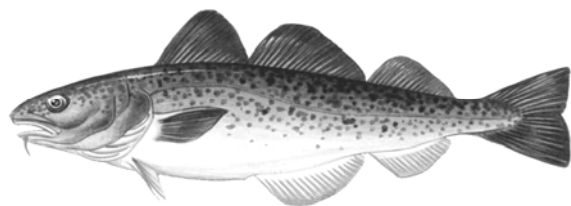




Gulf Region

Stock Status Report 2003/016



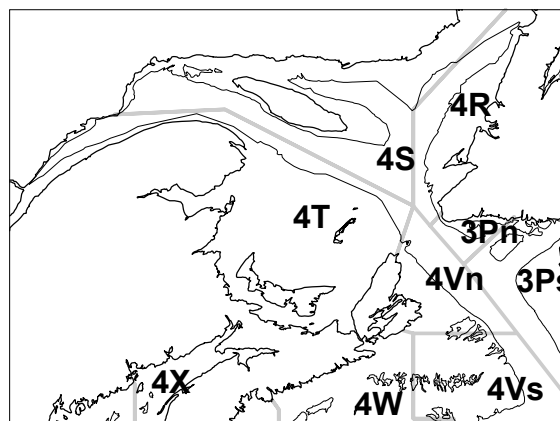
Cod in the Southern Gulf of St. Lawrence

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 8. 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 usually 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 commercially 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. A 3,000 t index fishery was allowed in 1998 and a TAC of 6,000 t was established in 1999. 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

- In 2002-2003, the TAC was 6,000 t. As of December 31, 2002, 5127 t had been landed.
- The abundance and spawning stock biomass of the stock are low and declining.
- All year-classes in the 1990s are estimated to be below average. Recent year-classes (1998-2000) are estimated to be the lowest on record since the early 1970s.
- Natural mortality remains higher than normal.
- With no fishing in 2003, the spawning stock biomass would be expected to decline.
- Rebuilding of spawning stock biomass over the next few years is unlikely, even with no fishery.
- Spawning stock biomass is estimated to be below the conservation limit reference point for this stock. There is a high likelihood that the productivity of a stock below the conservation limit has suffered serious harm.

The Fishery

A TAC of 6,000 t was in place in 2002. 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. Directed fisheries for cod were closed until June. By-catch of cod in other fisheries were restricted to between 5 and 25% depending on the target species. 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)

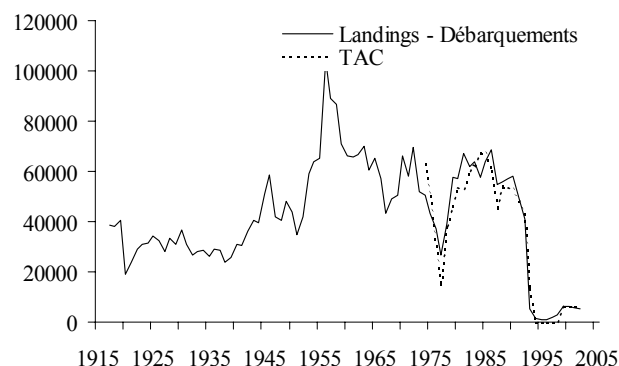
	1980- 1989	1990- 1994	1994- 1999	2000	2001	2002
Year	Avg.	Avg.	Avg.			
Landings	61	31	3	6	6	5
TAC	59	26	2 ¹	6 ²	6 ²	6 ²

