



ASSESSMENT OF SHRIMP STOCKS IN THE ESTUARY AND GULF OF ST. LAWRENCE IN 2008

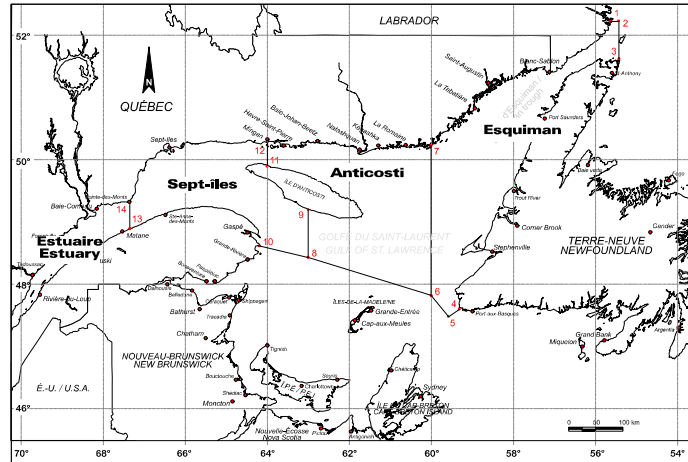
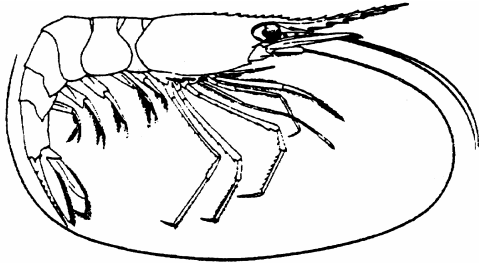


Figure 1. Shrimp fishing areas in the Estuary and Gulf of St. Lawrence.

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) are principally responsible for the fishing in four areas: Estuaire, Sept-Îles, Anticosti and Esquiman (Figure 1).

Shrimp fishing is regulated by a number of management measures, including the setting of total allowable catches (TAC) in the four areas. 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. The essential elements for the establishment of a precautionary approach were examined during a national DFO-Industry workshop held in 2008. Provisional reference points were adopted in order to initiate the development of an approach for the Gulf shrimp fishery.

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

- Landings totalled nearly 36,000 t in 2008 and were similar to those of 2007. Most of the stock abundance indicators for 2008 were close to or higher than the mean for the 1990-2005 period but several showed a decrease relative to 2007.
- Commercial fishery catch rates were similar to those in 2007 while survey biomass indices decreased in Estuaire and Anticosti. Male and female abundance indices were also similar to 2007 except for males in Estuaire and females in Anticosti and Esquiman,

where they were lower. Female sizes increased slightly in all areas except Esquiman where they decreased.

- The fishing effort remained similar or decreased slightly relative to the mean in all areas. The exploitation rate index increased and was similar to the mean in all areas except Anticosti where the index was higher.
- The spawning stock recruitment index remained higher than the mean in 2008 except for Estuary where it was similar to the mean. The multiparous females which will hatch larvae in 2009 should continue to be abundant. However, a proportion of the 2004 year-class which appears to be very abundant, especially in the eastern Gulf, has already changed sex in 2008 and produced small females. The 2006 year-class appears to be abundant in the four areas.
- In the context of developing of a precautionary approach, provisional reference points were established to delimit the adequate critical, cautious and healthy zones for each stock. The status of the stocks observed in 2008 and predicted for 2009 is determined from the combined indicators for the commercial fishery and the research survey and subsequently compared to the reference points.
- The stocks have been in the healthy zone since 2003 and this situation is predicted to continue for 2009. Catches similar to those of 2008 should generate exploitation rates in 2009 that are close to the mean value observed since the stocks are in the healthy zone. Consequently, status quo is recommended for the 2009 TACs in all fishing areas.
- However, the stock status indices for Estuary, Anticosti and Esquiman point to a decrease even if they remain in the healthy zone. It is thus important that exploitation rates do not increase significantly in order to help maintain these stocks in the healthy zone.

INTRODUCTION

Species Biology

The biology of shrimp has several particularities which in turn influence the exploitation strategy, fishery management and resource conservation.

Shrimp change sex over 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 by 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). In general, 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 bycatches. 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 request by DFO (5% coverage). The fishery opening date is set as April 1 and the closing date, December 31. 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. They 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. In 2008, they were exceptionally and temporarily increased by 2%. Preliminary statistics indicate that the Gulf landings were close to 36,000 tons in 2008.

