

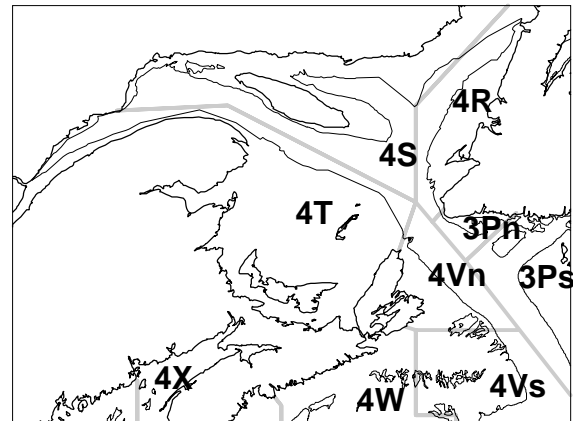
## Cod in the Southern Gulf of St. Lawrence

### Background

Southern Gulf of St. Lawrence cod are relatively long lived, and may reach ages of 20 or more when mortality is low. They begin to reach commercial size at age 4, and are fully available to the commercial fishery by age 7. They mature sexually at a size slightly below the commercial size of 41 cm.

Southern Gulf cod are highly migratory. Spawning occurs in the Shediac Valley and around the Magdalen Islands from late April to early July. During the summer, the cod are widely distributed while they feed heavily on krill, shrimp, and small fish, primarily herring, American plaice, and capelin. The fall migration begins in late October and cod become concentrated off western Cape Breton in November as they move into 4Vn. The stock overwinters in 4Vn and northern 4Vs, along the edge of the Laurentian Channel. The return migration begins in mid-April, although in some years (1991-92) this was delayed by the late breakup of the winter ice. The management unit for this stock includes all of 4T, catches in 4Vn during November-April, and some catches in 4Vs in January-April.

Southern Gulf cod have been exploited since the 16<sup>th</sup> century. Landings varied between 20,000 - 40,000 t annually between 1917-1940, and then began to increase to a peak of over 100,000 t in 1958. The fishery was primarily prosecuted with hook and line until the late 1940s, when a ban on otter trawling was lifted. Landings remained relatively high in the 1960s and early 1970s, in the range of 60,000 t. TAC's were first imposed in 1974, and these became restrictive as the stock declined in the mid-1970s. The stock recovered somewhat, and landings returned to the 60,000 t range during the 1980s. During the 1980s, the fixed gear fishery declined drastically, and the fishery was mainly prosecuted by mobile gear until it was closed in September 1993, due to low abundance.



### Summary

- The southern Gulf of St. Lawrence cod stock was in a state of rapid decline in biomass in the early 1990s. The decline was halted by the closure of the commercial fishery in September 1993.
- The population biomass remains at a level close to the lowest seen since 1950.
- Recruitment has been well below the historical average and there is no sign of improvement.
- Post-moratorium estimates of total mortality from research survey results indicate that the natural mortality rate of this stock is in the range of 33% to 40% per year, more than twice that traditionally assumed.
- With a natural mortality as high as the survey results suggest, the stock may decline even if there is no catch in 1998.
- Based on recruitment estimates for ages 2 and 3 that are well below average, it is unlikely that spawning stock biomass will increase significantly over the next 3 years, even with no fishing. Improved recruitment is essential for this stock to recover.

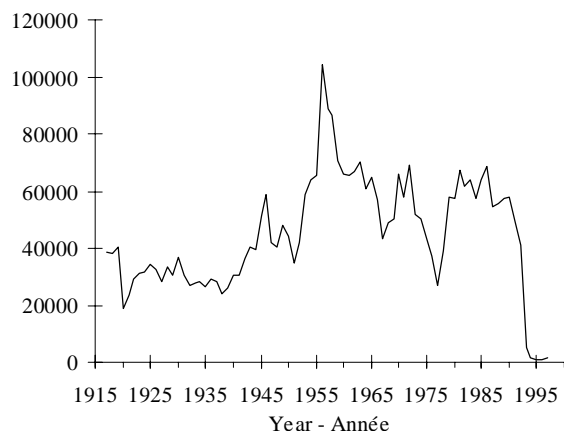
**The Fishery**

The cod fishery in the southern Gulf continued to be closed in 1997 but a 2,000 t allocation for by-catch, sentinel surveys, and experimental fisheries was established. Cod were caught as by-catch in fisheries directed at other species, mainly American plaice, witch flounder, winter flounder, and dogfish. These fisheries were closed if the catch of cod exceeded 20% by weight in winter flounder fisheries and 25% in the other fisheries. A recreational fishery using hook and line gear was allowed. The sentinel surveys, conducted under a scientific protocol designed to obtain additional indices of abundance of the stock, and the experimental fisheries yielded about half of the 1591 t of cod **landed** in 1997.