1. Including the allowance of 3000 t for an index fishery in 1998.

2. TAC for May 15 to May 14 of the following year.

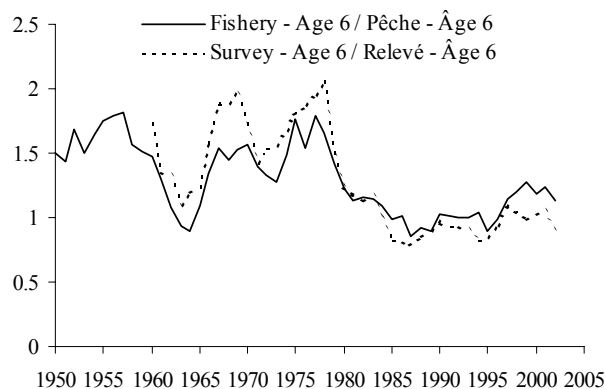
The total reported **landings** were 5,127 t in 2002. This is slightly lower than landings in the three previous years. Catches in the cod-directed and by-catch fisheries amounted to 4,326 t. Catch reporting in the commercial fishery is considered reliable. Sentinel surveys that are used to obtain additional indices of abundance of the stock caught 506 t. The recreational catches were estimated to be 295 t. As in recent years, the fishery in 2002 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. A winter fishery was allowed on the overwintering grounds in 4Vn during 2003, however only 16 t had been recorded at the end of February 2003.

Landings and TAC (t)



Ages six to eight were the most dominant age-groups in the 2002 landings but significant numbers of older fish were caught. Overall, the **average weights at age** of cod in the annual research vessel survey declined and remain low relative to the period before 1980. Weights at age in the fishery were also slightly lower than in 2001.

Average weight (kg)



Resource Status

The information used in this assessment included the annual research vessel survey (1971-2002), the landings data from 1917-2002, the commercial catch at age from 1971-2002, sentinel survey data from 1995-2002, the otter trawl catch rate data from 1982-1993, and the views of industry expressed in the annual telephone survey from 1996-2002.

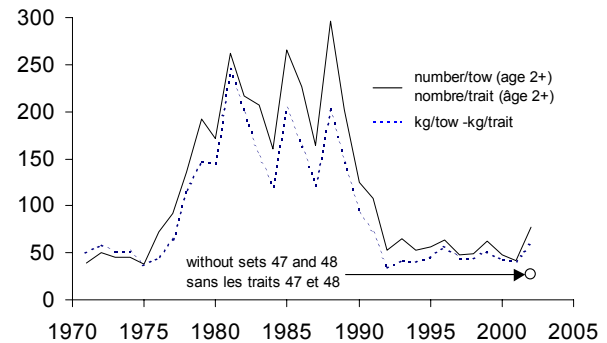
Abundance Indices

The **views of fishers** on the state of the resource were obtained primarily through a telephone survey of active cod fishers in 2002. Of 134 fishers interviewed, 37 % felt that the status of the stock was higher or much higher when compared to the previous year, while 20% considered the 2002 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 compared to surveys conducted when the fishery re-opened in the late 1990s, a higher percentage of them felt that there was either no increase or a decline in stock abundance.

The **annual research vessel (RV) survey** has been conducted in September since 1971. In 2002, 185 fishing sets were completed. All areas of the southern Gulf were covered. Due to two large sets in the survey, near the edge of the Laurentian Channel and separated by less than 6 nautical miles (sets 47 and 48), the index of abundance from the survey increased. These two catches accounted for 50% of the 2002 estimate. Even including these two sets, the mean catch rate in the 2002 survey is less than 40% of the average value for the 1980s.

The age composition of the two sets was composed primarily of cod of ages 4 to 8; the abundance of these year-classes was estimated to be lower in the previous surveys. When estimates of several year-classes increase simultaneously in a single survey, surveys in future years often indicate that the year of high catches was anomalous. The abundance index used in the assessment included all sets in the 2002 survey but the impact of excluding the two large sets was examined.

