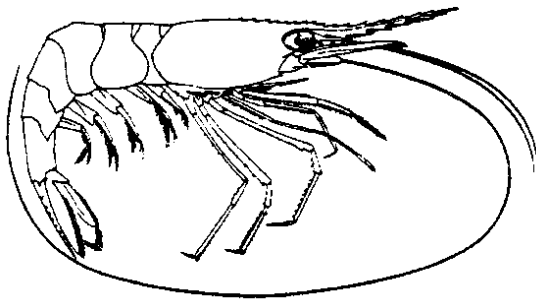




ASSESSMENT OF NORTHERN SHRIMP STOCKS IN THE ESTUARY AND GULF OF ST. LAWRENCE IN 2013



Northern Shrimp

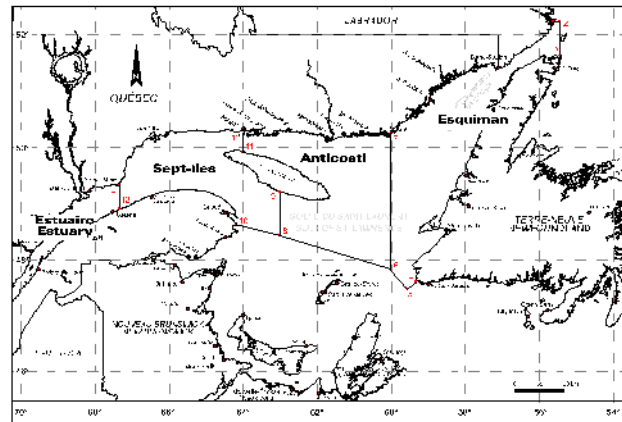


Figure 1. Shrimp fishing areas in the Estuary and Gulf of St. Lawrence.

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-Iles (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 adopted in 2012. 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. Once the harvest is projected, decision rules are applied to determine the TAC.

This Science Advisory Report is from the January 23, 2014 meeting on Assessment of Estuary and Gulf of St. Lawrence Shrimp Stocks. Additional publications from this meeting will be posted on the [Fisheries and Oceans Canada \(DFO\) Science Advisory Schedule](#) as they become available.

SUMMARY

- Since the establishment of a precautionary approach in 2012, the TAC has been adjusted annually in each area by a decision rule. In 2013, the TAC was increased by 15% in Estuary and Sept-Iles and reduced by 9% in Anticosti and 10% in Esquiman.
- In 2013, a total of 32,160 t was landed against a TAC of 33,112 t.
- The same areas are fished by shrimp harvesters from one year to the next. Since 2003, total fishing effort has been slightly below the historical average.

- The fishery's standardized catch rate decreased in Estuary from 2007 to 2010 and was average thereafter. In Sept-Iles, the catch rate has decreased since 2007 but remained above the historical average in 2013. It has been consistently stable and high since 2005 in Anticosti and Esquiman.
- DFO's survey biomass index decreased in the Estuary, Sept-Iles and Anticosti between 2007 and 2011 and remained stable thereafter. In Esquiman, the biomass index has been stable since 2007.
- The exploitation rate index increased in Estuary and Sept-Iles but decreased in Anticosti and Esquiman.
- The demographic structures show that males likely to change sex during the winter of 2014 were well represented in 2013 survey in Sept-Iles, Anticosti and Esquiman, but not in the Estuary. The recent year classes (2010 and 2011) seemed to be of low abundance in Estuary, Sept-Iles and Anticosti, but of average abundance in Esquiman.
- Bycatches represent between 1.0 and 2.6% (in weight) of Northern Shrimp catches for the period of 2000 to 2013. Estimated total catches for each species in these bycatches represent less than 1% of the biomass estimates in the DFO survey for each of them.
- The main indicator of stock status is calculated from the indices obtained from the summer fishery and the research survey. This indicator shows that the stocks were in the healthy zone in 2013. However, relative to 2012, the stock status indicator in 2013 decreased by 45%, 25% and 12% in Estuary, Sept-Iles and Esquiman, respectively, and increased by 19% in 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) in compliance with the precautionary approach. According to the guidelines, the projected harvest for 2014 is 802 t for Estuary, 10,570 t for Sept-Iles, 9,100 t for Anticosti and 8,248 t for Esquiman.
- Decision rules are agreed to calculate TAC from the main stock status indicator.

INTRODUCTION

Species Biology

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

Northern 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 and metamorphose and settle to the bottom at the end of the summer. Northern 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, Northern 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 Northern Shrimp fishery in 2013 was 132. 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 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 DFO'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 in the early 1970s to more than 35,000 tons in the late 2010s (Figure 2). Landings decreased thereafter to reach 32,000 tons in 2012. Preliminary statistics indicate that the Estuary and Gulf landings were 32,160 tons in 2013, of which 1,117 tons in Estuaire, 14,217 tons in Sept-Îles, 7,681 tons in Anticosti and 9,145 tons in Esquiman. In 2013, the TAC was increased by 15% in Estuaire and Sept-Îles and reduced by 9% in Anticosti and 10% in Esquiman (Figure 3). The landings reached 96% of TAC in all areas except in Estuaire where it represents 92% of the TAC, but the data are preliminary. The proportion of fishing effort between seasons spring, summer and autumn seems constant between years, with the exception of the Estuaire area for the last three years where the fishing effort in the spring has significantly reduced for the benefit of both other seasons.

