

Shrimp of the Estuary and Gulf of St. Lawrence

Background

Shrimp are fished commercially from spring to fall in four management areas. Resource assessment is conducted each year to determine whether changes that have occurred in the stock status necessitate adjustments to the conservation approach and management plan. Landings in 1999 were similar to those in 1998, and TACs were, once again, taken in all management areas.

A number of peculiarities of shrimp biology have influenced the fishery itself, 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 at about four or five years of age. 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 at depths of 150 to 350 m.

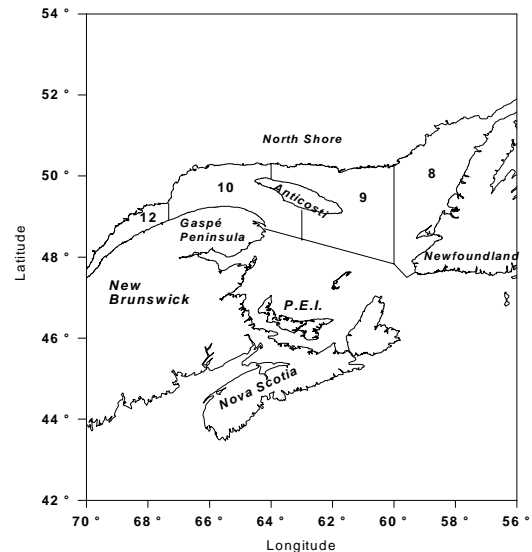


Figure 1. Shrimp fishery management units in the Estuary and Gulf of St. Lawrence.

Summary

- The commercial fishery and research survey indices show that shrimp abundance remained high from 1997 to 1999, after rising between 1992–93 and 1997.
- Female abundance was high between 1997 and 1999 whereas the abundance of the different categories of males varied over the same period. For instance, the 1996 year-class is weaker than the average of the last 10 years whereas the 1997 year-class is stronger than the average.
- The abundance of the resource will probably vary over the next two or three years, depending on the growth and survival of these year-classes, but will not show any significant upward or downward trend. In 2000, landings comparable to those of 1998 and 1999 should produce exploitation rates within the limits of the values recorded since 1995.
- Favourable environmental conditions (cold temperatures, low abundance of predators) probably contributed to the growth of the stocks in the 1990s. These conditions changed in 1999 (warmer temperatures, increased abundance of Greenland halibut) and they may affect the survival of the year-classes, but the impact cannot be quantified at present.

The Fishery

The northern shrimp fishery began in the Gulf of St. Lawrence in 1965. The Quebec fleet fishes mainly in the western Gulf, whereas the Newfoundland fleet concentrates its efforts in the Esquiman Channel and the New Brunswick fleet splits its operations between the western and eastern Gulf. A reorganization of management areas was proposed in 1992 to better reflect fishing operations and the geographic distribution of shrimp. The five management areas of the early 1980s were reduced to four in 1993: Sept Îles (Area 10), which includes the old South Anticosti Island area, Anticosti (Area 9), formerly known as North Anticosti, Esquiman (Area 8) and Estuary (Area 12) (Figure 1).

Shrimp fishing in the estuary and Gulf is controlled by a number of management measures, including TACs (total allowable catches) in the four management areas (Table 1). In 1999, there were 117 licences for shrimp. Licence holders in Quebec and New Brunswick have had individual quotas since 1991, and those of the Lower North Shore and west coast of Newfoundland since 1996. Since 1997, temporary allocations of shrimp have been granted to groundfish licence holders. 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 gradually increased since the fishery began in the mid-1960s. Landings rose from approximately 1,000 t to 7,500 t between the early and late 1970s, reaching over 15,000 t by the late 1980s. In 1992, landings dropped 22% from 1991 levels, but since then have steadily

increased (Table 1). TACs remained stable in 1999 and landings, totalling more than 23,000 t, were similar to those for 1998. The TACs have been taken in all shrimp fishing areas since 1995.

Conservation Approach

TAC-based management limits fishing so as 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 purpose is to maintain a spawning biomass large enough to ensure recruitment. If the resource status is known, the TAC can be adjusted accordingly. The tools required to calculate adjustments in the TAC in response to observed changes in the status of the resource are not available for shrimp, so changes to the TAC must be empirically or experimentally based.

In response to recent increases in abundance indices, the TAC was raised by 10% in 1996 in three of the four areas (Sept Îles, Anticosti and Esquiman), then by 10% in 1997 and by 15.8% in 1998 in all four management areas. The short-term outlook for the availability of shrimp to the fishery was excellent in 1995, 1996 and 1997. The TAC was not changed in 1999. Resource assessment indicated that abundance remained more or less stable between 1997 and 1998, while recruitment prospects were uncertain. So far, no negative effects of harvesting northern shrimp have been seen in populations of the estuary and Gulf.

Table 1. Landings (Ldg) in tons and total allowable catches (TAC) in tons of northern shrimp by management unit since 1982. Data for 1999 are preliminary, from December 31, 1999.