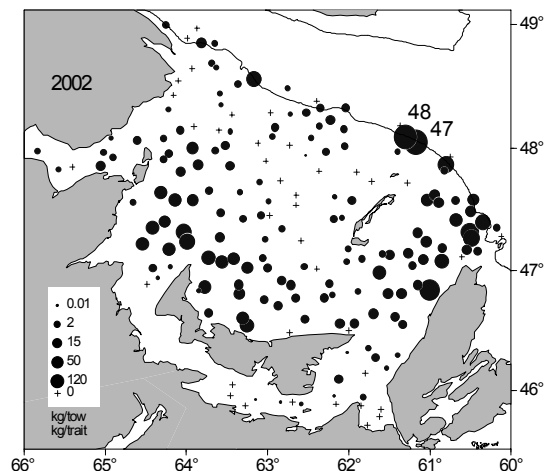
Survey Indices



The abundance of cod aged two and three years of age was near the lowest values observed in the survey in recent years. The results of the 2002 survey indicate that the stock continues to be at low abundance compared to the 1980s.

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

Distribution of cod (kg) in the 2002 survey



With the exception of the two large sets, the larger catches during the 2002 survey tended to be distributed close to shore and in shallower waters, a distribution characteristic of periods of low abundance.

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 was similar to that observed in 2001. The geographic range for the stock has contracted to the smallest area in the 32-year time series. This is consistent with the spatial pattern of the stock is at low abundance.

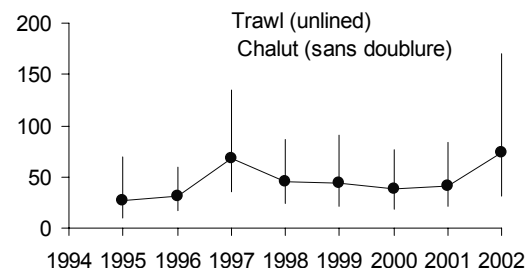
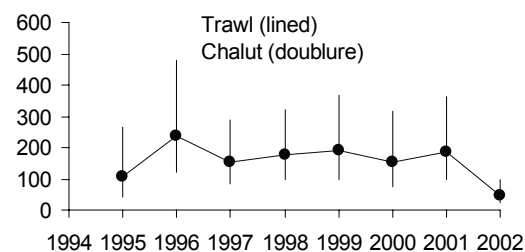
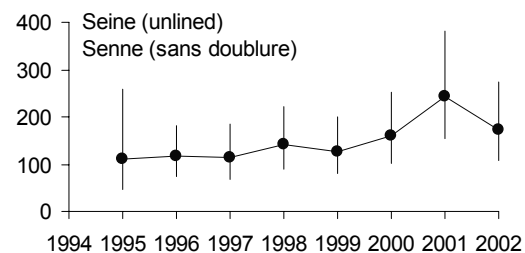
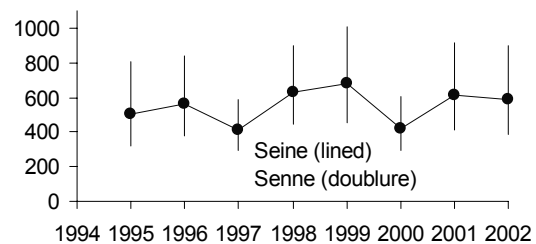
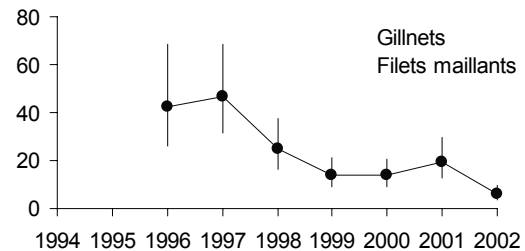
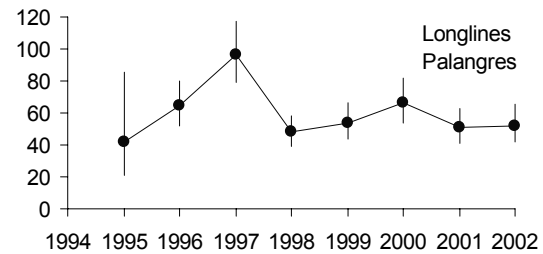
The **sentinel survey** program was continued in 2002. Thirty-seven vessels fishing with fixed and mobile gears in various areas of the southern Gulf were used to monitor cod abundance.

