



ASSESSMENT OF SHRIMP STOCKS IN THE ESTUARY AND GULF OF ST. LAWRENCE IN 2007

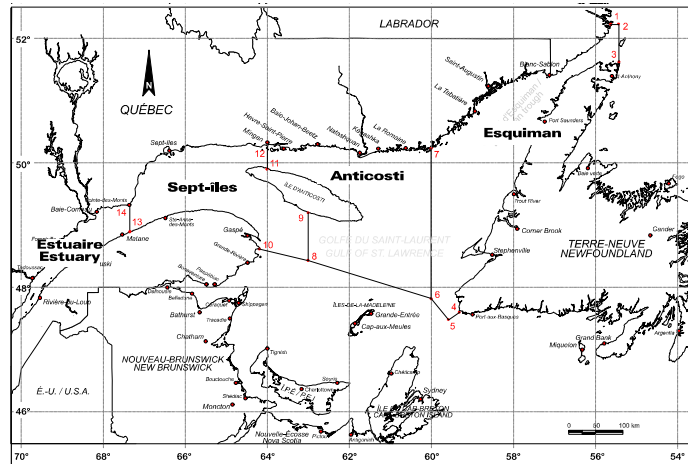
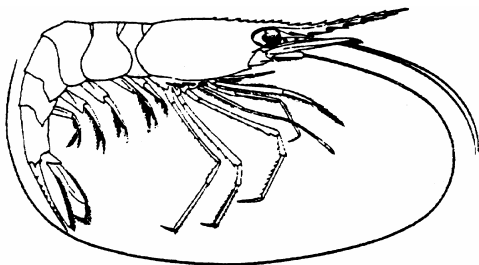


Figure 1. Shrimp fishing areas in the Estuary and Gulf of St. Lawrence.

Context

The northern shrimp (*Pandalus borealis*) fishery began in the Gulf of St. Lawrence in 1965. Three fleets of trawlers (Quebec, New Brunswick and Newfoundland) do most of the fishing in four areas: Estuaire, Sept-Îles, Anticosti and Esquiman (Figure 1).

A number of management measures, including total allowable catches (TAC) in the four areas, controls shrimp fishing. TAC-based management limits fishing to protect the reproductive potential of the population. Limiting the catch ensures that a certain proportion of shrimp will not be harvested and will thus remain available for spawning. However, minimum biomass or maximum fishing levels that could endanger the stock are not known, nor is the optimum fishing level that would allow precise targets to be set.

The resource is assessed each year to determine whether changes that have occurred in the stock status necessitate adjustments to the conservation approach and management plan.

SUMMARY

- Shrimp landings totalled more than 36,000 t in 2007 and TACs were reached in the four fishing areas.
- The stock status is determined by comparing the 2007 indices to the mean of the years 1990-2005.

- The catch per unit of effort stayed at a value that is much higher than the mean in all areas. It increased relatively to 2006 in Sept-Iles, was similar in Anticosti and Estuary and decreased in Esquiman.
- The biomass index of the research survey increased relatively to 2006 to reach a value that is higher than the mean in all areas except in Esquiman where the index decreased to reach a value similar to the mean.
- The spawning female abundance index in spring was higher than the mean in all areas except in Anticosti. The size of females increased in Estuary and Sept-Iles to approach the mean. It remained lower than the mean in Anticosti and Esquiman.
- The fishing effort stayed similar or slightly lower than the mean in all areas. The exploitation rate index decreased in all areas except in Esquiman. The indices reached values that are similar or slightly below the mean.
- The index of recruitment to the spawning stock remained above the mean in all areas except in Estuary where it is similar to the mean. The size of females that will carry eggs at spring in 2008 could be higher than the mean in Estuary and Sept-Iles while it should stay below the mean in Anticosti and Esquiman.
- The stock abundances have remained at a high level since the last four or five years. Predictions for 2008 indicate that the stocks should remain in good condition. The year classes that will sustain the fishery in the next few years seem to be of average abundance except that of 2004 which seems to be more abundant in Anticosti and Esquiman. It should recruit to the female component in 2009.
- In 2008, catches equal to the 2007 TACs should generate exploitation rates close to the mean. Consequently, the status quo is recommended in all areas for the 2008 TACs.

INTRODUCTION

Species Biology

A number of peculiarities of shrimp biology influences the fishery, fishery management and resource conservation.

Shrimp change sex in the course of their life cycle, achieving male sexual maturity at about two and a half, then becoming female between four and five years old. The females, which carry their eggs beneath the abdomen, are thus among the largest specimens in commercial catches; the males are smaller because they are younger. Mating takes place in the fall, and the females carry their eggs for eight months, from September until April. The larvae are pelagic when they hatch in the spring, but settle on the bottom in late summer. Shrimp migrations are associated with breeding (the egg-bearing females migrate to shallower water in winter) and feeding (at night, they leave the ocean floor to feed on small planktonic organisms). Generally speaking, shrimp are found throughout the Estuary and northern Gulf of St. Lawrence at depths of 150 m to 350 m.