Landings (thousands of tonnes)

	70-79	80-89	90-93	94	95	96	97
Year	Avg.	Avg.	Avg.				
Landings	50	61	32	1	1	1	2
TAC	48	59	39	0	0	0	0

Landings (t)

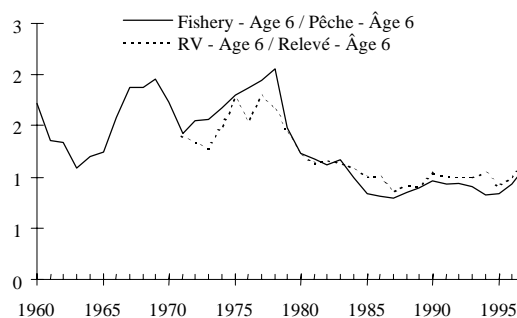


This was slightly higher than landings in 1995 (1036 t) when the lowest landings since 1917 were recorded. All of the 1997 landings came from 4T. Landings increased for all gear sectors.

The **views of fishers** on the state of the resource in 1997 varied from west to east. Fishers felt that the abundance was low in the Gaspé but a slight increase was noted in northeast NB. PEI fishers were of the opinion that cod abundance was very high. The opinions were divided on the Magdalen Islands while fishers from Nova Scotia felt that there was an increase in the abundance of the stock.

Age 9 was the most important age-group in the 1997 landings but fish of 6 to 8 years of age were also well-represented. Younger fish (ages 3 to 5) were landed predominantly by mobile gear either as by-catch in flatfish fisheries or in sentinel surveys. The **weights at age** of cod in the commercial fishery and the research vessel survey have increased slightly but remain low indicating that growth continues to be below average.

Weight (kg)



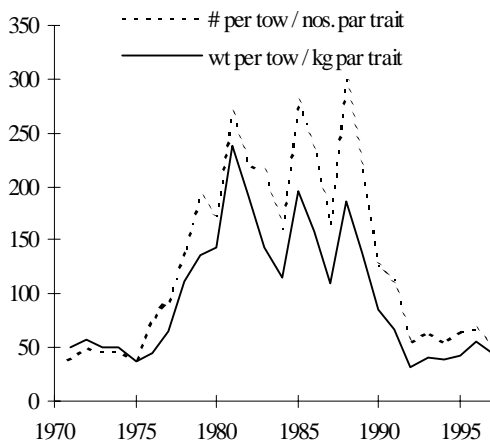
**Resource Status**

The information used in this assessment included the landings data from 1917-1997, research survey data from 1971-1997, sentinel survey data from 1994-1997, and commercial catch at age from 1971-1997.

The **annual groundfish survey** has been conducted in September since 1971. The

results of the 1997 survey indicate that the stock continues to be at low abundance with little sign of recovery. Stock biomass, as indicated by trends in the survey mean weight per tow, shows a decline from 1996. The total abundance of cod (mean numbers per tow) also declined in 1997 and remains near the lowest values seen in the series.

Survey Index (All ages)



Survey length frequencies indicated that the numbers of pre-recruits (< 40 cm) have not increased in recent years.

The **sentinel survey** program was continued in 1997. Thirty-five vessels fishing with fixed and mobile gears in various areas of the southern Gulf were used to monitor cod abundance. The 1997 catch rates of adult fish increased in 12 of 16 gear/area combinations. However, all of the projects designed to survey the full size range of cod (mobile gears with liners) indicated that the overall abundance of fish in the population has declined slightly. As well, length frequencies from catches using small mesh did not indicate an increase in the number of pre-recruits. There was a large increase in sentinel catch rates for longlines near P.E.I. The research vessel survey results also suggested an increase in the biomass in that area.