The catch rates in the sentinel surveys were compared to those of the research vessel index (weight/tow) and indicated similar trends.

Catch rates in the sentinel surveys suggest that there has not been a major change in population biomass since the mid-1990s. As in recent years, sentinel catch rates for fixed gears near PEI and for mobile gears in the Shediac Valley on the eastern shore of N.B. tended to be higher than in other areas. In a survey of opinions on stock abundance, sentinel fishers tended to be slightly optimistic about stock status.

An analysis of the strength of year-classes using the sentinel and survey indices suggested that recent year-classes (1998-2000) are poor.

Sentinel Catch Rate Indices



Natural Mortality

Previous work had indicated an increase in the **natural mortality** rate (M) of this cod stock. This would include unaccounted mortalities due to factors such as poor environmental conditions, predation, unreported catches and changes in life history characteristics.

Total mortality estimates from survey data have not declined despite population abundance indices and catches remaining relatively constant in recent years. This suggests that natural mortality has also remained relatively constant recently. Estimates of natural mortality from population analyses also suggested that M has not declined appreciably 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 2002.

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. The higher estimates were produced using diet compositions from outside the stock area.

Grey seals are estimated to consume more cod than harp seals in the southern Gulf. Although diet samples suggest that most cod consumed by seals appear to be less than 35 cm in length, diet analyses cannot account for cod that may be killed but not consumed totally (heads are not eaten). Changes in natural mortality estimates for cod are consistent with trends in grey seal

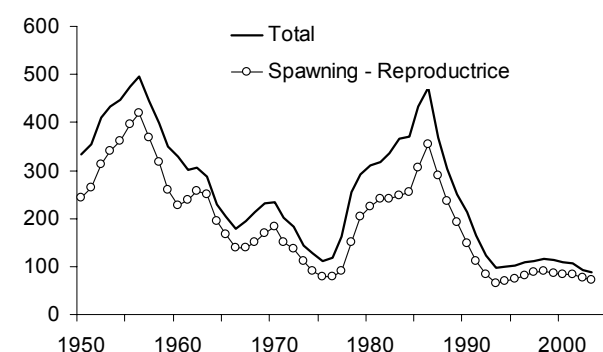
abundance in the southern Gulf of St. Lawrence.

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 (1974-75 1979-80), but then declined rapidly, reaching a low in 1993.

Spawning stock biomass has been low over the last five years, only 40% of the average spawning biomass of about 200,000 t.

Spawning stock biomass has declined over the last three years. The estimate of spawning stock biomass at the beginning of 2003 is 72,000 t. An analysis excluding the two large sets in the research vessel survey would result in similar trends but an estimate of spawning stock biomass that is about 10% lower in 2003.

Biomass ('000 t)

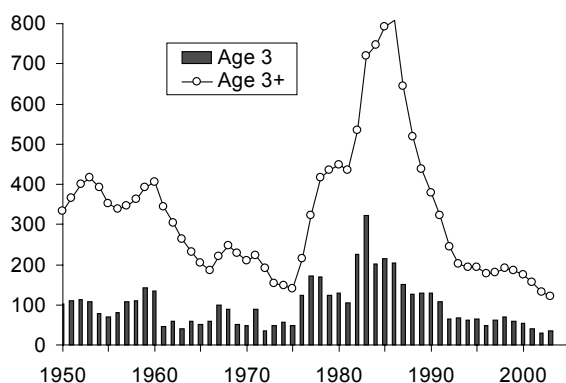


Although the overall biomass has not increased, the biomass of older age-groups (8+) is estimated to be somewhat larger than in 1993. The closure of the fishery in 1993 resulted in higher survival for these age groups. However, because of the lower recruitment since the early 1990s, the

biomass of younger age-groups (3-6) 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 continued decline in population abundance estimated in 2003 is caused by the low estimates of the 1998, 1999 and 2000 year-classes. 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 throughout the 1990s are significantly below the long-term average of about 100 million fish.

