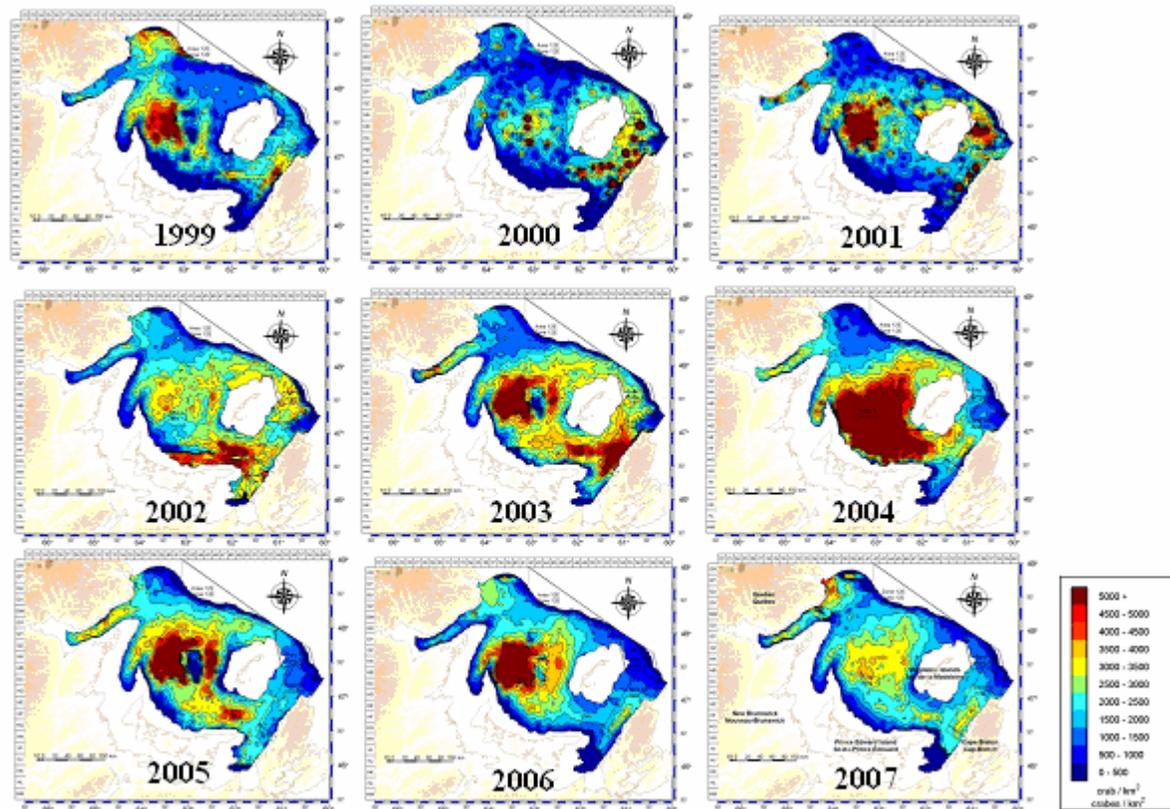


Figure 7: Density (number per km²) contours of adult male crab ≥ 95 mm CW in the southern Gulf of St. Lawrence, 1999 to 2007.

The difference between the commercial biomass from the fall survey of 2007 and the residual biomass from the fall survey in 2008, not attributable to fisheries harvests in 2008, was estimated at 27%. The average loss for the past five years has been 35%. This loss could be attributed to a number of factors including variability in survey estimates, natural mortality, non-harvest fishing mortalities, and emigration out of the sampled area.

The exploitation rate in the southern Gulf of St. Lawrence in 2008, corrected for the non-directed fishing losses, was 50.1%. Exploitation rates varied between 41% and 62% during 2000 to 2008 compared to 17% to 33% during 1990 to 1999 (Figure 8). The exploitation rates corrected for non-directed fishing losses are lower than the previously reported empirical rates.