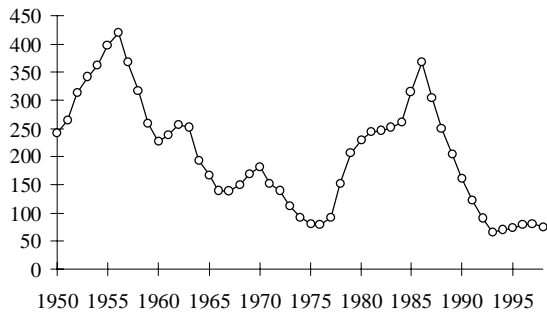
**Cod condition** has been monitored seasonally since September 1991. The winter and spring condition in 1997 reached the low levels seen in 1992. However, samples collected in July and August 1997 showed a marked recovery to the high levels seen in previous years.

Closure of the commercial cod fishery and the existence of a reliable research vessel survey have allowed direct estimation of the **natural mortality** rate of this cod stock. Estimates of natural mortality calculated last year were updated and the new estimates continue to indicate a high level in the range of 33% to 40% per year. Stock assessment models use the instantaneous rate of natural mortality (M) as opposed to the annual rate. Traditionally, M has been assumed to be 0.2 (18% per year with no fishing), but the current estimates indicate that M increased recently, and this assessment uses a value of 0.4 since 1986.

The causes of this increase in natural mortality include all sources of unaccounted mortalities such as those that may be caused by poor environmental conditions, seal predation, unreported catches and changes in life history characteristics. The relative contributions of these causes are not known.

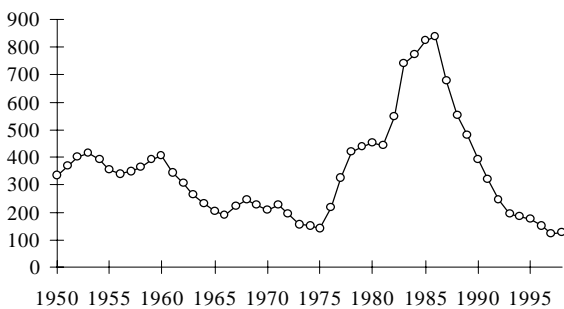
Spawning stock **biomass** was relatively high in the 1950s, but it declined throughout the 1960s and reached a minimum in the mid-1970s. There was a sharp increase in spawning biomass with the recruitment of strong year-classes born in 1974-75, and 1979-80. Spawning biomass was relatively high and stable in the early- to mid-1980s, but then declined rapidly, reaching a minimum in 1993. With the closure of the fishery, the decline in biomass stopped and has remained stable.

Spawning Biomass ('000 t)



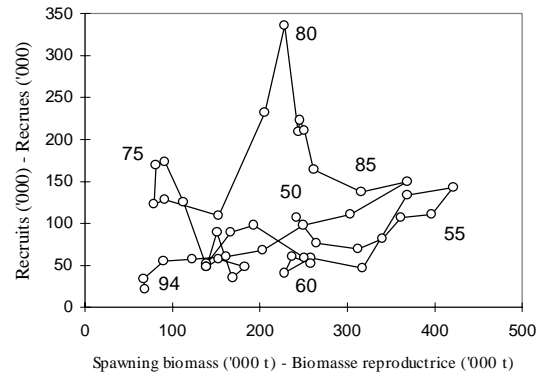
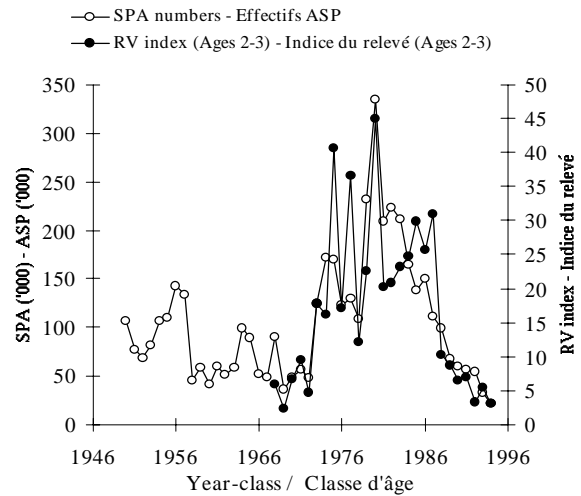
The trend in total abundance resembles that of spawning biomass, except that the relative heights of the peaks in the 1950s and 1980s are reversed. This was due to lower weights at age in the 1980s and 1990s as well as higher recruitment estimates caused by a higher M since 1986.

