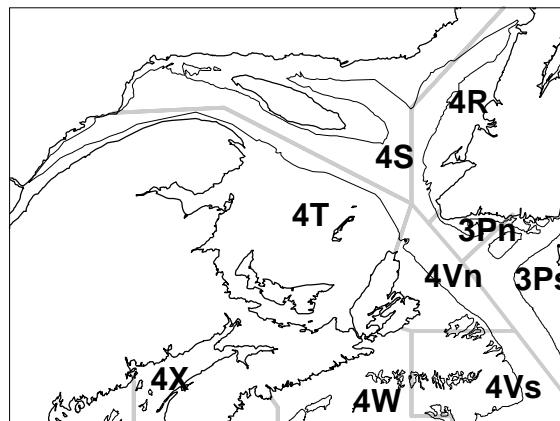


Cod in the Southern Gulf of St. Lawrence



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 (ages 4-5).

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, Am. 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 and catches in 4Vn during November-April. In some years, catches in 4Vs in January-April are attributed to this stock. In recent years, the winter fishery has been closed in 4Vsb to avoid catches of southern Gulf cod.

Southern Gulf cod have been exploited since at least the 16th 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. TACs 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

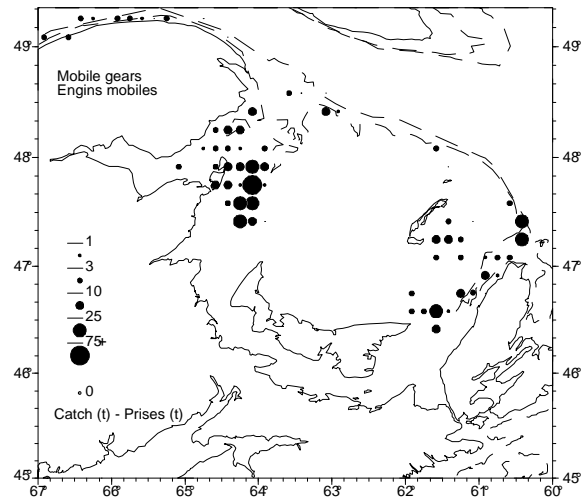
- The closure of the cod fishery in the southern Gulf of St. Lawrence in September 1993 stopped the rapid decline in abundance and biomass of the stock. Since the fishery closure in 1993, the stock has remained low.
- The recruitment produced in the early 1990s has been well below the historical average. However, there are now indications that recruitment is improving; the 1996 year-class is about average.
- Estimates of total mortality from research and sentinel surveys indicate that the natural mortality rate of this stock remains higher than the historical estimate of 0.2. Natural mortality is estimated to be in the range of 0.4 to 0.5.
- Stock projections indicate a 5 to 6% expected improvement in spawning stock biomass in 1999 if there is no fishing.
- The spawning stock biomass could increase by 10% in 2001 provided that the 1996 year-class continues to be about average and catches in 1999 and 2000 are near the 1998 level.

The Fishery

In 1998, the cod fishery in the southern Gulf continued to be closed but there was a 3,000t allocation for by-catch, sentinel surveys, and an index fishery. Cod were caught as by-catch in fisheries directed at other species, mainly flatfish. These fisheries were closed if the catch of cod exceeded 20% by weight in winter flounder and witch fisheries and 25% in the American plaice fishery. A recreational fishery using hook and line gear was allowed but the bag limit was reduced to five fish from ten fish in 1997. The sentinel surveys, conducted under a scientific protocol designed to obtain additional indices of abundance of the stock, accounted for 629 t of the total catch. The catch of the index fishery amounted to 1221 t and about 738 t were caught in the by-catch and recreational fisheries.

1998 was the first year of the **index fishery** which are fishing activities to obtain information on the status of the stock. This fishery was conducted by fixed gears in August-September and by mobile gears between late July and December.

