

## Shrimp of the Estuary and Gulf of St. Lawrence

### Background

There are mainly three provincial shrimp fleets which fish in four management units, from spring to fall. The stock assessment is conducted each year to determine whether changes that have occurred in the stock necessitate adjustments to the conservation approach and management plan. Landings in 1998 were the highest ever, and the TACs were taken in all areas once again.

A number of peculiarities of shrimp biology have influenced the fishery itself, fishery management and resource conservation. Shrimp go through a sex reversal in the course of their life history, 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. Spawning 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 females migrate to shallower water in winter and the young end up in shallower water at the heads of channels) 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..

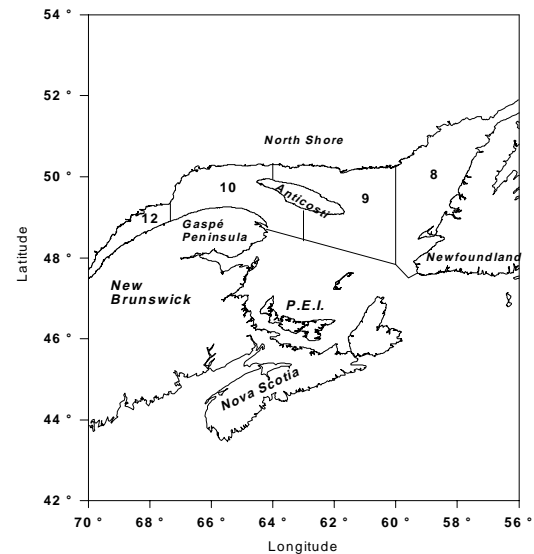


Figure 1. Shrimp fishery management units in the Estuary and Gulf of St. Lawrence.

### Summary

- CPUEs and biomass and abundance indices for commercial-size shrimp were still high in 1998. Spawning stock abundance remained high, despite the fact that catches of females have increased over the past few years.
- The TACs have been attained easily and 1998 exploitation rates were low, similar to those of the early 1990s, before the increases in abundance and TACs.
- Male abundance declined in 1998, however. Recruitment to spawning stock (the last mode of males in 1998) seems average for 1999. However, very few young males (the first modes of males) were observed in 1998 survey catches. Although it is difficult to forecast changes in young year-classes accurately, the abundance of shrimp available to the fishery in 1999 (males and females) should be lower than in 1998, but still higher than the lowest levels, seen in 1992 and 1993.
- In 1999, catches similar to those of 1998 should mean an increase in exploitation rates. A low abundance of young males has been observed before, in the early 1990s. At that time, those populations proved to be capable of sustaining higher exploitation rates over the following years.

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### ***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. The New Brunswick fleet splits its operations between the western and eastern Gulf. A reorganization of management units was proposed in 1992 in order to better reflect fishing operations and the geographic distribution of shrimp. The five management units 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 harvesting in the Estuary and Gulf is controlled by a number of management measures, including TACs (total allowable catches) in the four management units (Table 1). In 1998, 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. In 1997 and 1998, temporary allocations of shrimp were granted to fishers with groundfish licences. Other management tools include a minimum mesh size (40 mm) and, since 1993, the compulsory use of the Nordmore grate, which reduces groundfish bycatches 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). Landings in 1998 amounted to more than 23,000 t, a 40%

increase over 1995 and a new high. 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 units. The short-term outlook for the availability of shrimp to the fishery was excellent, in 1995, 1996 and 1997. The TAC for the Estuary area has not been increased to the same degree as the TAC in the other areas since 1982, because of uncertainty in the assessment of the stock abundance in the area. So far, no negative effects of harvesting have been seen on northern shrimp populations in 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 1998 are preliminary, from December 31, 1998.*

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	547	550	7719	7744	6044	6050	5483	5687	19793	20031
1998	634	633	8952	8966	6903	7004	6627	6584	23116	23187

### ***Resource Assessment***

A precautionary approach has been taken in assessing the shrimp stocks of the Estuary and Gulf. Management of the shrimp fishery in the Estuary and Gulf has always sought to err on the side of caution in order to avoid overfishing and to minimize the negative impacts of harvesting. The precautionary approach, which is being debated in Canada and in international forums such as the Northwest Atlantic Fisheries Organization (NAFO) and the International Council for the Exploration of the Sea (ICES), meets the objectives of Gulf shrimp management. The approach involves a number of concepts that have also served as the basis of this assessment.

