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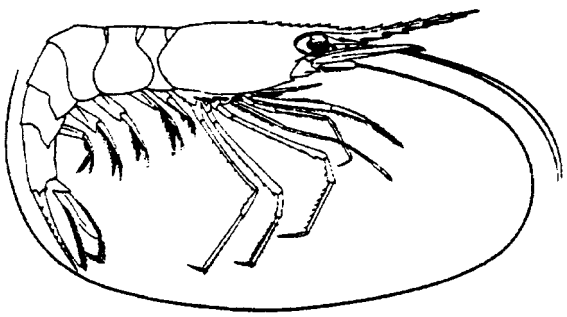
SHRIMP OF THE ESTUARY AND GULF OF ST. LAWRENCE IN 2004



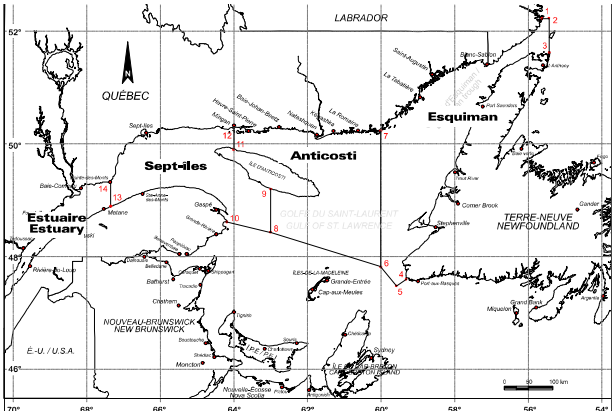


Figure 1: Shrimp fishing areas in the Estuary and the Gulf of St. Lawrence.

Context

The northern shrimp 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: Estuary, 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 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

- The landings went from 27,700 t in 2003 to 36,100 t in 2004 following a 27.5% increase in the TAC.

- In 2004, the catches per unit of effort (CPUE) for the four areas were higher than the 1990-1999 mean while the fishing effort was similar to the mean. The CPUE was higher in 2004 than in 2003 in Esquiman and similar in the other three areas. The fishing effort increased in 2004 relative to 2003 in all areas except in Esquiman where it decreased.

- The data from the 2004 research survey conducted on the *CGS Teleost* could not be used because there has been no calibration with the *CGS Needler* previously used. The exploitation rate index is therefore not available in 2004.

- The mean size of females in 2004 was once again below the 1990-1999 mean in all areas, but the decreasing tendency observed between 1992 and 2001 has stopped. The mean size of spawning females in 2005 could be at or below the minimum observed in all areas.

- The fishery in 2004 was sustained mainly by the very abundant 1999 year-class and this year-class should sustain the fishery again in 2005. The 2000 and 2001 year-classes seem to be of average abundance. Projections based on relationships between the catch rates of a given year and those of the next year suggest that the catch rates will be high in 2005 in all areas.

- In the Estuary, Sept-Îles and Anticosti areas, the fishery abundance indices have stabilized while they have again increased in Esquiman. However, the catches in Esquiman include of a large proportion of males, which represent the future recruitment.

- Given the strong increase in TACs in 2004 as well as the uncertainty that arises from the lack of research survey indices, the status quo is recommended in all areas for the 2005 TACs.

- Starting in 2006, it is likely that the abundance of shrimp will decrease relative to the 2003-2004 historical peaks because the 2000 and 2001 year-classes are of average abundance (while those of 1997 and 1999 were very abundant). Furthermore, the Greenland halibut biomass and the resulting mortality by predation on the shrimp have increased since the mid 1990s.

DESCRIPTION OF THE ISSUE

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 spring but settle on the bottom in late summer. Shrimp migrations are associated with breeding (the berried 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 in the northern Gulf of St. Lawrence at depths of 150 to 350 m.

Description of the Fishery

In 2004, there were 112 permanent shrimp licenses in the Estuary and the Gulf. In addition, since 1997, temporary allocations have been granted to shrimpers without permanent licenses. Other management tools include a minimum mesh size (40 mm) and, since 1993, the compulsory use of the Nordmore grate, which reduces groundfish by-catches significantly. The shrimp fishery runs from April 1 to December 31.

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. They reached nearly 15,000 tons by the late 1980s, and were over 23,000 tons by the late 1990s. The TACs were increased by 27.5 % in 2004. Preliminary statistics indicate that the Gulf landings reached 36,000 tons in 2004 and that the TACs were reached in all areas (Table 1).