Distribution of mobile gear index fishery catches



Landings (thousands of tonnes)

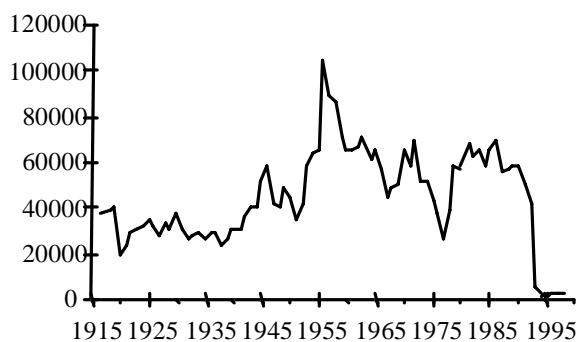
| | 1980-89 | 1990-94 | 1995 | 1996 | 1997 | 1998 |
|----------|---------|---------|------|------|------|------|
| Year | Avg. | Avg. | | | | |
| Landings | 61 | 26 | 1 | 1 | 2 | 3 |
| TAC | 59 | 31 | 0 | 0 | 0 | 0 |

The fixed gear index fishery was conducted near-shore in most areas and accounted for about 320 t .

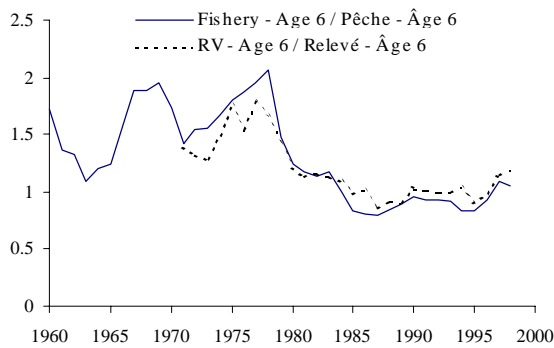
The total reported **landings** were 2588 t in 1998. This was higher than landings in 1997 (1726 t). The lowest landings since 1917 were recorded in 1995.

Age six and seven were the most important age-groups in the total 1998 landings but fish of eight to ten years of age were also well represented. The **weights at age** of cod in the research vessel survey have again increased slightly but remain low relative to the period before 1980. Weights at age in the fishery declined slightly because of the higher proportion of mobile gear catch in 1998.

Landings (t)



Weight (kg)



It appears that the variation in growth rates for the stock is the result of a combination of factors including size-selective fishing mortality, population density and temperature. Size-selectivity effects occur when fast or slow growing fish are caught in unequal proportions by the fishery. These effects are not evident since the fishery closed in 1993.

Resource Status

The information used in this assessment included the landings data from 1917-1998, the research vessel survey data from 1971-1998, sentinel survey data from 1994-1998, the otter trawl catch rate data from 1982-1993, and the commercial catch at age from 1971-1998.

The **views of fishers** on the state of the resource were obtained through various meetings and a telephone survey of active fishers in 1998. During the meetings, fishers from the eastern part of the southern Gulf and those active near Miscou Bank generally thought that the status of the stock was better than fishers from other areas.

Of the 18 sentinel fishers interviewed through the telephone survey, 11 thought that the status of the stock was lower than they have seen over the years that they have fished. However, in the same survey, 29 out of 42 fishers who were active in index or by-catch fisheries felt that the status of the stock

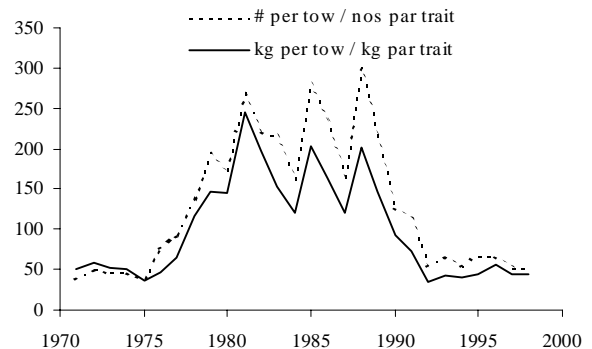
was the same or higher when compared to past experience. This difference in opinion was consistent throughout the southern Gulf.

The **annual groundfish survey** has been conducted in September since 1971. The results of the 1998 survey indicate that the stock continues to be at low abundance.

Although the total abundance (mean numbers per tow) of the population remains unchanged, the abundance of cod of ages two and three were about 30% higher than that seen in the previous two years of the survey.

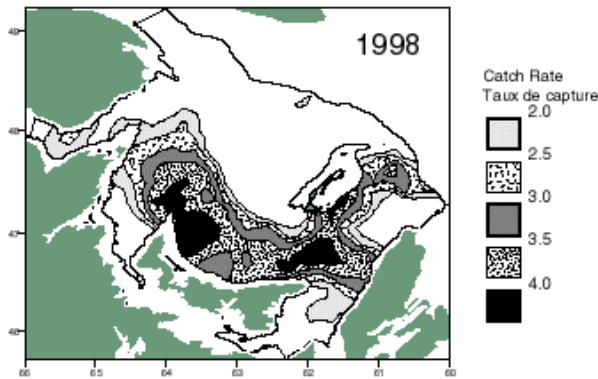
Survey mean weight per tow, indicates that stock biomass has remained low and stable over the last few years.