Description of the Fishery

The number of permanent shrimp licences in the Estuary and the Gulf in 2007 was 112. In addition, since 1997, temporary allocations have been granted to fishers who do not have permanent licences. The whole harvesters come from 5 provinces and 6 First Nations. The other fishery management measures include the imposition of a minimum mesh size (40 mm) and, since 1993, the compulsory use of the Nordmore grate, which significantly reduces groundfish by-catches. Shrimpers must also keep a log book, have their catches weighted by a dockside monitoring program and agree to have an observer on board upon DFO request (5% coverage). The fishery opening date is set at the first of April and the closing date, at the 31st of December. The fishery has been managed by TAC since 1982, and permanent fishermen have had individual transferable quotas since the mid-1990s.

Landings of northern shrimp in the Estuary and Gulf of St. Lawrence have risen gradually since the fishery began. Landings rose from approximately 1,000 tons to 7,500 tons between the early and late 1970s, and to 15,000 tons by the late 1980s. Landings remained mostly stable between 1990 and 1995 (Figure 2). The TACs increased gradually beginning in 1996, and landings totalled over 23,000 tons by the late 1990s. TACs rose again in 2000, 2001 and 2004, and landings followed, totalling over 36,000 tons in 2004. The TAC had however been lowered in the Esquiman area in 2003 in order to reduce the exploitation rate. The TACs did not change in 2005, except in Esquiman where the TAC was increased by 10%. They remained stable in 2006 and 2007. Preliminary statistics indicate that the Gulf landings reached more than 36,000 tons in 2007. TACs were reached in all areas.

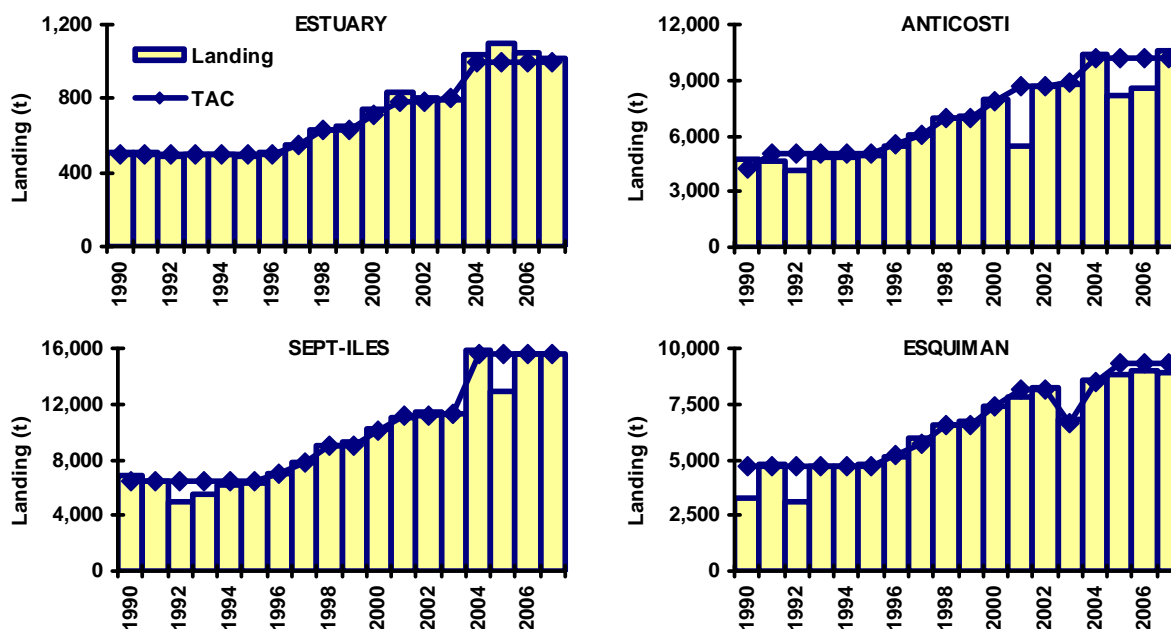


Figure 2. Landing and total of admissible catch (TAC) by fishing area and by year. The 2007 landing data are preliminary.

RESOURCE ASSESSMENT

The stock status is determined by examining a number of indicators from the commercial fishery and research survey. These indicators refer to fishing success, stock abundance and resource productivity. To assess the stock status in 2007, we compared each indicator to the mean value for 1990-2005 period. The 1995-2005 period was used for the indicators associated to the commercial sampling in the Estuary area.

Commercial fishery statistics (shrimper catch and effort) are used to estimate fishing effort and to calculate catches per unit of effort (CPUEs) and numbers per unit of effort (NPUEs). The data are standardized to take into account changes in fishing capacity and seasonal fishing patterns. The model used for the standardization explains more than 65% of the variability in the data. The commercial catch samples allow the estimation of the number of shrimp harvested by sexual maturity stage as well as the estimation of their mean size.

