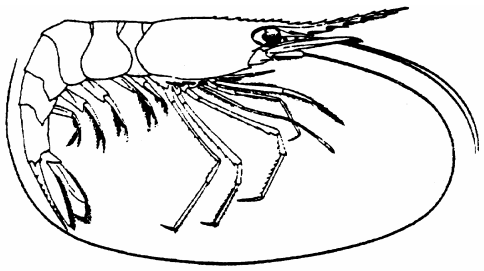
# ASSESSMENT OF SHRIMP STOCKS IN THE ESTUARY AND GULF OF ST. LAWRENCE IN 2011



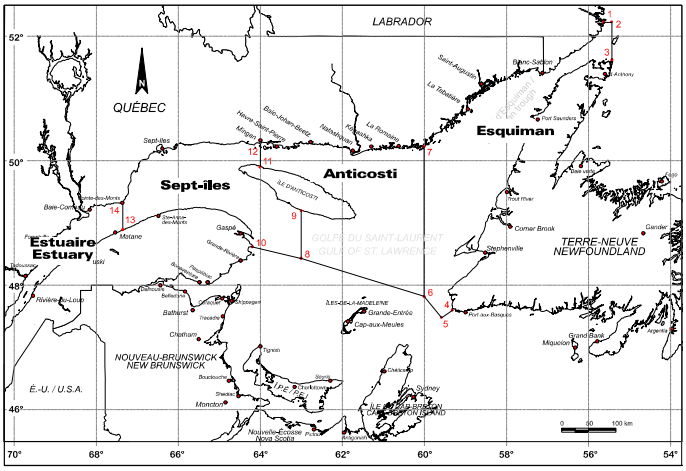



*Figure 1. Shrimp fishing areas in the Estuary and Gulf of St. Lawrence*

## Context

*The northern shrimp (Pandalus borealis) fishery began in the Gulf of St. Lawrence in 1965. The exploitation is conducted by trawlers in four shrimp fishing areas (SFA): Estuary (SFA 12), Sept-Îles (SFA 10), Anticosti (SFA 9) and Esquiman (SFA 8) (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. The essential elements for the establishment of a precautionary approach were examined in peer reviews and in workshops with the industry. The main stock status indicator is calculated from the indices obtained from the fishery in summer and the research survey. Reference points were determined and harvest guidelines were established based on the main indicator and its position in relation to the stock status classification zones (healthy, cautious and critical). These guidelines are consistent with a precautionary approach and could be used to develop decision rules to determine annual TACs.*

## SUMMARY


- In 2011, the TAC decreased by 5% relative to that of 2010 in all areas except in Estuary where it remained the same. The TAC was reached in all areas. The standardized catch rate from the fishery was similar to that of 2010 in Estuary while it decreased in Sept-Iles and increased in Anticosti and Esquiman. The survey biomass index decreased in Sept-Iles and Anticosti but increased in Estuary and Esquiman. The exploitation rate index increased in Sept-Iles and Anticosti and decreased in Estuary and Esquiman.

- The demographic structures show that the individuals likely to change sex during the 2012 winter, were very well represented in the 2011 fishery in the four areas as well as in Estuary and Esquiman survey catches. However, the recent year-classes (2008 and 2009) seemed to be average to low abundance everywhere, excepting the 2009 year-class which was very abundant in Esquiman.

- The main indicator of the stock status is calculated from the summer fishery and research survey indices. The main indicator show that the stocks were in the healthy zone in 2011. However, the stock status indicator increased by more than 40% in Estuary and Esquiman in 2011 relative to 2010 while it decreased by about 25% in Sept-Iles and Anticosti.

- Harvest guidelines were established according to the main indicator and its position in relation to the stock status classification zones (healthy, cautious and critical). These guidelines are compliant with a precautionary approach and could be used in the elaboration of decision rules to determine annual TACs.

# 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 active licences in the Estuary and Gulf shrimp fishery in 2011 was 140. The harvesters come from five provinces and seven First Nations. The 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 at the Department's request (5% coverage). The fishery opens on April 1 and closes on December 31. The fishery has been managed by TAC since 1982 and the traditional fishers have had individual 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 and increased gradually beginning in 1996, totalling over 23,000 tons by the late 1990s and over 36,000 tons in 2010 (Figure 2). In 2011, the TAC was reduced by 5% in all areas except Estuary, where it remained unchanged. Preliminary statistics indicate that the Estuary and Gulf landings were over 34,000 tons in 2011.