Survey Index (All ages)



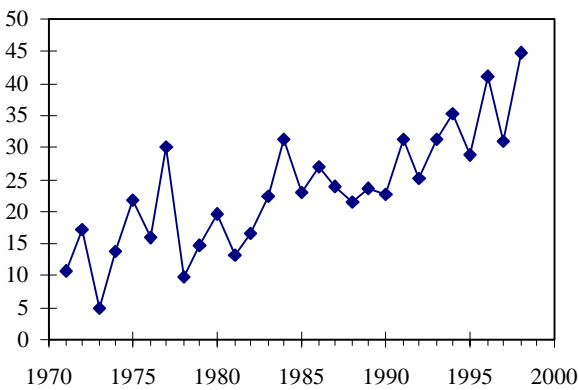
Catch rates during the 1998 survey tended to be higher close to shore and in shallower waters, a distribution characteristic of periods of low abundance.

Distribution of age 5 cod in 1998 survey



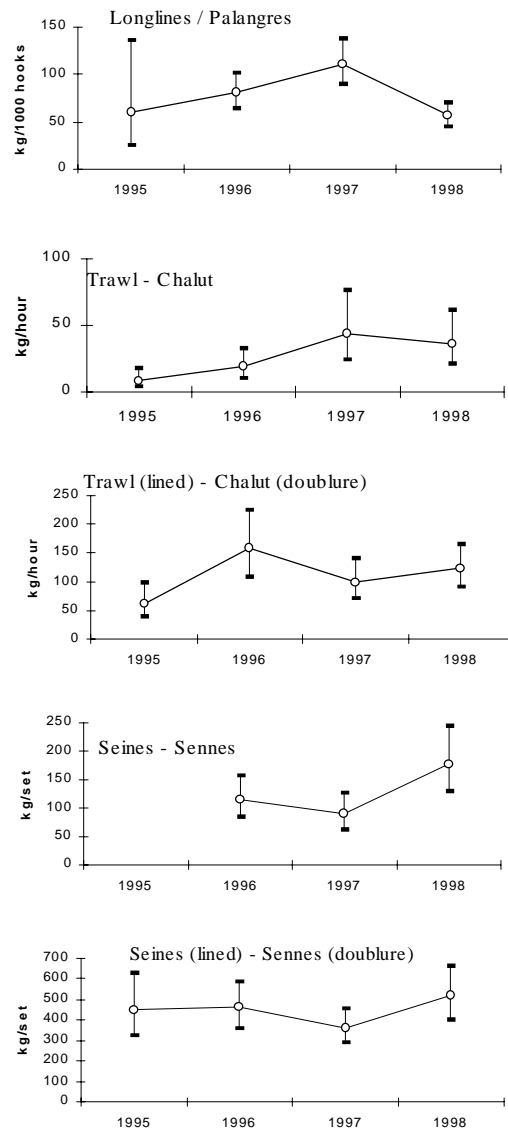
The proportion of the total biomass found in the eastern region of the southern Gulf increased again in 1998.

Percentage of biomass in eastern 4T



The **sentinel survey** program was continued in 1998. Thirty-six vessels fishing with fixed and mobile gears in various areas of the southern Gulf were used to monitor cod abundance. The catch rate index for longlines declined between 1997 and 1998. However, the catch rate of mobile gears sentinel surveys generally increased over those seen in 1997.

Sentinel Catch Rate Indices



Sentinel catch rates were higher off north-eastern New Brunswick (Shediac Valley) and near P.E.I.

Cod condition (fish plumpness) has been monitored since September 1991. Condition was slightly lower in 1998 than in 1997 but near the levels seen in previous years.

The previous assessment had indicated an increase in **natural mortality** rate (M) of this cod stock. Estimates of M calculated

previously were updated and the new estimates continue to indicate values in the range of 0.4 - 0.5, more than twice that traditionally assumed. Other analyses supported this conclusion; sentinel survey data indicate that M has been high recently and a sequential population analysis where M was estimated also produced high estimates in the recent period. As a result, the assessment model included an increase in M from 0.2 to 0.4 starting in 1986 for all age groups.

