

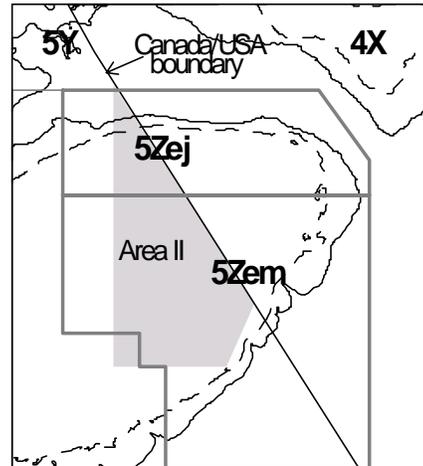
Eastern Georges Bank Cod

Background

The cod fishery on Georges Bank has been in operation since the late 1700s. Since 1977, only Canada and the USA have had directed fisheries and, with the establishment of the Canada/USA boundary in 1984, each country has been limited to their respective sides. Canadian catches of cod are taken primarily between June and October. Management of the Canadian fishery has been by seasonal closures to all gears and by EA's for vessels >65', ITQ for <65' mobile gear since June 1992 and by individual or community quotas for fixed gear. The USA fishery in the management area has been constrained by spatial expansion of closed Area II in 1994 and by extension to year-round closure in 1995.

In recent years, most of the biomass has been found on the Canadian side of the international boundary, although substantial seasonal movements relative to the boundary occur.

Georges Bank cod prey heavily on fish, but crustaceans and molluscs are also included in their diet. Cod in this area have a very fast growth rate, reach 50 cm (20 in) and begin to spawn for the first time by age 2, and by age 3 almost all are sexually mature.



Summary

- Canada and USA catches in 2000 were 2,250t, a decrease over 1999.
- Adult age 3+ biomass increased from 7,000t in 1995 to about 20,000t in 2001. However, almost all of this increase has been the result of growth and survival to ages 5+ of the 1992, 1995 and 1996 year-classes.
- Recruitment has been below the 1978-98 average of 7.5 million since the 1990 year-class.
- Recruitment has been observed to be low when adult biomass is less than 25,000t. Subsequent poor recruitment will lead to reduced prospects for an increase in biomass towards a 25,000t threshold.
- Exploitation rate on ages 4+ declined from 66% in 1994 to about 25% in 1995-1997 and has been less than the $F_{0.1}$ level (17%) since 1999. Exploitation at age 3 has not declined to the same extent.
- Other biological and fishery attributes include stable weight at age, an increase in the proportion mature at age 2 in the late 1990's despite an increase in biomass, consistent spatial and seasonal distribution, improved survival to ages 5+, reports of relatively good catch rates by fishers and high cod bycatch in haddock-directed trips.

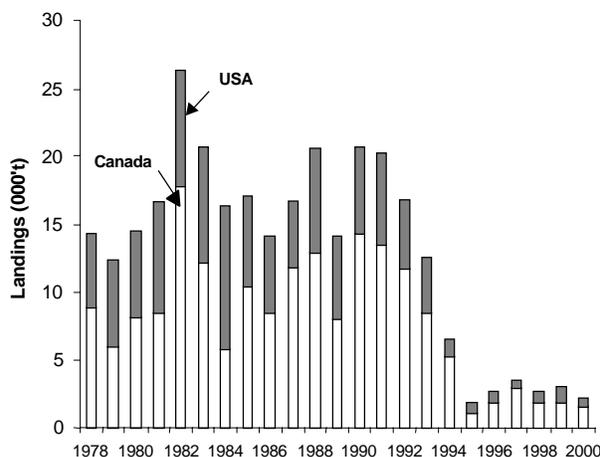
- Yield projection at $F_{0.1}$ for 2001 indicates a **combined** Canada/USA yield of about 3,500t. At the $F_{0.1}$ yield in 2001, **adult biomass** is expected to decrease by about 9% at the beginning of 2002. A stable biomass is expected to occur with a 2001 yield of about 2,000t but even with no catch in 2001, the 2002 biomass is expected to increase by less than 10%.