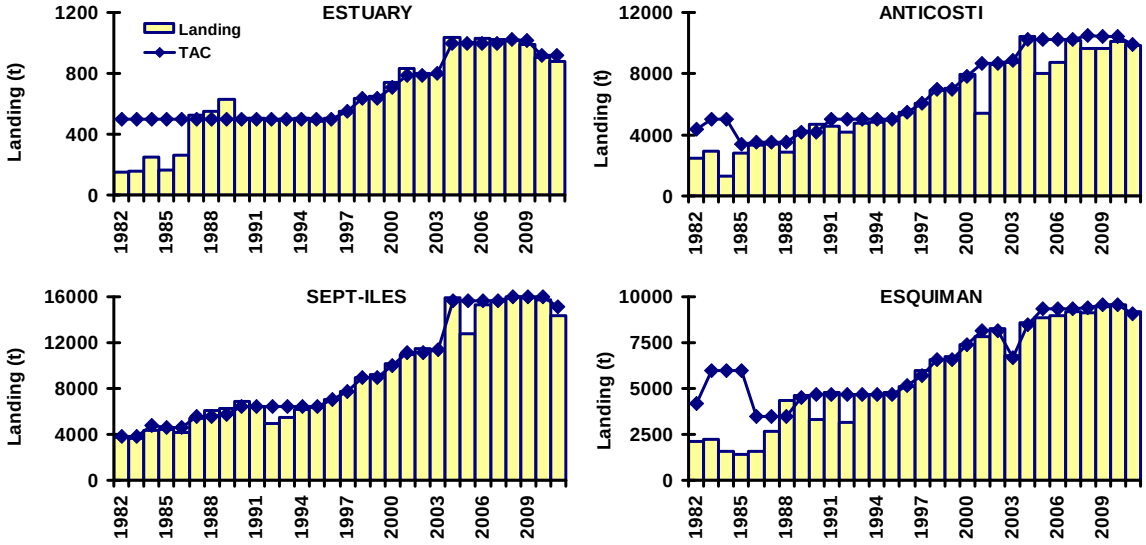



*Figure 2. Landing and total allowable catch (TAC) by fishing area and by year. The 2011 landing data are preliminary.*

## RESOURCE ASSESSMENT

Programs were implemented in the 1980s and 1990s to monitor the fishery and the status of northern shrimp populations in the Estuary and Gulf of St. Lawrence on an annual basis. Commercial fishery statistics (shrimper catch and effort) are used to estimate the fishing effort and calculate catch rates. 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 Department vessel. 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.

### Global Indicators

The sectors that sustain fishing in the four areas have not changed in recent years and correspond to the spots where high concentrations of shrimp were observed during the survey (Figure 3).

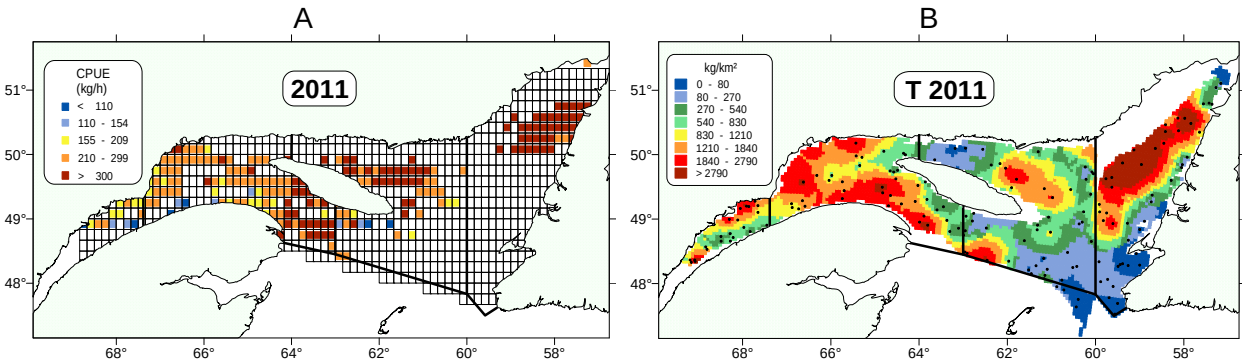



*Figure 3. A) Spatial distribution of catch rates (CPUE) from the shrimp fishery in 2011. B) Spatial distribution of shrimp biomass estimated by kriging during the research survey in 2011.*

There was no noticeable change in the distribution of fishing effort in 2011. In 2011, the total number of fishing hours decreased by 5% in Sept-Îles, 10% in Anticosti and 15% in Esquiman but increased by 25% in Estuary.