Table 1. Catch and total of allowable catch (TAC) in tons by fishing area and by year. 2004 data are preliminary.

Year	Estuary		Sept-Iles		Anticosti		Esquiman		Gulf
	Catch	*TAC*	**Catch**	*TAC*	**Catch**	*TAC*	**Catch**	*TAC*	**Catch**
1990	**507**	*500*	**6839**	*6400*	**4723**	*4200*	**3303**	*4700*	**15372**
1991	**505**	*500*	**6411**	*6400*	**4590**	*5000*	**4773**	*4700*	**16279**
1992	**489**	*500*	**4957**	*6400*	**4162**	*5000*	**3149**	*4700*	**12757**
1993	**496**	*500*	**5485**	*6400*	**4791**	*5000*	**4683**	*4700*	**15455**
1994	**502**	*500*	**6165**	*6400*	**4854**	*5000*	**4689**	*4700*	**16210**
1995	**486**	*500*	**6386**	*6400*	**4962**	*5000*	**4800**	*4700*	**16634**
1996	**505**	*500*	**7014**	*7040*	**5469**	*5500*	**5123**	*5170*	**18111**
1997	**549**	*550*	**7737**	*7744*	**6058**	*6050*	**5957**	*5687*	**20301**
1998	**634**	*633*	**8981**	*8966*	**6932**	*7004*	**6554**	*6584*	**23101**
1999	**634**	*633*	**9058**	*8966*	**6884**	*7004*	**6603**	*6584*	**23179**
2000	**725**	*709*	**9907**	*10042*	**7760**	*7844*	**7184**	*7374*	**25576**
2001	**812**	*786*	**10687**	*11136*	**5294**	*8700*	**7581**	*8178*	**24374**
2002	**784**	*786*	**11270**	*11136*	**8470**	*8700*	**8090**	*8178*	**28614**
2003	**796**	*802*	**11357**	*11360*	**8740**	*8874*	**6773**	*6674*	**27666**
2004	**1033**	*995*	**15932**	*15611*	**10439**	*10226*	**8601**	*8502*	**36005**

RESOURCE ASSESSMENT

Stock status was determined by examining a number of indicators from the commercial fishery and research surveys. These indicators are based on fishing success, stock abundance and resource productivity. To assess stock status in 2004, we compared each indicator to the mean value for 1990-1999 period (the 1995-1999 period was used for the indicators associated to the commercial sampling in the Estuary area). Indicators were assessed and given one of three ratings:

Positive (P) : The value of the indicator differs from the mean, with a positive result for resource status (for example, biomass above mean or mortality below mean).
Neutral (=) : The value of the indicator is similar to the mean.
Negative (N) : The value of the indicator differs from the mean, with a negative result for resource status.

The limits of the neutral category are defined by confidence intervals (95%) around the mean. The indicators are different from the mean when their annual value is outside the limits of the confidence interval.

Commercial fishery statistics (shrimper catch and effort) are used to estimate nominal 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 fishery capacity and seasonal fishing patterns. The commercial catch samples allow the identification of the year classes as well as the estimate of the number of shrimp harvested which is used to calculate the number of shrimp per kg. The mean size of primiparous females caught in the spring (April and May) provides an indication of the size of females that changed sex and that will lay eggs the following fall.

A research survey has been conducted in the Estuary and Gulf of St. Lawrence in August or September each year since 1990. This survey was conducted from the department vessel C.C.G.S. Alfred Needler from 1990 to 2003. In 2004, a new vessel, the *C.C.G.S. Teleost* equipped with a new shrimp trawl, was used. However, the data collected in 2004 cannot be included in the survey series and used in this assessment because the trawl and the vessel have changed. The correction that should be applied on the *Teleost* catches so they would be directly comparable to those of the Needler is not known. Indeed, the shrimp catchability could be different between the two trawls and it is necessary to conduct a comparative fishing to calibrate the indices and join them in the same historical series. There should be a comparative fishing in 2005.

Resource Status in 2004

Most of the resource status indicators were negative during the first half of the 1990s. But thereafter, several year-classes with higher than average abundance were recruited, causing the productivity to increase, with the result that most of the resource status indicators were positive during the second half of the 1990s. During the 2000s, the majority of the indicators of abundance and of biomass of shrimp available to the fishery as well as the indicator of success of the fishery were neutral or positive. However, most of the indicators of size of females available for reproduction and for the fishery were negative. This is still the case in 2004; however, the research survey and exploitation rate indicators are not available (Table 2).

