

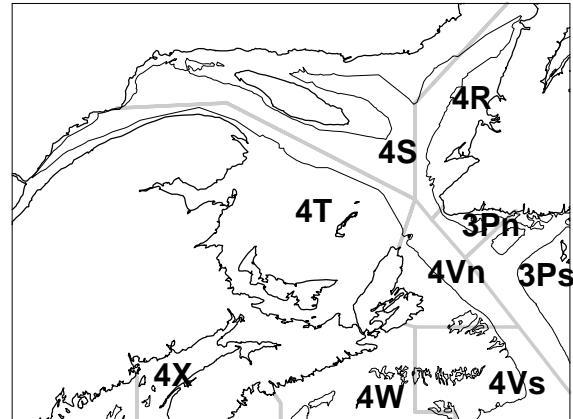
Cod in the Southern Gulf of St. Lawrence

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. The fishery has been re-opened since 1999.



Summary

- The directed fishery for cod re-opened in 1999. In 2000-2001, the TAC was 6,000t. As of December 31, 2000, 5792 t were caught.
- The abundance of the stock is low. Spawning stock biomass has remained stable in recent years.
- All year-classes in the 1990s are estimated to be below average. The 1993-1994 and 1998 year-classes are estimated to be amongst the lowest on record since the early 1970s.
- Natural mortality remains higher than normal.
- With no fishing in 2001, the spawning stock biomass would be expected to decline by about 1%.
- Stock projections indicate a decline of about 6% in spawning stock biomass if the 2001 TAC is maintained at the 1999-2000 level of 6,000 t.

The Fishery

A TAC of 6,000 t was in place in 2000, which was the second year that the fishery was opened after the moratorium. This included an allowance of 700 t for sentinel surveys. Cod were caught in cod-directed fisheries and as by-catch in fisheries directed at other species, mainly flatfish. A cap of 10% of the TAC on cod catches before June 15 was in effect. The by-catch fisheries were closed if the catch of cod exceeded 25% by fishing trip in the mobile winter flounder, witch flounder and American plaice fisheries. The fixed gear fisheries were closed if the catch of cod exceeded 10% or 500 kg by weight in the shark fishery and 25% and 10% by fishing trip in the American plaice and winter flounder fisheries, respectively. Similar to 1998 and 1999, a recreational fishery using hook and line gear was allowed with a daily bag limit of five groundfish.

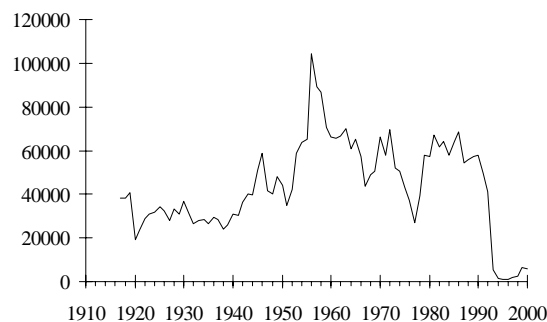
Landings (thousands of tonnes)

	1980-89	1990-93	1994-98	1999	2000
Year	Avg.	Avg.	Avg.		
Landings	61	48	2	6	6
TAC	59	51	0	6 ¹	6 ¹

¹ TAC for May 15 to May 14 of the following year

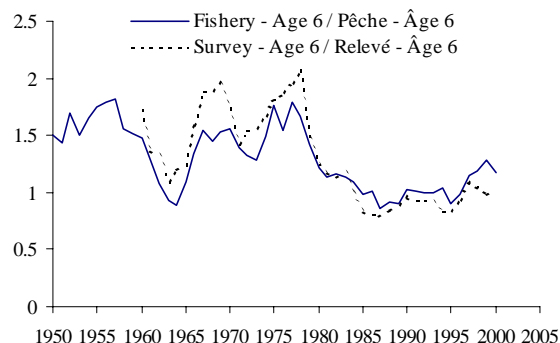
The total reported **landings** were 5792 t in 2000. This is similar to landings in 1999. The catches in the cod-directed and by-catch fisheries amounted to 5181 t. Sentinel surveys were conducted under a scientific protocol designed to obtain additional indices of abundance of the stock and caught 611 t. As in 1999, the fishery in 2000 was concentrated close to shore in the Miscou Bank – Shediac Valley, north shore of PEI, western shore of Cape Breton and the edge of the Laurentian Channel near 4Vn.