A research survey is conducted every year in the Estuary and Gulf of St. Lawrence in August from a Departmental vessel. The survey was conducted from 1990 to 2003 and then again in 2005 from the *C.C.G.S. Alfred Needler* equipped with a *URI 81'/114'* shrimp trawl. However, it was decided that the fishing gear and platform would be replaced in order to continue the annual survey beyond 2005. The *C.C.G.S. Teleost* equipped with a *Campelen* shrimp trawl has been used since 2004. Because the vessels and gear are quite different, comparative fishing missions were conducted in 2004 and 2005 in order to estimate the catchability differences between the two vessel/trawl tandems. The *Needler* survey catches were adjusted to match those that would have been made by the *Teleost* for the 1990 to 2005 period. Overall, the corrections to be made are higher in the case of small individuals.

Biomass indices are calculated using a geostatistical method. Biomass and abundance estimates are produced using the data from all stations whether they were visited at night or during the day. All stations visited during the northern Gulf survey except for the Strait of Belle Isle areas and subdivision 3Pn, just outside Cabot Strait are included in the analyses. Finally, survey catch samples provide abundance estimates of shrimp by sexual maturity stage.

The new series of indices adjusted to match those that would have been obtained by the *Teleost* was compared to the *Needler* series covering the years 1990 to 2003 and 2005. Results show that the differences between the two series are marginal (Figure 3).

An exploitation rate index is obtained by dividing the commercial catches (in number) by the abundance index derived from the research surveys. This method cannot be used to estimate the absolute exploitation rate or to relate it to target exploitation rates, but the method does make it possible to track relative changes in the exploitation rate over the years.

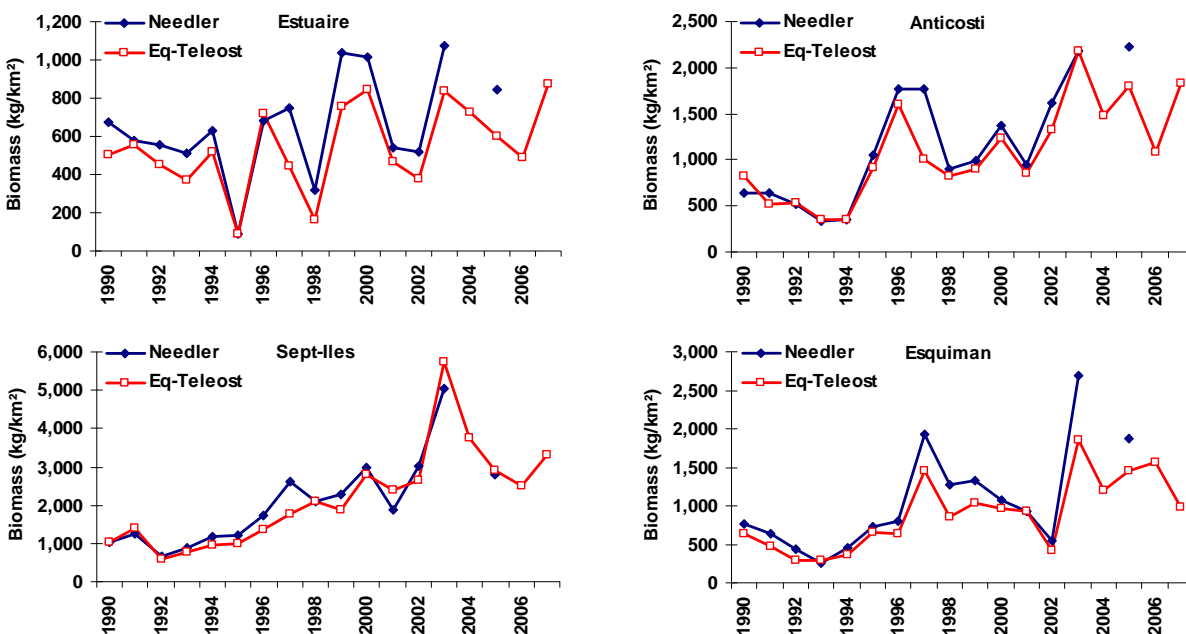


Figure 3. Biomass estimated by krigging for the two data series : 1) Needler series obtained by using the CCGS Alfred Needler uncorrected data from 1990 to 2003 and in 2005, 2) Teleost-equivalent series obtained by using the adjusted data from the CCGS Alfred Needler from 1990 to 2003 and in 2005 in combination with the data from the CCGS Teleost from 2004 to 2007.

Resource Status in 2007

There was no noticeable change in the distribution of fishing effort in 2007. The sectors that sustain fishing in the four areas have not changed in recent years. They are the north shore of the Estuary, near the border of the Sept-Iles area, the western part of the Sept-Iles area, the two slopes of the Laurentian Channel south of Anticosti Island, the Anticosti Channel and the head of the Esquiman Channel.

The fishing effort stayed similar or slightly lower than the 1990-2005 mean in all areas. The total fishing effort increased in 2007 relatively to 2006 in all areas except in Sept-Iles where it decreased.