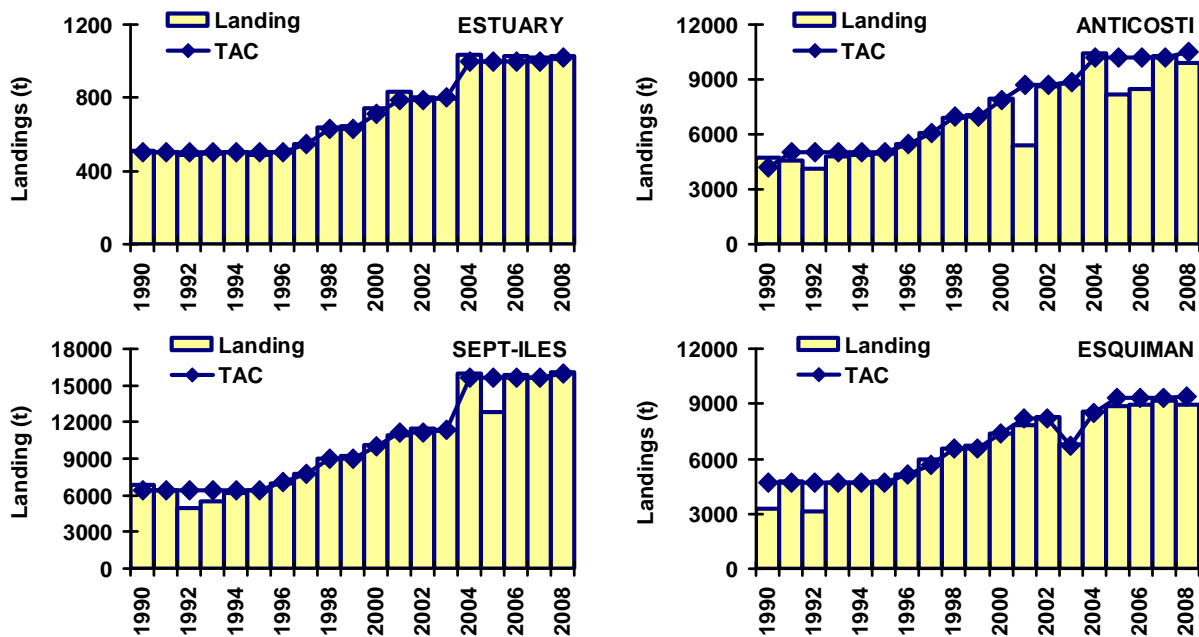


Figure 2. Landing and total of admissible catch (TAC) by fishing area and by year. The 2008 landing data are preliminary.

RESOURCE ASSESSMENT

The stock status is determined by examining a number of indices from the commercial fishery and the research survey.

Commercial fishery statistics (shrimper catch and effort) are used to estimate fishing effort and to calculate catch rates in weight or in number. 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 67% of the variability in the data. The commercial catch samples allow the estimation of the number of shrimp harvested by size classes and by sexual maturity stage.

A research survey is conducted every year in the Estuary and Gulf of St. Lawrence in August from a Departmental vessel. The *CCGS Alfred Needler* was used to do the survey from 1990 to 2003 and in 2005. Its catches were adjusted to match those that would have been made by the *CCGS Teleost*, the vessel used for the survey since 2004. Biomass indices are calculated using a geostatistical method. Survey catch samples provide abundance estimates of shrimp by size classes and by stage of sexual maturity.

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 nor 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.

The fishery and survey indices referring to a same stock characteristic are combined and compared to the 1990-2005 mean in order to comment on their trend over time. These combined indicators correspond to the mean of the indices that are first standardized to the 1990-1999 period (annual value of the index divided by the 1990-1999 geometric mean). The stock status is determined by the geometric mean of five combined indicators, referring to the stock size, male and primiparous female abundance, and abundance and size of female spawners. Predictions for 2009 are made from the relationships between the survey and the fishery indices.

A national workshop was held in November 2008 on the development of precautionary approach frameworks for Canadian shrimp fisheries. The establishment of limit reference points and upper stock reference points delineating the healthy, cautious and critical stock status zones was discussed at the meeting. Provisional reference points based on a combined index for female abundance were proposed for the Gulf of St. Lawrence fishery. The lowest observed value was used as the limit reference point and the upper stock reference was based on a reference period corresponding to the index appearing to plateau before increasing again. The stock status indicator observed in 2008 and that predicted for 2009 are compared to the provisional reference points for each of the four stocks in the Gulf. The provisional reference points are the lowest observed value (corresponding to 1992 for Estuary and Sept-Iles and to 1993 for Anticosti and Esquiman) as the limit reference point and the mean of the indicator when it reaches a plateau (corresponding to the years 1998-2001 for all stocks) as the upper stock reference.

Resource Status in 2008

There was no noticeable change in the distribution of fishing effort in 2008. The sectors that sustain fishing in the four areas have not changed in recent years and correspond to the sectors where high concentrations of shrimp were observed during the survey (Figure 3). In 2008, the total number of fishing hours stayed similar or slightly lower than the 1990-2005 mean in all areas.

