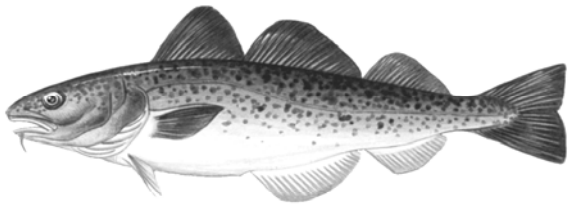
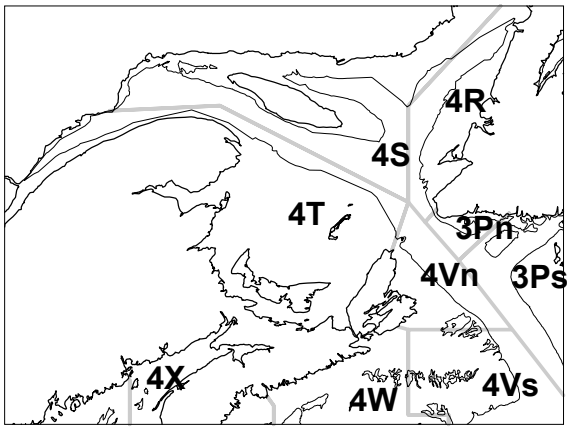


Cod in the Southern Gulf of St. Lawrence



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 ususally begins in mid-April, although this can be 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

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. Larger mesh sizes are in use in the mobile gear fishery since the re-opening. The management year for the fishery now runs from May 15 of the current year to May 14 of the following year.

Summary

- The directed fishery for cod re-opened in 1999. In 2001-2002, the TAC was 6,000 t. As of December 31, 2001, 5794 t had been landed.
- The abundance of the stock is low. Spawning stock biomass has remained stable at a low level in recent years.
- All year-classes in the 1990s are estimated to be below average. Recent year-classes (1998-1999) are estimated to be the lowest on record since the early 1970s.
- Natural mortality remains higher than normal.
- With no fishing in 2002, the spawning stock biomass would be expected to decline.
- Rebuilding of spawning stock biomass over the next 2-3 years is unlikely, even with no fishery.

The Fishery

A TAC of 6,000 t was in place in 2001, which was the third 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. As in previous years, a recreational fishery using hook and line gear was allowed with a daily bag limit of five groundfish.

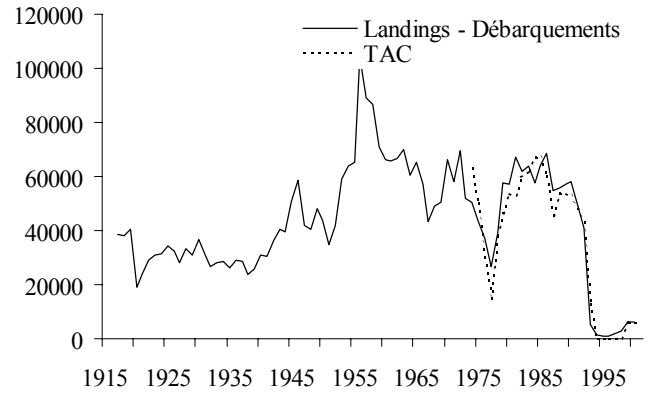
Landings (thousands of tonnes)

Year	1980-1989 Avg.	1991-1993 Avg.	1994-1998 Avg.	1999	2000	2001
Landings	61	48	2	6	6	6
TAC	59	51	-[1]	6	6[2]	6[2]

[1]An allowance of 3000 t was permitted for an index fishery in 1998.
[2]TAC for May 15 to May 14 of the following year.

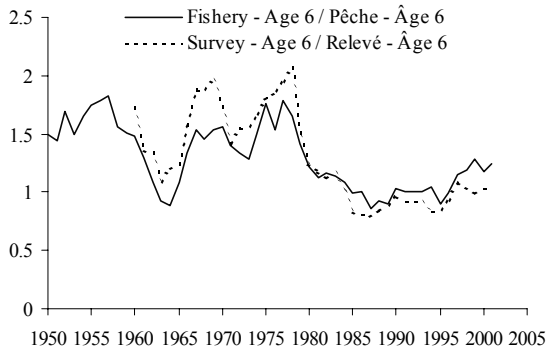
The total reported **landings** were 5794 t in 2001. This is similar to landings in the two previous years. The catches in the cod-directed and by-catch fisheries amounted to 5149 t. Sentinel surveys were conducted under a scientific protocol designed to obtain additional indices of abundance of the stock and caught 644 t. As in recent years, the fishery in 2001 was concentrated close to shore in the Miscou Bank – Shediac Valley area, north shore of PEI, western shore of Cape Breton and the edge of the Laurentian Channel near 4Vn. No fishery was conducted in the winter in 4Vn.