The commercial fishery catch rates are considered as good indicators of the abundance of shrimp available to the fishery. The annual standardized catch per unit of effort (CPUE) in 2007 stayed at a value that is much higher than the mean in all areas (Figure 4A). It increased relatively to 2006 in Sept-Iles, was similar in Anticosti and Estuary and decreased in Esquiman.

The catch rate for the multiparous females that carry eggs in April and May is an indicator of the abundance of the spawning stock, which is responsible for the production of the year-class of the same year. The catch rate for multiparous females in the spring of 2007 was above the mean in all areas except in Anticosti (Figure 4B). The catch rate for primiparous females in June, July and August provides an indication of the abundance of recruit females that just completed sex change during the few preceding months. These females will participate in the reproduction for the first time during the fall of the same year. The catch rate of recruit females

remained above the 1990-2005 mean in all areas except in Estuary where it is similar to the mean (Figure 4C).

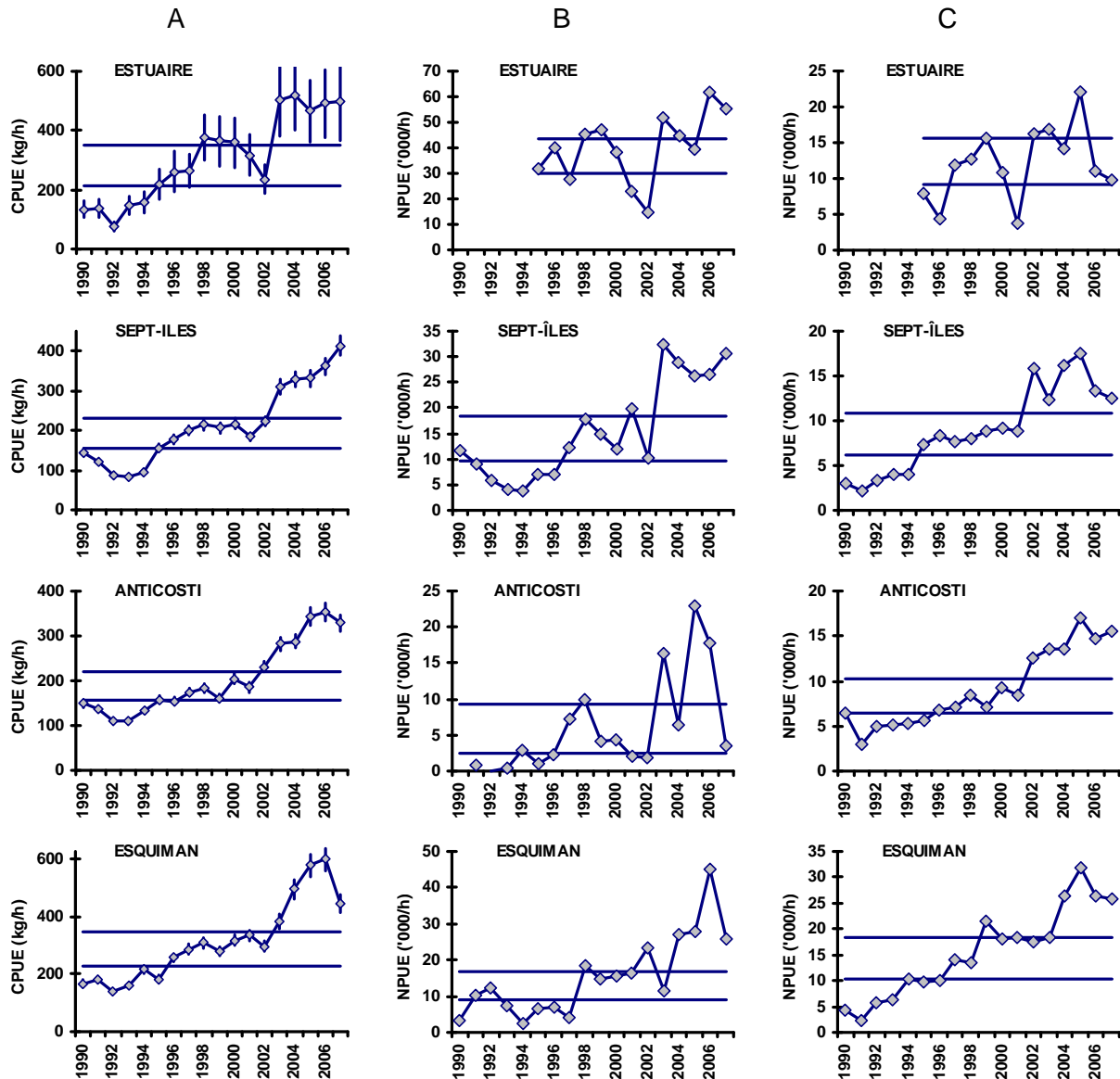


Figure 4. Commercial fishery catch rate by fishing area from 1990 to 2007. A) Annual standardized catch per unit of effort. B) Number per unit of effort for multiparous females in spring. C) Number per unit of effort for primiparous females in summer. The continuous lines represent the limits of the confidence interval of the 1990-2005 mean.

