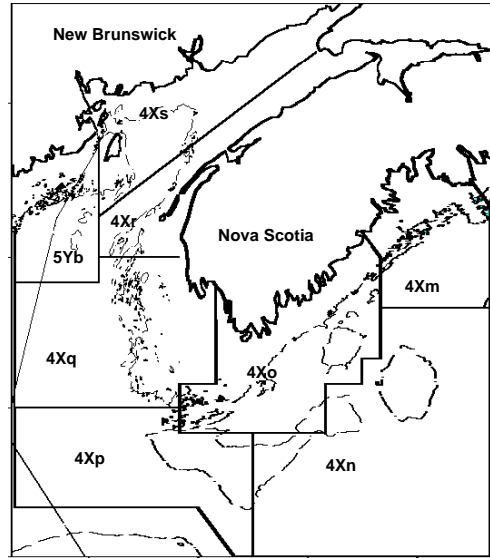


Cod on the Southern Scotian Shelf and in the Bay of Fundy (Div. 4X/5Y)



Background

Atlantic cod (*Gadus morhua*) is a bottom dwelling fish occurring on both sides of the North Atlantic. In the Canadian Atlantic, cod range from northern Georges Bank to northern Labrador. There are several concentrations of cod within this range, including those on the southern Scotian Shelf and Bay of Fundy (NAFO Division 4X and Canadian portions of 5Y).

Juvenile cod feed on a wide variety of invertebrates and as they grow include fish in their diet. Seasonal movements associated with spawning occur and a number of spawning areas exist in this management area with the largest occurring during winter on Browns Bank. Cod in this area reach on average 53 cm (21 inches) by age 3 years and increase to 72 cm (29 inches) by age 5 and 110 cm (43 inches) by age 10. Growth rates, however, vary among cod in this area with more rapid growth noted in the Bay of Fundy. Age at first reproduction generally occurs at 3 years and individuals tend to spawn several batches of eggs during a single spawning period.

Cod has supported a commercial fishery in this area since the 1700s and until the 1960s was primarily an inshore fishery. Following extension of jurisdiction to 200 miles by coastal states in 1977, only Canada has made substantial landings of cod from this area. Minimum mesh size and hook size regulations have been enacted to reduce the catch of juvenile cod. Closure of Browns Bank is in place from 1 February-15 June.

Summary

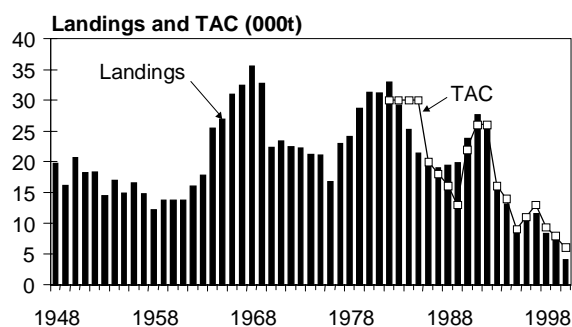
- Landings and TAC have declined throughout the 1990s, and were the lowest on record in 1999.
- Exploitation rate declined from the high of 60% in 1992 to about 23% in 1999.
- Age 4+ biomass has remained stable at a low level since 1996.
- With a harvest of 6,000t in 2001, there is a 50% chance of a 20% increase in the 4+ biomass between 2001 and 2002, due to improved recruitment.
- The recruiting 1998 year-class is the strongest since 1992; initial indications are that the 1999 year-class is at least as large.
- The 1999 year-class must be at least as strong as the 1998 to approach the growth implied by the three-year rebuilding plan.

The Fishery

Landings (thousands of tonnes)

Year	1994	1995	1996	1997	1998	1999	2000
TAC	13	9	11	13	9.3	7.9 ¹	6.0 ²
Total	13	9	11	11.5	8.2	7.2	

1. Fishing year, landings and TAC refer to the 15-month period from January 1 1999 to March 31, 2000.
2. Commencing in 2000, fishing year, landings and TAC refers to the period April 1 of the current year to March 31 of the following year.