Year	ESTUARY		SEPT ÎLES		ANTICOSTI		ESQUIMAN		GULF	
	Ldg	TAC	Ldg	TAC	Ldg	TAC	Ldg	TAC	Ldg	TAC
1982	152	500	3774	3800	2464	4400	2111	4200	8501	12900
1983	158	500	3647	3800	2925	5000	2242	6000	8972	15300
1984	248	500	4383	4800	1336	5000	1578	6000	7545	16300
1985	164	500	4399	4600	2786	3400	1421	6000	8770	14500
1986	262	500	4216	4600	3340	3500	1592	3500	9410	12100
1987	523	500	5411	5600	3422	3500	2685	3500	12041	13100
1988	551	500	6047	5600	2844	3500	4335	3500	13777	13100
1989	629	500	6254	5700	4253	4200	4614	4500	15750	14900
1990	507	500	6839	6400	4723	4200	3303	4700	15372	15800
1991	505	500	6411	6400	4590	5000	4773	4700	16279	16600
1992	489	500	4957	6400	4162	5000	3149	4700	12757	16600
1993	496	500	5485	6400	4791	5000	4683	4700	15455	16600
1994	502	500	6165	6400	4854	5000	4689	4700	16210	16600
1995	486	500	6386	6400	4962	5000	4800	4700	16634	16600
1996	505	500	7014	7040	5469	5500	5123	5170	18111	18210
1997	549	550	7737	7744	6058	6050	5483	5687	19827	20031
1998	634	633	8978	8966	6932	7004	6554	6584	23098	23187
1999	627	633	9046	8966	6886	7004	6648	6584	23207	23187

Resource Assessment

Stock status was determined by examining a number of indicators from the commercial fishery and research surveys. These indicators refer to factors that can affect fishing success, stock abundance or resource productivity. The factors are assessed from the standpoint of impacts on resource status, on future abundance and stock productivity, using three categories of criteria: (1) positive outlook, (2) uncertainty about the magnitude of the impact and (3) concerns about the future status of the stock. Resource status is then assessed globally by combining all the indicators. To situate the current and future status of the resource, data for the 1999 season are compared with data for recent years and with data for the 1992–93 period,

when abundance was low. This period of low abundance constitutes, in a way, the benchmark for the 1990s. The results are presented as performance reports for each management area.

Data Used

Commercial fishery statistics (shrimper catch and effort) are used to calculate catches per unit of effort (CPUEs) and numbers per unit of effort (NPUEs), i.e., the mean number of shrimp caught per hour of fishing. The data are standardized to take into account changes in fishery capacity (increased fishing power resulting from vessel changes and fleet renewal) and seasonal fishing patterns. Data from the three fishing fleets have been included in the analyses since 1982.

Research surveys have been conducted in the estuary and Gulf of St. Lawrence in August–September each year since 1990. The surveys use a stratified random design and are conducted from DFO's *C.S.S. Alfred Needler*, equipped with a shrimp trawl. The survey index is a relative abundance index, as the trawl used does not catch all the shrimp in the water column while passing over the seabed. However, since the survey is carried out in a standard manner from one year to the next and since it covers the entire geographic range of shrimp in the estuary and the northern Gulf, the survey index is considered to be a reliable indicator of variations in shrimp abundance.

Carapace length frequency distributions are calculated on the basis of samples from commercial catches and research surveys. Modes or year-classes can be identified by examining size frequency distributions, since individuals born the same year grow at more or less the same rate and therefore will be approximately the same size at a given age. Individuals with a mean length of 11 mm form the first mode and would be one year old, meaning that they would have been born in the spring of the year before. Once shrimp are 14 mm long, they begin to be retained by trawls with 40 mm mesh. At that point they are two years old and are male. When they reach 22 mm in length, at around four or five years of age, they are fully recruited to the fishery, meaning that the trawls catch 100% of them. The majority of them are then female.

An exploitation rate index can be obtained by comparing commercial catches (in number) with the abundance index derived from the research surveys. The exploitation rate is a measure of the intensity of fishing pressure. Because the abundance index is a

relative index, the method cannot be used to estimate the absolute exploitation rate or to relate it to target exploitation rates. The exploitation rate index does make it possible, however, to track relative changes in the exploitation rate over the years.

Resource Status and Prospects

The commercial fishery and research survey indices show that shrimp abundance remained high from 1997 to 1999, after rising between 1992–93 and 1997 (Fig. 2 and 3).

Female abundance stayed high and stable from 1997 to 1999, while male abundance varied over the same period because of the contrasting contributions of the 1996 and 1997 year-classes. These year-classes had a noticeable impact on the catches of the commercial fishery and the research surveys in 1998 and 1999. In 1999, for a given landing size (similar TAC), the fishing effort and catch in numbers rose while yields fell owing to the greater proportion of small specimens from the 1997 year-class. This phenomenon was more apparent in the eastern part of the Gulf, where males make up a larger proportion of catches. The ratio of male-to-female abundance in the survey catches declined in 1998 because of the very low contribution of the 1996 year-class, but increased in 1999 as a result of the strong input of the 1997 year-class.