Catches per unit effort (CPUE) are standardized to take into account changes in fishery capacity and seasonal fishing patterns. In 2011, the standardized catch rate was similar to that for 2010 in Estuary but it decreased in Sept-Îles and increased in Anticosti and Esquiman (Figure 4). The catch rate was above the mean in all areas except Estuary, where it was similar. It has been decreasing for some years in the Estuary and Sept-Iles areas while it has increased in Esquiman.

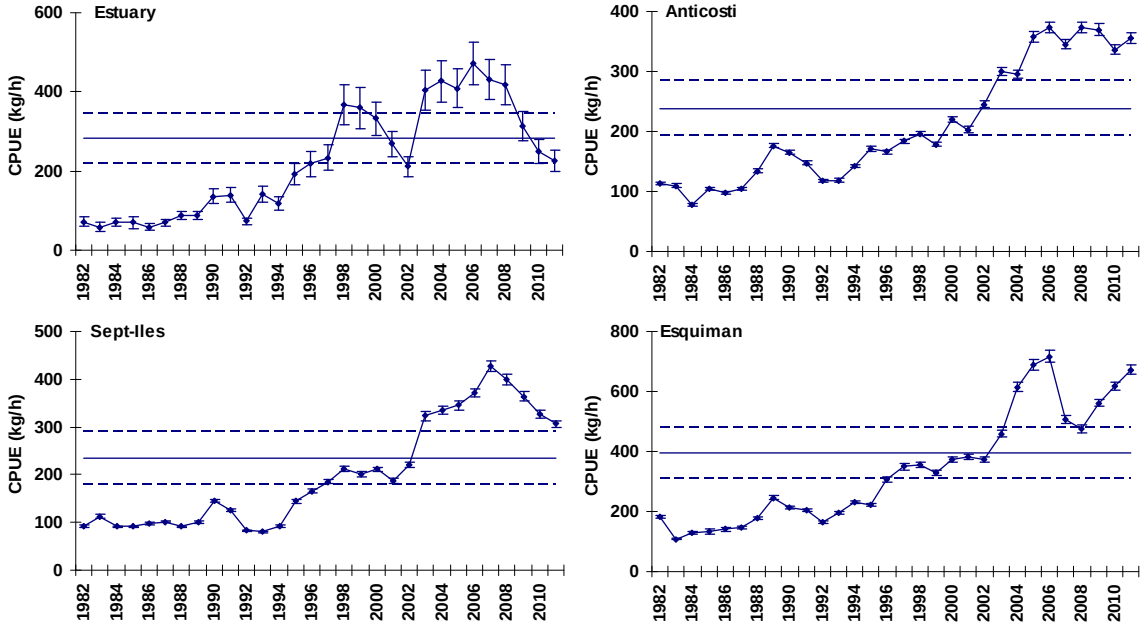



*Figure 4. Standardized catch per unit effort ± confidence interval (95%). The solid horizontal line represents the 1990–2010 mean ± 0.5 standard deviation.*

In 2011, the survey biomass index decreased in Sept-Îles and Anticosti but increased in Estuary and Esquiman (Figure 5). The Sept-Iles area biomass index has decreased in a

sustained way since 2007. The 2011 it is similar to the mean in Estuary while it is lower than the mean in Sept-Îles and Anticosti, and higher than the mean in Esquiman.