Resource 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 condition of the stock. Resource status is then assessed globally by combining all the indicators. The results are presented as performance reports for each management unit.

### ***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 amount of shrimp caught per hour of fishing. The data are standardized to take into account changes in the fleets (changes in 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 carapace 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. The modes that follow represent the preceding year-classes, while the last mode consists of females of several different year-classes.

Once shrimp are 14 mm long (carapace length), 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. Shrimpers target large shrimp in particular, and as a result their catch rates depend

essentially on the abundance of shrimp (females and the last mode of males) having a carapace length greater than 19 or 20 mm.

The exploitation rate is a measure of the intensity of fishing pressure. An exploitation rate index can be obtained by comparing commercial catches with the abundance index derived from the research survey. 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. With the exploitation rate index, however, it is possible to track relative changes in the exploitation rate over the years.

### ***Resource Status and Outlook***

The indices confirm the high abundance of shrimp in the Gulf of St. Lawrence in 1998. The catch rates of commercial shrimpers are at their highest level since 1982. The abundance indices from research surveys have followed the same trend and are above or similar to values observed since 1990 (Figures 2 and 3).

The recent increase in abundance is due to the successive entry into the population of strong year-classes born in the first half of the 1990s. It is difficult, however, to estimate accurately the strength of year-classes that will support the fishery in 1999, because they are only partially vulnerable to the survey gear. Nonetheless, the abundance of males that will change sex in 1999 seems about average, and few young males were observed in the survey catches (Figure 4). The abundance of shrimp available to the fishery at the start of the 1999 season should therefore be lower than that observed in 1998.

The most likely explanation for the recent increase in shrimp abundance is a reduction in predation. The biomass of redfish and cod, both major shrimp predators, is very low in the Gulf. If this hypothesis is true,