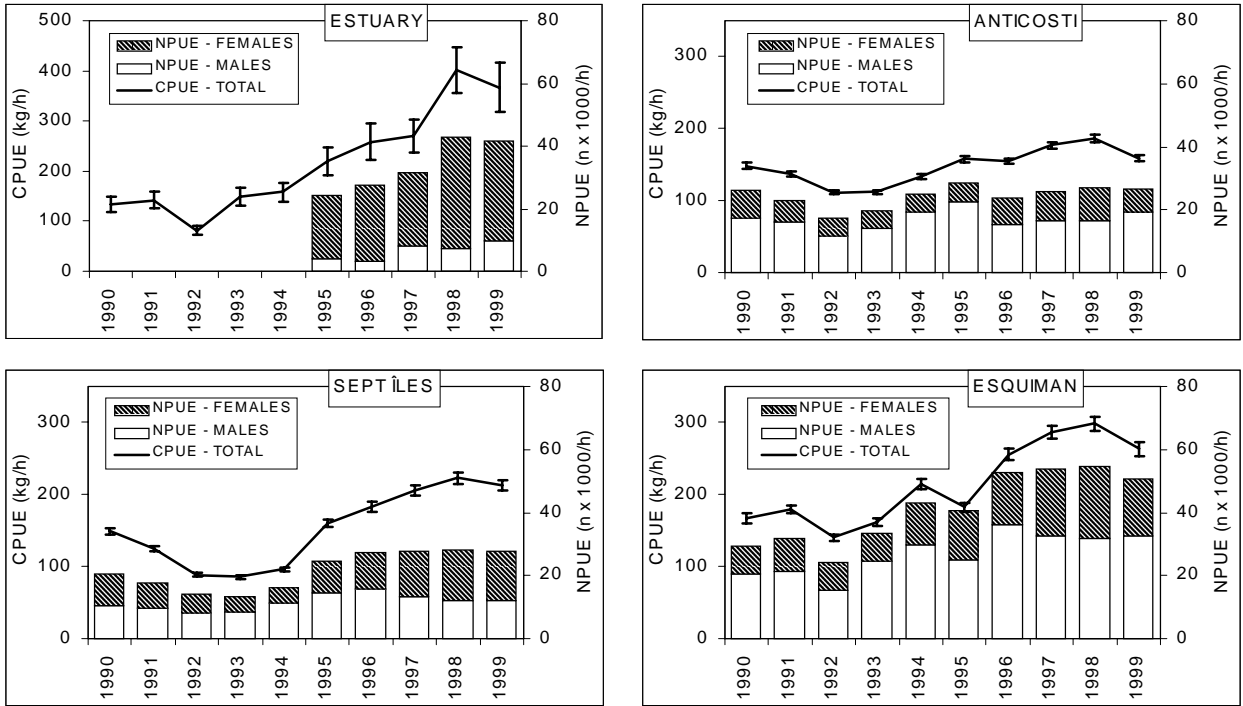


Figure 2. Standardized catch per unit of effort (CPUE) for both sexes and standardized number per unit of effort (NPUE) by sex, by management area and by year since 1990.

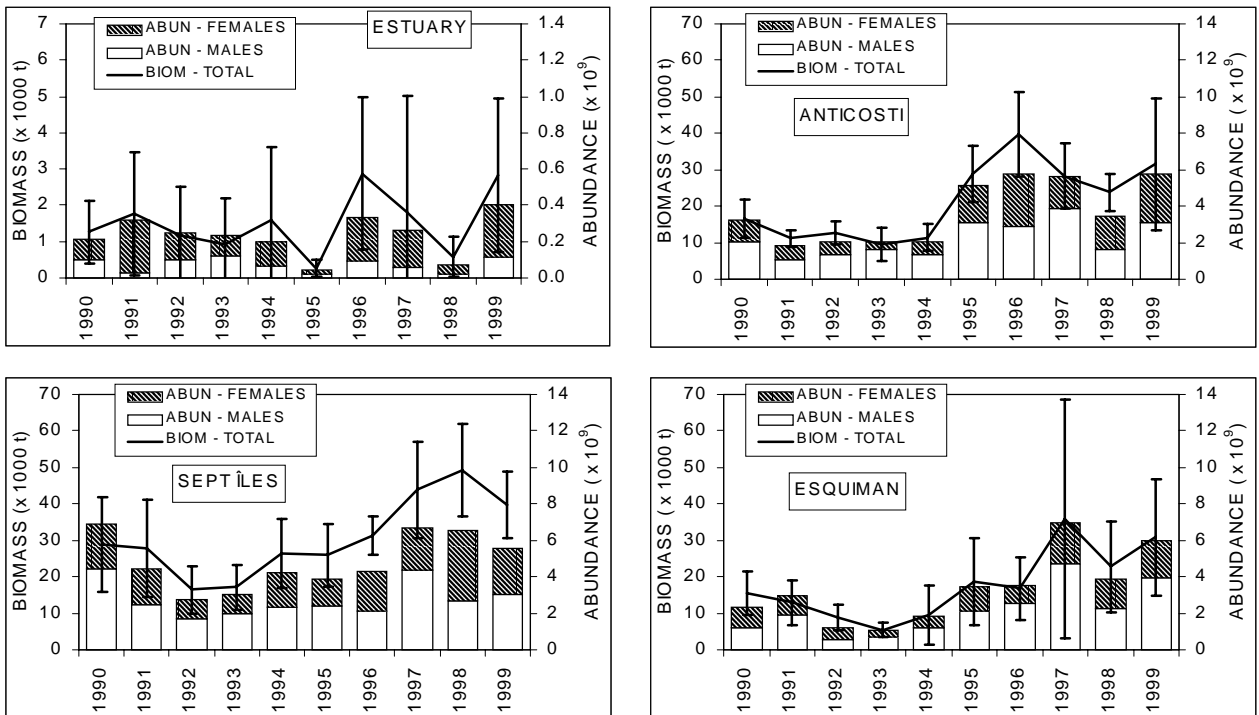


Figure 3. Biomass index for both sexes and abundance index by sex, by management area and by year since 1990.

The length frequency distributions for the commercial fishery and the research surveys in 1998 and 1999 are given in Figure 4. The strength of the 1996 year-class, estimated by the 1998 and 1999 surveys, is below the average calculated at the same age for the last ten years. On the other hand, the numbers of the 1997 year-class, estimated in 1999, are higher than the average of the last

ten years. These results were confirmed by the preliminary results of the new recruitment survey conducted in the estuary in 1998 and 1999, which revealed the very strong representation of the 1997 year-class.