Although M remains high, preliminary analyses suggested that it may have started to decline at younger ages. However, further investigations and additional data are needed to determine whether this is the case.

The exact causes of the recent high estimates of M are undetermined but would include all sources of unaccounted mortalities such as poor environmental conditions, seal predation, unreported catches and changes in life history characteristics.

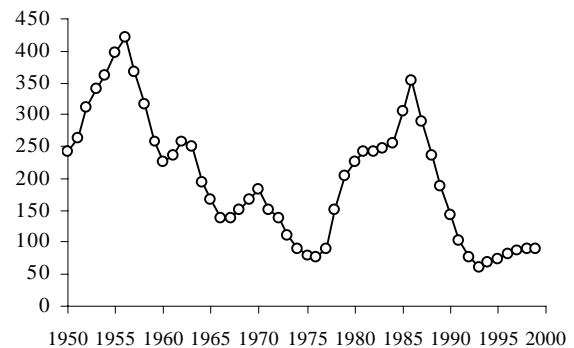
The absence of comprehensive diet information for seals in the southern Gulf is limiting the ability to quantify their impacts on cod. Tentative estimates of the combined cod consumption by grey and harp seals range from 7,000 to 15,000 t annually.

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 in the early- to mid-1980s, but then declined rapidly, reaching a minimum in 1993. With the closure of the fishery, the decline in

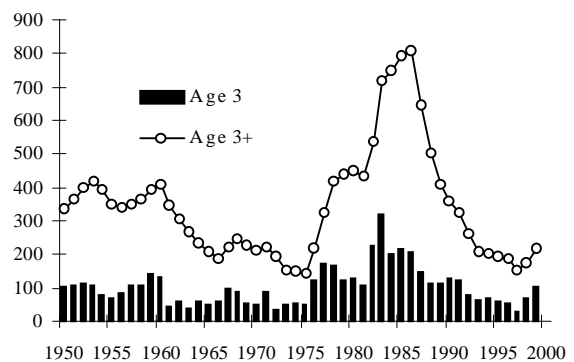
biomass stopped and it has remained stable since.

Spawning Biomass ('000 t)



The trend in total **abundance** is similar to that of spawning biomass, except that the relative heights of the peaks in the 1950s and 1980s are reversed. Spawning biomass was lower in the 1980s than the 1950s due to lower weights at age. The increase in population abundance observed in 1999 is due largely to the 1996 year-class which does not yet contribute significantly to the spawning biomass.

Abundance (millions)

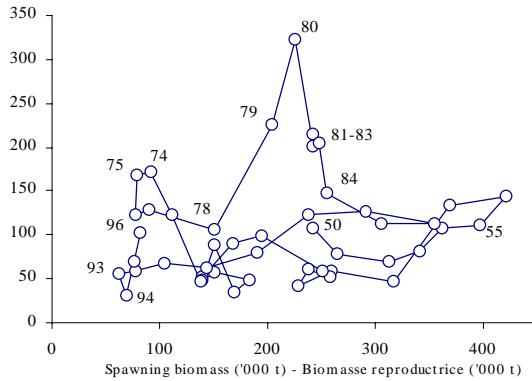


Recruitment of year-classes produced in the late 1980s and early 1990s appears to be well below average.

The 1994 year-class is estimated to be the lowest seen for this stock. However, there appears to be some improvement in recruitment. The 1995 year-class, although

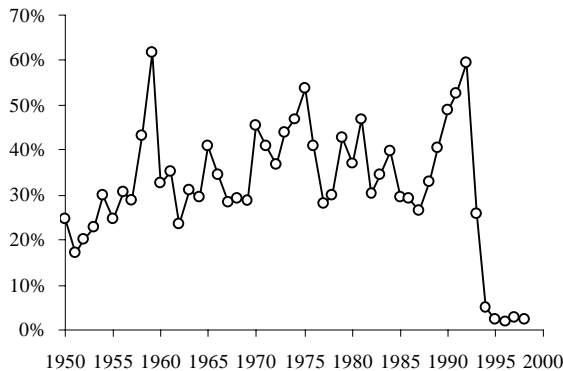
relatively low, is the highest of the preceding five year-classes and the 1996 year-class is estimated to be near average. More recruits were produced per unit of spawning biomass in the 1970s and early 1980s.