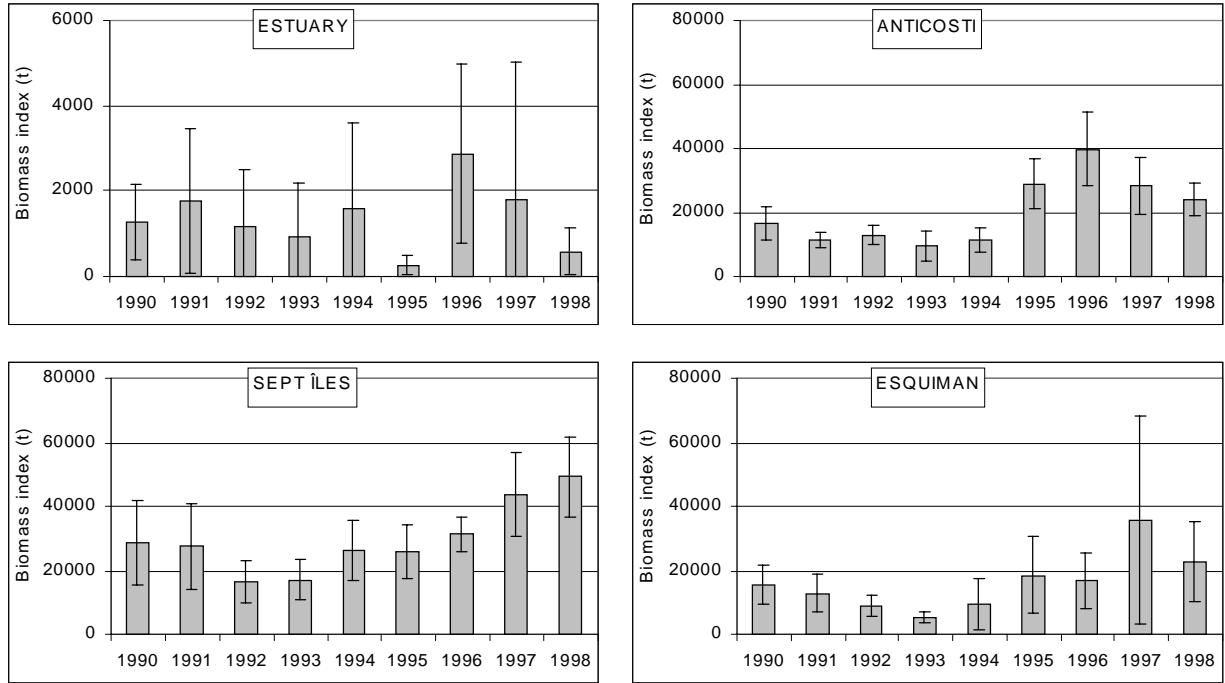


Figure 2. Biomass index derived from research surveys, by management unit since 1990.

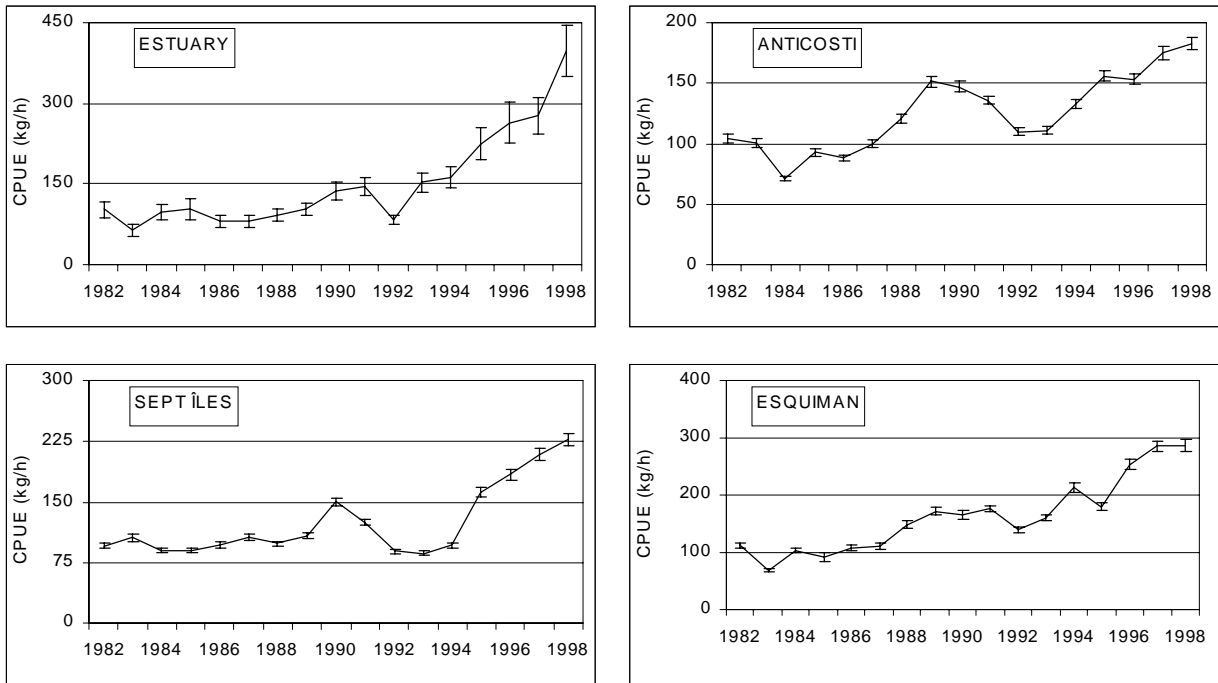


Figure 3. Standardized catch per unit of effort (CPUE) derived from commercial fishery statistics, by management unit since 1982.

the current situation of high abundance would have to be regarded as exceptional and temporary. Furthermore, the recent

increase in turbot, another shrimp predator, suggests that predation by that species is on the rise.