Shrimp distribution has remained stable in recent years. The biomass increase observed between 1992–93 and 1997 occurred in both the intermediate (183–274 m) and deep

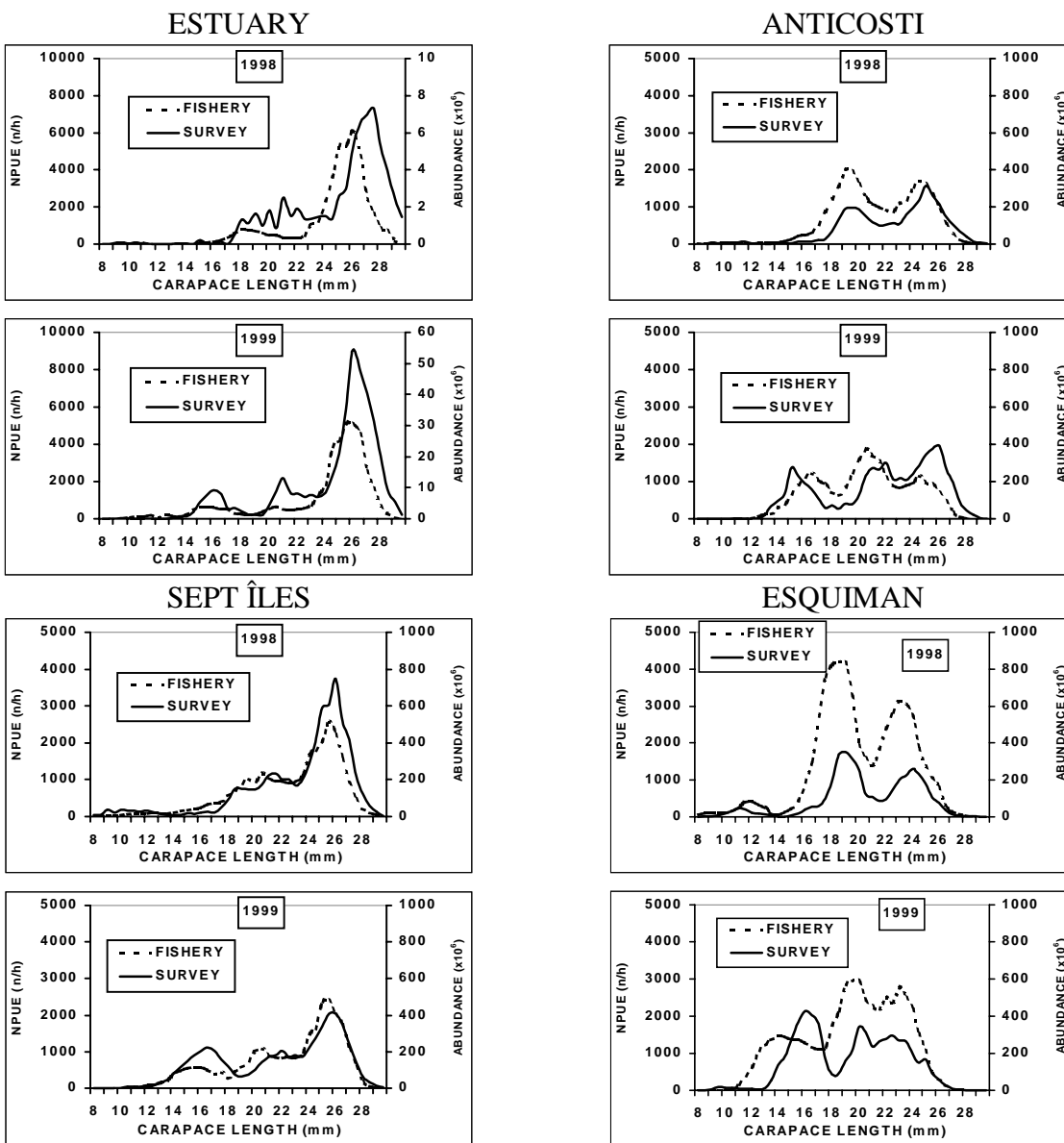


Figure 4. Number per unit of effort (NPUE) from the commercial fishery and abundance from the survey results by carapace length class by management area, in 1998 and 1999.

(274–366 m) strata, particularly in the Sept Îles area. The distribution also spread to the southern portions of the Sept Îles and Anticosti fishing areas, along the Laurentian Channel. Fishing effort followed the same trends, spreading along the Laurentian Channel. However, the fishing grounds located along the Laurentian Channel have declined in importance since 1997. The seasonal fishing pattern has remained

similar over the last few years, which seems to indicate that shrimp migration patterns have not undergone any major changes.

In 1999, the exploitation rate index, which is the ratio of commercial catches to the abundance derived from research survey data, calculated for females, was within the values observed since 1995. The trajectory of the rate index as a function of the abundance index shows that the exploitation rate was highest when abundance was lowest, in 1992–93 (Fig. 5). Recent commercial fishing does not seem to have had any adverse effects on the population. The increases in the TAC allocated in 1996, 1997 and 1998 have kept the exploitation rate relatively stable.

The 1996 and 1997 year-classes, which will recruit to the female spawning stock and to the fishery in the next two or three years, differ in their numbers, with the 1996 year-class being below average and the 1997 year-class being above average. The abundance of the resource will therefore probably vary over the next two or three years, depending on the growth and survival of these year-classes, but will not show any significant upward or downward trend. In 2000, landings comparable to those of 1998 and 1999 should produce exploitation rates within the limits of the values recorded since 1995.

Favourable environmental conditions (very cold temperatures, greater thickness of the Cold Intermediate Layer [CIL], and low abundance of predators [cod, redfish, Greenland halibut]) probably contributed to the growth of the stocks in the 1990s. These conditions changed in 1999 (warmer temperatures and thinning of the CIL, increased abundance of Greenland halibut) and may affect the survival and growth of the year-classes, although it is impossible to quantify the impact.