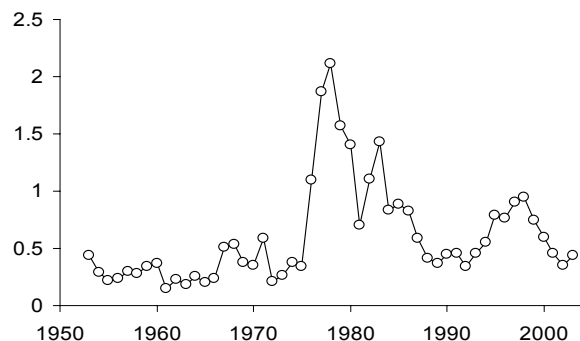
The 1993-1994 year-classes were previously estimated to be amongst the lowest for this stock since the early 1970s. The previous assessment indicated that the 1998 and 1999 year-classes were even poorer. This assessment indicates that the 1998-99 year-classes are still estimated to be the lowest on record. In addition, the 2000 year-class is estimated to be of similarly low abundance.

For each kg 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. Analyses have indicated that the high production of recruits per kg of biomass during that period may have resulted from the low abundance of pelagic fish species (herring and mackerel). Herring and mackerel feed on small preys including the early life stages of cod (eggs and larvae). Pelagic fish biomass (particularly mackerel) is expected to be very high over the next few years.

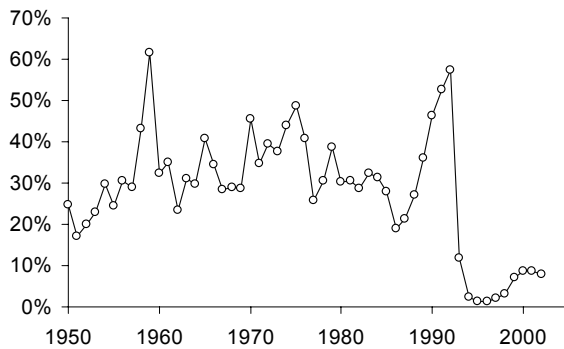
Despite improved recruitment per unit of biomass in the mid-1990s, no improvement in stock biomass was observed because of the high mortality rates and slower growth.

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 2002, the exploitation rate was estimated at about 8%, about the same as in the period 1999 to 2001.

Exploitation rate (7+)



Sources of Uncertainty

The estimate of natural mortality in recent years remains a source of **uncertainty** in the assessment. The predation by seals is considered to be a significant component of natural mortality and analyses suggest that changes in natural mortality are consistent with grey seal abundance trends. Recent analyses indicate that seal predation is higher than previously estimated, however, there is considerable uncertainty about seal diets in the southern Gulf. Diet analyses rely on the presence of hard parts from prey species in seal stomachs. Conclusions about diet composition would be affected if seals tend not to eat the heads of larger cod.

The estimate of the 2000 year-class (age 3 in 2003) is uncertain, as it is the first estimate of this year-class. 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 may cause many fishers to view the status of the stock more 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.

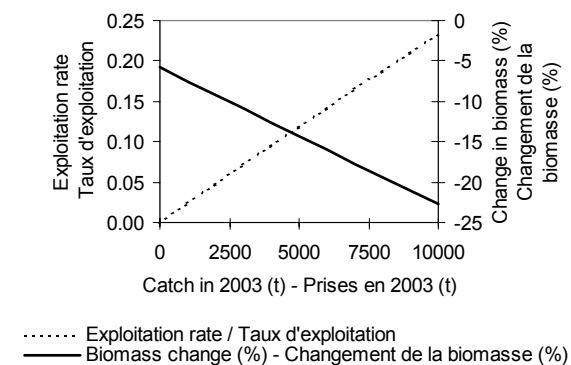
Because of the low fishing mortalities, estimates of population abundance are particularly dependent upon indices of abundance.