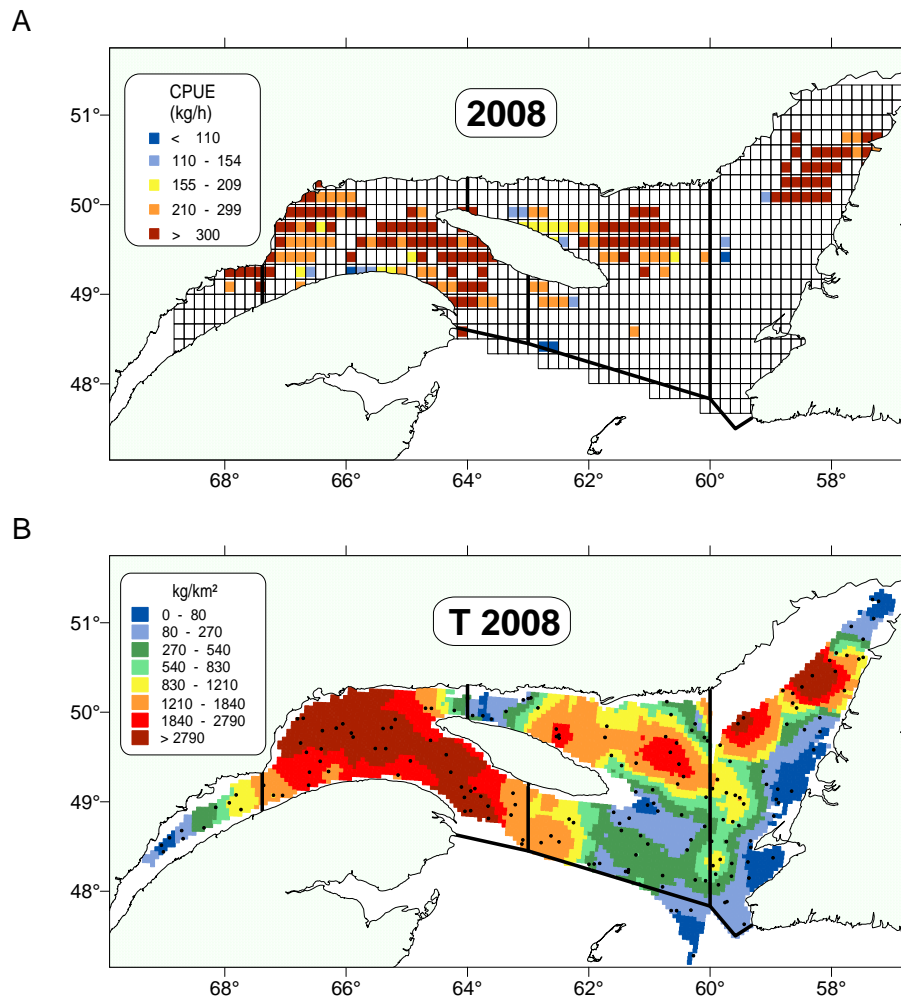


Figure 3. A) Spatial distribution of catch rates (CPUE) from the shrimp fishery in 2008. B) Spatial distribution of shrimp biomass estimated by kriging during the research survey in 2008.

The commercial fishery catch rate and the research survey biomass index are considered as good indicators of the size of the stocks. The annual catch rate in 2008 was similar to that of 2007 and stayed at a value that is higher than the mean for the years 1990-2005 in all areas (Figure 4A). The minimum trawlable biomass index from the research survey decreased in 2008 in Estuary and Anticosti (Figure 4B). The index was slightly higher than the mean in Estuary and Sept-Iles but remained within confidence intervals in Anticosti and Esquiman.

The catch rate from the fishery and the biomass index from the survey were standardized (annual value of the index divided by the 1990-1999 geometric mean) and combined (geometric

mean of the standardized indices) to provide an indicator of the size of the stocks (Figure 4C). The combined indicator for 2008 showed a decrease relative to 2007 in all areas. It remained however above the mean throughout.