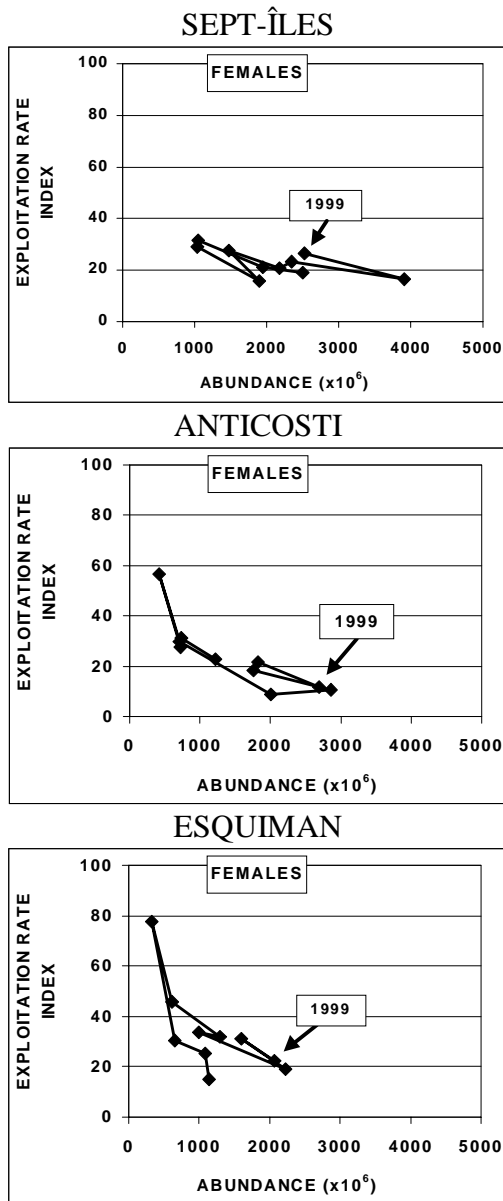


Figure 5. Exploitation rate index based on female abundance by management area since 1990.

PERFORMANCE REPORT: ESTUARY

CONTEXT: Previous stock assessments have shown that shrimp abundance rose during the 1990s. To determine the present and future status of the resource, data for the 1999 season have been compared with data for recent years and with data for 1992–94, when abundance was lower. This period of low abundance constitutes the benchmark for the 1990s.

INDICATOR	OBSERVATION	INTERPRETATION	OUTLOOK
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FISHING SUCCESS: Fishing capacity is similar from one year to the next. Fishing success depends on the quality and quantity of the resource available.

Landings	1999 TAC taken easily. Landings for 1999 similar to 1998. Values for 1998 and 1999 are 28% higher than the 1992 and 1993 levels.		
Catch	The catch (in number) rose slightly between 1998 and 1999. The 1999 catch was higher than the 1995 catch. Females dominated, accounting for 77% of numbers caught in 1999 and 83% in 1998.	Average weight of catches has remained stable since 1995.	+
Effort	Fishing effort has remained relatively stable and low since 1995. Value for 1999 is below that for 1992.	Fishing intensity has been stable since 1995.	+
Yield	CPUEs were similar in 1998 and 1999. They have reached a plateau far above the 1992 level.	Fishing ground biomass was stable and high in 1998 and 1999.	+
Industry perception	No major problems in fishery.	No major changes observed in 1999.	+

STOCK SIZE: Stock size varies with the abundance of the year-classes that make it up. The strength of the year-classes has an impact on both fishing success and the reproductive potential of the stock.

Total stock	NPUEs were high in 1998 and 1999 and were above the 1995 level. Biomass and abundance indices vary widely from year to year. The 1999 values were very high, however.	Research survey indices vary greatly from year to year and are hard to interpret. NPUEs indicate that abundance was high in 1998 and 1999.	+
Female spawning stock	NPUEs for females were high in 1998 and 1999, and were higher than the values seen in 1995 and 1996. Female biomass and abundance indices vary greatly from one year to the next, but 1999 values were very high.	Research survey indices vary greatly from year to year and are hard to interpret. NPUEs indicate that female abundance was high in 1998 and 1999.	+
Male component	NPUEs for males have been high since 1997 and are much higher than the values seen in 1995 and 1996. Male biomass and abundance indices vary greatly from one year to the next, but 1999 values were very high.	Research survey indices vary greatly from year to year and are hard to interpret. NPUEs indicate that male abundance has been high since 1997.	+
Recruitment to female spawning stock	The 1996 year-class is smaller in numbers than the average for the last 10 years. It is still uncertain whether this year-class will change sex in 2000 or 2001.	Female abundance and biomass should decline when this weak year-class changes sex.	-
Recruitment to fishery	The 1997 year-class, which should be targeted by the fishery in 2000 as males, is larger than the average for the last 10 years.	Abundance and biomass of males targeted by the fishery should increase in 2000.	+

INDICATOR	OBSERVATION	INTERPRETATION	OUTLOOK
STOCK BEHAVIOUR: Different environmental conditions (oceanographic, predation, exploitation) can modify the distribution, migration pattern or growth of the individuals of a stock.			
Distribution of stock	In 1999, biomass seemed to be more heavily concentrated near the area's eastern boundary. Fishing effort was likewise concentrated near the area's eastern boundary.	Fishing pattern was similar in 1998 and 1999.	+
Seasonal pattern	In spring, yields are very high, but they then decline over the remainder of the season. With the exception of the June and August values, the 1999 pattern was similar to the 1998 one.	Seasonal fishing pattern was similar in 1998 and 1999.	+
Growth	Mean length of oldest males and of females has remained similar since 1997.	Growth of most recent year-classes is stable.	+
Oceanographic conditions	Temperature of Cold Intermediate Layer (CIL) was higher in 1999 and layer was thinner. Seabed temperature, at depths of more than 274 m, has been relatively stable since 1990 (between 5 and 6°C).	Change noted in CIL can modify the spatial distribution of shrimp.	?
Predation	Abundance of cod and redfish was still low in 1999. That of Greenland halibut has climbed since 1993.	While total abundance of predators is low, the increase in Greenland halibut may intensify predation on shrimp.	?
Exploitation by fishery	Since research survey indices vary greatly, ratios of commercial catches to survey abundance figures also vary widely from year to year.	Impossible to draw any conclusions about relative value of exploitation rate.	?
RESOURCE STATUS ASSESSMENT: Resource status is assessed globally by combining all the indicators.			
Current status	Abundance and biomass seemed high in 1999. No major change seen in 1999 in relation to last three years.		+
Prospects	The 1996 and 1997 year-classes, which will recruit to the female spawning stock and to the fishery in the next two or three years, vary in numbers. The abundance of the resource will likely vary over the next two or three years, depending on the growth and survival of these year-classes, but will not show any significant upward or downward trend. Favourable environmental conditions probably contributed to the growth of the stocks in the 1990s. These conditions changed in 1999 and may adversely affect the survival and growth of the year-classes, although it is impossible to quantify the impact.		+/-

PERFORMANCE REPORT: SEPT ÎLES

CONTEXT: Previous stock assessments have shown that shrimp abundance rose during the 1990s. To determine the present and future status of the resource, data for the 1999 season have been compared with data for recent years and with data for 1992–94, when abundance was lower. This period of low abundance constitutes the benchmark for the 1990s.