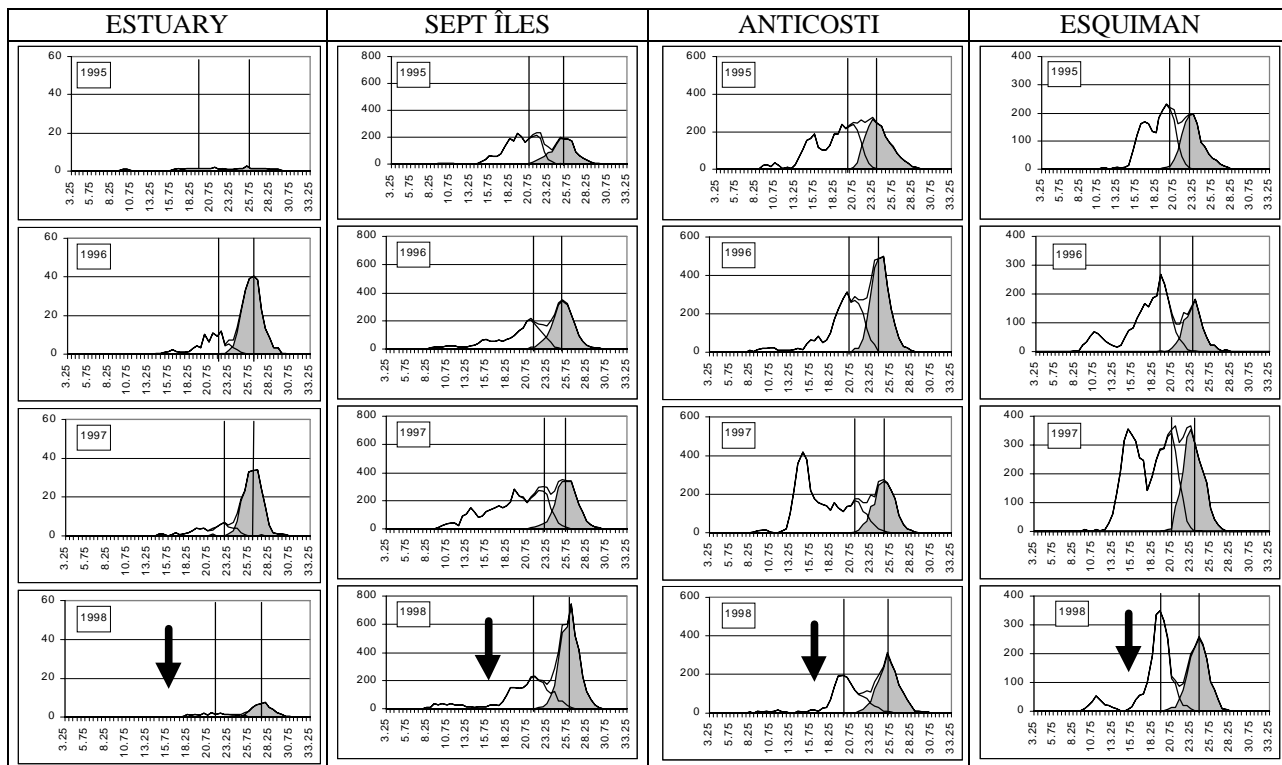


Figure 4. Length frequency distribution (y-axis: abundance in millions of individuals; x-axis: carapace length class in millimetres) derived from research surveys, by management unit since 1995. Vertical lines indicate mean lengths of the last mode of males and the mode of females (shaded). Arrows indicate the position of the very weak cohort in 1998.