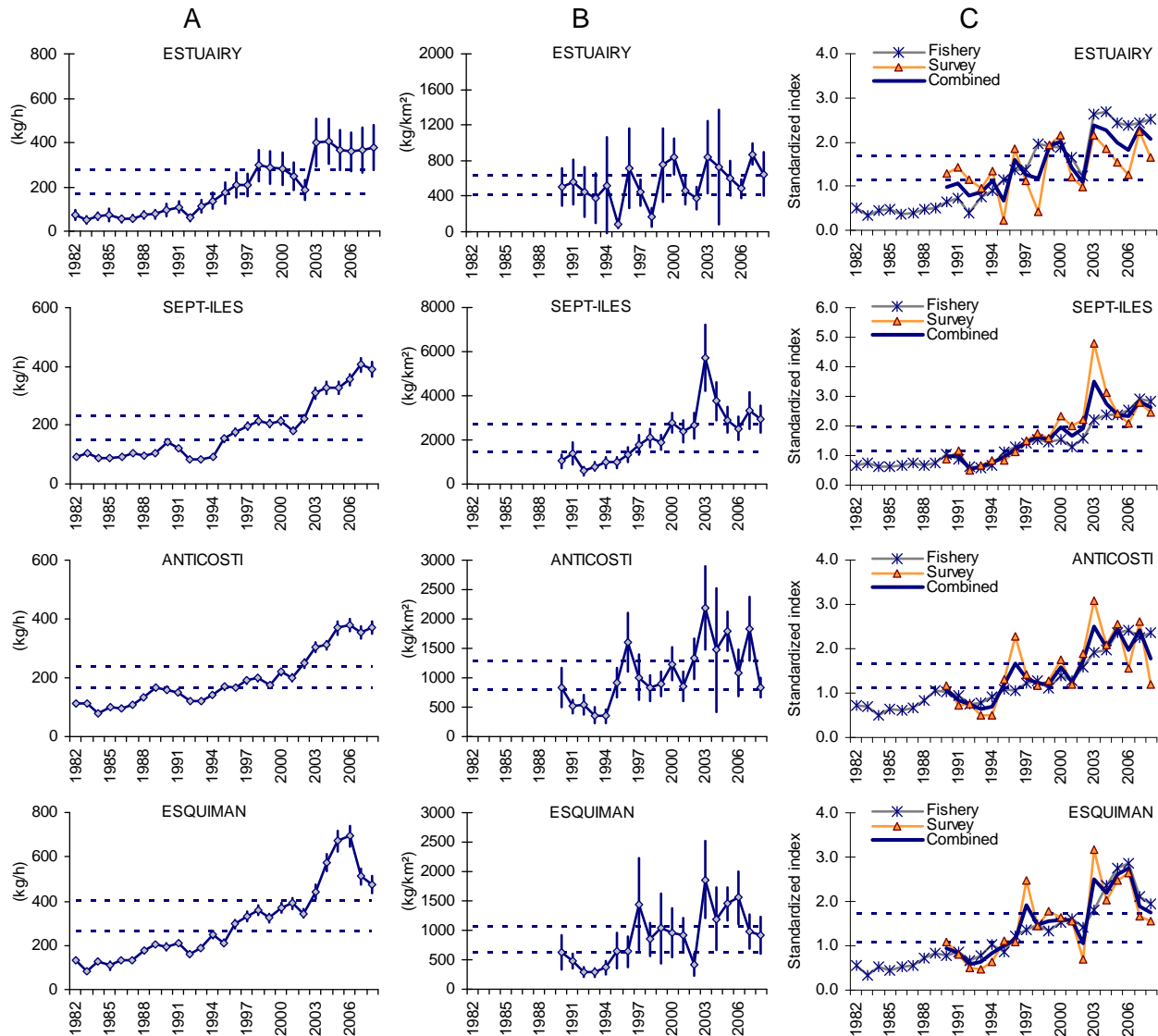


Figure 4. Indices of the stock size. A) Catch rate from the fishery \pm confidence interval (95%). B) Biomass index from the research survey \pm confidence interval (95%). C) Standardized indices from the fishery (catch rate) and from the survey (biomass index) and the combined indicator for the stock size. The dotted lines represent the confidence interval limits (95%) of the 1990-2005 mean.

The indicator for male abundance is a combination of the standardized indices from the fishery (catch rate in summer) and the survey (biomass index). The combined indicator in 2008 remained above the 1990-2005 mean in all areas except for Estuary where it was below the mean (Figure 5A). The indicator for primiparous females (catch rate in summer) provides an indication of the abundance of recruit females that have just completed their sex change and that will reproduce for the first time during the fall of the same year. There is no similar index

from the research survey. The catch rate of primiparous females remained above the 1990-2005 mean in all areas except in Estuary where it was similar to the mean (Figure 5B).

