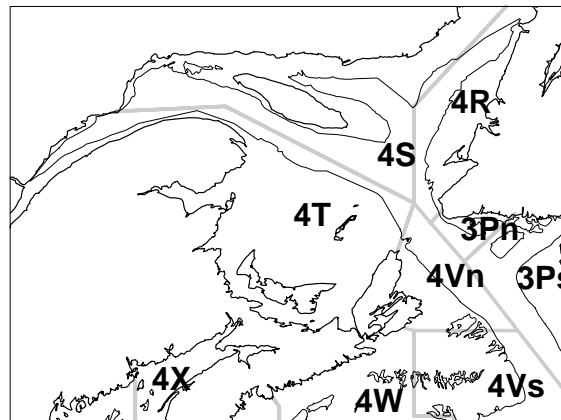




Cod in the Southern Gulf of St. Lawrence



Background

Southern Gulf of St. Lawrence cod are relatively long lived, and may reach ages of 20 or more when fishing 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 Magdelan 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 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 16th century. Landings statistics are available for the period 1917 to the present (Chouinard and Fréchet 1994). 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 1960's and early 1970's, 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-1970's. The stock recovered somewhat, and landings returned to the 60,000 t range during the 1980's. During the past decade, 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.

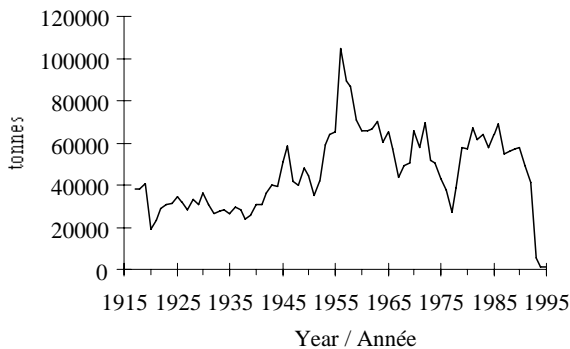
The Fishery

Cod fishing in the southern Gulf was greatly restricted in 1995. Cod were caught as by-catch in fisheries directed at other species, mainly American plaice, witch flounder, winter flounder, and dogfish. However, these fisheries were also closed if the catch of cod exceeded 10% by weight. A recreational fishery using hook and line gear was allowed. A sentinel fishery conducted under a scientific protocol and designed to obtain additional indices of abundance of the stock was also conducted.

The total reported landings was 1075 t in 1995. This was slightly lower than landings in 1994 (1334 t) and represents the third consecutive lowest landing on record since 1917. Almost all of the 1995 landings came from 4T, there were 6 t reported from 4Vn in November-December. Landings decreased for all gear sectors except the recreational fishery.

Landings (thousands of tonnes)

	71-80	81-91	92	93	94	95	96
Landings	51	60	41	5	1	1	
TAC	42	57	43	13	0	0	0



The **views of fishers** from the southwestern Gulf differed from those in the eastern area. Fishers from the western area (Gaspé and northeast N.B.) indicated that cod abundance was low and had not changed in the past few years. In the Magdalen Islands, the views were mixed with some indicating cod abundance had increased particularly in inshore waters. In eastern areas (P.E.I. and Gulf Nova Scotia), fishers indicated cod abundance had increased as indicated by incidental catches in lobster traps and on handlines. These observations were similar to those reported in 1994.

Age 7 was the dominant age in the limited 1995 landings, and ages 4-8 were well represented. Most of the age 4 and 5 landings came from the sentinel fishery where small mesh liners were used in order to collect information on the abundance of recruiting year-classes. The weights at age of cod in the commercial fishery and the research vessel survey remained low in 1995, indicating that growth rates continue to be below average.

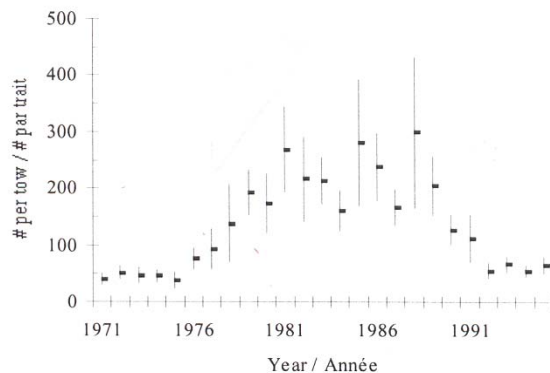
Resource Status

The main ingredients in this assessment are the landings data from 1917-1995, commercial catch rate data from 1982-1993, research survey data from 1971-1995, and commercial catch at age from 1971-1995.