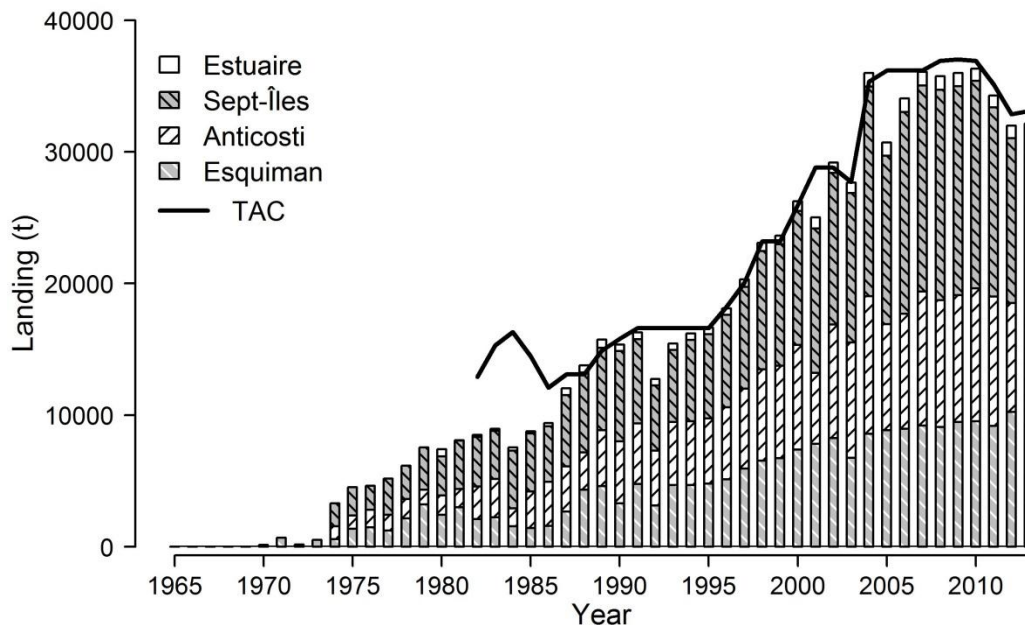


Figure 2. Landing and total allowable catches (TAC) by fishing area and by year. The 2013 landing data are preliminary.