Outlook

The productivity of the stock has been low for more than a decade because of poor growth and high natural mortality. Although the situation has improved marginally in terms of growth, the most recent incoming year-classes seem to be very weak. The estimates of the 1998, 1999 and 2000 year-classes are amongst the lowest on record.

Catch projections at various levels of catch in 2003 are provided. The estimates referred to below were made using the best available point estimates of stock size. For any catch in 2003, 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.

Catch projections in 2003



Given the low productivity, the spawning biomass is estimated to decline by about 6% if there is no catch in 2003.

Maintaining the TAC at 6,000 t in 2003 would result in about a 16% decline in spawning biomass.

A projection over five years was also conducted assuming 3 scenarios. It is noted that predictions over this longer period can be expected to be more uncertain as there are currently no estimates for year-classes that would contribute significantly to the biomass at the end of the period. As well, it is assumed that a number of factors such as growth and natural mortality do not change.

The three scenarios examined were as follows:

- no fishery from 2003 to 2007
- 2000-2002 exploitation rate (about 8%) from 2003-2007
- quota of 6,000 t from 2003-2007

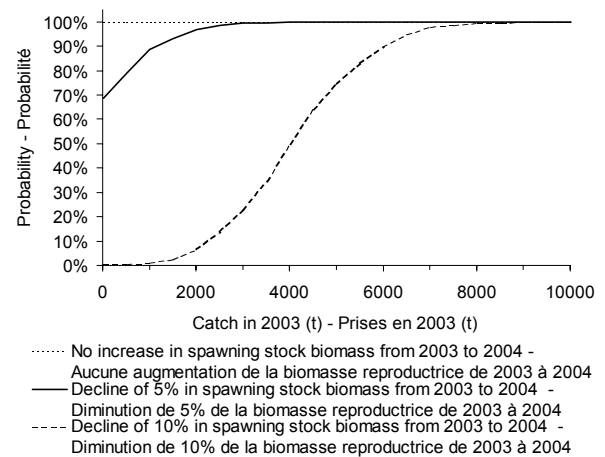
The results indicate that spawning stock biomass can be expected to decline even with no fishing over the next year because of low incoming year-classes. Spawning stock biomass would be slowly increasing at the end of the period. Maintaining the current exploitation rate or catch would result in a continued decline of the stock over the time period.

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 2004 spawning biomass would be less than the 2003 biomass, b) the probability that the 2003 spawning biomass would decline by 5% and c) the probability that the 2003 spawning biomass would decline by 10%.

There is a 100% probability that spawning biomass will decline during 2003 with no catch. There is also a high

probability (69%) of a 5% decline with no catch. The chance that the spawning biomass would decline by 10% if the TAC in 2003 was the same as in 1999-2002 (6000 t) is about 90%.

Risk analyses



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.

At the low spawning biomass observed recently for this stock, there can be concerns that spawning stock biomass is sufficiently depressed such that the chance of obtaining good recruitment is greatly reduced. This could pose a risk of serious harm to the stock. Analyses for this stock indicated that the chance of obtaining good recruitment is reduced when spawning stock biomass is below about 80,000 t. The risk of being below this conservation limit reference point at the end of 2003 is 100%, even in the absence of fishing. There is a high likelihood that the productivity of a stock

below the conservation limit has suffered serious harm.

The mid-term outlook (5 years) suggests that declines in spawning stock biomass are likely un-avoidable in the short-term, and rebuilding of spawning stock biomass is unlikely even with no fishery. The strength of recent year-classes and the level of natural mortality can affect this conclusion but a significant change in these parameters would be required to change this outlook.

For more Information

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