Commercial catch rate data were not considered relevant to the stock assessment in 1994-95 because the fishery was closed. However, the data from 1982-93 were used as an indication of the relative abundance of different year-classes of cod.

A **groundfish survey** has been conducted annually in September since 1971, and this is the main abundance index used in the assessment. The results of the 1995 survey indicate that the stock continues to be at low abundance with little sign of recovery. The abundance of age 4+ cod was virtually the same as seen in the 1993 and 1994 September surveys, close to the lowest values seen. The cod length frequency distribution from the survey may provide some encouragement in

terms of improved recruitment, however the results must be interpreted with caution. The catch of age 0 cod was the highest seen in the time series and catches were distributed in several areas. Unfortunately, there has been no correlation between age 0 catches in the survey and subsequent recruitment, and it is too early to get a quantitative estimate of year-class strength. There was also one large catch of age 1-3 cod in the Shediac Valley area (Set 127). However, a juvenile survey conducted in the same area in July failed to detect improved numbers of fish 3 years of age and younger.



The sixth annual **juvenile cod survey** in the Shediac Valley was conducted in July, 1995. The total abundance index was the second lowest in the time series and less than half the 1994 value. The abundance of age 1-3 cod was low in comparison to other years. It is likely that the July survey is more susceptible to changes in cod distribution than the September survey which covers virtually all of the stock area.

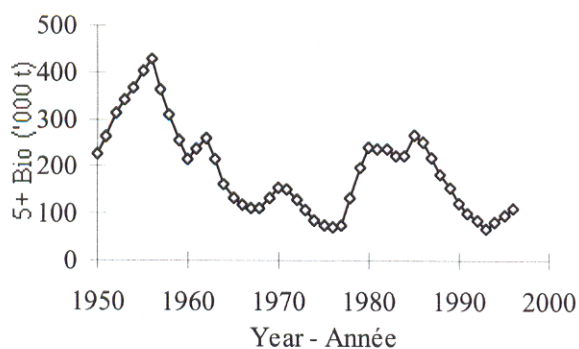
The third **winter groundfish survey** was conducted in the Cabot Strait area in January, 1996. Several concentrations of cod were found on both sides of the Laurentian Channel and cod abundance was lower in the center of the Laurentian Channel than on either side. Juvenile cod were found to be more abundant in the northern part of the survey area, and the size of cod increased in a southerly direction. These observations are consistent with current stock structure definitions where the two Gulf of St. Lawrence cod stocks are thought to occupy opposite sides of the Channel in winter. The overall distribution of cod was similar to that seen in the previous two surveys.

A **sentinel fishery** program was initiated for this stock in the fall of 1994. The main objectives were to obtain an additional index of cod abundance and monitor the timing of cod migration. The activity in 1994 was limited to one project in the Shediac Valley area of the southern Gulf. Coverage in 1995 included mobile gear

projects in the Shediac Valley, Gaspé, eastern PEI, and western Cape Breton, as well as a fixed gear project off western Cape Breton. The results indicated similar catch rates, and therefore similar relative abundance in the Shediac Valley in 1995 as in the previous year, as well as a similar timing of cod migration from the area in October. Additional years of sentinel fishery projects are needed to develop a useful and comprehensive index of abundance.

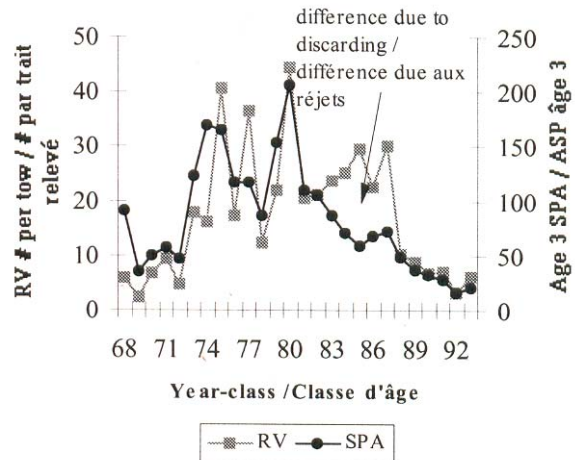
Cod condition (plumpness) has been monitored seasonally since September 1991. Condition in 1995 was similar to that in 1994, and higher than the low values observed in 1992. An annual condition index has been derived from data collected during the September groundfish survey since 1971. The 1994 and 1995 values were close to the average values observed.