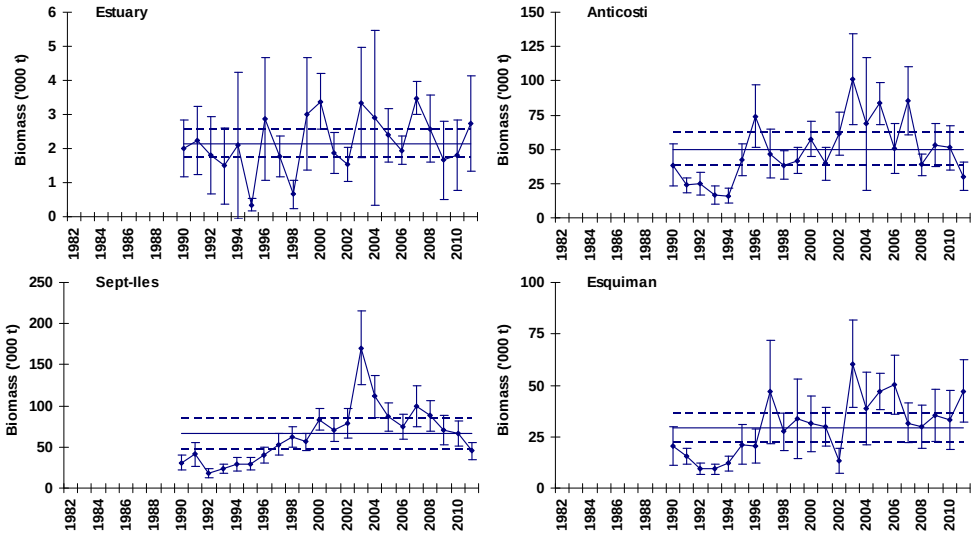



*Figure 5. Biomass index from the research survey ± confidence interval (95%). The solid horizontal line represents the 1990–2010 mean ± 0.5 standard deviation.*

An index of the exploitation rate is obtained by dividing the commercial catches in number by the abundance estimated from the research survey. This method cannot be used to estimate the absolute exploitation rate or to relate it to target exploitation rates. However, the method does make it possible to track relative changes in the exploitation rate over the years. The exploitation rate index increased in 2011 in Sept-Îles and Anticosti but decreased in Estuary and Esquiman (Figure 6). The index shows a sustained increase in Sept-Iles since 2007. In 2011, it is above the mean in Sept-Îles and Anticosti, while it is similar to the mean in Estuary and below it in Esquiman.

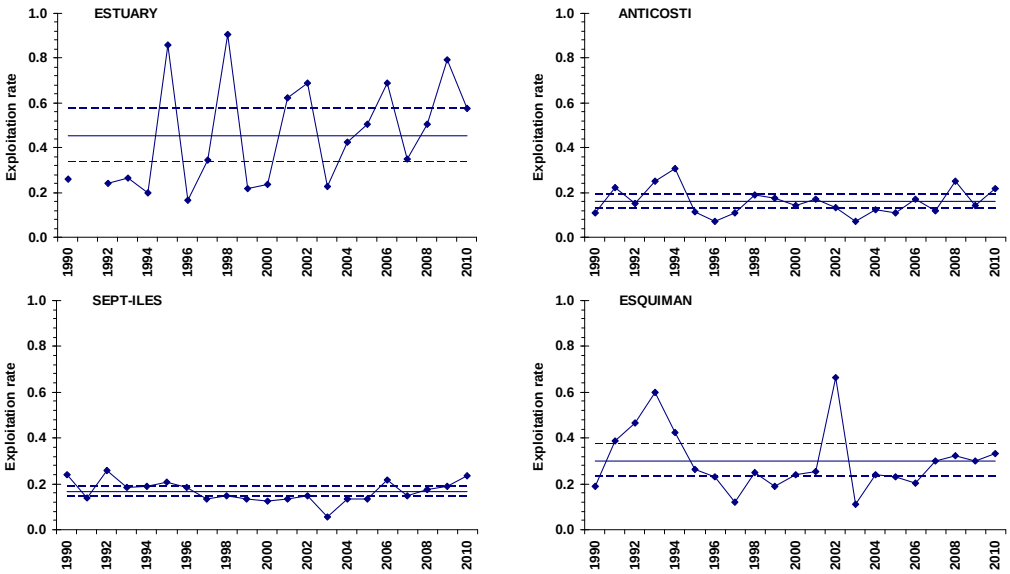



*Figure 6. Index of the exploitation rate by fishing area and by year. The solid horizontal line represents the 1990–2010 mean ± 0.5 standard deviation.*

## Main Stock Status Indicator

The quantity of (primiparous) females recruited in a given year depends on the number of males that changed sex in the preceding winter. The abundance of reproductive females which will hatch the larvae in spring can be predicted from the reproductive stock estimated in summer and made up of primiparous females that have just changed sex and of multiparous females that survived reproduction and larvae hatching.