Age 3+ abundance (millions)



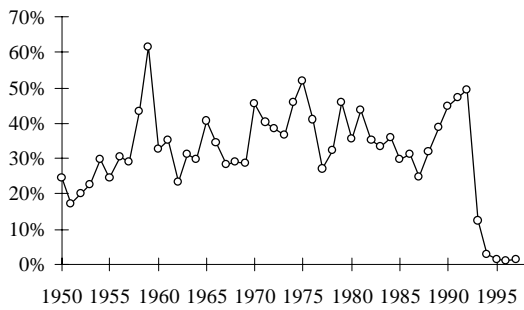
**Recruitment** of year-classes produced in the late 1980s and early 1990s appears to be well below average. Although the index of recruitment from the research survey shows a modest increase in the size of the 1995 year-class, the value is still well below average and considerably lower than the estimates for the year-classes that promoted the recovery in the late 1970s. The small year-classes observed recently were produced by low spawning biomasses.

Recruitment estimates



The **exploitation rate** increased from the early 1950s to the mid-1970s, with the exception of a high value in 1959. There was a decrease in 1977 and 1978 with the extension of fisheries jurisdiction and the rate was relatively stable until 1987. The exploitation rate then increased sharply and exceeded 50% in 1992. Fishing effort was reduced markedly in 1993 with the closure of the fishery. The further decrease in effort in 1994 resulted in a decline in the exploitation rate to the lowest recorded. The exploitation rate has remained low since 1995.

Exploitation rate (7+)



The main source of **uncertainty** in the assessment is the estimate of natural mortality for recent years. However, the population estimates in 1998 with the increase in M were found to be quite similar to those with an analysis assuming an M of 0.2. It is not known if this is a temporary situation or whether it will continue. The implications on reference points such as  $F_{0.1}$  need further study. The estimated  $F_{0.1}$  is higher for an M of 0.4 than for an M of 0.2, but fishing a stock harder when its productivity is declining would accelerate its depletion.

There are differences in opinion regarding stock status among fishers from the eastern and western portions of 4T. Fishers from P.E.I. and Cape Breton indicated at several consultation meetings that cod are increasing in abundance in their areas. Fishers from Gaspé indicate that cod abundance is lower than in the late 1980s and early 1990s. Fishers from the Magdalen Islands were divided on the state of the stock while those from northeastern N.B. noted a slight increase. Results from the September RV survey support the views of both the eastern and western area fishers. The surveys indicate that cod are distributed closer to shore in recent years, that cod are rarely found in the central part of the survey area, and that the relative abundance of cod in the eastern part of 4T has increased.

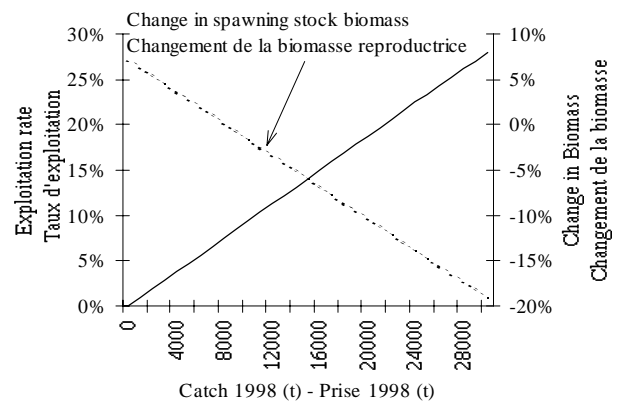
**Outlook**

The productivity of the stock remains low because of low recruitment, poor growth and high mortality.

The assumed M for the stock has important implications in terms catch projections for 1998. The results of two catch projections, one based on an SPA assuming an M of 0.2 and the other assuming an M of 0.4, are provided. The weight of evidence supports the  $M = 0.4$  scenario for 1998. In the following graphs, for any catch in 1998, the associated exploitation rate is determined by reading up to the solid black line, then across to the left side. The percent change in spawning stock biomass can be determined by reading up to the dotted line then across to the right side.

For an M of 0.2, the spawning biomass would increase by about 6% if there is no catch in 1998. A catch of 8,000 t in 1998 would result in no increase in spawning biomass. The catch at the  $F_{0.1}$  reference point (16% exploitation) is projected at 21,500 t but this would result in a 10% decline in the spawning biomass.