Adult population **biomass** was relatively high in the 1950's, but this declined throughout the 1960's and reached a minimum in the mid- 1970's. There was a sharp increase in biomass with the recruitment of strong year-classes born in 1974-75, and 1979-80. Biomass was relatively high and stable in the early- to mid-1980s, but then declined rapidly, reaching a minimum in 1993. The trend in total abundance resembles that of biomass, except that the relative heights of the peaks in the 1950's and 1980's are reversed. Biomass was lower in the 1980's than the 1950's due to lower weights at age. With the closure of the fishery in 1993, the decline in biomass stopped and it is beginning to increase, due mainly to growth of adult cod. Year-classes since 1987 have been well below average in abundance.



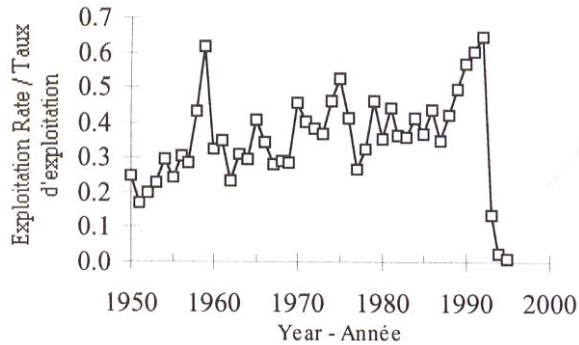
The 1985-87 year-classes experienced significantly higher total mortality than those before and after. The most likely cause is heavy fishing and discarding in the late 1980's and early 1990's and it is unlikely to be the result of adverse environmental conditions or increased predation by seals (Sinclair et al. 1995). This high exploitation significantly reduced their contribution to the commercial stock. It is important to note that SPA

underestimates the sizes of these year-classes because discards are not included in the analysis. Increased minimum mesh sizes in 1992 and the reduction of fishing effort have reduced the exploitation of young fish.



Recruitment of year-classes produced in the late 1980's and early 1990's appears to be well below average. The September 1995 RV survey did find high numbers of age 0 cod, however, catches of this age group have never been used in a quantitative manner in this assessment. The survey also made one large set of age 1-3 cod in the Shediac Valley area. We recommend caution in interpreting this result because large numbers of similar aged cod were not found in other areas in September, or in the same area in the July juvenile survey. These fish will not be of a commercial size for another 2-3 years, and if they are indeed abundant, they should be found in future surveys.

The **exploitation rate** increased from the early 1950's to the mid-1970's, with the exception of a high value in 1959. There was a decrease in 1977 and 1978 with the extension of fisheries jurisdiction, but the exploitation rate increased again and averaged approximately 40% up to 1988. The exploitation rate then increased sharply and exceeded 60% in 1992. Fishing effort was reduced markedly in 1993 with the closure of the fishery. The catch of slightly more than 5,000 t in 1993 resulted in an exploitation rate near the $F_{0.1}$ reference level. The further decreases in effort in 1994 and 1995 resulted in declines in the exploitation rate to the lowest levels recorded.