Landings increased through the 1960s from 14,000t to 36,000t as large offshore trawlers became active in the fishery. Landings and TAC have declined throughout the 1990s, and were the lowest on record in 1999. Recent decreases in landings are a reflection of the total allowable catch (TAC), which declined from 26,000t in 1992 to 6,000t in 2000. 4,100t of the 2000 quota was landed by Oct. 18, with 84% of the fixed gear quota already landed. Fishermen indicate that the mixed species groundfish fishery in 1999 was most constrained by cod quota, while in 2000 the fishery was constrained by both cod and white hake.

The fishery takes place year round, peaking in June and July. Landings from the winter fishery have declined since 1992. Due to the relatively low cod quotas, many quota groups are treating cod as a bycatch as they pursue other species.

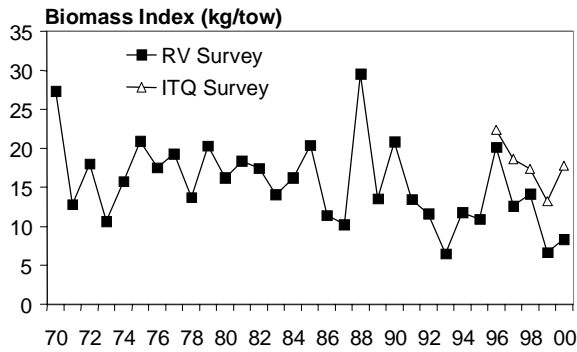
The fishery in 1999 was reported to have been good in inshore areas for the first time in four years. In 2000, most quota groups are reporting no difficulty in catching their quota despite the fact that many are directing their effort primarily at haddock.

Effort by all gear sectors has declined from a peak in 1991 or 1992. The number of vessels engaged in the fishery continued to decline for fixed gear, along with fishing effort (days fished), from 1996 to 1999, and appears to be dropping again in 2000. Catch rates for gillnet and longline have increased in 2000 to the highest levels in 5 years.

In 1999, all ages from 2-7 were present in the landings at proportions about equal to long term averages. In the first half of 2000, landings were dominated by the 1996 year-class, while the contribution from ages 7+ was below average.

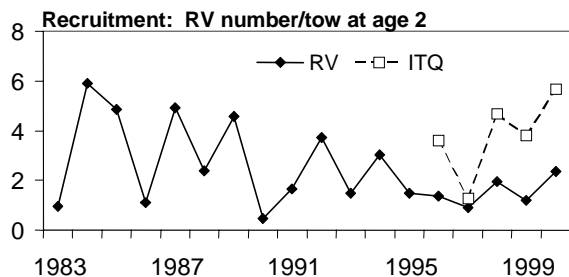
Resource Status

The catch per tow (**biomass index**) for the **summer research vessel (RV) survey** increased in 2000, but remains among the lowest in the series. The 1992 year-class remains strong in the survey, which saw the highest catch at age 8 since 1988. The proportion of cod aged 7+ has declined more in the commercial landings than in the survey, indicating that they make up a higher proportion of the population than reflected in landings. Shifts in the spatial and temporal distribution of the fishery, related to the change for many quota groups to treating cod as a bycatch, are partially responsible for reductions in landings of age 7+ fish.



Due to changes in the joint industry-DFO Science (ITQ) survey protocols in 1996, data from the developmental 1995 survey have been dropped from the abundance indices. The ITQ survey in 2000 had one station which caught more cod than the remainder of the survey combined. This set caught primarily 2 year old cod, and its inclusion produces an age 2 index which diverges markedly from the RV survey in relative magnitude. The catch/tow excluding this station is up from 1999, and comparable to 1997 and 1998.

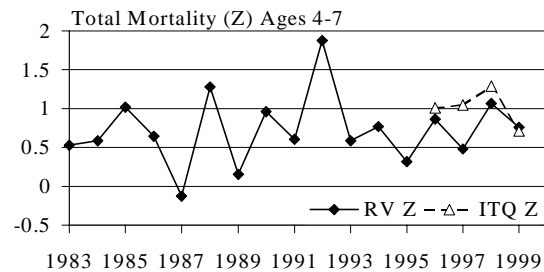
Recruitment prospects based on the catch of the 1998 year-class at age 2 in the ITQ and RV surveys appears better than recent years, but still below average for the RV series. Catches at age 0 in 1999 and age 1 in 2000 suggest the 1999 year-class may be at least as strong as the 1998.