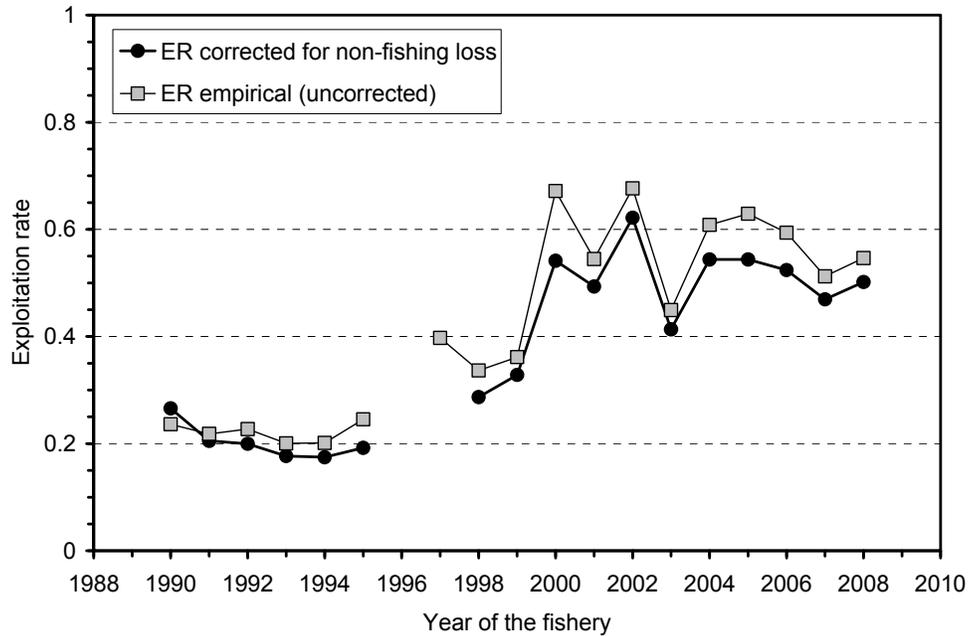


Figure 8. Exploitation rates in the southern Gulf of St. Lawrence snow crab fishery, 1990 to 2008.

The recruitment to the fishery in the southern Gulf is expected to remain low in 2009 and 2010 because of the low abundance of prerecruit males (R-3, and R-2) observed in the trawl survey in 2008 (Figures 4, 9, 10). An increase in the abundance of prerecruits (R-4) was observed in 2008, which may indicate an upward phase in recruitment to the fishery starting in 2011. The abundance of males smaller than 56 mm CW observed in the trawl surveys from 2002 to 2008 has increased but is lower than the previous recruitment waves observed from 1993 to 1998 (Figures 11, 12).