The minimum trawlable biomass index of the research survey increased relatively to 2006 to reach a value that is higher than the 1990-2005 mean in all areas except in Esquiman where the index decreased to reach a value similar to the mean (Figure 5A).

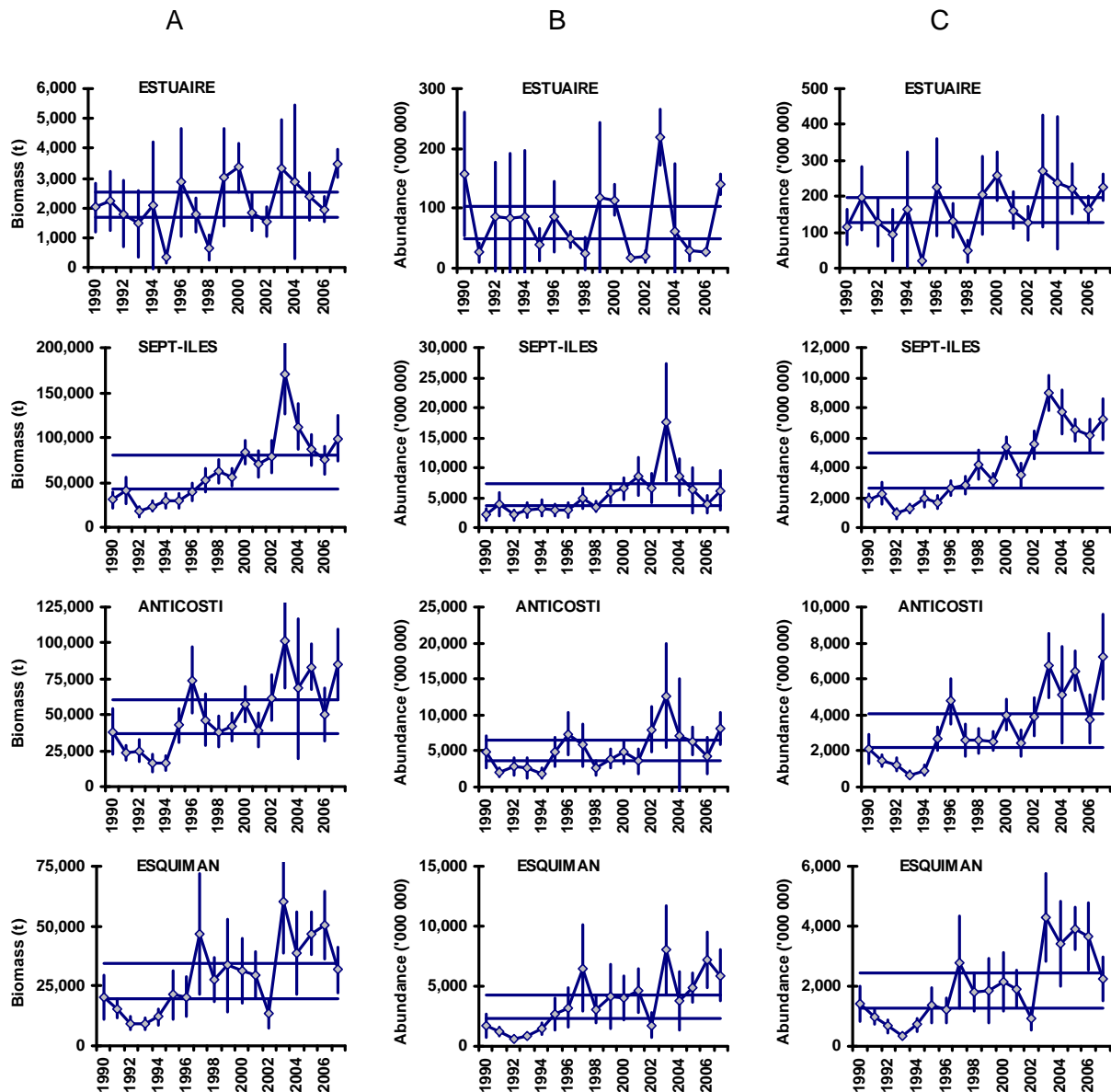


Figure 5. Research survey indices by fishing area from 1990 to 2007. A) Minimum trawlable biomass. B) Abundance of males. C) Abundance of females. The continuous lines represent the limits of the confidence interval of the 1990-2005 mean.

The abundance index for males and females from the research survey increased in 2007 in all areas except in Esquiman where it decreased. The male abundance index is higher than the 1990-2005 mean in all areas except in Sept-Iles where it is similar (Figure 5B). The female index is higher than the mean in all areas except in Esquiman where it is similar (Figure 5C).

The variations in female sizes follow an east-west gradient, the smallest being observed in the Esquiman Channel and the largest, in the Estuary. For a same abundance of spawning females, the stock egg production would be theoretically lower in the east.