Recruits ('000)



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. The exploitation rate increased again and averaged approximately 40% up to 1988. The exploitation rate then increased sharply and reached 60% in 1992. Fishing effort was reduced markedly in 1993 with the closure of the fishery. Exploitation rates in the last few years have ranged between two and three percent.

Exploitation rate (7+)



Sources of Uncertainty

The main source of **uncertainty** in the assessment is the estimate of the 1996 year-class. Analyses excluding the sentinel indices of abundance at ages two to four gave a less precise but significantly lower abundance estimate for this year-class. However, it should be noted that the 1996 year-class will not contribute significantly to the fishery or the spawning biomass until 2001. There is continued uncertainty about the rate of natural mortality and its dynamics. Finally, the estimate of spawning biomass prior to the late seventies is based on recent maturity observations and may be over-estimated.

The distribution of cod, as observed in the research and sentinel surveys, causes the perception of the various groups of fishers to differ depending upon their geographic location. Fishers from Cape Breton, P.E.I. and those who participated in fishing activities near Miscou Bank (northeast N.B.) tend to perceive that the status of the stock has improved. Fishers from other areas tend to be more pessimistic. The results from the September RV survey and the sentinel surveys support the views of both groups. 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, contrary to the early 1990s, and that the relative abundance of cod in the eastern part of 4T has increased.

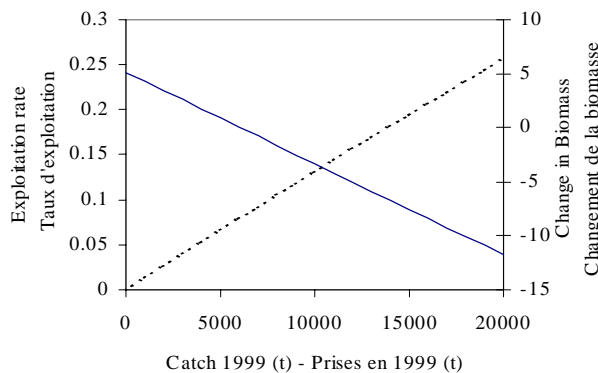
Outlook

The productivity of the stock has been low recently because of low recruitment, poor growth and high natural mortality. The situation appears to be improving slowly in terms of growth and incoming year-classes seem to be larger.

The results of **catch projections** at various levels of catch in 1999 are provided. For any

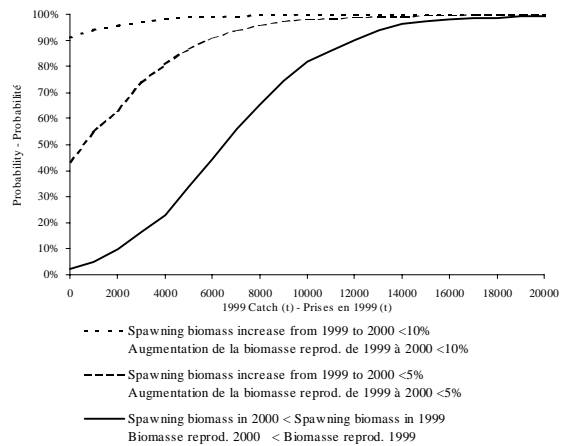
catch in 1999, the associated exploitation rate is determined by reading up to the dotted black line, then across to the left side.

The percent change in spawning stock biomass can be determined by reading up to the solid line then across to the right side.



The spawning biomass is expected to increase by about 5% to 6% if there is no catch in 1999. A catch of 6,000 t in 1999 would result in no increase in spawning biomass. 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 2000 spawning biomass would be less than the 1999 biomass, b) the probability that the 2000 spawning biomass would increase by less than 5%, and c) the probability that the 2000 spawning biomass would increase by less than 10%.

There is a 90% probability that spawning biomass would not increase by 10% in 1999 with no catch. The chance that the spawning biomass would decline if landings in 1999 would be the same as in 1998 (2588 t) is about 13%.



These risk analyses include uncertainties of the population estimates but not those associated with natural mortality, weight at age and partial recruitment. However, they do provide some guidelines for decision making.

The mid-term (three years) depends on the estimate of the 1996 year-class and the trends in natural mortality. If the 1996 year-class is not as large as estimated then there would be little increase in spawning stock biomass at the level of catches seen in recent years. Otherwise, a 10% increase in spawning biomass could be expected by 2001.

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