INDICATOR	OBSERVATION	INTERPRETATION	OUTLOOK
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FISHING SUCCESS: Fishing capacity is similar from one year to the next. Fishing success depends on the quality and quantity of the resource available.

Landings	1999 TAC taken easily. Landings for 1999 similar to 1998. Values for 1998 and 1999 are 76% higher than the low 1992 and 1993 levels, when TAC was not taken.		
Catch	The catch (in number) rose slightly between 1998 and 1999. The 1999 catch was higher than the 1992 and 1993 catches. Proportion of females in catches was similar in 1998 and 1999 (females accounted for 56% of numbers caught in 1999).	Average weight of catches remains far above that of 1992–93.	+
Effort	Value for 1999 is slightly above that for 1998, but is well below that for 1992 and 1993.	Fishing intensity remains well below that of 1992–93.	+
Yield	CPUEs were similar in 1997, 1998 and 1999. They have reached a plateau far above the low 1992, 1993 and 1994 levels.	Fishing ground biomass has been stable and high since 1997.	+
Industry perception	No major problems in fishery.	No major changes observed in 1999.	+

STOCK SIZE: Stock size varies with the abundance of the year-classes that make it up. The strength of the year-classes has an impact on both fishing success and the reproductive potential of the stock.

Total stock	NPUEs have been stable and high since 1996. Biomass index fell in 1999, but is similar to the 1997 index. Abundance dropped in 1999, whereas 1997 and 1998 values were similar. All these indices are far above 1992 and 1993 levels.	After rising between 1992–93 and 1997, abundance and biomass remained high and relatively stable from 1997 to 1999.	+
Female spawning stock	NPUEs for females have been high and stable since 1996. Biomass and abundance indices for females declined in 1999, but are comparable to values observed since 1996. All these indices are well above 1992 and 1993 levels.	After rising between 1992–93 and 1996, female abundance and biomass remained high and relatively stable from 1996 to 1999.	+
Male component	NPUEs for males have been high and stable since 1995. Male biomass index has been stable and high since 1995. Male abundance has been high since 1994. All these indices are well above the 1992 levels.	After rising between 1992 and 1995, male abundance and biomass remained high and relatively stable from 1995 to 1999.	+
Recruitment to female spawning stock	The 1996 year-class is smaller in numbers than the average for the last 10 years. It is still uncertain whether this year-class will change sex in 2000 or 2001.	Female abundance and biomass should decline when this weak year-class changes sex.	–
Recruitment to fishery	The 1997 year-class, which should be targeted by the fishery in 2000 as males, is larger than the average for the last 10 years.	Abundance and biomass of males targeted by the fishery should increase in 2000.	+

INDICATOR	OBSERVATION	INTERPRETATION	OUTLOOK
STOCK BEHAVIOUR: Different environmental conditions (oceanographic, predation, exploitation) can modify the distribution, migration pattern or growth of the individuals of a stock.			
Distribution of stock	Since 1994–95, biomass has increased in the deep strata from 274 to 366 m and in the southern part of the area, along the Laurentian Channel. Biomass distribution was similar in 1998 and 1999. Fishing effort has spread along the slopes of the Laurentian Channel since 1994; however, the southern part of the area declined in importance from 1997 to 1999.	Fishing pattern and shrimp distribution were similar in 1998 and 1999. The increase in biomass also occurred in the deep strata, at depths between 274 and 366 m. Distribution also spread along the Laurentian Channel.	+
Seasonal pattern	With the exception of a high yield in July 1999, the 1999 pattern was similar to the 1998 one. Yields declined in the course of the season.	Seasonal fishing pattern was similar in 1998 and 1999.	+
Growth	Mean length (CL) of oldest males and of females was 2 to 3 mm longer in 1999 than in 1994. Difference in size of females could be enough to cause a difference of 20% in the egg production of a female.	Growth of most recent year-classes is high in relation to that of year-classes produced in the early 1990s.	+
Oceanographic conditions	Temperature of Cold Intermediate Layer (CIL) was higher in 1999 and layer was thinner. Seabed temperature, at depths of more than 274 m, has been relatively stable since 1990 (between 5 and 6°C).	Change noted in CIL can modify the spatial distribution of shrimp.	?
Predation	Abundance of cod and redfish was still low in 1999. That of Greenland halibut has climbed since 1993.	While total abundance of predators is low, the increase in Greenland halibut may intensify predation on shrimp.	?
Exploitation by fishery	Ratio of commercial catches to survey abundance increased in 1999, but was within limits of values observed since 1990.	Exploitation rate within limits of values observed since 1990.	+

RESOURCE STATUS ASSESSMENT: Resource status is assessed globally by combining all the indicators.			
Current status	After rising between 1992–93 and 1997, abundance and biomass remained high and relatively stable from 1997 to 1999. No major change seen in 1999 in relation to last three years.		+
Prospects	The 1996 and 1997 year-classes, which will recruit to the female spawning stock and to the fishery in the next two or three years, vary in numbers. The abundance of the resource will likely vary over the next two or three years, depending on the growth and survival of these year-classes, but will not show any significant upward or downward trend. In 2000, landings comparable to those of 1998 and 1999 should produce exploitation rates within the limits of the values recorded since 1995. Favourable environmental conditions probably contributed to the growth of the stocks in the 1990s. These conditions changed in 1999 and may adversely affect the survival and growth of the year-classes, although it is impossible to quantify the impact.		+/-

PERFORMANCE REPORT: ANTICOSTI

CONTEXT: Previous stock assessments have shown that shrimp abundance rose during the 1990s. To determine the present and future status of the resource, data for the 1999 season have been compared with data for recent years and with data for 1992–94, when abundance was lower. This period of low abundance constitutes the benchmark for the 1990s.