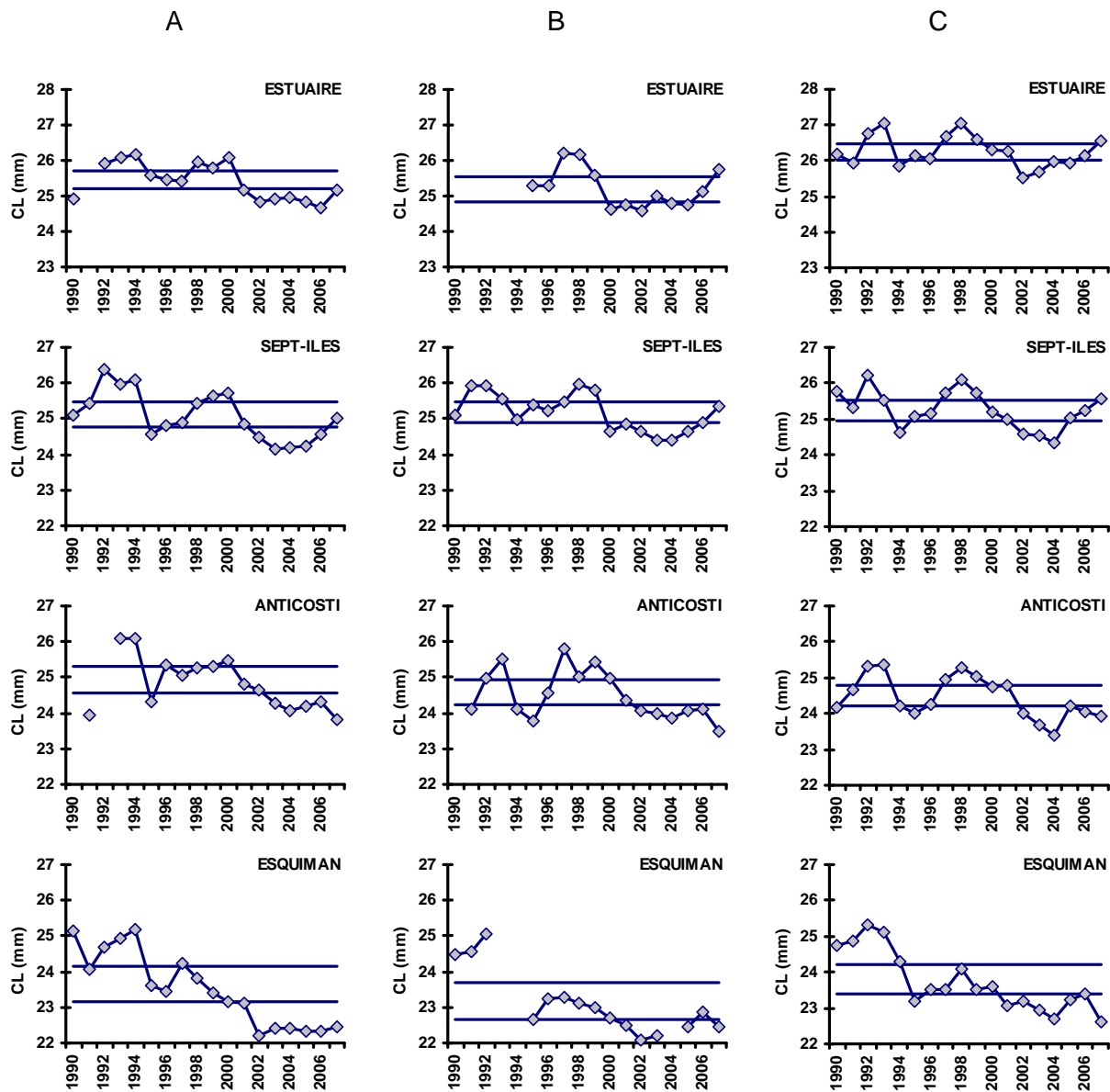


Figure 6. Carapace mean length (CL) of females by fishing area from 1990 to 2007. A) Multiparous females from the spring fishery. B) Females from the fall fishery. C) All females from the survey. The continuous lines represent the limits of the confidence interval of the 1990-2005 mean.

The mean size of females caught in the commercial fishery increased slightly in 2007 as compared to 2006 to approach or exceed the 1990-2005 mean in the Estuary and Sept-Iles areas (Figures 6A and 6B). They stayed below the mean in the Anticosti and Esquiman areas and the 2007 values are among the lowest in the series. The variations in female sizes caught in the survey show the same trends as in the fishery (Figure 6C).

The exploitation rate index (commercial catch / survey abundance) decreased in 2007 in all areas except in Esquiman where it was slightly higher than in 2006 (Figure 7). The index is similar or slightly below the mean from the 1990-2005 period in all areas.