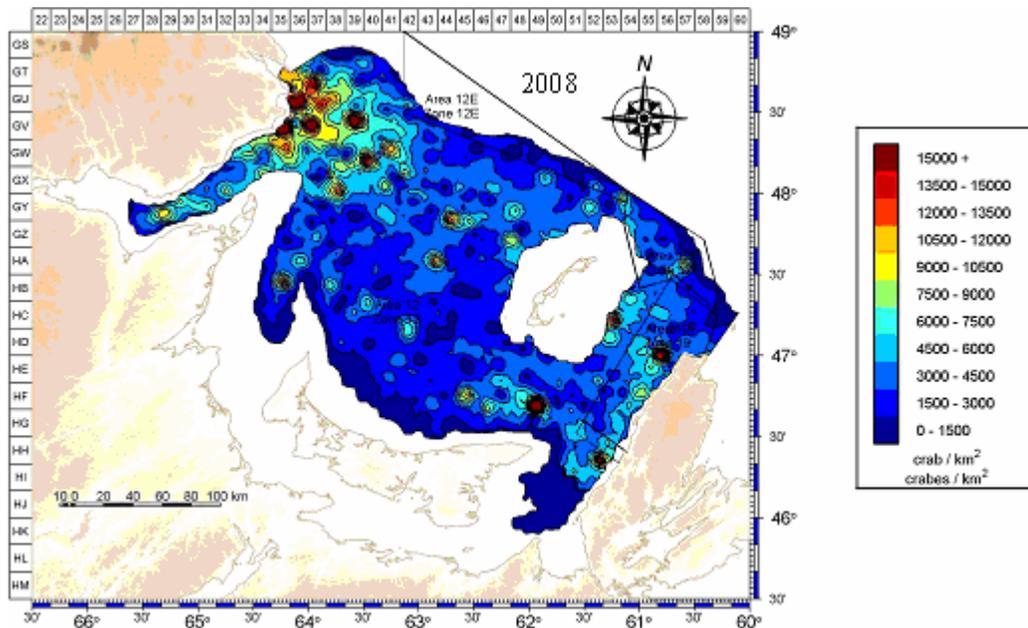


Figure 9: Density (number per km²) contours of adolescent male crab ≥ 56 mm CW in the southern Gulf of St. Lawrence in 2008.