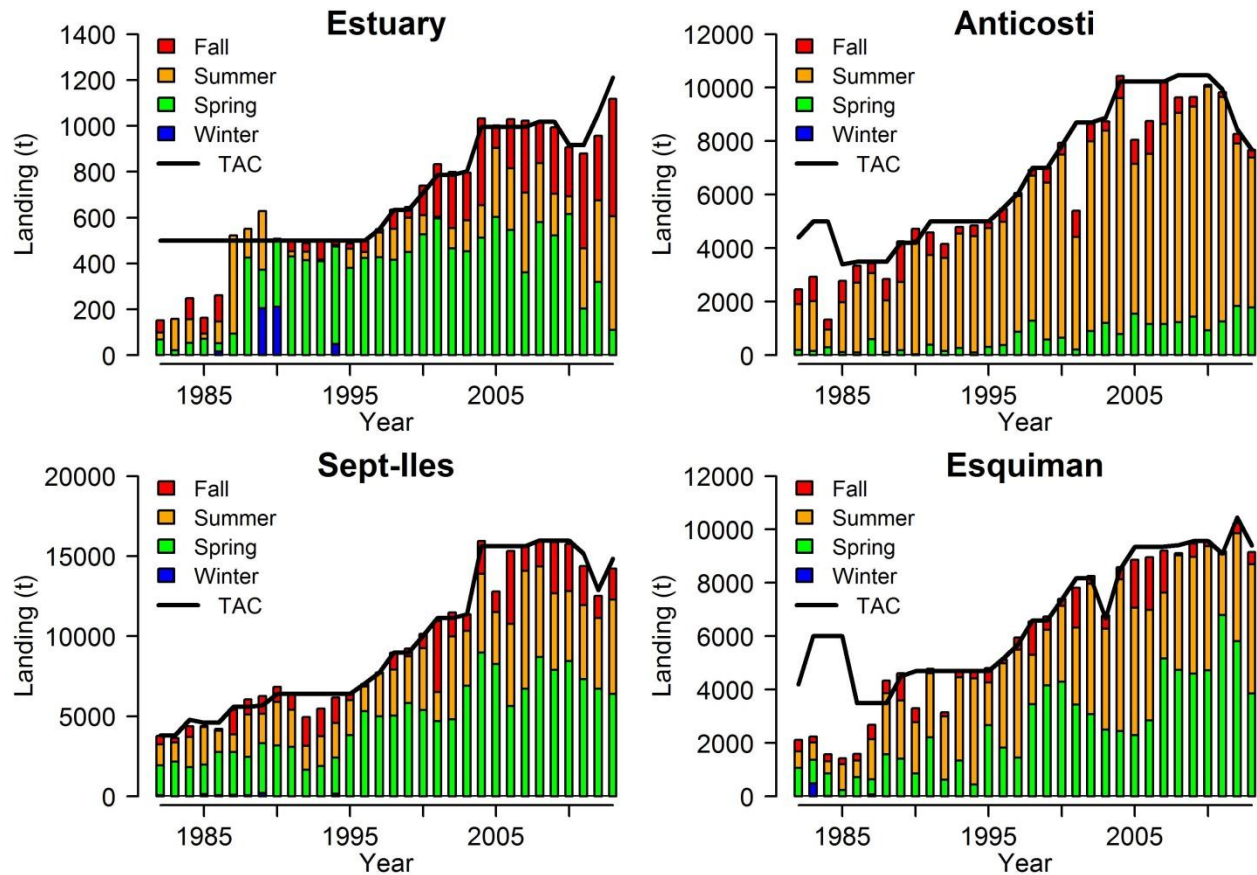


Figure 3. Seasonal landing and total allowable catches (TAC) by fishing area and by year. The 2013 landing data are preliminary.

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 DFO 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 4). The distribution of the biomass from the research survey shows that high concentrations of Shrimp were found in all fishing areas in 2013. However, as before, the southern sector of Anticosti and Esquiman areas sustained very few Shrimp.

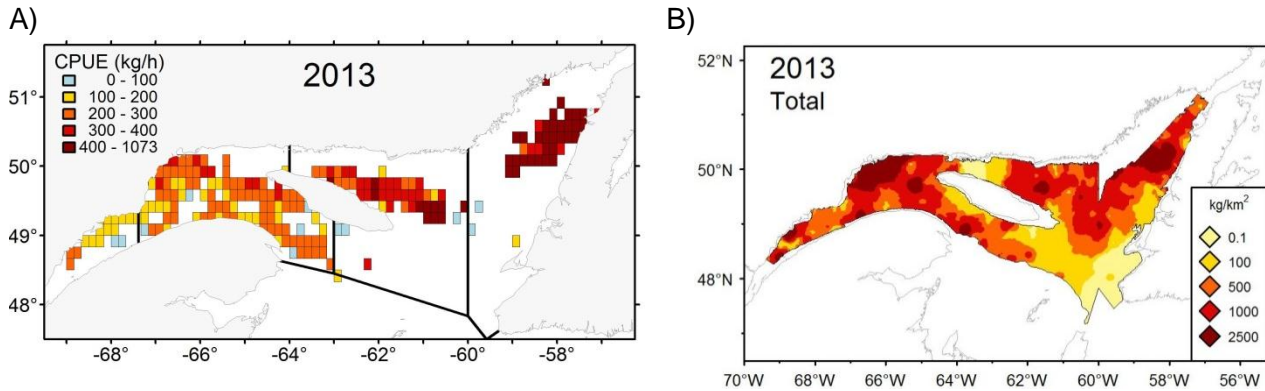


Figure 4. A) Spatial distribution of catch rates (CPUE) from the Shrimp fishery in 2013. B) Spatial distribution of Shrimp biomass estimated by kriging during the research survey in 2013.

There was no significant change in the distribution of fishing effort in 2013 (Figure 5A). The same areas are fished by shrimp harvesters from one year to the next. Since 2003, the total annual fishing effort was around 100,000 hours, which is slightly below the historical average (Figure 5B).

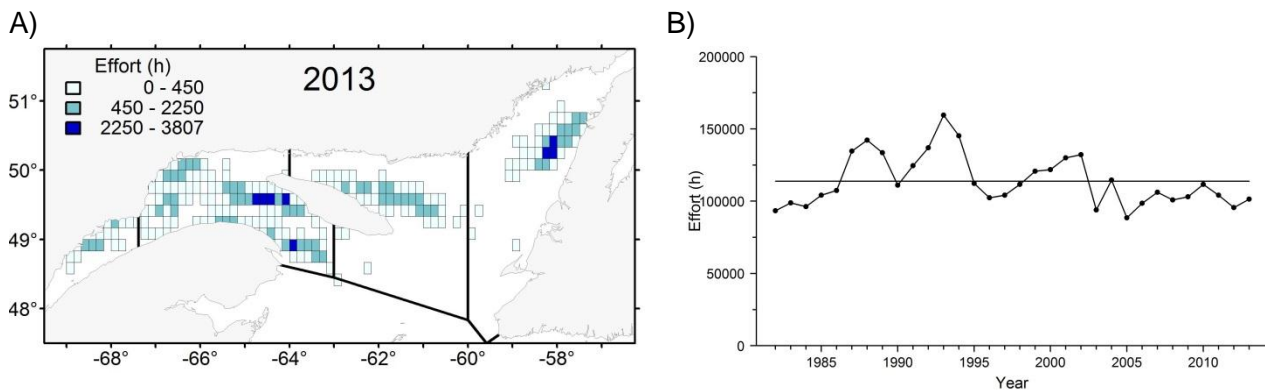


Figure 5. A) Spatial distribution of fishing effort in 2013. B) Total number of fishing hours by year for the Estuary and Gulf of St. Lawrence.