Landings and TAC (t)



Ages six to eight were the most dominant age-groups in the 2001 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 increased marginally.

Average weight (kg)



Resource Status

The information used in this assessment included the annual research vessel survey (1971-2001), the landings data from 1917-2001, the commercial catch at age from 1971-2001, sentinel survey data from 1995-2001, the otter trawl catch rate data from 1982-1993, and the views of industry expressed in the annual telephone survey from 1996-2001.

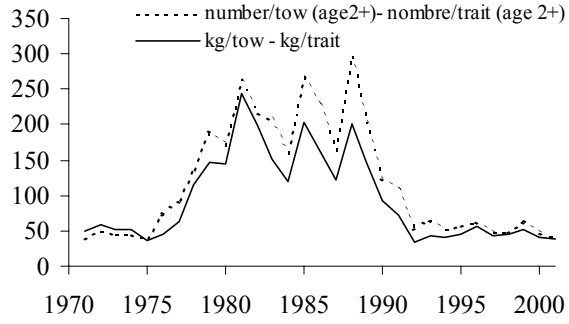
Abundance Indices

The **views of fishers** on the state of the resource were obtained primarily through a telephone survey of active cod fishers in 2001. Of 142 fishers interviewed, 38 % felt that the status of the stock was higher or much higher when compared to the previous year, 39% felt that there was no change and 23% considered the 2001 cod abundance to be lower or much lower than in the previous year. Although the opinion of fishers about stock abundance continues to be optimistic, a higher percentage of them felt that there was either no increase or a decline in the stock abundance compared to previous surveys.

The **annual research vessel (RV) survey** has been conducted in September since 1971. In 2001, fewer survey sets (148) were conducted but that number has been shown to be sufficient to monitor changes in abundance. All areas of the southern Gulf were covered. The results of the 2001 survey indicate that the stock continues to be at low abundance.

The index of abundance (mean numbers per tow for ages 2+) of the population declined from 48 fish/tow in 2000 to 41 fish/tow in 2001. The abundance of cod aged two and three years of age was near the lowest values observed in the survey.

Survey Indices



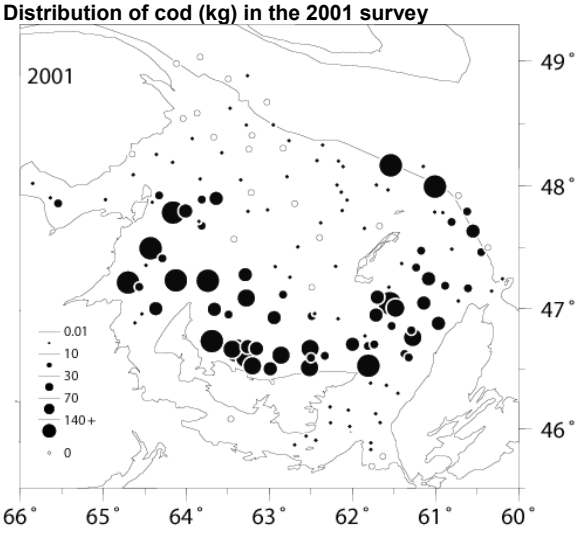
Survey mean weight per tow indicates that stock biomass has remained low and stable since 1993.

Similar to recent years, the larger catches during the 2001 survey tended to be primarily concentrated close to shore and in shallower waters, a distribution characteristic of periods of low abundance.

Estimates of year-class strength from the RV survey are not reliable until age 2. However, one large set of age 1 (2000 year-class) cod (>10,000 fish) was made in the Miramichi Bay area in 2001. An analysis of the prevalence of age 1 in the survey does not suggest that it is a very large year-class. The 2002 survey should provide more reliable information on the strength of this year-class.