Recent commercial fishing does not seem to have had any adverse effects on the population. The TACs have been taken in all areas since 1995, even though significant increases were allocated in 1996, 1997 and 1998. The population has grown substantially and the exploitation rate index is the same as in 1990 (Figure 5). Maintaining the TAC at the same level in 1999 as last year (1998 TAC of 23,187 t) would present only a low risk to resource conservation over the short term. The exploitation rate produced by this TAC should be higher than in 1998, however. Owing to natural fluctuations in abundance, a strategy of stabilizing TACs can still lead to wide variations in the exploitation rate, like the ones observed between 1990 and 1998. Over that period, the resource was

able to sustain these exploitation rates, but we have no idea what the impact would be of maintaining an exploitation rate at such a high level for several years running.

Some changes that occurred in 1998 point to a variation in shrimp productivity that may have a longer-term influence on stock abundance and fishing success. Commercial catch rates actually declined over the past season, although they had remained very high in preceding seasons. Moreover, the distribution of the shrimp resource seems to have changed, as commercial catch rates and shrimp densities in the survey were lower along the Laurentian Channel in 1998. These changes and fishers' comments about shrimp distribution, which was more contagious in 1998, suggest that increases in abundance and the subsequent extension of

the population's range have come to an end. Furthermore, the mean size of males declined in 1998 after increasing for several years, which suggests that growth has slackened. Additionally, males will probably change sex at smaller sizes over the next few years, producing smaller females. Finally,

the higher abundance of turbot, a companion species to shrimp, means that predation by this species will probably rise.