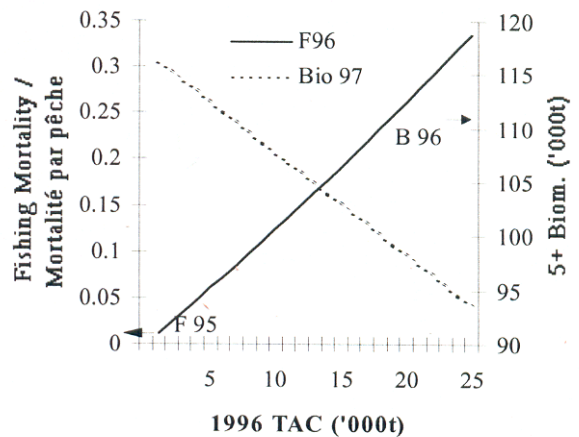


The main source of **uncertainty** in the assessment is the abundance of recruiting year-classes, specifically the 1992-94 year-classes. The September RV estimate of these year-classes was strongly influenced by one large set made in the Shediac Valley area, a known area of juvenile concentration. A sentinel fishery vessel also made a large set of juveniles in the same area and time, but in both cases the area of distribution was restricted. The July juvenile survey did not find large numbers of these year-classes in the Shediac Valley area. The January, 1996 survey in the Cabot Strait had a mode which corresponds to age 1-2 cod. However, this survey used the Campelen 1800 trawl which is known to be more selective of small fish than the Western IIA trawl used on previous surveys in this area. Therefore it is difficult to interpret the January results. In any event, these year-classes will not be of commercial size for 2-3 years, and additional information on their abundance will be obtained on future surveys.

There are differences in opinion regarding stock status among fishers from the eastern and western portions of 4T. Fishers from P.E.I., Cape Breton, and from the Magdalen Islands indicated at several consultation meetings that cod are abundant and even increasing in abundance in their areas. They cite high incidence of cod by-catch in other fisheries, and high catches of cod in lobster traps. Fishers from Gaspé and northeast N.B. indicate that cod abundance is much lower than in the late 1980's and early 1990's, and they have not noticed increases in abundance. 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, contrary to the early 1990's, and that the relative abundance of cod has increased in the eastern part of 4T and declined in the western area.

Outlook

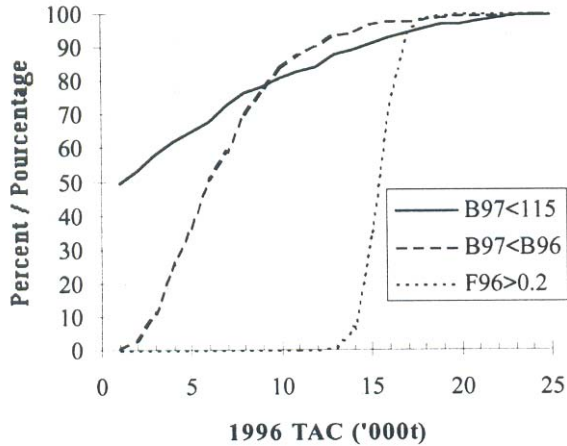
The productivity of the stock remains low because of low recruitment and poor growth. The estimated $F_{0.1}$ catch in 1996 is about 16,000 t, however, if this is taken the adult biomass (ages 5+) is projected to decline by 8%. A 1996 catch of 6,000 t is projected to leave the adult biomass unchanged. Even if directed fishing remains closed in 1996, a total catch of 2,000 t is expected, coming mainly from by-catch in other commercial fisheries and the sentinel surveys. Little change in stock status is expected in 1997, provided catches remain low. Higher catches will result in reduced adult biomass in 1998.



The estimates referred to above were made using the best available "point" estimates of stock size. It is possible to estimate the uncertainties regarding stock size and then use these in risk analysis. The FRCC released a discussion paper on "Considerations on Re-opening a Closed Fishery" in July 1995. One suggested re-opening criterion was that adult biomass increase over a given threshold. Following their guidelines, the threshold for this stock was determined to be 115,000 t. The risk analysis considered a) the probability that the 1997 biomass would be below the threshold, b) the probability that the 1997 adult biomass would be less than the 1996 biomass, and c) the probability that the fishing mortality would exceed the $F_{0.1}$ reference level.

When the 1996 catch was kept at 1,000 t, the probability that the 1997 adult biomass would be below the re-opening threshold was approximately 50%. The probability that the adult biomass would decrease from 1996 to 1997 increased from about 0% for a 1,000 t 1996 catch to about 50% for a 6,000 t catch, and to about 90% for a 12,000 t catch in 1996. The probability that F exceeded 0.2 increased from 0% at a 13,000 t 1996 catch to almost 100% at an 18,000 t catch.

This risk analysis is based on approximations and does not include uncertainties in natural mortality, weight at age, and partial recruitment, but it should provide rough guidelines.



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