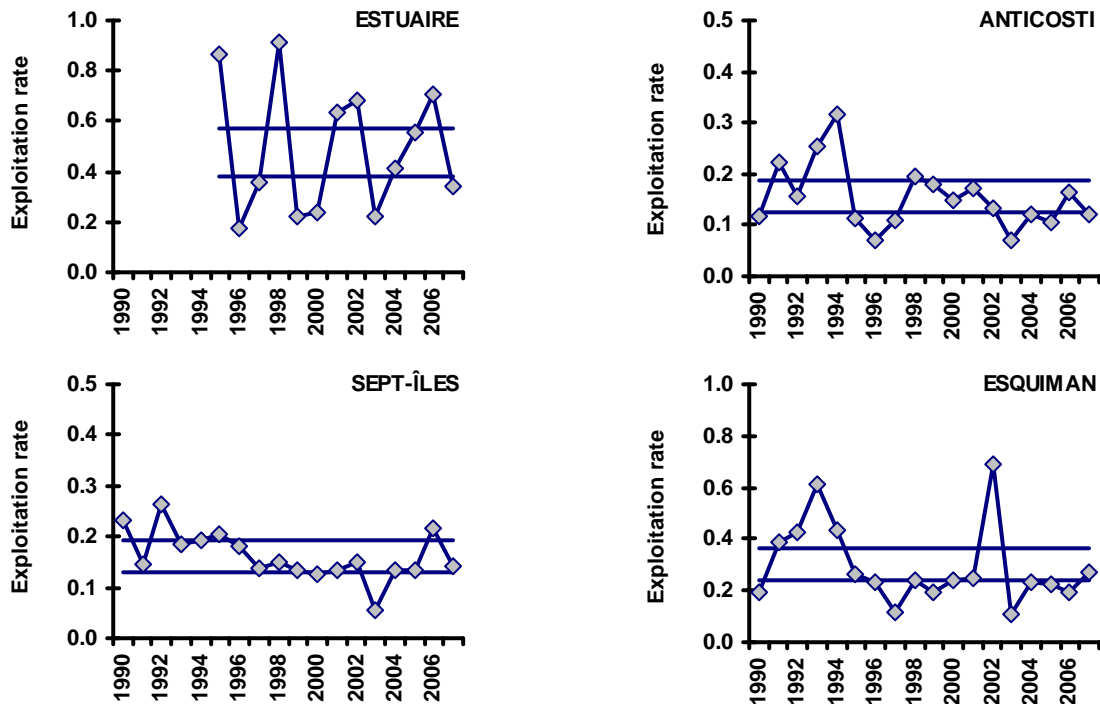


Figure 7. Exploitation rate index by fishing area from 1990 to 2007. The continuous lines represent the limits of a 20% interval around the 1990-2005 mean.

Outlook

The recent years have been characterized by the recruitment to the fishery of two very abundant cohorts (1997 and 1999). The catch rates from the commercial fishery and the biomass indices from the research survey have increased to very high levels as these cohorts grew and recruited to the female component. However, these cohorts do not contribute significantly to the fishery anymore. The catch rates and biomass indices do not increase anymore but rather stay at values that are higher than the 1990-2005 mean. The female component of shrimp that sustain the fishery shows catch rates or abundances that are still higher than the mean in the four areas (Figure 8).

Year classes that are still males and that will sustain the fishery for the next few years seem to be of average abundance in the catches of the commercial fishery and of the research survey except that of 2004 which dominates the male catches in Anticosti and Esquiman areas (Figure 8). This year class should change sex and recruit to the female component in 2009. It should reproduce in fall 2009 and have a positive impact on the abundance of the spawning stock in spring 2010.