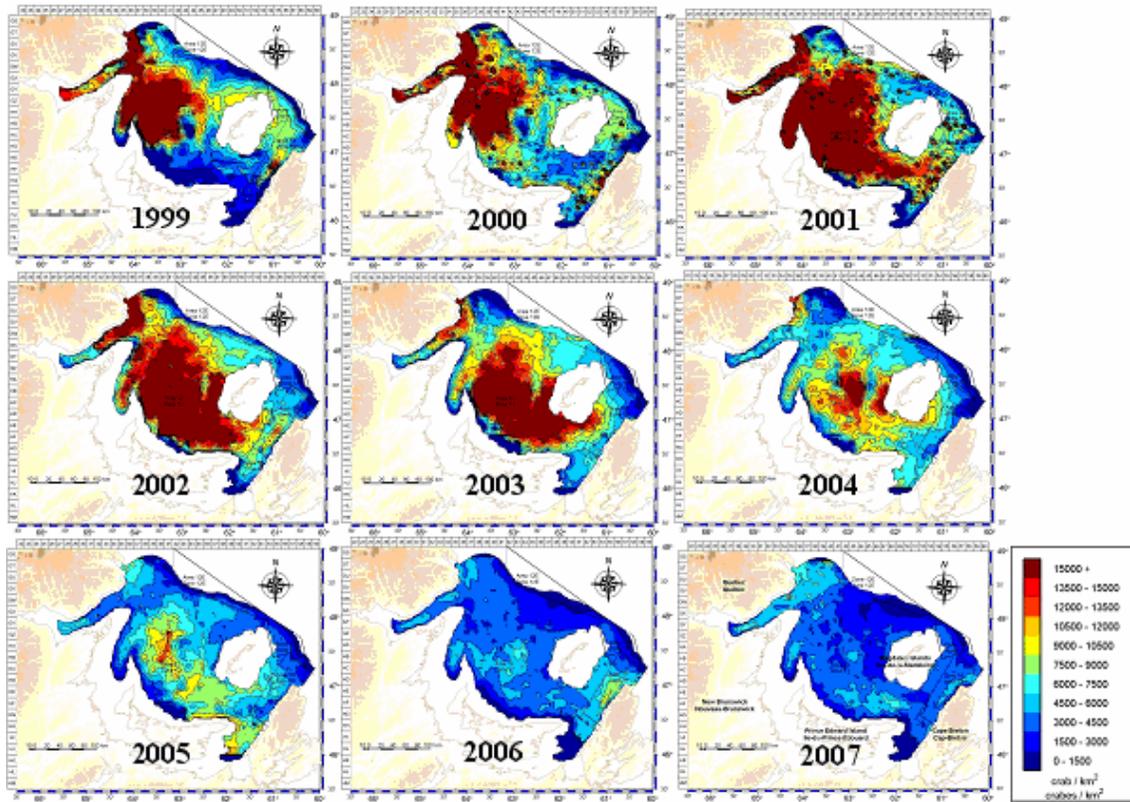
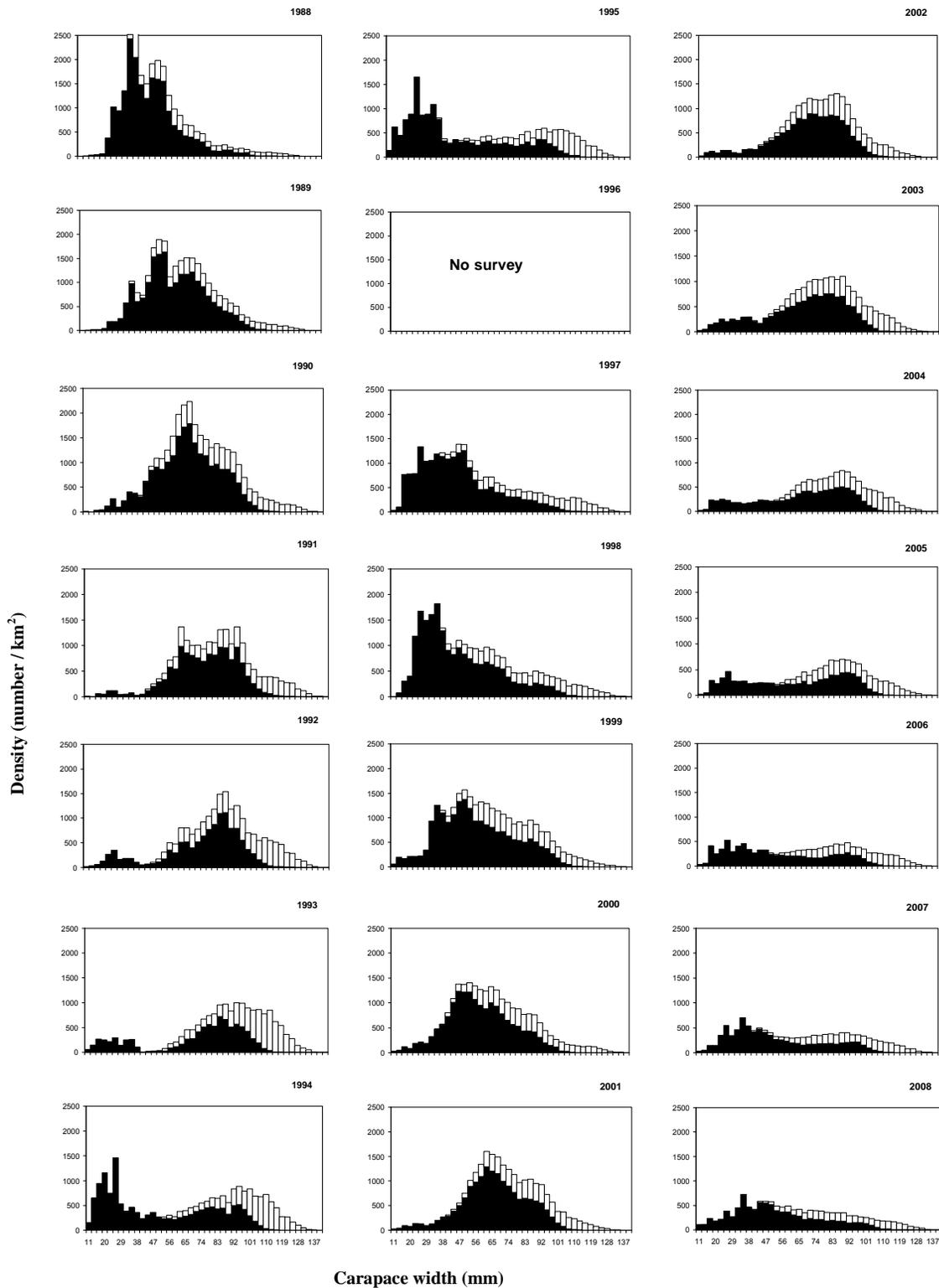


Figure 10: Density (number per km²) contours of adolescent male crab ≥ 56 mm CW in the southern Gulf of St. Lawrence, 1999 to 2007.



Adolescent crabs
 Adult crabs

Figure 11: Size frequency distributions of male crab sampled during the trawl survey in the southern Gulf of St. Lawrence after the fishing season.