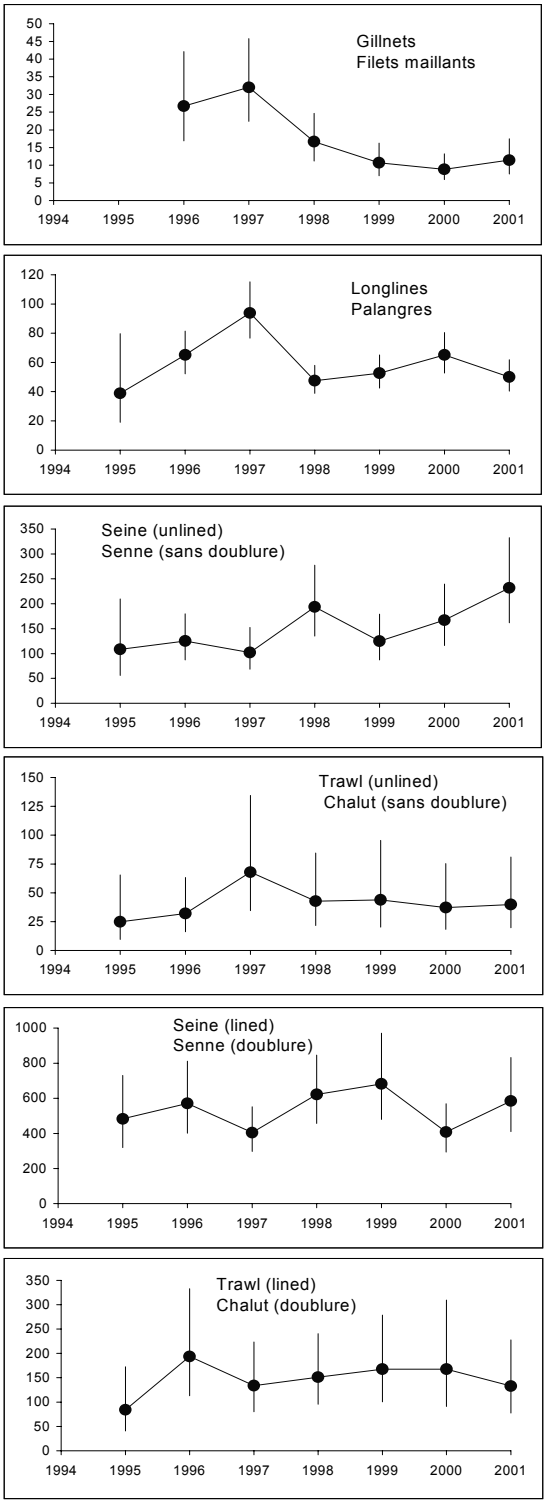
Highest concentrations were found in the Shediac Valley, the north coast of PEI and in the area between the Magdalen Islands and Cape Breton. The proportion of the survey biomass distribution found in the east declined from the high value observed in 2000. The geographic range for the stock has contracted to the smallest area in the 31-year time series. This is consistent with the spatial pattern at low abundance.

Distribution of cod (kg) in the 2001 survey



The **sentinel survey** program was continued in 2001.

Sentinel Catch Rate Indices



Forty-one vessels fishing with fixed and mobile gears in various areas of the southern Gulf were used to monitor cod abundance. Over the time series, the catch rate indices for sentinel gears have not increased, except for seines unlined.

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 RV index (weight/tow).

Catch rates in the sentinel surveys suggest that there has not been a major change in population biomass over the last 6 years. As in recent years, sentinel catch rates for fixed gears near PEI were high. In a survey of opinions on stock abundance, sentinel fishers also tended to be optimistic about stock status.

Natural Mortality

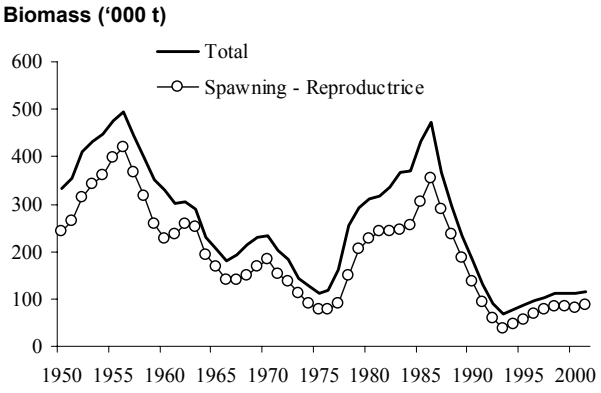
The previous assessments had indicated an increase in **natural mortality** rate (M) of this cod stock. This would include all sources of unaccounted mortalities such as poor environmental conditions, predation, unreported catches and changes in life history characteristics.