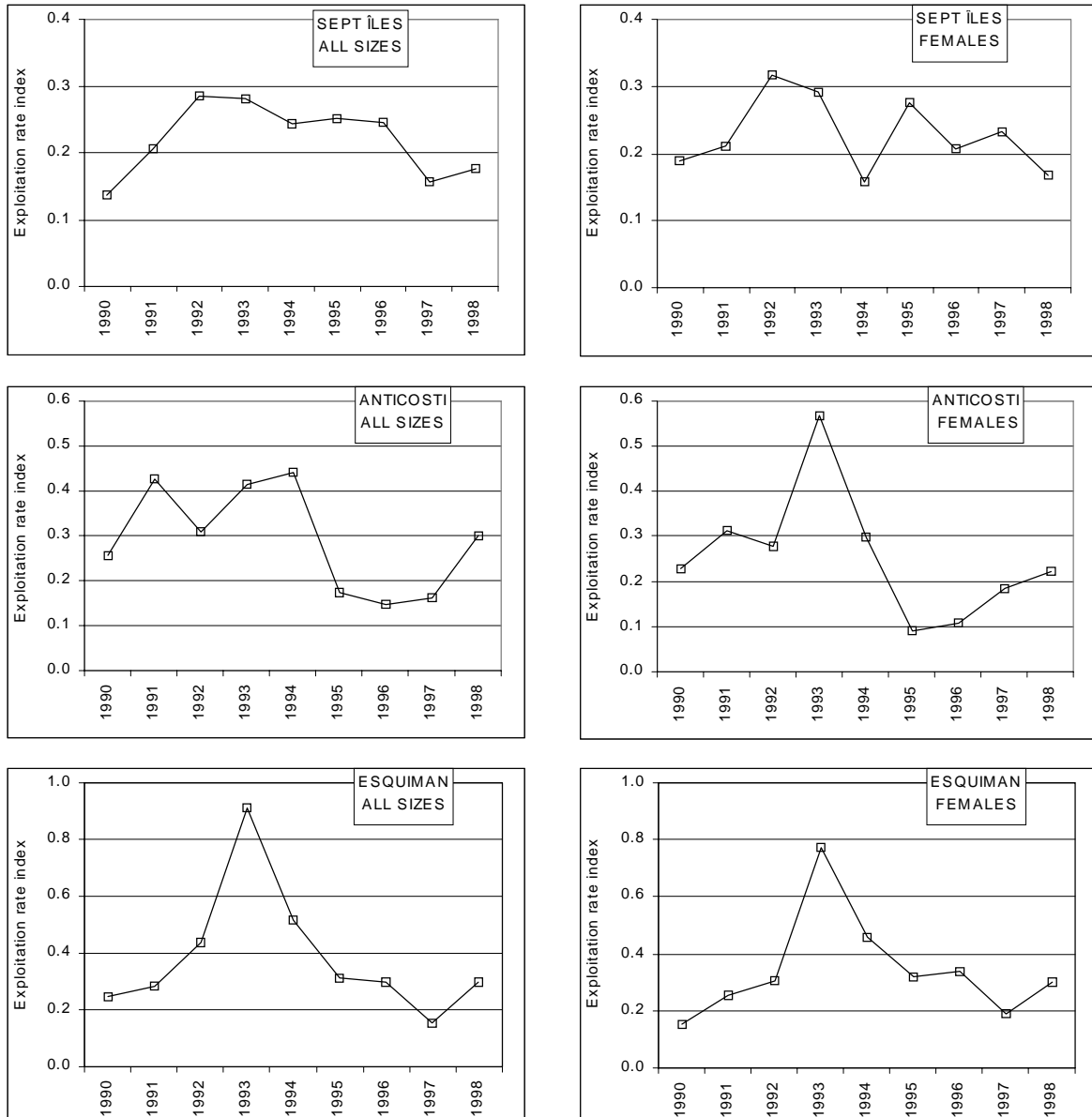


Figure 5. Exploitation rate index based on commercial fishery statistics and research surveys, by management unit since 1990.

**PERFORMANCE REPORT: ESTUARY**

INDICATOR	OBSERVATION	INTERPRETATION	OUTLOOK
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**FISHING SUCCESS**

Landings	Increased TACs (27%) and landings (25%) since 1996; TAC taken easily since 1987	Large biomass	+
Catch (number)	Data not available		
Effort	64% drop between 1992 and 1995; 1998 value one of lowest on record	High density	+
Seasonal pattern	High monthly CPUEs in 1998; CPUEs declined over season	High density; return to seasonal pattern of early 1980s	▼
Spatial pattern	Distribution of effort stable since 1990; effort concentrated in eastern part of area	High density	+
Stock distribution	Drop in densities in eastern part of area	Possibly localized impact of fishing	▼
Industry perception	Data not available		

**STOCK ABUNDANCE**

Biomass index	Varies widely from year to year; 1998 value one of lowest on record	Small biomass	▼
CPUE	Increasing since 1992; 1998 value highest in series	High density	+
Abundance index	Varies widely from year to year; 1998 value one of lowest on record	Low abundance	▼
NPUE	Data not available		

**RESOURCE PRODUCTIVITY**

Population structure	Age structure stable from year to year; growth gradient from east to west	No loss of female component; productivity lower in eastern part of Gulf	+
Size of males	Size of last mode of males smaller in 1998	Size at sex change will drop in 1999; females will be smaller	▼
Size of females	Stable from 1994 to 1997, higher in 1998; 1998 value highest in series	Fewer individuals for same catch	+
Female abundance	Varies widely from year to year; 1998 value one of lowest on record	Small spawning stock	▼
Male abundance	Varies widely from year to year; 1998 value one of lowest on record	Low recruitment to spawning stock	▼
Recruitment	Male abundance has fallen to very low level; very few small males in 1998 survey	Low recruitment to fishery	✗
Predation	Cod and redfish abundance low, but increase in turbot	Predation pressure will rise	▼
Exploitation rate	Data not available		

**ASSESSMENT**

<i>All indicators combined</i>	<b>Uncertainty about condition of stock in 1998; it could begin to decline in 1999 because of lower recruitment</b>	▼
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<b>MEANING OF SYMBOLS:</b> POSITIVE OUTLOOK: +    IMPACT UNCERTAIN: ▼    CAUSE FOR CONCERN: ✗		
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**PERFORMANCE REPORT: SEPT ÎLES**