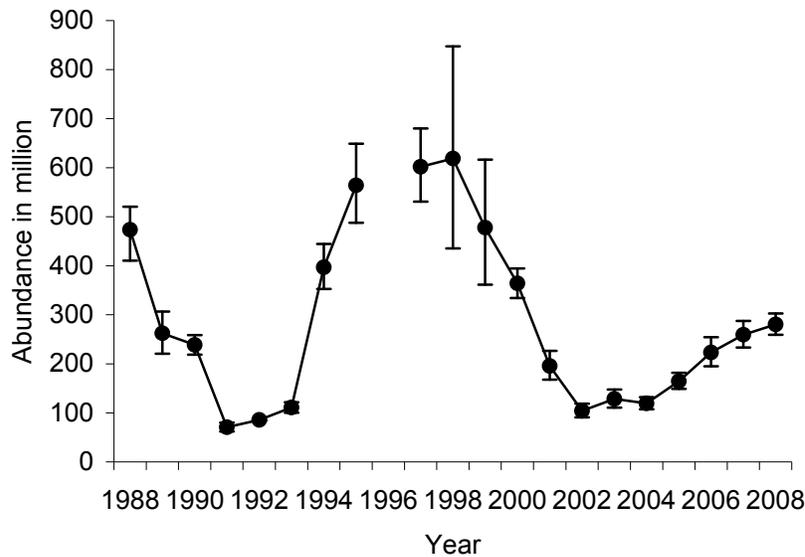


Figure 12. Abundance of crab < 56 mm (with 95% confidence intervals) in the southern Gulf of St. Lawrence, 1988 to 2008.

Reproduction

A decrease in the abundance of mature females has been observed since 1990 (Figure 13). The mean size of these females was higher during the first observed period of high abundance (1989-1992) compared to 1999-2002. The low abundance of immature and pubescent females in the population in recent years indicates that the abundance of mature females will remain lower than the levels during 1999-2002 (Figures 13).

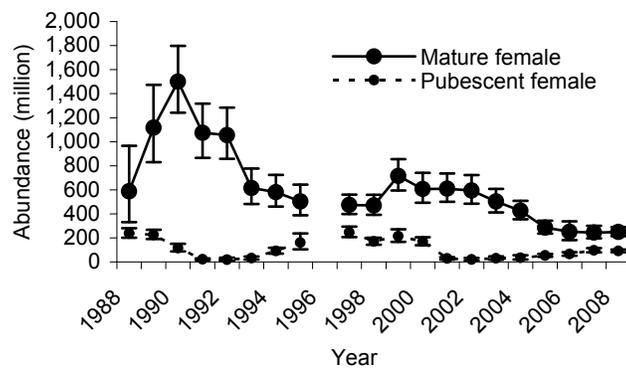


Figure 13: Annual female abundances (with 95% confidence intervals) in the southern Gulf of St. Lawrence based on the trawl surveys.

Sources of Uncertainty

The trawl survey data were processed using the procedure defined in the framework meeting (DFO 2006). A review of the standardization for the tow length, trawl opening width and area of polygon for the time series 1988 to 2006 was presented and accepted at the meeting. But other factors such as the vessel itself cannot be addressed without a comparative survey. It was

assumed that the trawl survey biomass estimates are absolute measures of abundance. If they are less than 100% of the biomass, then the exploitation rates estimated for this fishery represent maximum values.

Other uncertainties such as growth, natural mortality and movement make it difficult to predict the commercial biomass more than one year in advance.

In the absence of a defined stock-recruitment relationship in this population, there are uncertainties about the future recruitment to the population related to the reduced abundance of mature females in the southern Gulf.

The movement of crabs within the southern Gulf among the management areas is a major source of uncertainty in the provision of advice for area-specific management.

The abundance of prerecruits ≥ 56 mm CW in the southern Gulf is low and is retracting to the Area 12. This may reduce the availability of the resource to the fisheries in Areas 19, E and F in the near future.

CONCLUSIONS AND ADVICE

The recruitment to the fishery in the southern Gulf is expected to remain low for the foreseeable future (at least to 2010) due the low abundances of prerecruits (R-3 and R-2). An increase in the abundance of prerecruits R-4 was observed in 2008, which may indicate a potential upward phase in recruitment to the fishery starting in 2011. The abundances of males smaller than 56 mm CW has increased from 2002 to 2008 but remains low compared to the 1993 to 1998 period.