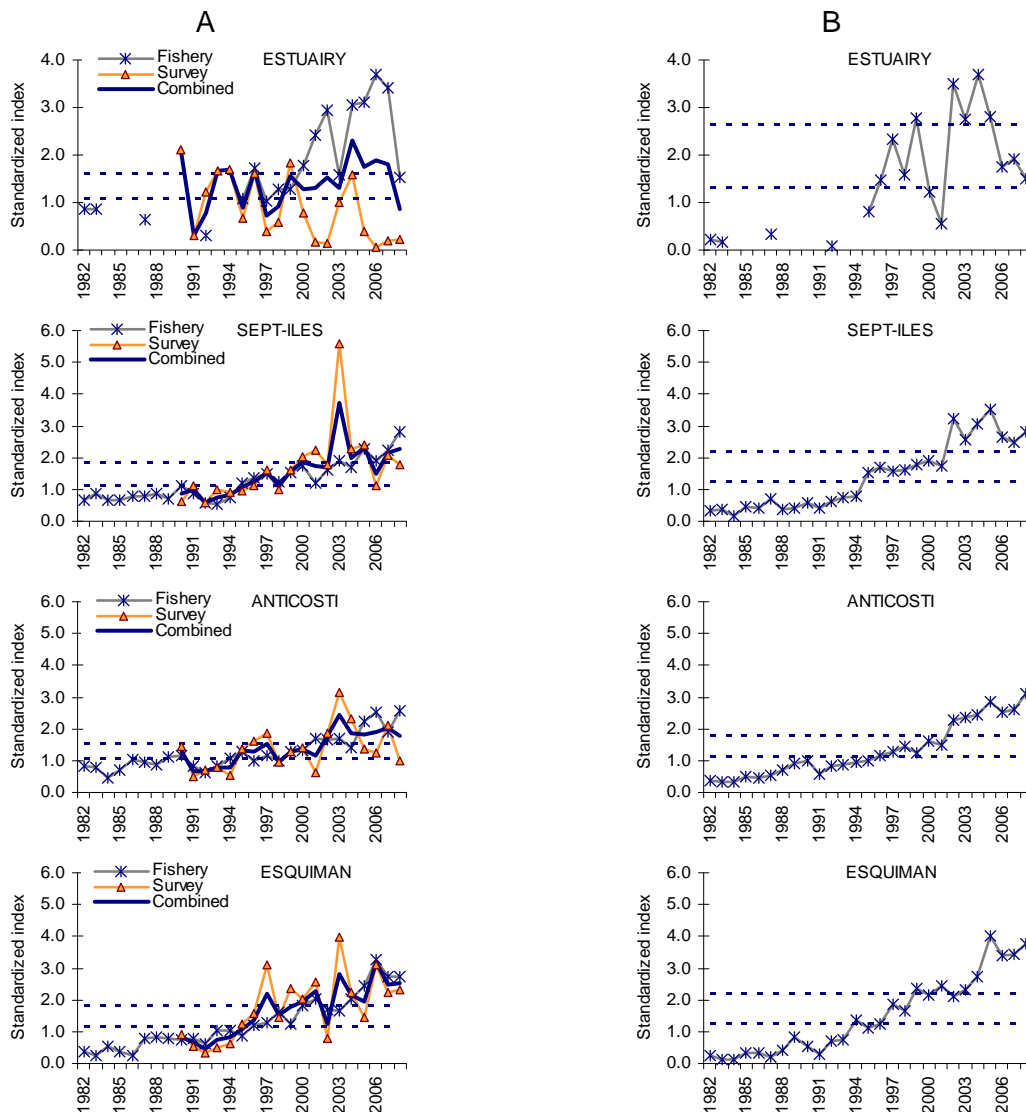


Figure 5. Abundance indices by maturity stage. A) Standardized index from the fishery (catch rate in summer) and from the survey (abundance index) and the combined index for males. B) Standardized index from the fishery (catch rate in summer) for the primiparous females. The dotted lines represent the confidence interval limits (95%) of the 1990-2005 mean.

The indicator for the spawning females comes from the combination of the standardized indices from the fishery (catch rate of multiparous females at spring) and from the survey of the year before (abundance index of all females). This combined index corresponds to an index of the abundance of the spawning stock, which is responsible for the production of the larvae of a same cohort. The combined indicator for the spawning females fell within the confidence interval of the 1990-2005 mean in all areas except in Sept-Iles where it remained above the mean (Figure 6A). Since 2006, however, the combined indicator has shown a decrease in Estuary and Esquiman.