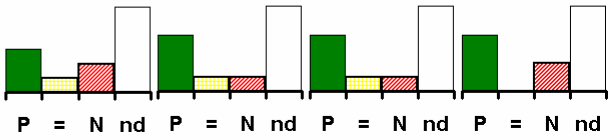
There was no noticeable change in the distribution of fishing effort in 2004. The same sectors sustained the fishing in the four areas: the north shore of the Estuary, the western part of Sept-Îles, the two slopes of the Laurentian Channel, the Anticosti Channel and the head of the Esquiman Channel. The nominal fishing effort increased in 2004 in the Estuary, Sept-Îles and Anticosti areas and was similar to the 1990-1999 mean (Figure 2). The fishing effort decreased slightly in Esquiman and was below the 1990-1999 mean.

In 2004, the CPUE was still higher than the 1990-1999 mean in the four areas (Figure 3). The 2004 CPUE was similar to that of 2003 in the Estuary, Sept-Îles and Anticosti while it increased in Esquiman. The number of shrimp caught per hour of fishing was still high in 2004 in all areas, for the males as well as for the females. In general, the commercial fishery indicators suggest that the catch rates stabilized in 2004 in the Estuary, Sept-Îles and Anticosti while they increased in Esquiman.

Table 2. Indicators used to assess the status of the resource in the four fishing areas in 2004. The indicators are assessed relatively to the 1990-1999 mean (P : positive impact, = : neutral impact, N : negative impact, nd : indicator not available).

2004	ESTUARY	SEPT-ILES	ANTICOSTI	ESQUIMAN
FISHERY INDICATORS				
Effort	=	=	=	P
Catch per unit of effort	P	P	P	P
Male number per unit of effort	P	P	P	P
Female number per unit of effort	P	P	P	P
Number of shrimp per kg	N	P	P	N
Size of recruits (females)	N	N	N	N
SURVEY INDICATORS				
Minimum trawlable biomass	nd	nd	nd	nd
Number of males	nd	nd	nd	nd
Number of females	nd	nd	nd	nd
Size of females	nd	nd	nd	nd
Pre-recruit abundance	nd	nd	nd	nd
EXPLOITATION RATE INDICATOR				
Fishery / Survey (numbers)	nd	nd	nd	nd
	ESTUAIRE	**SEPT-ILES**	**ANTICOSTI**	**ESQUIMAN**

SUMMARY
(number of indicators by impact ratings)



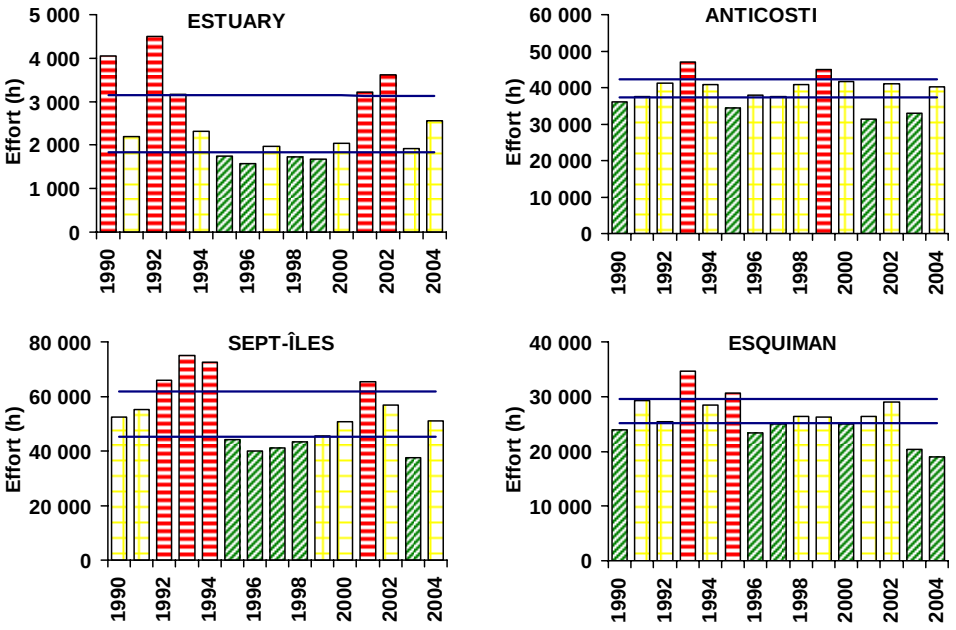


Figure 2. Nominal fishing effort by fishing area and by year since 1990. The continuous lines represent the limits of the confidence interval of the 1990-1999 mean.