INDICATOR	OBSERVATION	INTERPRETATION	OUTLOOK
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FISHING SUCCESS: Fishing capacity is similar from one year to the next. Fishing success depends on the quality and quantity of the resource available.

Landings	1999 TAC taken easily. Landings for 1999 similar to 1998. Values for 1998 and 1999 are 68% higher than the low 1992 level, when TAC was not taken.		
Catch	The catch (in number) rose slightly between 1998 and 1999. The 1999 catch was higher than the 1992 catch. Proportion of females in catches was only 28% in 1999 and 38% in 1998.	Average weight of catches remains stable in relation to 1992 and 1993.	+
Effort	Fishing effort for 1999 increased from 1998. Value for 1999 similar to values for 1992–94.	Fishing intensity for 1999 similar to that for 1992–94.	+
Yield	CPUEs declined between 1998 and 1999. Value for 1999 was similar to values for 1995 and 1996 but was greater than 1992 and 1993 levels.	Fishing ground biomass remains high in relation to 1992–93.	+
Industry perception	Fishers suffered a drop in yields during the summer, especially south of Anticosti Island. Problems were caused by gelatinous matter (probably jellyfish or ctenophores) plugging up the trawls.	Season was difficult and not particularly satisfactory.	–

STOCK SIZE: Stock size varies with the abundance of the year-classes that make it up. The strength of the year-classes has an impact on both fishing success and the reproductive potential of the stock.

Total stock	NPUEs were high and relatively stable between 1994 and 1999. Biomass and abundance indices for 1999 were high and similar to values from 1995 to 1998. All these indices remain far above the low levels of 1993.	After rising in 1995, abundance and biomass remained high and relatively stable from 1995 to 1999.	+
Female spawning stock	NPUEs for females have been high since 1995. Biomass and abundance indices for females in 1999 were high and similar to values observed since 1995. All these indices are above 1993 levels.	After rising in 1995, female abundance and biomass remained high and relatively stable between 1995 and 1999.	+
Male component	NPUEs for males were high in 1999. Male biomass and abundance indices for 1999 were similar to values observed since 1995. All these indices are above the 1992 and 1993 levels.	After rising in 1995, male abundance and biomass remained high and relatively stable between 1995 and 1999.	+
Recruitment to female spawning stock	In terms of numbers, the 1996 year-class is equal to or below the average for the last 10 years. It is still uncertain whether this year-class will change sex in 2000 or 2001.	Female abundance and biomass should decline when this weak year-class changes sex.	–
Recruitment to fishery	The 1997 year-class, which should be targeted by the fishery in 2000 as males, is larger than the average for the last 10 years.	Abundance and biomass of males targeted by the fishery should increase in 2000.	+

INDICATOR	OBSERVATION	INTERPRETATION	OUTLOOK
STOCK BEHAVIOUR: Different environmental conditions (oceanographic, predation, exploitation) can modify the distribution, migration pattern or growth of the individuals of a stock.			
Distribution of stock	Since 1994–95, biomass has increased in the deep strata from 274 to 366 m and in the southern part of the area, along the Laurentian Channel. Biomass distribution was similar in 1998 and 1999. Fishing effort has spread along the slopes of the Laurentian Channel since 1994; however, the southern part of the area declined in importance from 1997 to 1999.	Fishing pattern and shrimp distribution were similar in 1998 and 1999. The increase in biomass also occurred in the deep strata, at depths between 274 and 366 m. Distribution also spread along the Laurentian Channel.	+
Seasonal pattern	Yields declined in the course of the season; 1999 pattern was similar to 1998 one.	Seasonal fishing pattern was similar in 1998 and 1999.	+
Growth	Mean length (CL) of oldest males and of females was 2 mm longer in 1999 than in 1994. Difference in size of females could be enough to cause a difference of 20% in the egg production of a female.	Growth of most recent year-classes is high in relation to that of year-classes produced in the early 1990s.	+
Oceanographic conditions	Temperature of Cold Intermediate Layer (CIL) was higher in 1999 and layer was thinner. Seabed temperature, at depths of more than 274 m, has been relatively stable since 1990 (between 5 and 6°C).	Change noted in CIL can modify the spatial distribution of shrimp.	?
Predation	Abundance of cod and redfish was still low in 1999. That of Greenland halibut has climbed since 1993.	While total abundance of predators is low, the increase in Greenland halibut may intensify predation on shrimp.	?
Exploitation by fishery	Ratio of commercial catches to survey abundance fell in 1999, but was within limits of values observed since 1995.	Exploitation rate within limits of values observed since 1995.	+

RESOURCE STATUS ASSESSMENT: Resource status is assessed globally by combining all the indicators.			
Current status	After rising between 1992 and 1995, abundance and biomass remained relatively stable and high from 1995 to 1999. No major change seen in 1999 in relation to last three years.		+
Prospects	The 1996 and 1997 year-classes, which will recruit to the female spawning stock and to the fishery in the next two or three years, vary in numbers. The abundance of the resource will likely vary over the next two or three years, depending on the growth and survival of these year-classes, but will not show any significant upward or downward trend. In 2000, landings comparable to those of 1998 and 1999 should produce exploitation rates within the limits of the values recorded since 1995. Favourable environmental conditions probably contributed to the growth of the stocks in the 1990s. These conditions changed in 1999 and may adversely affect the survival and growth of the year-classes, although it is impossible to quantify the impact.		+/-

PERFORMANCE REPORT: ESQUIMAN

CONTEXT: Previous stock assessments have shown that shrimp abundance rose during the 1990s. To determine the present and future status of the resource, data for the 1999 season have been compared with data for recent years and with data for 1992–94, when abundance was lower. This period of low abundance constitutes the benchmark for the 1990s.