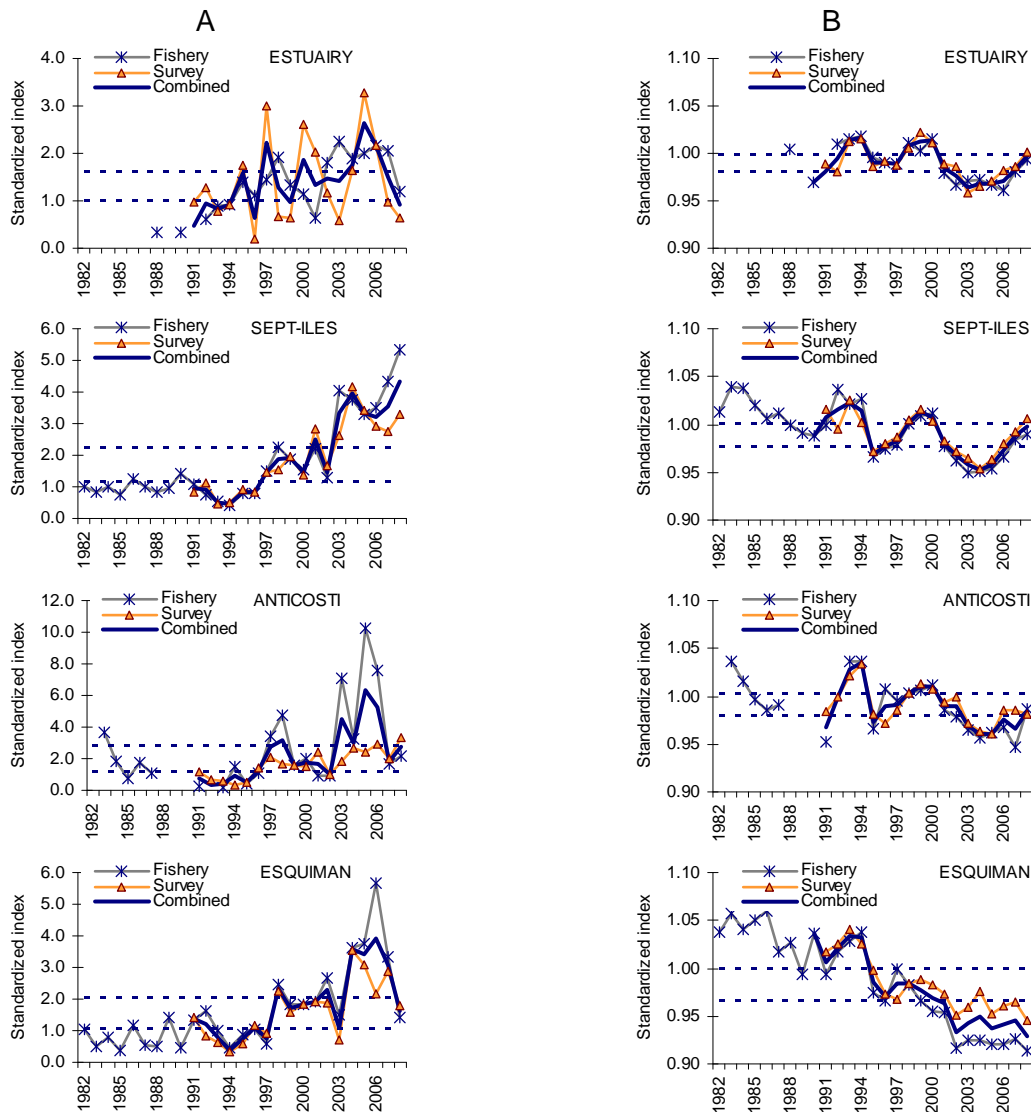


Figure 6. Indicators for the spawning females. A) Abundance indicator: standardized index for multiparous females in the fishery at spring (catch rate) and standardized index for all females from the survey of the preceding year (abundance index) and the indicator combining the two indices. B) Size indicator: standardized index for the mean size of multiparous females at spring and standardized index for the mean size of all females in the survey of the preceding year and the indicator combining the two indices. The dotted lines represent the confidence interval limits (95%) of the 1990-2005 mean.

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 the same abundance of spawning females, the stock egg production would theoretically be lower in the East. The combined indicator for the size of spawning females (standardized index for multiparous females at spring and standardized index for all females in the survey of preceding year) showed an increase in 2008 relative to 2007 in all areas except in Esquiman (Figure 6B). The mean sizes of females have been increasing since 2004 in Estuary, Sept-Iles and Anticosti. The size remained below the mean in Esquiman and the 2008 value was among the lowest of the series.

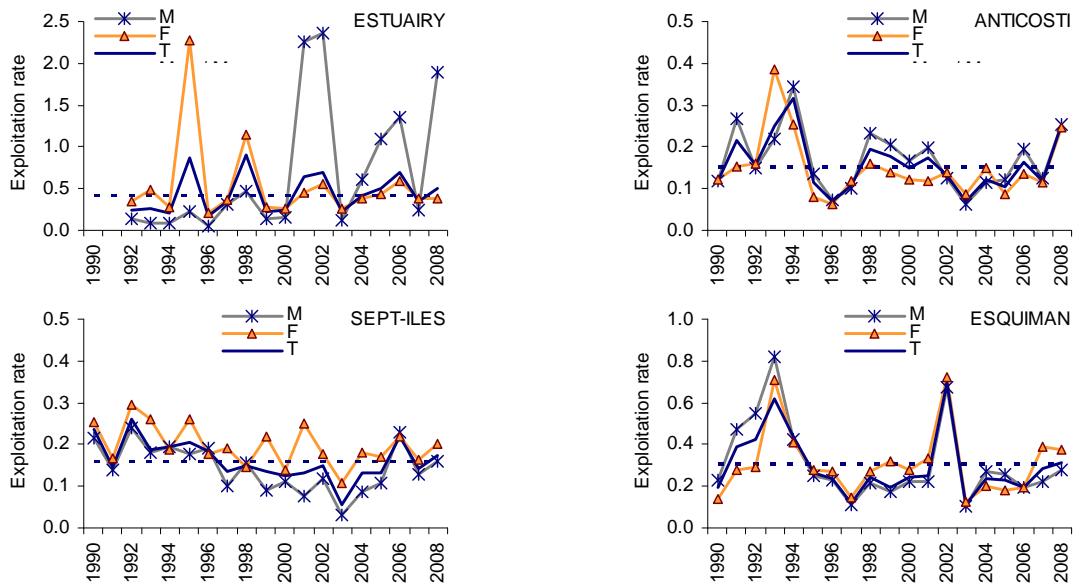


Figure 7. Exploitation rate index for males, females and in total. The dotted line represents the mean of the total index for the 1990-2005 period.