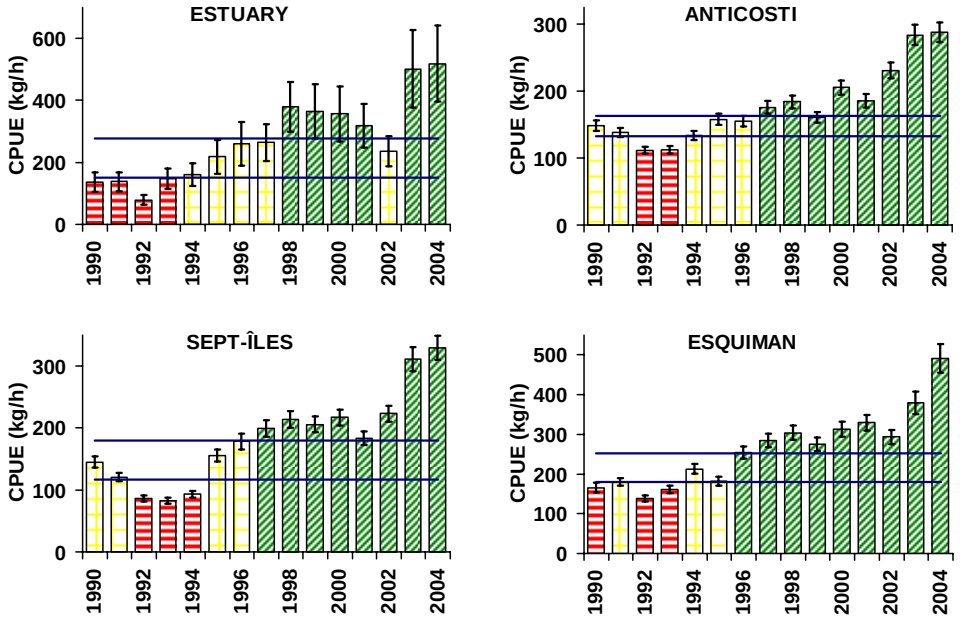


Figure 3. Standardized catch per unit of effort (CPUE) by fishing area and by year since 1990. The continuous lines represent the limits of the confidence interval of the 1990-1999 mean.

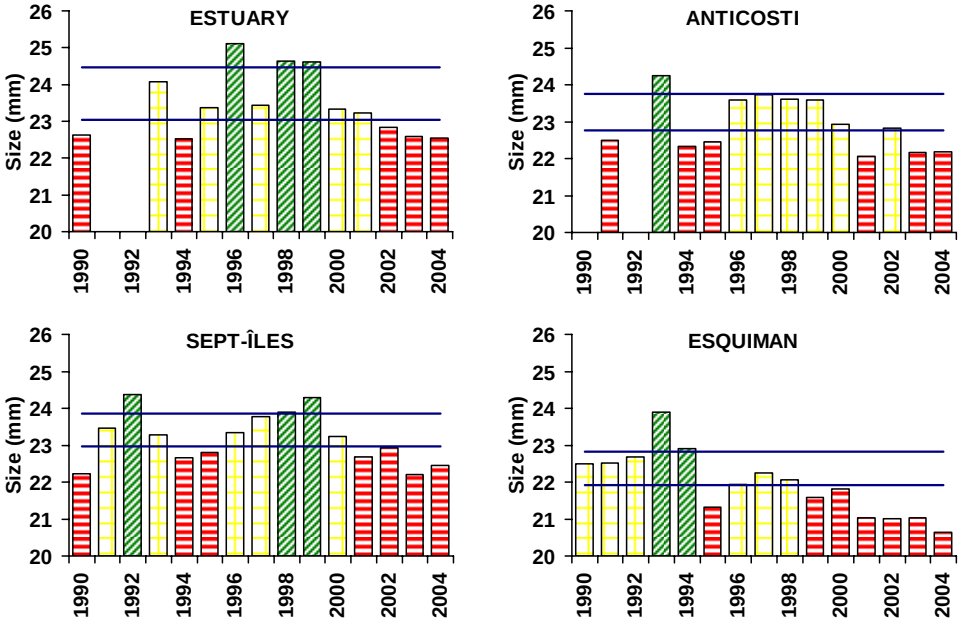


Figure 4. Mean size of recruiting females at spring in the commercial catches by fishing area and by year since 1990. The continuous lines represent the limits of the confidence interval of the 1990-1999 mean.