Landings (t)



Ages six to eight were the most dominant age-groups in the 2000 landings but significant numbers of older fish were caught. Overall, the **average weights at age** of cod in the annual research vessel survey increased slightly, but remain low relative to the period before 1980. Weights at age in the fishery declined slightly.

Average weight (kg)



Resource Status

The information used in this assessment included the annual research vessel survey (1971-2000), the landings data from 1917-2000, the commercial catch at age from 1971-2000, sentinel survey data from 1994-2000, the otter trawl catch rate data from 1982-1993 and the views of industry expressed in the annual telephone survey from 1996-2000.

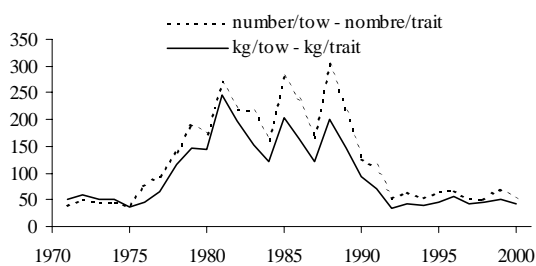
Abundance Indices

The **views of fishers** on the state of the resource were obtained primarily through a telephone survey of active cod fishers in 2000. Of 91 fishers interviewed, 57% felt that the status of the stock was higher or much higher when compared to past fishing experience. This optimistic view of the stock is similar to that received in recent years. By contrast, 12% of respondents considered the 2000 cod abundance to be lower or much lower than in all the years they fished.

The **annual research vessel survey** has been conducted in September since 1971. The results of the 2000 survey indicate that the stock continues to be at low abundance.

The index of abundance (mean numbers per tow) of the population declined from 69 fish/tow in 1999 to 49 fish/tow in 2000. The abundance of cod aged two and three years of age was near the lowest values observed in survey.

Survey Index (all ages)

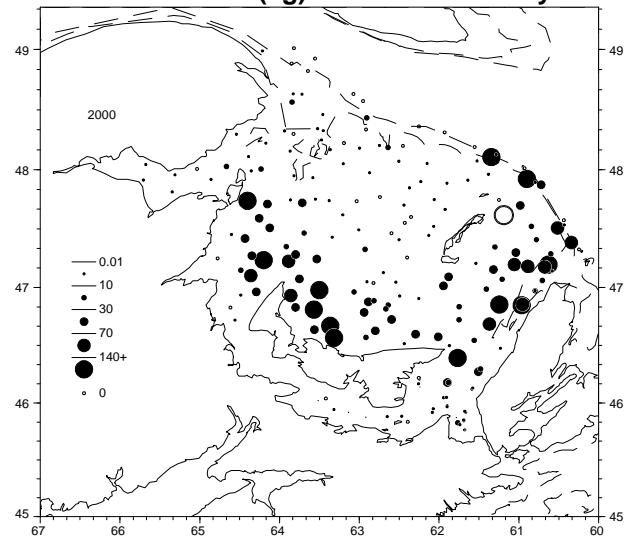


Survey mean weight per tow, indicates that stock biomass has remained low and stable over the last few years, similar to the early seventies.

Similar to recent years, the larger catches during the 2000 survey tended to be primarily concentrated close to shore and in shallower waters, a distribution characteristic of periods of low abundance.

The proportion of the survey biomass distribution found in the east was the highest in the survey time series. Causes for this shift in distribution are unclear but have been observed in other species such as American plaice.