The exploitation rate index (commercial catch / survey abundance) for the males increased in 2008 in all areas (Figure 7). The index for the females increased in Sept-Iles and Anticosti while it was similar to 2007 in Estuary and Esquiman. The total exploitation rate index was similar to the 1990-2005 mean in all areas except in Anticosti where it was higher.

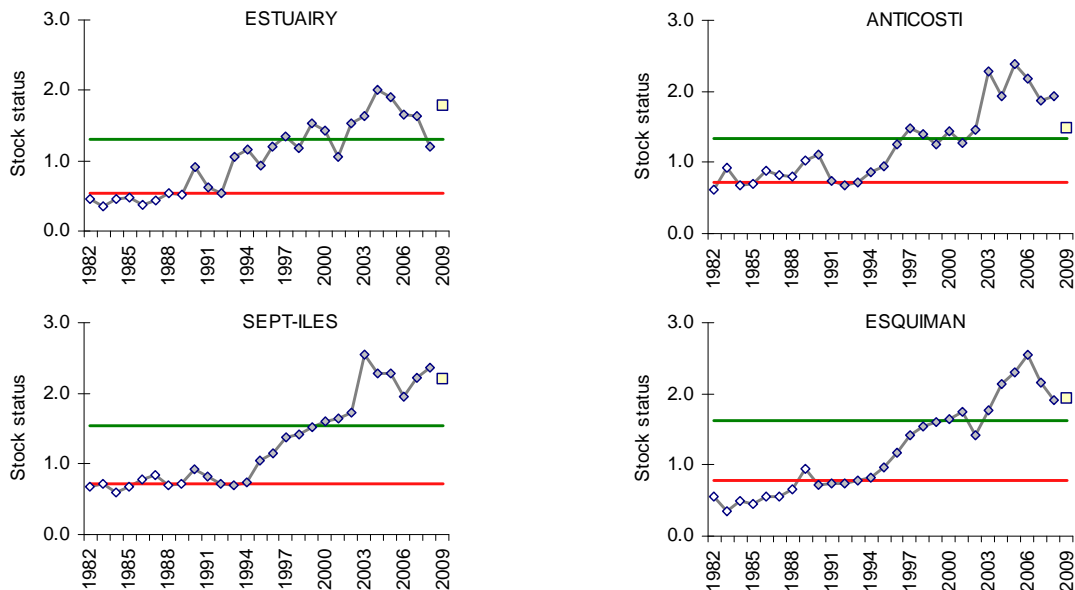


Figure 8. Stock status observed in 2008 and predicted for 2009. The full lines correspond to the provisional reference points.

The stock status is determined by the mean of the indicators for the stock size, for the abundance of males, recruit females and spawning females and for the size of spawning

females. In general, the stock status indicators increased from the mid 1990s to the mid 2000s (Figure 8). They decreased thereafter, but still remained in the healthy zone except for Estuary where it was slightly lower than the upper stock reference point. Indeed, the first half of the 2000s was 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 increased to very high levels as these cohorts grew and recruited to the female component. However, these cohorts have not contributed significantly to the fishery for the last three or four years. Catch rates from the fishery are no longer increasing but remain high while the biomass indices have begun to decrease. However, there are no concerns in the short term neither for the recruitment to the fishery nor for the recruitment to the female component. The abundance of the recruit females remains high and the year-classes that are still males and which will sustain the fishery in the following years appear to be more abundant than the mean (Figure 5).

Outlook

The 2004 year-class which dominated the male catches in Anticosti and Esquiman areas in 2007 should have changed sex and been recruited to the female component in 2009 (Figure 9). However, it seems that it had already changed sex in winter 2008 in Esquiman resulting in females of small sizes. The contribution of this year-class to the success of the spring fishery should begin to be felt in 2009 in Esquiman and by 2010 in the other areas. Otherwise, the 2006 year-class seems to be more abundant than the average in all areas. The individuals of this year-class measured between 13 and 16 mm (carapace length) in 2008 and should increasingly contribute to the fishery as they grow and approach the size at sex change.