The 2004 research survey preliminary results indicate that good concentrations of shrimp were found in all areas. The distribution pattern does not show any major changes relatively to the preceding years. However, the 2004 survey indicators are not used in this assessment.

Changes in the structure and functioning of the northern Gulf of St. Lawrence ecosystem related to the northern shrimp stocks for the mid-1980s, the mid-1990s, and the early 2000s were examined from modeling studies. The net decrease in biomass of the large-bodied demersal species and the ensuing drop in predation from the mid-1980s to the mid-1990s may explain the increase in abundance and commercial catches of the northern shrimp at the end of the 1990s. However, Greenland halibut (*Reinhardtius hippoglossoides*) replaced progressively redfish (*Sebastes spp.*) and cod *(Gadus morhua*) as main predator of shrimp. Given that the biomass of Greenland halibut as well as the proportion of shrimp in its diet has sharply increased since the mid-1990s, the models suggest an increase in mortality by predation on shrimp between mid-1990s and the early 2000s.

Outlook

The recruitment of the very abundant year-classes of 1997 and 1999 is at the origin of the increases in the abundance indices that have been observed since 2001. Spawning females of the 1997 year-class as well as recruiting females of the 1999 year-class contributed to the success of the fishery in 2004. The 1997 year-class will not contribute significantly to the fishery in 2005. The 2005 spring fishery will then focus on the females of the 1998 year-class for which the abundance seems weak and, on the females of the abundant 1999 year-class which will produce larvae for the first time. The females of the 1999 year-class should still sustain the fishery in 2006, year during which their second production of larvae will occur. The abundance of the 2000 and 2001 year-classes does not seem as strong as that of the 1997 and 1999 year-classes at the same age. Their contribution to the female component from 2005 and beyond should be of average.

Females have eggs beneath their abdomen from September to May. So the fishery in the fall and following spring focuses on the same group of females for which there was neither somatic growth nor recruitment. The fishing success at spring that depends essentially on the abundance of the egg bearing females over the fishing grounds, determines also the success of the entire season. Analyses were conducted to verify if it is possible to predict the catch rate of the entire season or of the spring (April and May) of a given year from the catch rate observed the preceding fall (September to December). Regressions examined between the fall CPUE and the spring CPUE or the season CPUE of the following year were all positives with coefficients (R^2) ranging between 0.58 and 0.90. The CPUEs observed in 2004 fall indicate that the 2005 CPUEs should be very high in all areas. On the other hand, analyses were conducted to verify if it is possible to predict the size of egg bearing females at spring from the size of females harvested during the preceding fall or from the size of recruiting females caught at the preceding spring. Regressions examined were all positive with coefficient (R^2) ranging between 0.10 and 0.81. The sizes observed in 2004 indicate that the size of the egg bearing females in 2005 spring should be low, close or below the minimum observed in all areas.

CONCLUSIONS AND ADVICE

The fishing results were very good in 2004 and outlooks are still good for 2005. The TACs were increased in 2004 to take advantage of the 1997 and 1999 year-classes. The 1997 year-class will not contribute to the fishery in 2005. The 1998 year-class is weak but the 1999 year-class is very abundant. Therefore, there are no concerns for the abundance of females available to the fishery in 2005. Consequently, the 2004 TACs can be reinstated in 2005 in all areas. However, it is expected to be back to an average situation from 2006 and beyond because the new year-classes (2000 and 2001) that will contribute to the fishery in 2006 are of average abundance. Moreover, it is possible that the mortality by predation that has increased during the recent years has a negative impact on the abundance of the stocks.

Sources of uncertainty

The absence of survey indices in 2004 prevents the estimate of the exploitation rate index. Consequently, it is not possible to assess the impact of the 2004 TAC increases on the exploitation rates. The absence of major negative changes in the commercial fishery indicators suggests that the increase in TACs has not have any immediate impact on the fishing success. However, long-term consequences of TACs at this level are uncertain.

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