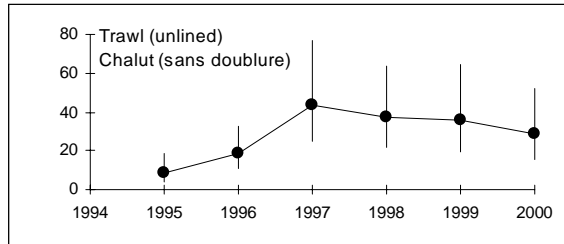
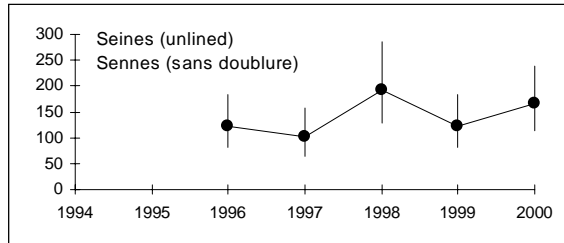
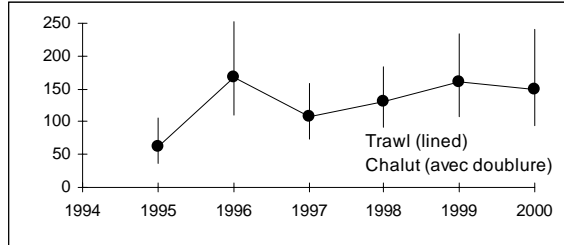
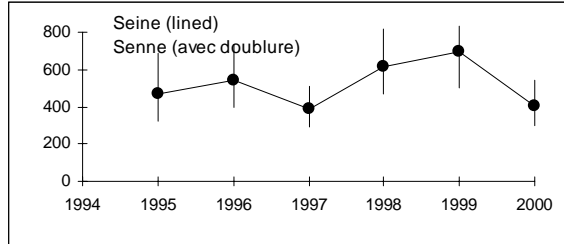
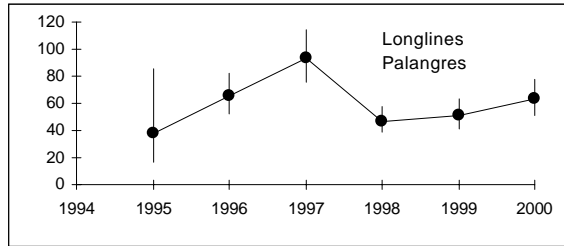
Distribution of cod (kg) in the 2000 survey



The **sentinel survey** program was continued in 2000. Thirty-nine 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 and unlined seines increased slightly between 1999 and 2000. Catch rates for other gears remained stable or declined slightly. Catch rates for sentinel surveys using lined mobile gears (seines and otter trawls), which sample the same portion of the population, have a similar trend to the research vessel index (weight/tow). Catch rates in the sentinel surveys suggest that there has not been a major change in population biomass over the last 5 years.

Sentinel catch rates for fixed gear were significantly higher near PEI but remained about the same or declined in other areas.

Sentinel Catch Rate Indices



Assessment Results

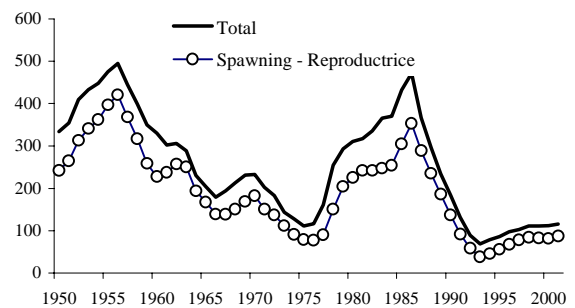
The previous assessments had indicated an increase in **natural mortality** rate (M) of this cod stock. Estimates of M calculated previously were updated and the new estimates continue to indicate values in the range of 0.4 in recent years, more than twice historical values. As opposed to the previous assessment, results do not suggest a decline

in M. Consequently, the assumptions for M were the same used in previous assessments. M for all age groups was set at 0.2 from 1971 to 1985 and 0.4 from 1986 to the present.

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, predation, unreported catches and changes in life history characteristics such as a decline in growth rate.

Spawning stock biomass was high in the 1950s, but 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 of 1974-75, and 1979-80, but then declined rapidly, reaching a low in 1993. Spawning stock biomass has remained stable at a low level over the last four years, below one half of the average spawning biomass of about 200,000 t.