Catches per unit effort (CPUE) are standardized to take into account changes in fishery capacity and seasonal fishing patterns. The fishery's standardized catch rate decreased in Estuary from 2007 to 2010 and was average thereafter (Figure 6). In Sept-Iles, the catch rate has decreased since 2007 but remained above the historical average in 2013. It has been consistently stable and high since 2005 in Anticosti and Esquiman.

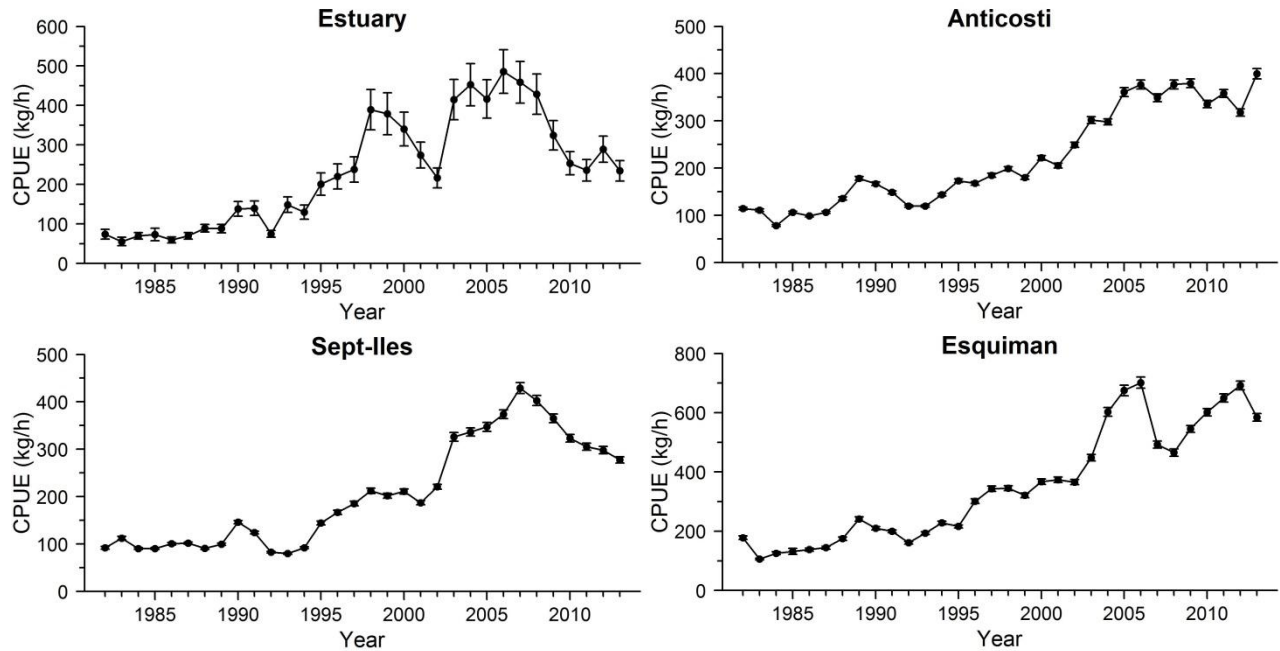


Figure 6. Standardized catch per unit effort (CPUE) from the fishery \pm confidence interval (95%).

DFO's survey biomass index decreased in the Estuary, Sept-Iles and Anticosti between 2007 and 2011 and remained stable thereafter. In Esquiman, the biomass index has been stable since 2007 (Figure 7).