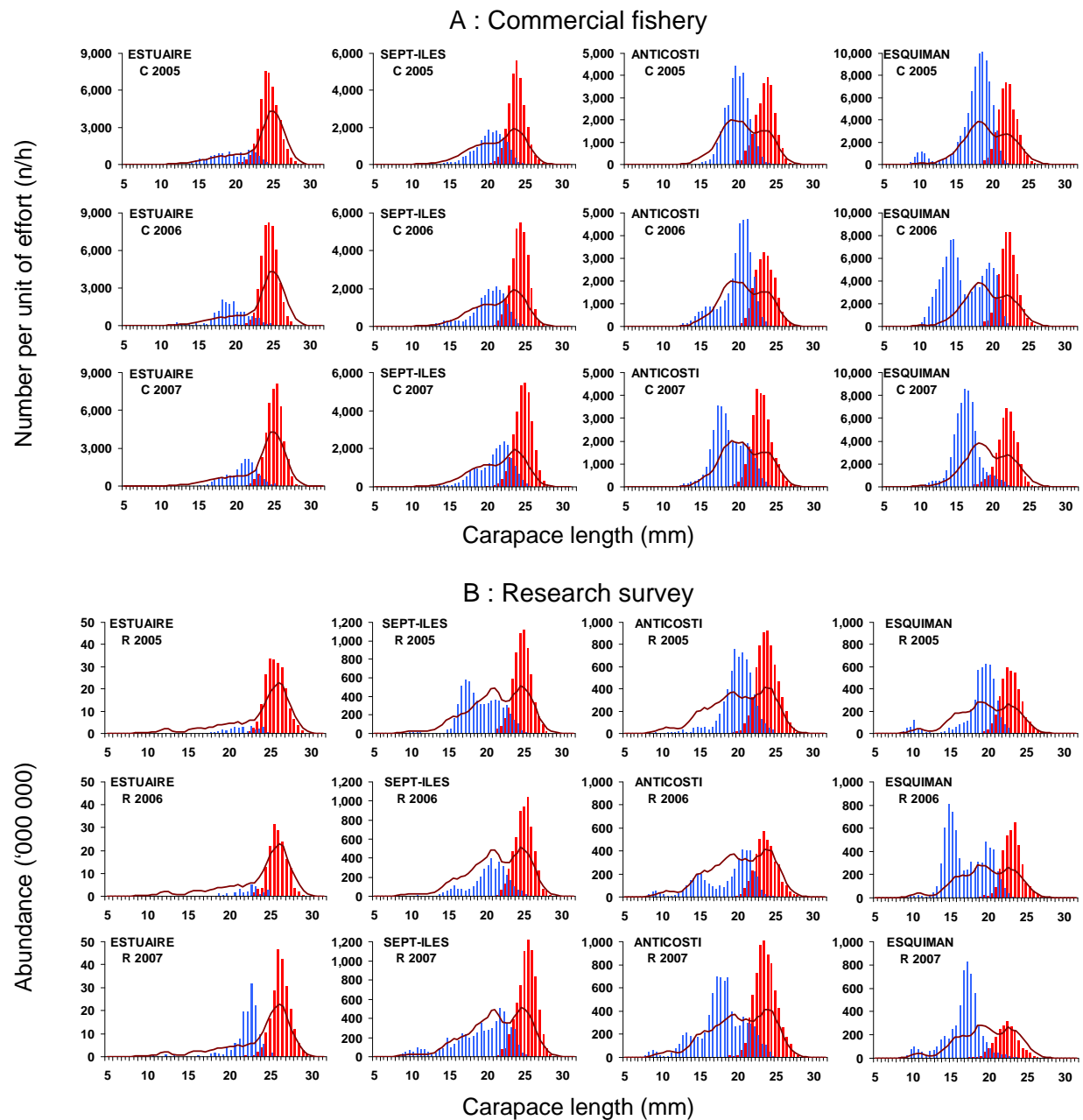


Figure 8. Abundance indices by length class from 2005 to 2007. A : Number per unit of effort from the commercial fishery. B : Abundance from the research survey. The histograms represent males (in blue) and females (in red) and the continuous line represents the 1990-2005 mean.

The predictions for 2008 made from the 2007 fall fishery results indicate that the stocks should remain in good condition. The female catch rates in spring should be still above the mean. The size of female that will carry eggs in spring 2008 could exceed the mean in Estuary and Sept-Iles while it should stay below the mean in Anticosti and Esquiman.

Sources of Uncertainty

As with many groundfish species, the indices of all components of the shrimp stocks (juveniles, males and females) increased simultaneously in the 2003 survey. Moreover, the variance associated with the 2003 biomass estimates is higher than in the past. It is possible that environmental factors could have had an impact on the availability to the trawl of shrimp of all the sizes, which could explain the increase in their catchability observed in 2003.

CONCLUSIONS AND ADVICE

The stock abundances have remained at a high level since the last four or five years. Predictions for 2008 indicate that the stocks should remain in good condition. In 2008, catches equal to the 2007 TACs should generate exploitation rates close to the mean. Consequently, the status quo is recommended in all areas for the 2008 TACs.

OTHER CONSIDERATIONS

By-catches of small fish in the shrimp fishery between 1999 and 2007 were examined from the at-sea observer database. Species that were most frequently observed were Greenland halibut, capelin and redfish, which were present in more than 70% of the observed tows. Cod was present in about 20% of the observed activities. Fish by-catches were in majority in the range of 1 kg or less per observed tow. The presence of observers on board does not seem to have changed the general fishing pattern since the shrimper catch rates with and without observers do not show any changes. In general, by-catch of a given species is variable between areas and years. No upward trend was observed between 1999 and 2007. In 2007, by-catches in the Estuary and Gulf of St. Lawrence shrimp fishery represented catches of about 93 tons (1.5 million individuals) for turbot, 35 tons (0.92 million individuals) for redfish, 5 tons (0.06 million individuals) for cod and 71 tons (5.0 million individuals) for capelin.

SOURCES OF INFORMATION

Bourdages H., L. Savard, D. Archambault and S. Valois. 2007. Results from the August 2004 and 2005 comparative fishing experiments in the northern Gulf of St. Lawrence between the *CCGS Alfred Needler* and the *CCGS Teleost*. Canadian Technical Report of Fisheries and Aquatic Sciences. 2750 : ix + 57 p..

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