The main indicator of stock status is calculated from the male and female indices obtained from the summer fishery (number per unit effort for June, July and August) and research survey (abundance). In order to combine the indices, each is first standardized with respect to the 1990–1999 period (annual value of the index divided by the 1990–1999 geometric mean). An integrated index by sex is obtained by calculating the mean between the index from the fishery and the index from the survey. The main stock status indicator represents the mean of the integrated indices by sex (Figure 7).

A peer review held on November 2, 2011, examined new points of reference based on the main indicator used to assess the status of the resource in each fishing area (Figure 7). New limit and upper stock reference points that define the healthy, cautious and critical zones of a stock's status will be used to define a precautionary approach to Gulf shrimp stock management.

The main stock status indicator shows that stocks were in the healthy zone in 2011. However, the stock status indicators for Estuary and Esquiman increased by 88 and 44%, respectively, in 2011 compared to 2010, whereas the indicators for Sept-Îles and Anticosti decreased by 21 and 26%, respectively. The Sept-Îles stock status indicator has shown a decreasing trend for some years.

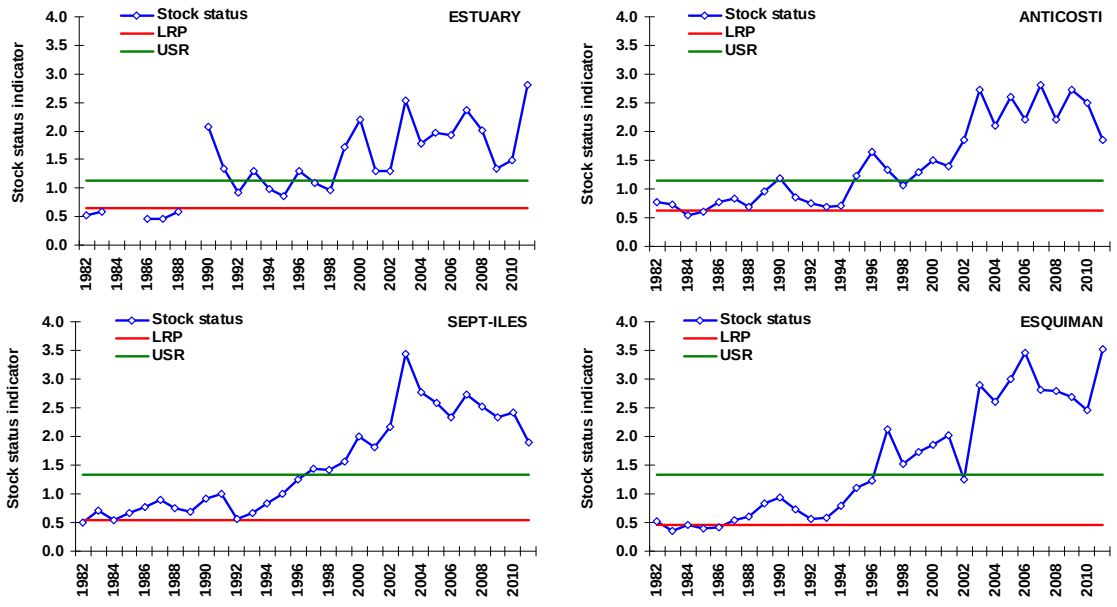



*Figure 7. Main stock status indicator by year and limit and upper stock reference points for each fishing area.*

## Outlook

It is possible to obtain an estimate of the relative abundance of the year classes by examining their contribution to the research survey catches (Figure 8). The year classes are identified by the year of their birth and their progression through the years can be followed with the arrows. The range of sizes at which males may change sex during the winter following the survey is also identified by a horizontal bracket. The abundances for the Estuary area correspond to those estimated for the area that was extended in 2008 (see Sources of Uncertainty).

In 2011, the 2007 year class seemed more abundant than the mean in Estuary and Esquiman and less abundant than the mean in Sept-Îles and Anticosti. The 2008 and 2009 year classes seem to be of average to low abundance in all areas except Esquiman. One-year-old individuals (year class 2010) were well represented in catches in the survey in the Esquiman area.