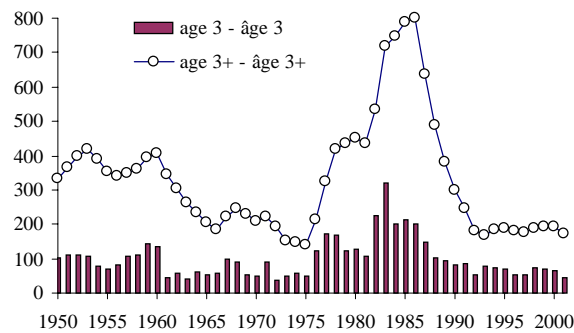
Biomass ('000 t)



Although the overall biomass has not increased significantly, the biomass of older age-groups (8+) is now estimated to be somewhat larger than in 1993. The closure of the fishery in 1993 resulted in higher survival for these age groups. However, because of the lower recruitment since the early 1990s, the biomass of younger age-groups is estimated to be lower than in 1993.

The trend in total **abundance** is largely similar to that of spawning biomass. However, spawning biomass was lower in the 1980s than the 1950s due to lower weights at age. The decline in population abundance estimated in 2001 is mainly caused by the reduced estimate of the 1997 year-class and the low estimate for the 1998 year-class. The contribution of these year-classes to the spawning biomass in future years can be expected to be low.

Abundance (millions)

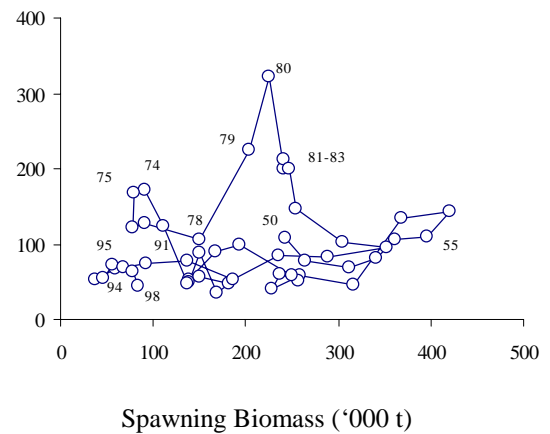


Recruitment of year-classes produced in the late 1980s and early 1990s are below the long-term average of about 100 million fish.

The 1993-1994 year-classes are estimated to be amongst the lowest seen for this stock since the early 1970s. Recent year-classes (1995-1997) are estimated to be more abundant, although well below the long-term average. The 1998 year-class is currently estimated to be very poor and lower than the 1993-94 year-classes.

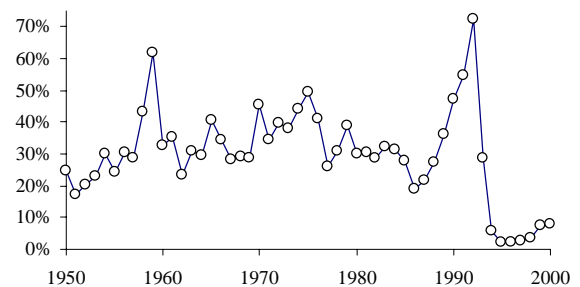
For each unit of spawning biomass, the production of recruits was higher in the period of the mid-1970s to the early 1980s. This promoted the rapid recovery of the stock observed in that period.

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 slight decrease in 1977 and 1978 with the extension of fisheries jurisdiction. The exploitation rate increased again and averaged near 30% up to 1988. The exploitation rate then increased sharply and reached near 70% in 1992. Fishing effort was reduced markedly in 1993 with the closure of the directed fishery. Exploitation rates during the period of the moratorium have ranged between two and three percent. In 2000, exploitation rate was estimated at 8%, about the same as in 1999.

Exploitation rate (7+)



Sources of Uncertainty

The estimate of natural mortality in recent years remains a source of **uncertainty** in the assessment. In 2000, comments received from industry suggest that unreported

catches may be increasing and could be significant relative to the documented catches. Members of the fishing industry consider the predation by seals to be a significant component of natural mortality.