Total mortality estimates from survey data did not decline despite population abundance indices and catches remaining relatively constant in recent years. This suggests that natural mortality has also remained relatively constant recently. 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 2001.

The contribution of each of the various potential causes to the recent high estimates of M is undetermined. Estimates of the predation of cod by grey and harp seals for this stock range from 19,000 to 39,000 t (all

ages), depending on diet assumptions. For instance, the higher estimates were produced using diet compositions from outside the stock area. Diet samples suggest that most cod consumed by seals appear to be less than 35 cm in length.

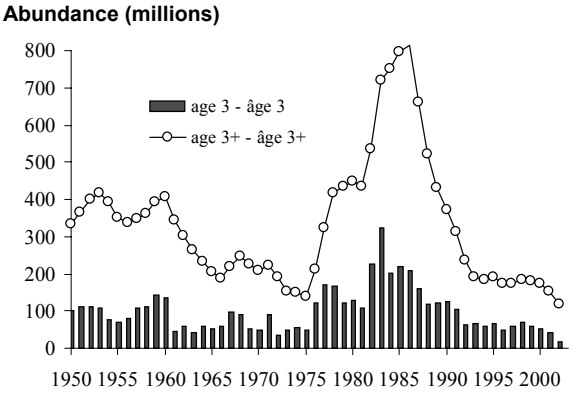
Spawning stock biomass was high in the 1950s, but declined throughout the 1960s and reached a minimum in the mid-1970s. There was a sharp increase in spawning biomass with the recruitment of strong year-classes of 1974-75, and 1979-80, but then declined rapidly, reaching a low in 1993. Spawning stock biomass has remained stable at a low level over the last five years, below one half of the average spawning biomass of about 200,000 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 (3-5) is estimated to be lower than in 1993.

The trend in total **abundance** is 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 2002 is caused by the low estimates of the 1998 and the 1999 year-classes. The contribution of these year-classes to the spawning biomass in future years can be expected to be low.

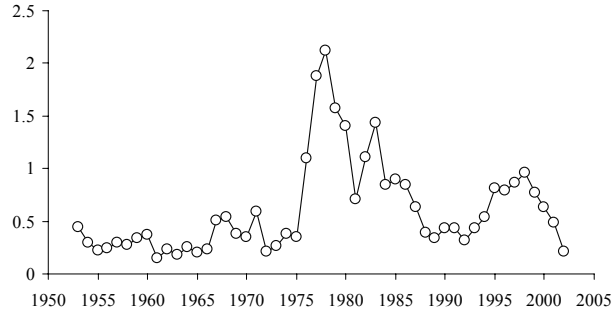
Recruitment of year-classes produced in the late 1980s and early 1990s are significantly below the long–term average of about 100 million fish.



The 1993-1994 year-classes were previously estimated to be amongst the lowest seen for this stock since the early 1970s. Both the 1998 and the 1999 year-classes are now estimated to be even poorer. In particular, the 1999 year-class is currently estimated to be the poorest on record (18 million fish). This is the first available estimate of this year-class.

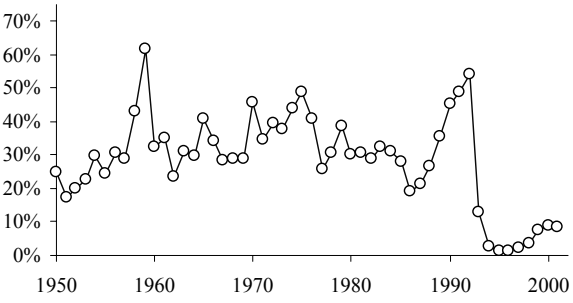
For each unit of spawning biomass, the production of recruits was higher in the period of the mid-1970s to the early 1980s. This promoted the rapid recovery of the stock observed in that period. Despite above average recruitment per unit of biomass, no improvement in stock size in the mid-1990 was observed because of the high mortality rates and slower growth.

Recruits per kg of spawning biomass



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 60% 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 2001, the exploitation rate was estimated at about 9%, about the same as in 1999 and 2000.