The rate of decline of the commercial biomass after 2008 will depend on the exploitation rate, higher exploitation rates will result in more rapid declines. Since 2000, this fishery has become largely dependent on the annual recruitment (carapace condition 3) rather than on the residual biomass from one year to the next (Figure 5). The residual biomass since 2003 has been maintained between 20,000 and 26,000 t (Figure 5).

The trajectory of stock abundance (biomass of commercial sized male crab from the fall trawl survey in year $t - 1$) versus exploitation rate (corrected for non-fishing losses) on this biomass in the fishery of year t is shown in Figure 14. Following an increase in biomass from 1991 to 1995, the biomass declined rapidly to low levels by 1998 and has varied between 44,000 t and 85,000 t during 2000 to 2008. Over the period of lower abundance, exploitation rates have varied between 41% and 62%, resulting in fisheries harvests of 18,513 to 36,078 t. The estimated biomass from the 2008 fall survey, which would be available to the fishery in 2009, was 48,000 t (95% CL range 43,800 t – 52,400 t), the lowest since 2000. Under a precautionary approach framework, one would expect the exploitation rates to be reduced as stock abundance declines.

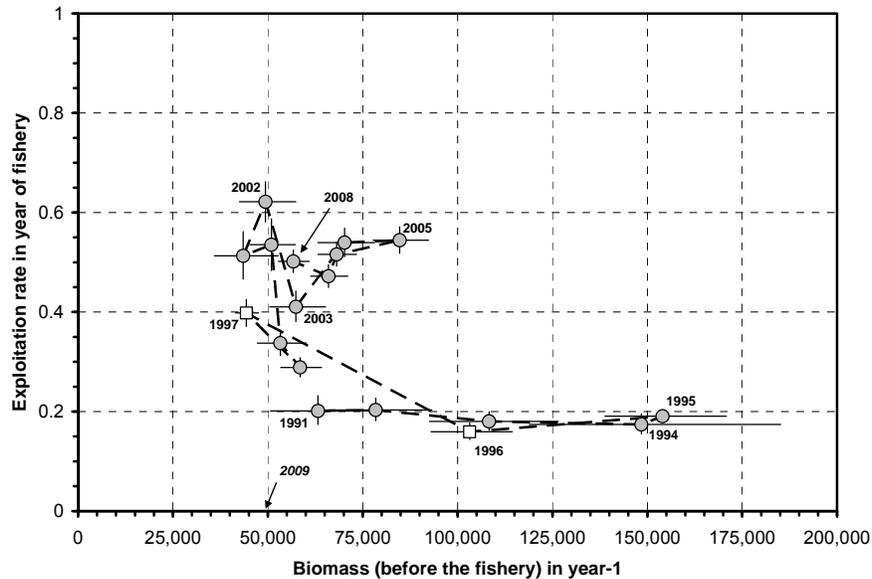


Figure 14. Trajectory of stock abundance (biomass of commercial sized male crab as estimated from the fall trawl survey in year $t - 1$) versus exploitation rate (corrected for non-fishing losses) of this biomass in the fishery of year t . Year of the fishery is labeled on the figure. Error bars are 90% confidence interval ranges based on Monte Carlo simulations. The white squares show exploitation and / or biomass estimates which are different from other years because there was no trawl survey in 1996.

Reference points and management objectives have yet to be defined for this resource. In the absence of such indicators, a risk analysis model was developed using as an example the probability of a decrease in the commercial biomass index after the 2009 fishery given various catch options in 2009 (Figure 15). As an illustration of how the risk analysis in figure 15 is to be understood, a catch of 20,000 t in 2009 entails that there is about an 80% chance that the commercial biomass will decline by at least 15% and a 46% chance of a greater than 25% decline (Figure 15). Other indicators of stock performance could be examined using the same risk analysis structure. The choice of biomass change indicator to use and the risk level (probability of the event happening) to apply are decisions to be made by management and stakeholders.