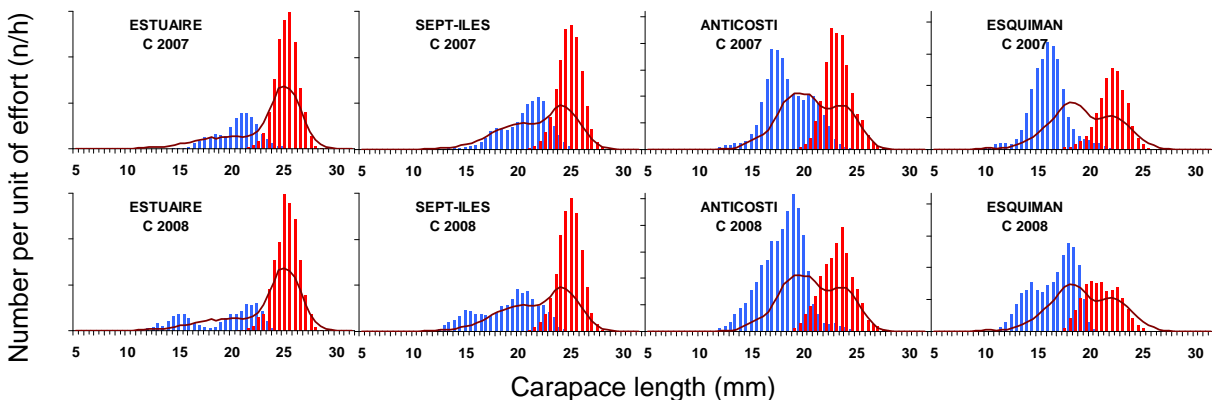


Figure 9. Catch rate by length class from the commercial fishery. The histograms represent males (in blue) and females (in red) and the continuous line represents the 1990-2005 mean.

Predictions for 2009 were made for the stock size indicators as well as for the indicators for the female components, from regressions made between the survey indices of one year and the fishery indices of the following year for Sep-Iles, Anticosti and Esquiman. The 2009 value for the abundance of males and for all indicators for the Estuary area corresponded to the mean observed during the last few years. The predictions indicate that all stocks should stay in the healthy zone in 2009 (Figure 8).

Sources of Uncertainty

As was the case with many groundfish species, the indices of all components of the shrimp stocks (juveniles, males and females) increased simultaneously in the 2003 survey. It is possible that environmental factors could have had an impact on the availability to the trawl for shrimp of all the sizes which affected their catchability during that survey.

CONCLUSIONS AND ADVICE

The stocks have been in the healthy zone since 2003 and predictions for 2009 are that stocks should remain in that zone. In 2009, catches similar to those of 2008 should generate exploitation rates that are close to the mean value observed since the stocks are in the healthy zone. Consequently, status quo is recommended for the 2009 TACs in all fishing areas. However, the stock status indices for Estuary, Anticosti and Esquiman seem to indicate a decrease even if they remain in the healthy zone. It will be important then that exploitation rates do not increase significantly, in order to help maintain these stocks in the healthy zone.

OTHER CONSIDERATIONS

Bycatches of small fish in the shrimp fishery between 1999 and 2008 were examined from the at-sea observer database. Fish bycatches were predominantly 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, bycatch of a given species varied between areas and years. In 2008, bycatches in the Estuary and Gulf of St. Lawrence shrimp fishery represented catches of about 128 tons (2.0 million individuals) for turbot, 25 tons (0.6 million individuals) for redfish, 26 tons (0.3 million individuals) for cod and 74 tons (5.0 million individuals) for capelin.

SOURCES OF INFORMATION

- Bourdages H., D. Archambault, B. Bernier, A. Fréchet, J. Gauthier, F. Grégoire, J. Lambert et L. Savard. 2008. Preliminary results from the groundfish and shrimp multidisciplinary survey in August 2008 in the northern Gulf of St. Lawrence. *Can. Data Rep. Fish. Aquat. Sci.* 1210 : xi + 73 p.
- DFO. 2008. Proceedings of the Precautionary Approach Workshop on Shrimp and Prawn Canadian Stocks and Fisheries; November 26-27, 2008. *DFO Can. Sci. Advis. Sec. Proceed. Ser.* 2008/031.

FOR MORE INFORMATION

Contact : Louise Savard
Institut Maurice-Lamontagne
850, route de la Mer
C.P. 1000
Mont-Joli, Québec
G5H 3Z4

Tel. : (418) 775-0621
Fax : (418) 775-0740
E-mail : louise.savard@dfo-mpo.gc.ca

This report is available from the:

Center for Science Advice (CSA)
Quebec Region
Fisheries and Oceans Canada
Maurice Lamontagne Institute
P.O. Box 1000, Mont-Joli
Quebec (Canada)
G5H 3Z4

Telephone: (418) 775-0825
Fax: (418) 775-0679
E-Mail: Bras@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas

ISSN 1919-5079 (Print)
ISSN 1919-5087 (Online)
© Her Majesty the Queen in Right of Canada, 2009

La version française est disponible à l'adresse ci-dessus.



CORRECT CITATION FOR THIS PUBLICATION

DFO. 2009. Assessment of shrimp stocks in the Estuary and Gulf of St. Lawrence in 2008. DFO
Can. Sci. Advis. Sec., Sci. Advis. Rep. 2009/001.