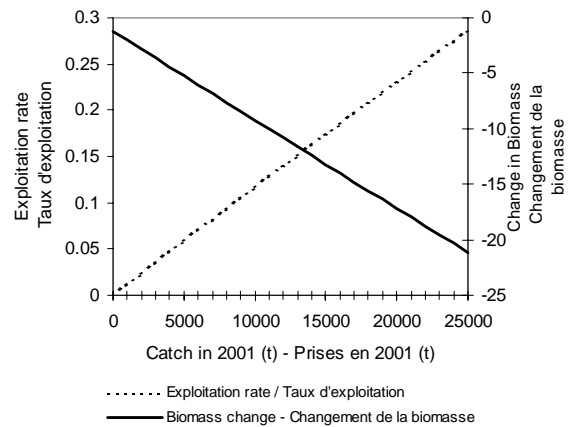
The estimate of the 1998 year-class (age 3 in 2000) is uncertain, however, the influence of this year-class will not be important in the fishery or the spawning biomass until 2003.

The increased proportion of larger fish in the population causes many fishermen to view the status of the stock favorably. Their views also vary according to the local abundance. The surveys indicate that cod were distributed closer to shore in recent years and that cod were rarely found in the central part of the survey area, contrary to the early 1990s. The increasing proportion of the stock found in the east is also a cause of uncertainty.

Outlook

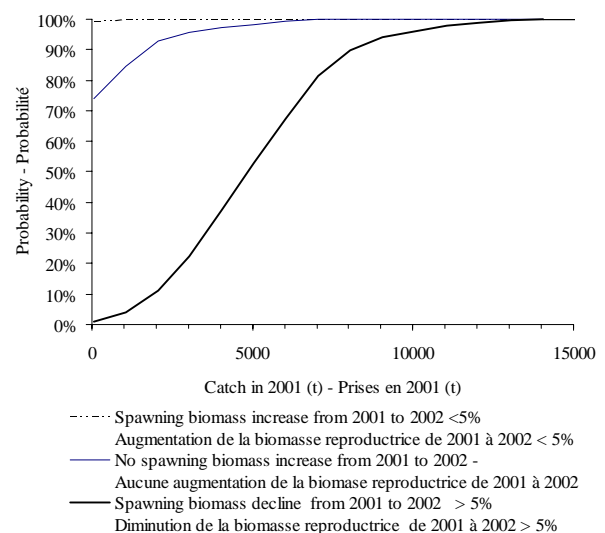
The productivity of the stock has been low recently because of poor growth and high natural mortality. The situation appears to be improving marginally in terms of growth. However, strong year-classes are unlikely given the low spawning stock biomass. The most recent incoming year-classes seem to remain well below average.

Catch projections at various levels of catch in 2001 are provided. The estimates referred to below were made using the best available point estimates of stock size. For any catch in 2001, the associated exploitation rate is determined by reading up to the dotted 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.



Given the low productivity, the spawning biomass is estimated to decline by about 1% if there is no catch in 2001. Maintaining the TAC at 6,000 t in 2001 would result in about a 6% decline in spawning biomass.

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 2002 spawning biomass would increase by less than 5%, b) the probability that the 2002 spawning biomass would be less than the 2001 biomass, and c) the probability that the 2002 spawning biomass would decline by more than 5%.



There is nearly 100% probability that spawning biomass would not increase by 5% in 2001 with no catch. The chance that the spawning biomass would decline by 5% if the catch in 2001 would be the same as the last 2 years is about 68%.

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.

In considering the TAC for the year 2001, it should be noted that risk was calculated for the calendar year, whereas TACs for this stock are set for the period 15 May to 14 May.

The mid-term outlook (three years) currently suggests no significant improvement in spawning biomass and a potential decline. The strength of the 1998 year-class, the trends in natural mortality and the level of removals can affect this conclusion, but even with favorable conditions, rebuilding of the stock can be expected to be slow.

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Correct citation for this publication:

DFO, 2001. Cod in the southern Gulf of St.
Lawrence. DFO Science Stock Status
Report A3-01(2001).