INDICATOR	OBSERVATION	INTERPRETATION	OUTLOOK
<b>FISHING SUCCESS</b>			
Landings	40% increase in TACs and landings since 1995; TAC taken easily since 1995	Large biomass	+
Catch (number)	19% increase since 1995; decrease in males (12%), increase in females (62%)	High abundance; mean weight of catches has increased	+
Effort	40% reduction between 1994 and 1995; effort low and stable since 1995	High density	+
Seasonal pattern	High monthly CPUEs in 1998; CPUEs decline over season	High density; return to seasonal pattern of early 1980s	▼
Spatial pattern	Effort reduced in southern part of Laurentian Channel; effort increased in western part of area	Change in distribution; geographic range may be shrinking	▼
Stock distribution	Drop in densities in southern part of Laurentian Channel; increase in densities in western part of area	Change in distribution; geographic range may be shrinking	▼
Industry perception	Good concentrations of shrimp in areas different from other years; few or no small shrimp	Densities still high, but change in distribution and low recruitment	▼

**STOCK ABUNDANCE**

Biomass index	Increasing since 1992–93; 1998 stable in relation to 1997; 1997 and 1998 values highest in series	Large biomass	+
CPUE	Increasing since 1992–93; 1998 value highest in series	High density	+
Abundance index	Increasing since 1992–93; 1998 stable in relation to 1997; 1997–98 values similar to that of 1990	High abundance	+
NPUE	Increasing since 1992–93; 1998 value highest in series	High density	+

**RESOURCE PRODUCTIVITY**

Population structure	Age structure stable from year to year; growth gradient from east to west	No loss of female component; productivity lower in eastern part of Gulf	+
Size of males	Size of last mode of males smaller in 1998	Size at sex change will drop in 1999; females will be smaller	▼
Size of females	Increasing since 1994; very big in 1998	Fewer individuals for same catch	+
Female abundance	Increasing since 1992–93; 1998 value highest in series	Large spawning stock	+
Male abundance	Abundance of all male components relatively stable in 1992–96, but fell in 1998 to average level	Average recruitment to spawning stock	▼
Recruitment	Drop in male abundance to average level; very few small males in 1998 survey	Low recruitment to fishery	×
Predation	Cod and redfish abundance low, but increase in turbot	Predation pressure will rise	▼
Exploitation rate	No increase with recent rise in catches; 1998 rates were same as those of early 1990s	Fishing mortality has not increased since early 1990s	+

**ASSESSMENT**

<i>All indicators combined</i>	<b>Stock in very good condition in 1998, but could begin to decline in 1999 because of lower recruitment</b>	▼
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## MEANING OF SYMBOLS:

POSITIVE OUTLOOK: + IMPACT UNCERTAIN: ▼ CAUSE FOR CONCERN: ×

**PERFORMANCE REPORT: ANTICOSTI**

INDICATOR	OBSERVATION	INTERPRETATION	OUTLOOK
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**FISHING SUCCESS**

Landings	40% increase in TACs and landings since 1995; TAC taken easily since 1995	Large biomass	+
Catch (number)	16% increase between 1995 and 1998; decrease in males (12%), increase in females (124%)	High abundance; mean weight of catches has increased	+
Effort	17% increase between 1995 and 1998; 1998 value slightly above average	Increase in density smaller than increase in TAC	▼
Seasonal pattern	High monthly CPUEs in 1998; CPUEs declined over season	High density; return to seasonal pattern of early 1980s	▼
Spatial pattern	Effort reduced in southern part of Laurentian Channel; effort increased in northern part of area	Change in distribution; geographic range may be shrinking	▼
Stock distribution	Drop in densities in southern part of Laurentian Channel; densities still high in northern part of area	Change in distribution; geographic range may be shrinking	▼
Industry perception	Yields not as good south of island; distribution spotty	Change in distribution related to lower density	▼

**STOCK ABUNDANCE**

Biomass index	Falling since 1996; 1998 stable in relation to 1997; 1997-98 values higher than those of 1991-94	Large biomass	+
CPUE	Increasing since 1992-93; 1998 value highest in series	High density	+
Abundance index	39% drop from 1997 to 1998, but 1998 value is still high compared with 1991-94.	High abundance	+
NPUE	Increasing since 1992; 1998 value among highest in series	High density	+