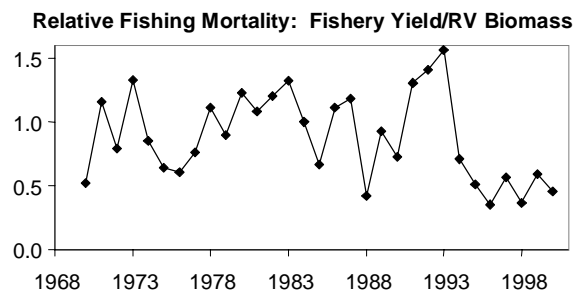
Mean **lengths-at-age** have shown no long-term trends and are currently above average. No trends are apparent in **condition**

(calculated weight at 50cm) which is currently about average.

Total mortality (Z) as calculated from the RV survey has considerable inter-annual variability. There is no trend apparent in total mortality, and estimates remain near the long-term average. Estimates of total mortality from the ITQ survey are comparable to those from the RV survey. Both these surveys suggest that total mortality remains high.



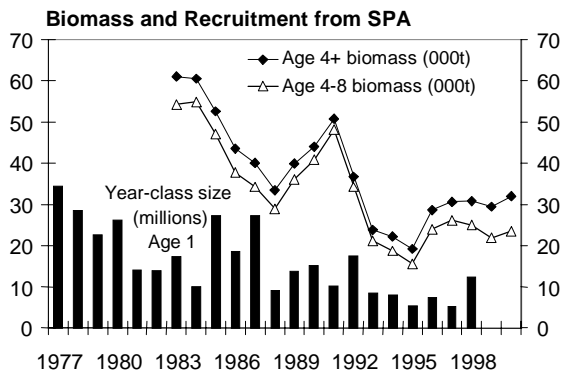
Dividing commercial landings by survey biomass is an estimate of **relative fishing mortality**. This suggests exploitation has been relatively low in recent years.



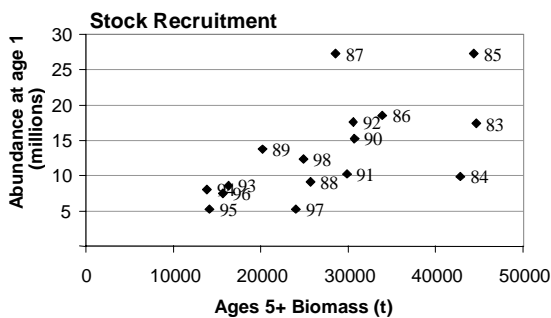
While the relative fishing mortality declined sharply after 1992 and has remained low since, the total mortality (Z) from RV and ITQ surveys both suggest mortality remains high in recent years. This divergence could suggest that natural mortality has increased. Survey Z, however, did not detect the increase in mortality which is thought to have occurred in the early 1990s, when fishing effort was very high, thus no clear

conclusions can be made from the discrepancy in these data.

Population biomass estimates indicate that the stock biomass has been stable but low, since 1996, and little change is anticipated for the beginning of 2001. In recent years population biomass for ages 4+ peaked in 1991, then dropped to the lowest levels in the time series in 1995. The increase in 1996 was due to the recruitment of the 1992 cohort.

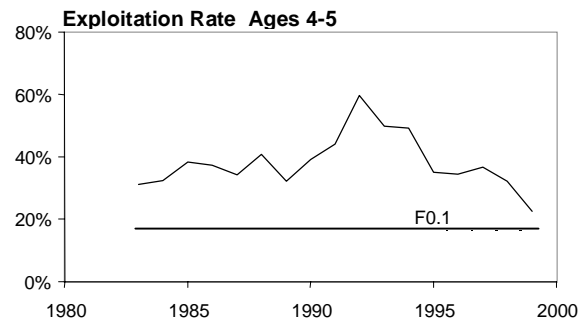


Recruitment as estimated by sequential population analysis (SPA) has been below average since the 1992 year-class. The 1993 to 1997 year-classes are the five lowest in the series. The 1998 year-class is the strongest since 1992, but remains below average.