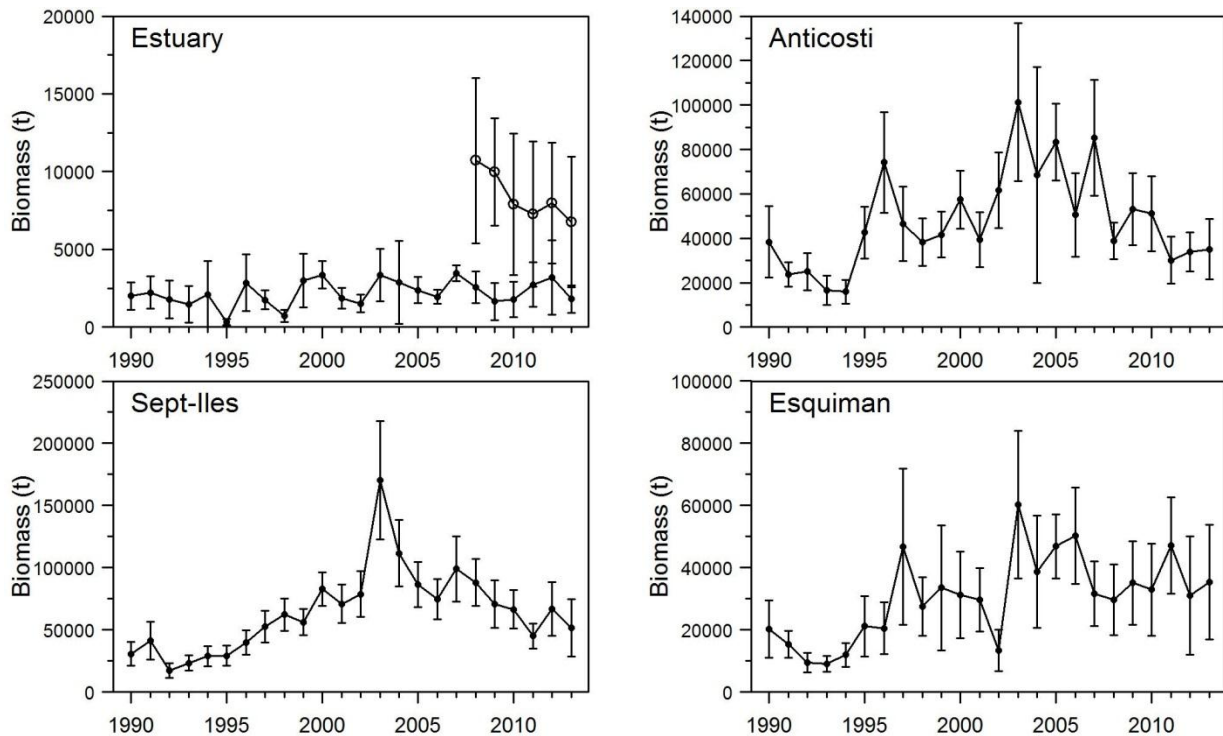


Figure 7. Biomass index from the research survey \pm confidence interval (95%). For Estuary, open circles show the results obtained when adding strata in shallow waters in 2008.

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 Estuary and Sept-Iles but decreased in Anticosti and Esquiman (Figure 8).

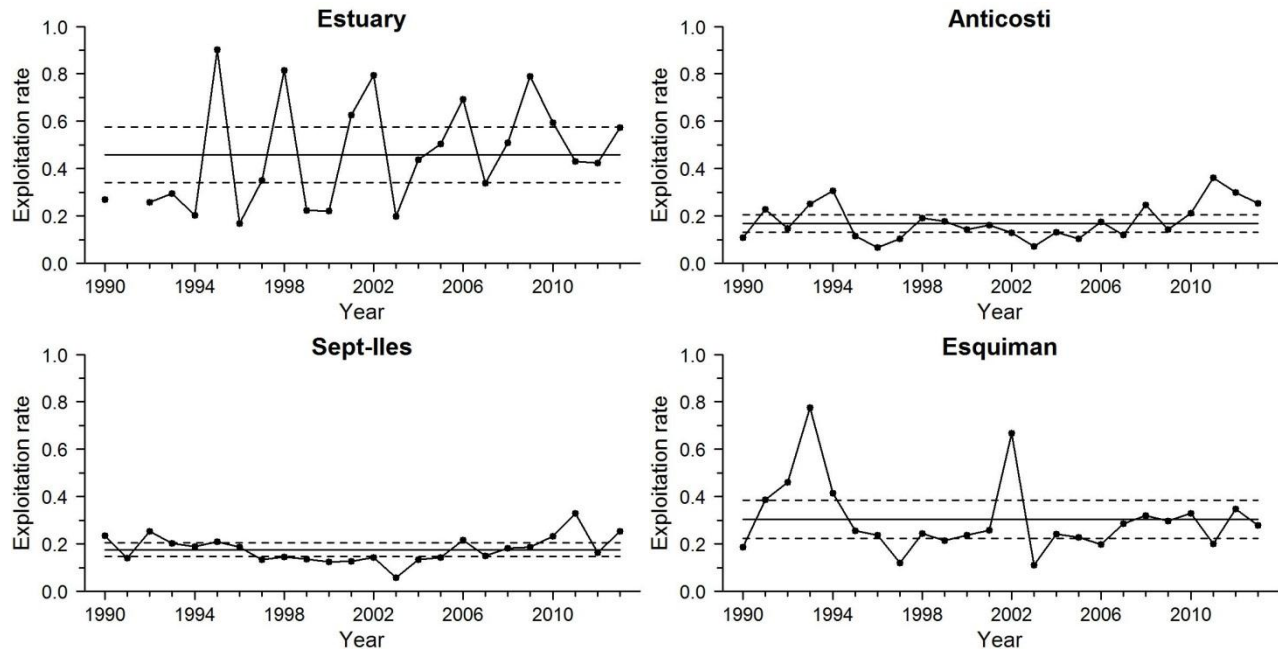


Figure 8. Index of the exploitation rate by fishing area and by year. The solid horizontal line represents the 1990-2011 mean \pm 0.5 standard deviation.

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 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 standardized with respect to the reference period. The main stock status indicator represents the mean of the four indices (Figure 9).

The main indicator shows that the stocks were in the healthy zone in 2013. However, relative to 2012, the stock status indicator in 2013 decreased by 45%, 25% and 12% in Estuary, Sept-Iles and Esquiman, respectively, and increased by 19% in Anticosti. The Sept-Iles stock status indicator has shown a decreasing trend for some years.