Exploitation rate (7+)



Sources of Uncertainty

The estimate of natural mortality in recent years remains a source of **uncertainty** in the assessment. In 2001, comments received from industry suggest that unreported catches in the recreational and commercial fisheries 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. There is considerable uncertainty about seal diets in the southern Gulf but the recent analyses indicate that seal predation may be higher than previously thought.

The estimate of the 1999 year-class (age 3 in 2002) is uncertain, however, this year-class will not contribute significantly to the fishery or the spawning biomass until 2004.

The increased proportion of larger fish in the population causes many fishers to view the status of the stock favorably. Their views also vary according to 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 1980s.

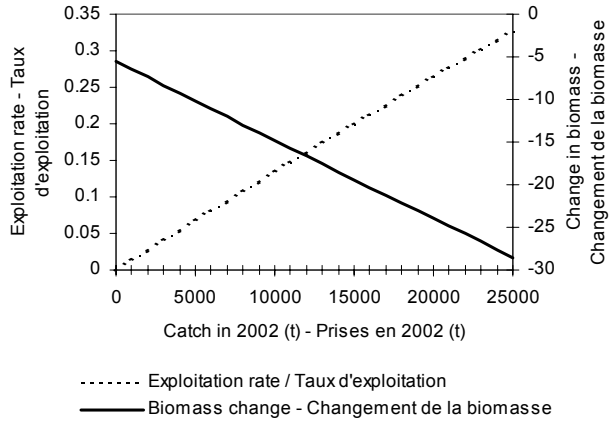
Fishers expressed uncertainties regarding the trends in the RV survey in recent years. They suggest that a comparative fishing experiment with a commercial fishing vessel should be conducted to determine if both vessels would arrive at a similar view of resource distribution.

Outlook

The productivity of the stock has been low recently because of poor growth and high natural mortality. Although the situation appears to be improving marginally in terms of growth, the most recent incoming year-classes seem to be very weak. The first estimate of the 1999 year-class is the lowest on record.

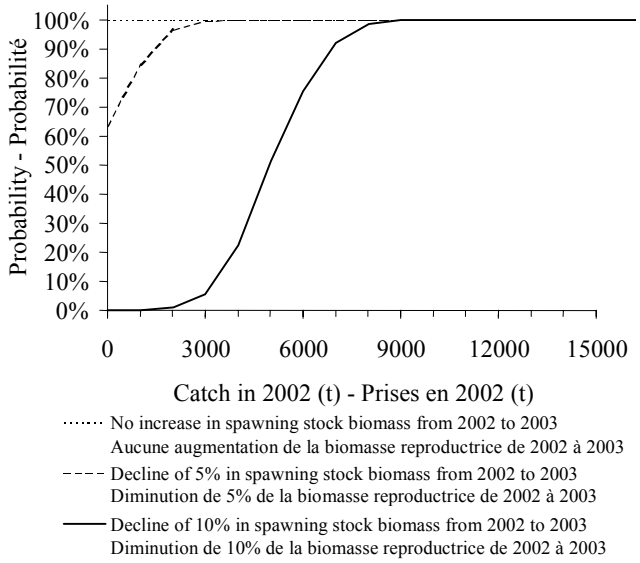
Catch projections at various levels of catch in 2002 are provided. The estimates referred to below were made using the best available point estimates of stock size. For any catch in 2002, the associated exploitation rate is determined by reading up to the dotted line,

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 6% if there is no catch in 2002. Maintaining the TAC at 6,000 t in 2002 would result in about a 12% 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 2003 spawning biomass would be less than the 2002 biomass, b) the probability that the 2002 spawning biomass would decline by 5% and c) the probability that the 2002 spawning biomass would decline by 10%.



There is a 100% probability that spawning biomass will decline during 2002 with no catch There is also a high probability (63%) of a 5% decline with no catch. The chance that the spawning biomass would decline by 10% if the TAC in 2002 was the same as in 1999-2000 (6000 t) is about 75%.

These risk analyses include uncertainties of the population estimates but not those associated with natural mortality, weight at age and partial recruitment.

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 (2-3 years) suggests that declines in spawning stock biomass are likely un-avoidable in the short-term. Rebuilding of spawning stock biomass is unlikely even with no fishery. The strength of the 1999 year-class and the trends in natural mortality can affect this conclusion but a significant change in these parameters would be required to change this outlook.

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Correct citation for this publication:

DFO, 2002. Cod in the southern Gulf of St. Lawrence. DFO Science Stock Status Report A3-01(2002).