INDICATOR	OBSERVATION	INTERPRETATION	OUTLOOK
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FISHING SUCCESS: Fishing capacity is similar from one year to the next. Fishing success depends on the quality and quantity of the resource available.

Landings	1999 TAC taken easily. Landings for 1999 similar to 1998. Values for 1998 and 1999 are 110% higher than the low 1992 level, when TAC was not taken.		
Catch	The catch (in number) rose slightly between 1998 and 1999. The 1999 catch was higher than the 1992 catch. Proportion of females in catches was only 36% in 1999 and 42% in 1998.	Average weight of catches remains stable in relation to 1992 and 1993.	+
Effort	Fishing effort has increased since 1996. Value for 1999 similar to values for 1998 and 1992.	Fishing intensity similar to values observed in early 1990s.	+
Yield	CPUE declined between 1998 and 1999. Value for 1999 was similar to value for 1996 and was higher than 1992 and 1993 levels.	Fishing ground biomass remains high in relation to 1992–93.	+
Industry perception	Fishery experienced no major problems in 1999.	No major change observed in 1999.	+

STOCK SIZE: Stock size varies with the abundance of the year-classes that make it up. The strength of the year-classes has an impact on both fishing success and the reproductive potential of the stock.

Total stock	NPUEs were high and relatively stable between 1996 and 1999. Biomass and abundance indices rose in 1999 and were similar to the 1997 level. All these indices remain far above 1992–94 levels.	After rising between 1992–94 and 1997, abundance and biomass remained high and relatively stable between 1997 and 1999.	+
Female spawning stock	NPUEs for females rose gradually from 1993 to 1998, then declined in 1999. Biomass and abundance indices for females in 1999 were comparable to 1997 and 1998 levels. All these indices are well above the 1993 levels.	After rising between 1993 and 1997, female abundance and biomass remained high and relatively stable between 1997 and 1999.	+
Male component	NPUEs for males have been high since 1996. Male biomass and abundance indices have been stable and high since 1997. All these indices are well above the 1992–93 levels.	After rising between 1992–93 and 1996–97, male abundance and biomass remained high and relatively stable between 1997 and 1999.	+
Recruitment to female spawning stock	The 1996 year-class is smaller in numbers than the average for the last 10 years. It is still uncertain whether this year-class will change sex in 2000 or 2001.	Female abundance and biomass should decline when this weak year-class changes sex.	–
Recruitment to fishery	The 1997 year-class, which should be targeted by the fishery in 2000 as males, is larger than the average for the last 10 years.	Abundance and biomass of males targeted by the fishery should increase in 2000.	+

INDICATOR	OBSERVATION	INTERPRETATION	OUTLOOK
STOCK BEHAVIOUR: Different environmental conditions (oceanographic, predation, exploitation) can modify the distribution, migration pattern or growth of the individuals of a stock.			
Distribution of stock	Since 1997, biomass has increased in the deep strata from 274 to 366 m. Biomass distribution was similar in 1998 and 1999. Fishing effort is concentrated in the northern part of the area.	Fishing pattern and shrimp distribution were similar in 1998 and 1999.	+
Seasonal pattern	Yields varied from month to month, but the general trend was a decline over the course of the season.	The seasonal fishing pattern varied, but showed signs of the same trends as in 1998 and 1999.	+
Growth	Mean length of oldest males and of females was similar to that observed in 1997. Mean length (CL) of females was 2 to 3 mm shorter than that of females in the Sept Îles and Anticosti areas. Difference in size of females could be enough to cause a difference of 20% in the egg production of a female from one area to the next.	Growth of most recent year-classes is stable.	+
Oceanographic conditions	Temperature of Cold Intermediate Layer (CIL) was higher in 1999 and layer was thinner. Seabed temperature, at depths of more than 274 m, has been relatively stable since 1990 (between 5 and 6°C).	Change noted in CIL can modify the spatial distribution of shrimp.	?
Predation	Abundance of cod and redfish was still low in 1999. That of Greenland halibut has climbed since 1993.	While total abundance of predators is low, the increase in Greenland halibut may intensify predation on shrimp.	?
Exploitation by fishery	Ratio of commercial catches to survey abundance fell in 1999, but was within limits of values observed since 1995.	Exploitation rate within limits of values observed since 1995.	+

RESOURCE STATUS ASSESSMENT: Resource status is assessed globally by combining all the indicators.			
Current status	After rising between 1992–93 and 1997, abundance and biomass remained relatively stable and high from 1997 to 1999. No major change seen in 1999 in relation to last three years.		+
Prospects	The 1996 and 1997 year-classes, which will recruit to the female spawning stock and to the fishery in the next two or three years, vary in numbers. The abundance of the resource will likely vary over the next two or three years, depending on the growth and survival of these year-classes, but will not show any significant upward or downward trend. In 2000, landings comparable to those of 1998 and 1999 should produce exploitation rates within the limits of the values recorded since 1995. Favourable environmental conditions probably contributed to the growth of the stocks in the 1990s. These conditions changed in 1999 and may adversely affect the survival and growth of the year-classes, although it is impossible to quantify the impact.		+/-

References

Savard, L. 1999. Shrimp of the Estuary and Gulf of St. Lawrence. DFO Atlantic Fisheries. Stock Status Report C4-06.

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