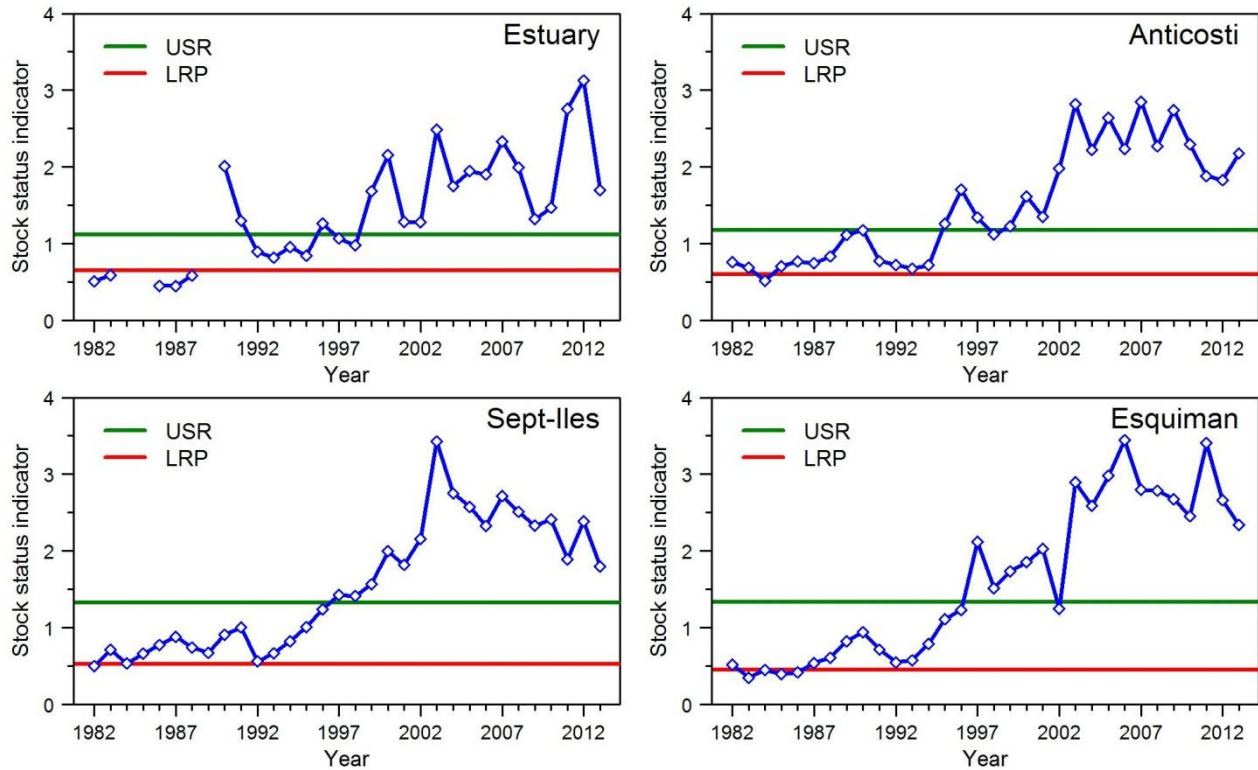


Figure 9. Main stock status indicator by year and limit (LRP) and upper (USR) stock reference points for each fishing area.

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 10). The abundances for the Estuary area correspond to those estimated for the area that was extended in 2008 (see Sources of Uncertainty).

The demographic structures show that males likely to change sex during the winter of 2014 were well represented in 2013 survey in Sept-Iles, Anticosti and Esquiman, but not in the Estuary. The recent year classes (2010 and 2011, carapace length of 8 to 20 mm) seemed to be of low abundance in Estuary, Sept-Iles and Anticosti, but of average abundance in Esquiman.