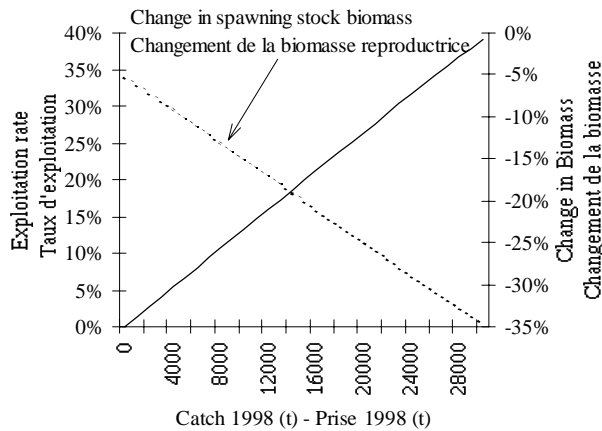
M=0.2



If M is assumed to remain at 0.4, then the spawning biomass is projected to decline by

5% even with no catch in 1998. A catch at an exploitation rate of 16% would be 16,000 t and would result in a 17% decline in spawning biomass.

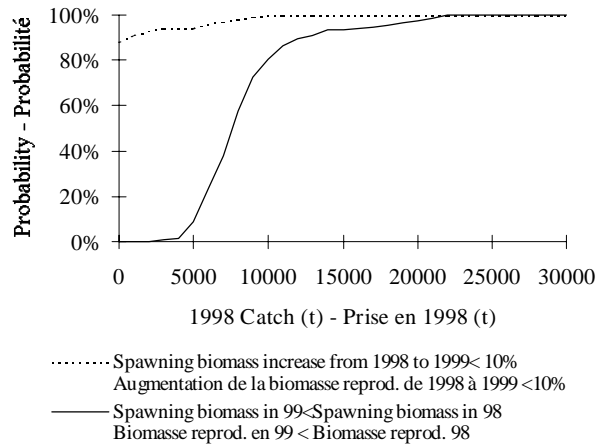
M=0.4



The estimates referred to above were made using the best available “point” estimates of stock size. It is also possible to estimate the uncertainties regarding stock size and then use these in risk analysis. The risk analyses considered were: a) the probability that the 1999 spawning biomass would be less than the 1998 biomass, and b) the probability that the 1999 spawning biomass would increase by less than 10%.

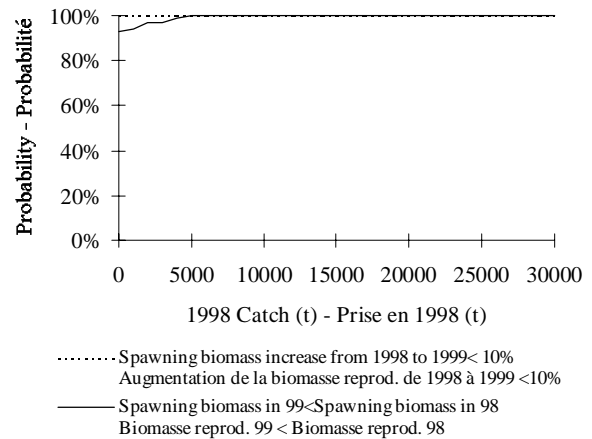
For an M of 0.2, there is only a 10% probability that spawning biomass will decline for a catch of 5,000 t. A catch at the F of 0.2 will have a 70% probability of a decline in spawning biomass. Even with no catch in 1998, there is an 88% chance that spawning biomass will not increase by 10%.

M=0.2



For an M of 0.4, there is a 93% probability that the biomass will decline even if there is no catch in 1998 and essentially no chance that the spawning biomass will increase by 10%.

M=0.4



These risk analyses do not include uncertainties in natural mortality, weight at age, and partial recruitment, but provide some guidelines for decision making.

***For more Information***

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***References***

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*La version française est disponible à l'adresse ci-dessus.*



## ***Erratum***

*Please note the following corrections in regards to certain references in the Stock Status Report:*

Delete this reference:

Sinclair, A. 1997. Natural mortality of cod in the southern Gulf of St. Lawrence. DFO Canadian Stock Assessment Secretariat Res. Doc. **97/64**.