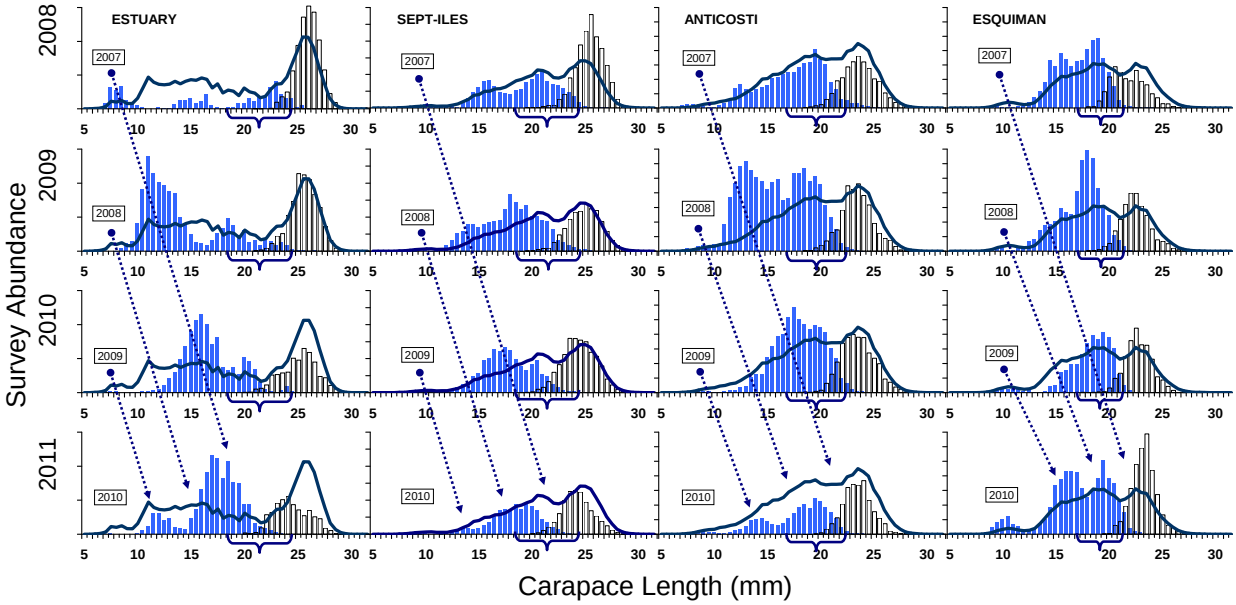



*Figure 8. Abundance from the research survey (in number) by length class and by fishing area from 2008 to 2011. The histograms represent males (dark) and females (light) and the solid line represents the mean of the years 1990–2010 (2008–2011 for the Estuary area).*

## Sources of Uncertainty

The allocation of supplementary stations in the Estuary shallow waters since 2008 had a very significant impact on the catches of males and females in the Estuary fishing area. The results obtained after four surveys conducted on this extended area are consistent among the years and indicate that the abundance in the Estuary area is much greater than that previously estimated and that the exploitation rate index is much lower. However, the series is still too short to be able to identify with certainty trends in the abundance or biomass of the stock.

## CONCLUSIONS AND ADVICE

The use of the main indicator leads to conclusions similar to those obtained with the informal method used to assess stock status and make TAC recommendations. Without the analytical model for estimating mortality by fishery, harvest guidelines were established based on the relationship observed between the main stock status indicator for one year and the harvest for the following year. A modulation of this relationship according to the different stock status zones made it consistent with a precautionary approach (Figure 9). The harvest rate when the stock is in the healthy zone corresponds to a stable exploitation rate equal to the mean rate observed between 1990 and 2010. The harvest rate decreases in the cautious zone and the critical zone, where it is stable at a value four times smaller than that of the healthy zone. These guidelines can help in the development of decision rules for determining annual TACs as part of the implementation of the precautionary approach for shrimp fishing in the Estuary and northern Gulf of St. Lawrence.