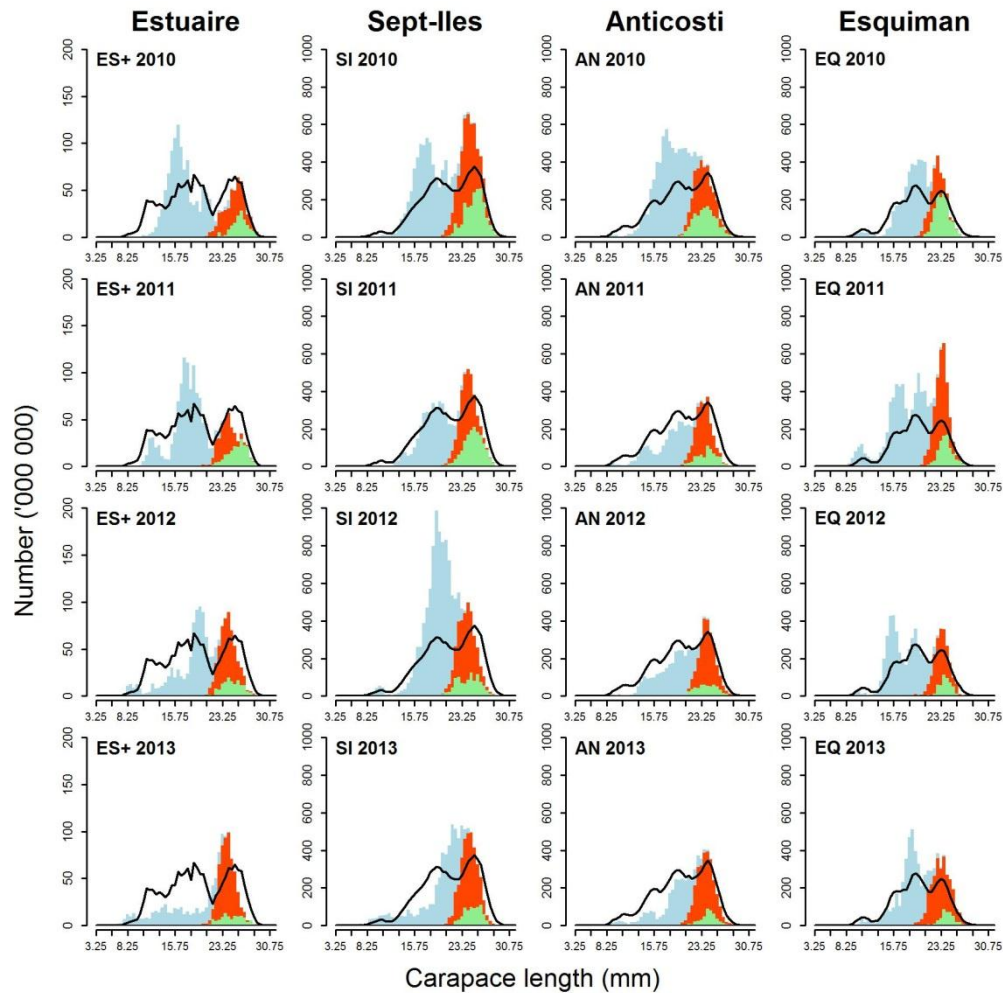


Figure 10. Shrimp abundance from the research survey (in number) by length class and by fishing area from 2010 to 2013. The histograms represent males (in blue), primiparous females (in red) and multiparous females (in green) and the solid line represents the mean of the years 1990-2011 (2008-2011 for 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 six 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. In the short term, shallow strata should be integrated into estimates of the main indicator of stock status.

The industry said that the fishing pattern had changed in the Esquiman area in 2013 because of the presence of White Shrimp (*Pasiphaea multidentata*). Fishermen had to focus on practicing their activity in deeper waters in order to decrease catches of this species; which could have had an impact on catch per unit effort. Changes in fishing effort distribution are occasionally observed either to avoid bycatches or to focus activities on areas where shrimp is more abundant. Spatial distribution of fishing effort is not considered in the CPUE estimate.

CONCLUSIONS AND ADVICE

The purpose of the precautionary approach adopted in 2012 is to maintain a constant exploitation rate when the stock is in the healthy zone. TAC variations in the past two years were reflected through exploitation rate variations in the same directions, which maintained or came close to exploitation rates near historical averages.

Harvest guidelines were established according to the main indicator and its position in relation to the stock status classification zones (healthy, cautious and critical) in compliance with the precautionary approach. According to the guidelines, the projected harvest for 2014 is 802 t for Estuary, 10,570 t for Sept-Iles, 9,100 t for Anticosti and 8,248 t for Esquiman.

The 2014 TACs will be determined from these harvests according to the decision rules adopted in 2012.

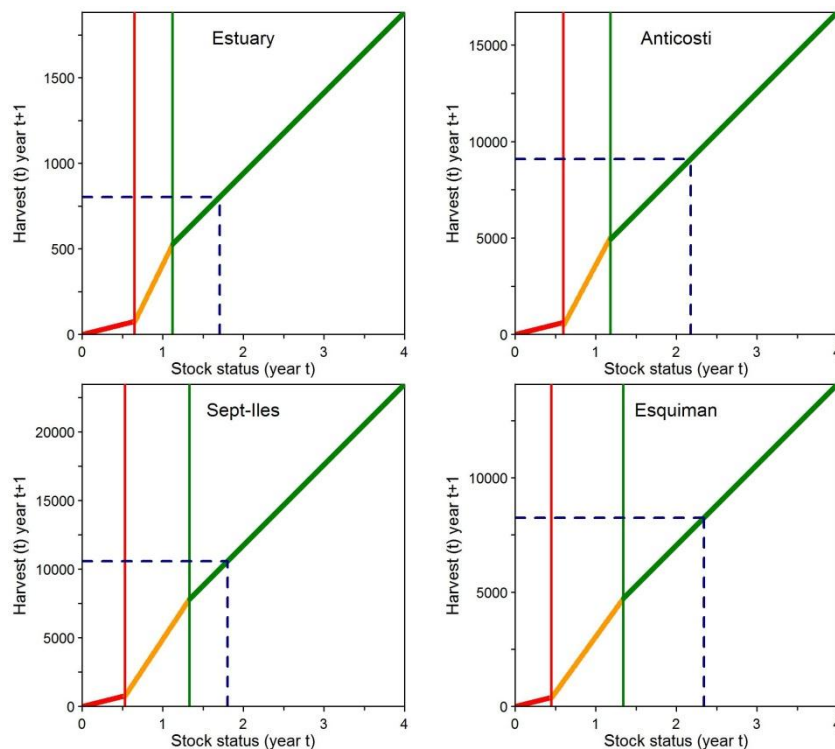


Figure 11. Harvest guidelines by fishing area. The projected harvest for 2014 is shown in view of the main stock indicator in 2013.