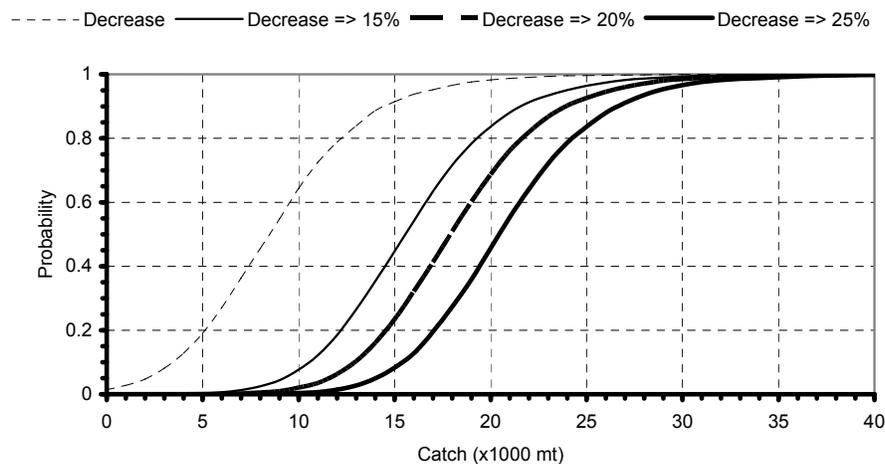


Figure 15. Risk analysis example for the southern Gulf of St. Lawrence showing probabilities of a commercial biomass decrease relative to 2008 for different catch options for 2009.

OTHER CONSIDERATIONS

Ecosystem Considerations

Environmental factors, such as water temperature, can affect the moulting and reproductive dynamic as well as the movement of snow crab. Bottom temperatures over most of the southern Gulf of St. Lawrence are typically less than 3 °C, which is considered suitable thermal habitat for snow crab. Temperature data from research surveys indicate that the bottom temperatures in deeper waters of Areas E and F are higher (1 to 5 °C) than on crab grounds (-1 to 2 °C) in Area 12. Bottom temperatures in Area 19 are usually 1° to 2 °C warmer than the crab grounds in Area 12.

Bottom temperatures in 2008 in most of the Magdalen Shallows, including Chaleur Bay, were just at or below the long-term average while in the southwestern part of Area 12, they were above average. The mean bottom temperature within the habitat area in 2008 decreased compared to 2007 by about 0.6 °C (Figure 16). The cooler bottom water temperature is consistent with a significant increase of the Gulf-wide snow crab habitat index (area of the bottom covered by water temperatures between -1 and 3 °C). The habitat index increased by about 6% to nearly 52,000 km² and was similar to its long-term mean (Figure 16). The temperature conditions are considered to be favorable for snow crab as the mean temperature index is below the long-term average, especially since the habitat index itself is at average level. However, the influence of habitat area and mean temperature on snow crab abundance and distribution is unknown.

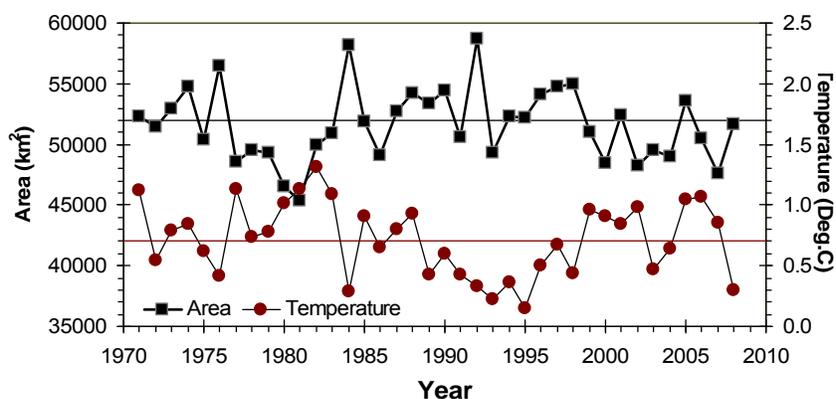


Figure 16: Snow crab habitat area and mean temperature index in the Southern Gulf of St. Lawrence.

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