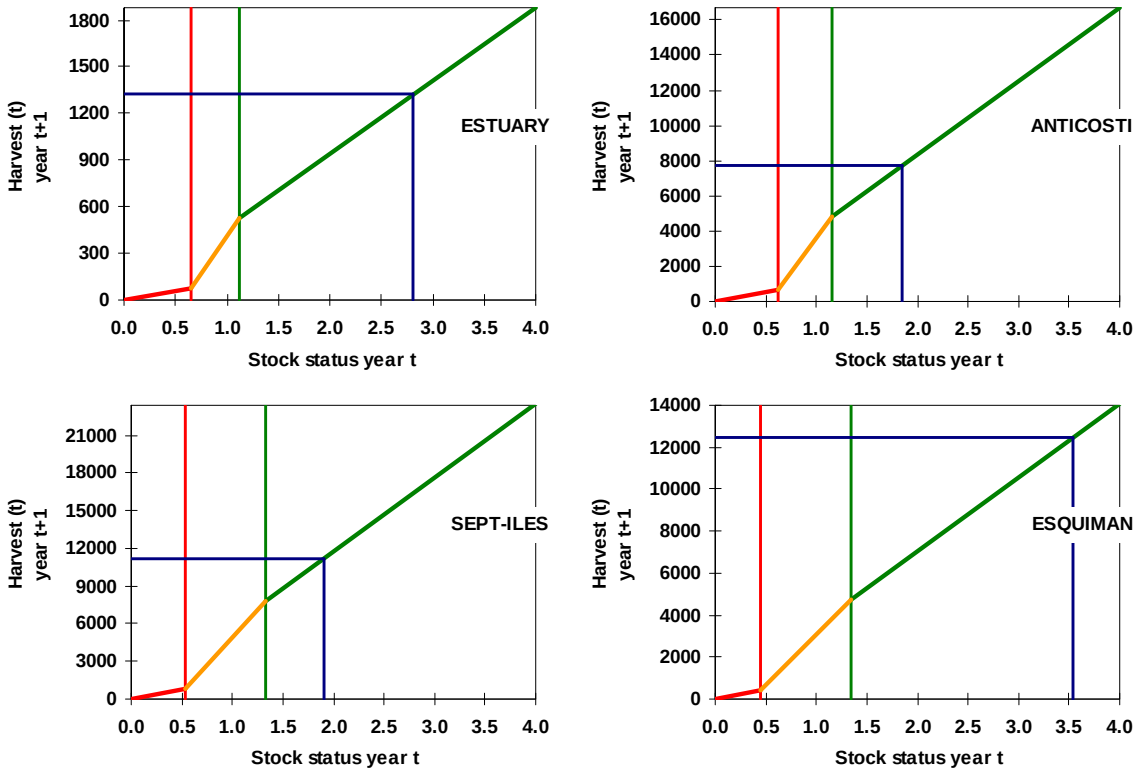



*Figure 9. Harvest guidelines by fishing area. The projected harvest for 2012 is shown in view of the main stock indicator in 2011.*

## OTHER CONSIDERATIONS

By-catches of small fish in the shrimp fishery between 1999 and 2011 were examined from the at-sea observer database. Fish by-catches were predominantly in the range of 1 kg or less per species and per sampled tow. In 2011, shrimp fishery by-catches represented catches of about 82 tons (2.3 million individuals) for turbot, 16 tons (500 000 individuals) for

redfish, 10 tons (100 000 individuals) for cod and 190 tons (13 million individuals) for capelin.

## SOURCES OF INFORMATION

This Science Advisory Report is from the Fisheries and Oceans Canada Canadian Science Advisory Secretariat regional advisory meeting of January 26, 2012 on Assessment of Estuary and Gulf of St. Lawrence Shrimp Stocks. Additional publications from this process will be posted as they become available on the DFO Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs /index-eng.htm.

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## FOR MORE INFORMATION

Contact: Louise Savard
Maurice Lamontagne Institute
850 route de la Mer
P.O. Box 1000
Mont-Joli, Quebec
G5H 3Z4

Tel.: 418-775-0621
Fax: 418-775-0740
Email: louise.savard@dfo-mpo.gc.ca

This report is available from the:

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

Telephone: 418-775-0825
Fax: 418-775-0679
Email: bras@dfo-mpo.gc.ca
Internet Address: www.dfo-mpo.gc.ca/csas

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