OTHER CONSIDERATIONS

Bycatches of small fish in the shrimp fishery between 2000 and 2013 were examined from the at-sea observer database. Fish bycatches were predominantly in the range of 1 kg or less per species and per sampled tow. In 2013, the bycatches in the Shrimp fishery have risen well above average to reach 800 tons and accounted for 2.6% by weight of the catch of Northern Shrimp (Figure 12). This increase is mainly due to a significant increase in catches of redfish of 6 to 10 cm in length. The main species in the catch in 2013 in order of importance are Redfish, Capelin, Greenland Halibut, Herring, Cod and American plaice. Estimated total catches for each species in these bycatches represent less than 1% of the biomass estimates in the DFO survey for each of them.

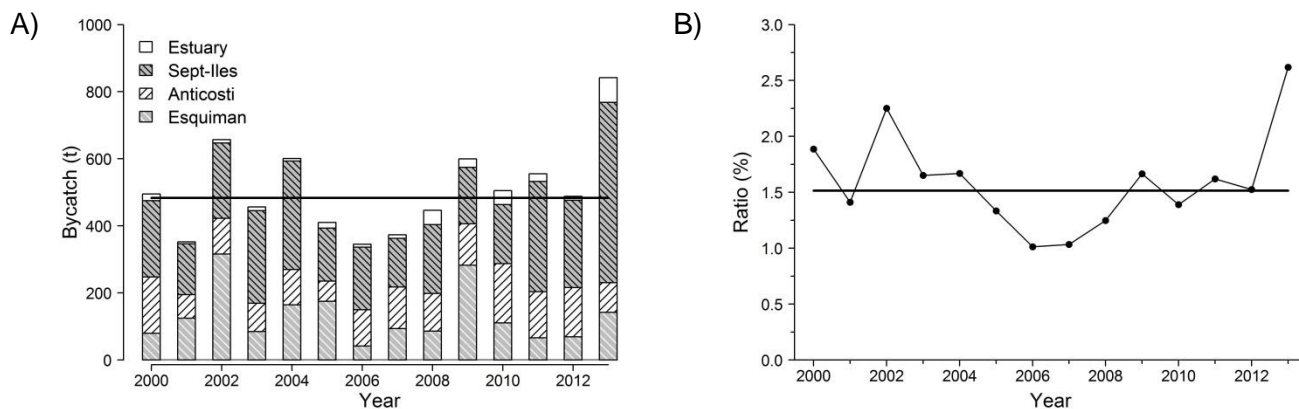


Figure 12. A) Bycatches for all species for each year and shrimp fishing area during fishing activities directed at Northern Shrimp and in the presence of an at-sea observer. B) Ratio (%) of bycatches to total Northern Shrimp catches. Solid lines indicate the average for the years 2000 to 2011.

In recent years, deep water temperature has increased for the entire Gulf. The warming of waters at 300 m observed in the northwestern and central Gulf for three to four years should persist for another one to two. The colder temperature at the same depth in the estuary in recent years has now returned to normal and should increase in the next three to four years. In 2013, a return to a lower temperature was observed in the Cabot Strait at 200 and 300 m; this could lead to a return to normal in the Gulf in the next few years. These temperature changes may have an impact on shrimp population dynamics through, among other things, effects on growth, reproduction and trophic relationships.

SOURCES OF INFORMATION

This Science Advisory Report is from the January 23, 2014 meeting on Assessment of Estuary and Gulf of St. Lawrence Shrimp Stocks. Additional publications from this meeting will be posted on the [Fisheries and Oceans Canada \(DFO\) Science Advisory Schedule](#) as they become available.

Bourdages, H. and Marquis, M.C. 2014. Assessment of Northern Shrimp stocks in the Estuary and Gulf of St. Lawrence in 2013: commercial fishery data. DFO Can. Sci. Advis. Sec. Res. Doc. 2014/051. v + 90 p.

Bourdages, H. and Marquis, M.C. 2014. Assessment of Northern Shrimp stocks in the Estuary and Gulf of St. Lawrence in 2013: survey data. DFO Can. Sci. Advis. Sec. Res. Doc. 2014/050. v + 38 p.

DFO 2011. [Reference points consistent with the precautionary approach for northern shrimp in the Estuary and Gulf of St. Lawrence](#). DFO Can. Sci. Advis. Sec., Sci. Advis. Rep. 2011/062.

DFO. 2012. [Assessment of the impact of northern shrimp trawling on benthic habitats communities in the Estuary and northern Gulf of St. Lawrence](#). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/054.

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Galbraith, P.S., Chassé, J., Larouche, P., Gilbert, D., Brickman, D., Pettigrew, B., Devine, L., and Lafleur, C., 2012. [Physical oceanographic conditions in the Gulf of St. Lawrence in 2012](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2013/026. v + 89 p.

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