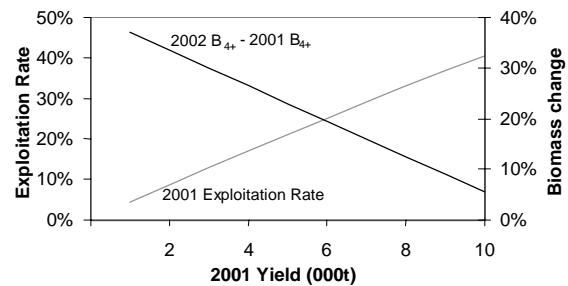


A correlation exists between age 5+ biomass and recruitment, although no causal relationship has been established. The poor recruitment from 1993 to 1997 is associated with very low biomass.

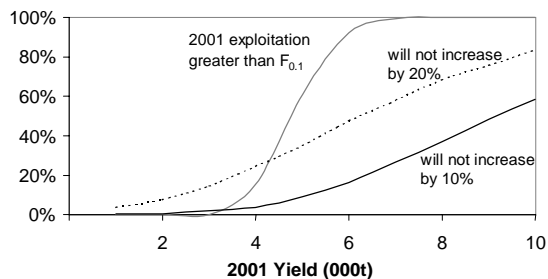
The **exploitation rate** estimated for ages 4-5 from SPA, has consistently been well over twice the target of 17%, corresponding to $F_{0.1}$, throughout most of the recent past, reaching a high of 60% in 1992. Exploitation rate has declined since then, dropping to about 23% in 1999, and is projected as 25% for 2000.



Outlook



With a harvest of 6,000t in 2001 the exploitation rate is projected to be 25% and is almost certain to exceed that which corresponds to $F_{0.1}$. At this yield however, it is also expected that there will be at least 10% growth in biomass for ages 4+ between 2001 and 2002, and a 50% chance of achieving at least 20% growth. This increase is due to the contribution of the incoming 1998 year-class, which is estimated to be stronger than the previous 5 year-classes. While strong biomass rebuilding is projected, the 1999 year-class will have to be at least as strong as the 1998 year-class to approach the growth implied by the current three-year rebuilding plan.



Although point estimates of biomass and exploitation rate for alternative projected yields are provided, these numbers should not be treated as precise values. The risk plots are provided to give a general sense of the associated uncertainties and to assist in assessing the consequences of alternative choices. Further, these uncertainties are dependent on the set of assumptions, data, and model used in the analyses. Though these assumptions were deemed most suitable, there may be other plausible assumptions.

These calculations do not include uncertainty due to variations in weight at age, partial recruitment to the fishery, natural mortality, systematic errors in data reporting, or the possibility that the model may not reflect the stock dynamics closely enough. The uncertainty associated with making a choice among competing assumptions and models must be considered when making management decisions. Estimates from the model of relative values, such as change in biomass, rather than absolute quantities, such as biomass, should be more reliable.

The results of the current assessment suggest greater abundance at older ages than the 1999 assessment. It appears that changes in fishing practices may account for the reduced commercial catch at these ages. The low catches in the survey in recent years, however, is grounds for concern and suggests increased mortality from other sources. There is a great deal of uncertainty regarding the

abundance of fish at ages 9 and older. The survey does not consistently catch fish at these older ages in sufficient numbers to permit reliable estimation. Yield projections, however, are not influenced greatly by the abundance estimated above age 7, because the partial recruitment to the fishery for these ages is low. Further, anticipated growth for this stock in the near-term comes primarily from recruitment and is not reliant on abundance of older cod

Biomass growth in the immediate future will be largely dependent on the incoming recruitment. Measures should be considered to ensure that the recruiting fish are not targeted by the fishery in order to maximize their yield and to enhance the future spawning potential.

For More Information

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References

Clark, D. S., S. Gavaris, and S. D. Paul. 2000. Assessment of cod in Division 4X in 2000. Can. Stock Assess. Sec. Res. Doc. 2000/139.

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