**RESOURCE PRODUCTIVITY**

Population structure	Age structure stable from year to year; growth gradient from east to west	No loss of female component; productivity lower in eastern part of Gulf	+
Size of males	Size of last mode of males smaller in 1998	Size at sex change will drop in 1999; females will be smaller	▼
Size of females	Increasing since 1995; very big in 1998	Fewer individuals for same catch	+
Female abundance	Relatively stable since 1995, dropped in 1997; stabilized in 1998 at high level	Large spawning stock	+
Male abundance	Decreased in 1998 to level seen in 1990-94	Average recruitment to spawning stock	▼
Recruitment	Male abundance declined to a lower level; very few small males in 1998 survey.	Low recruitment to fishery	×
Predation	Cod and redfish abundance low, but increase in turbot	Predation pressure will rise	▼
Exploitation rate	Increasing since 1995; 1998 rates similar to those of early 1990s	Fishing mortality has not increased since early 1990s	+

**ASSESSMENT**

<i>All indicators combined</i>	<b>Stock in good condition in 1998, but could begin to decline in 1999 because of lower recruitment</b>	▼
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<b>MEANING OF SYMBOLS:</b> POSITIVE OUTLOOK: +    IMPACT UNCERTAIN: ▼    CAUSE FOR CONCERN: ×		
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**PERFORMANCE REPORT: ESQUIMAN**

INDICATOR	OBSERVATION	INTERPRETATION	OUTLOOK
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**FISHING SUCCESS**

Landings	40% increase in TACs and landings since 1995; TAC taken easily since 1993	Large biomass	+
Catch (number)	7% increase between 1995 and 1998; stable for males, increased for females (143%)	High abundance; mean weight of catches has increased	+
Effort	24% drop between 1995 and 1996; stable, average effort since 1996	High density	+
Seasonal pattern	High monthly CPUEs since 1998; CPUEs do not decline over season	High density	+
Spatial pattern	Distribution of effort stable; effort concentrated north of 50th parallel	Shrimp distribution stable	+
Stock distribution	Distribution stable since 1995	Shrimp distribution stable since 1995	+
Industry perception	Excellent yield, catch composition excellent	High density and abundance	+

**STOCK ABUNDANCE**

Biomass index	Relatively stable between 1995 and 1998 (1997 value uncertain); 1998 value higher than those of 1991-94	Large biomass	+
CPUE	Increasing since 1992; 1998 value highest in series	High density	+
Abundance index	Stable between 1995 and 1998 (1997 value uncertain), but 1998 value still higher than those of 1992-94	High abundance	+
NPUE	Increased between 1992 and 1996; stable and high since 1996	High density	+

**RESOURCE PRODUCTIVITY**

Population structure	Age structure stable from year to year; growth gradient from east to west	No loss of female component; productivity lower in eastern part of Gulf	+
Size of males	Size of last mode of males smaller in 1998	Size at sex change will drop in 1999; females will be smaller	▼
Size of females	Recent values smaller than in early 1990s; slight increase since 1995	Slower growth; fewer individuals for same catch	▼
Female abundance	Increased between 1993 and 1998 (1997 value uncertain); 1998 value highest in series	Large spawning stock	+
Male abundance	Increased between 1992 and 1995; stable since 1995 (1997 value uncertain)	Good recruitment to spawning stock	+
Recruitment	Male abundance stable since 1996, but very few small males in 1998 survey	Low recruitment to fishery	×
Predation	Cod and redfish abundance low, but increase in turbot	Predation pressure will rise	▼
Exploitation rate	No increase with recent increase in catches; 1998 rates were similar to those of early 1990s	Fishing mortality has not increased since early 1990s	+

**ASSESSMENT**

<i>All indicators combined</i>	<b>Stock in good condition in 1998, but could begin to decline in 1999 because of lower recruitment</b>	▼
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<b>MEANING OF SYMBOLS:</b> POSITIVE OUTLOOK: +    IMPACT UNCERTAIN: ▼    CAUSE FOR CONCERN: ×		
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