The Fishery

Catches (thousands of tonnes)

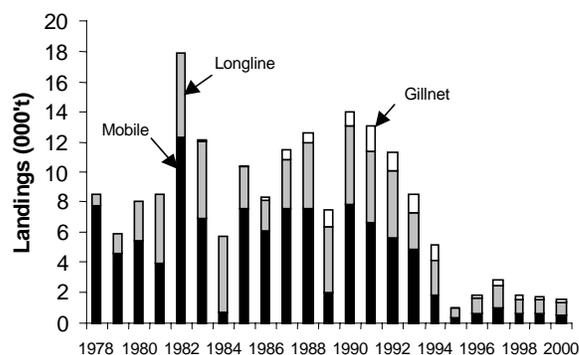
Year	1978-90 Avg.	1991-96 Avg.	1997	1998	1999	2000
Cdn. Quota	-	11.3	3.0	1.9	1.8	1.6
Canada	10.2	7.0	2.9	1.9	1.8	1.6
USA	7.0	3.1	0.6	0.8	1.2	0.7
TOTAL	17.2	10.1	3.5	2.7	3.0	2.3

Combined Canada/USA catches peaked at 26,000t in 1982, averaged about 17,900t between 1978-92 and declined to 1,800t in 1995, the lowest observed. Landings since 1996 have been about 3,000t. Canada has accounted for over 65% of the total 5Zej and 5Zem landings.



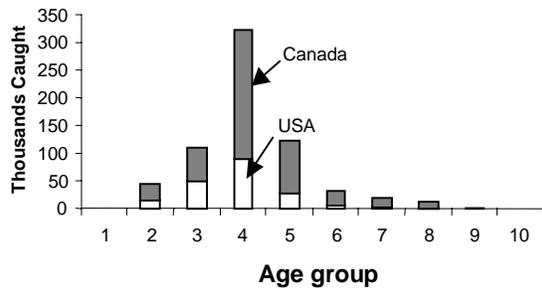
Canadian catches are now dominated by landings from fixed gear components. Since 1995, and with reduction in allowable yields, the Georges Bank fishery has become more of a mixed species fishery with reduced

targeting for cod and in 1995 fishing was restricted to bycatch only. Since 1995, industry also imposed self-regulation to avoid overrunning allocations, including directing for haddock in early June and late fall when cod bycatch was low. In 2000, most gear sectors reached their allocation, a high proportion of trips included observers and landings were subject to 100% dockside monitoring. The Canadian groundfish fishery in 5Zj,m has been closed to all vessels from January to June since 1994.



USA catches for 1995-98 ranged from 557t to 795t. In 1995, the USA imposed a year-round closed area (Area II) in part of the 5Zej and 5Zem area and also increased minimum mesh sizes in 1994 and again in 1999. Limits on sea days were also used as an additional measure for effort reduction. USA catches increased from 795t in 1998 to 1,150t in 1999 and declined to 660t in 2000. Area restrictions were expanded in August, 1999 to include the the NW part of USA zone and remained in effect for 2000.

The 1996 year-class dominated the 2000 fishery and comprised over 50% of the total catch in numbers. Contribution from the 1996 year-class was higher than expected from the yield projection of 2000 and catches of age 5+ cod was lower than expected.



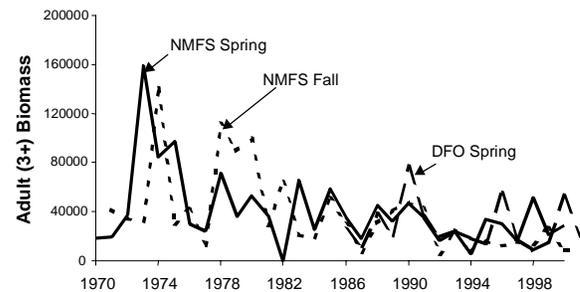
Environmental Conditions

Examination of the physical and biological oceanographic conditions on Georges Bank indicates that water temperatures in recent years (1998-2000) have been about 1°C above normal. The temperature conditions that were observed during the 2000 and 2001 Canadian groundfish bottom-trawl surveys are consistent with this pattern. Although the recent temperatures are above normal, they are still within the range normally associated with demersal stages of cod and haddock caught within the Georges Bank and Scotian Shelf areas. The degree of vertical mixing, as indicated by the annual mean difference in water density between 0 and 50m, has been relatively constant for the past 20 years. The shelf/slope front and Gulf Stream was closer to Georges Bank in 2000 than the long-term normals and the concentration of chlorophyll on the Bank was higher in 2000 than in 1999 or 1998. Connections between the oceanographic conditions and the status of assessed fish stocks within 5Z are still elusive and remain under investigation.

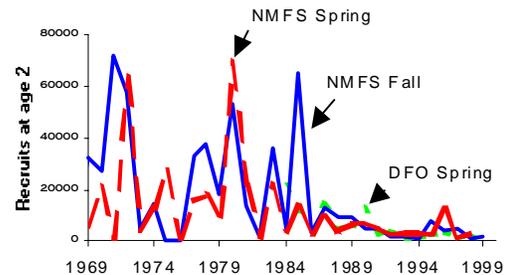
Resource Status

Surveys of Georges Bank have been conducted by the USA National Marine Fisheries Service (NMFS) each fall (October) since 1963 and each spring (April) since 1968, and by Canada's Department of Fisheries and Oceans (DFO) each spring

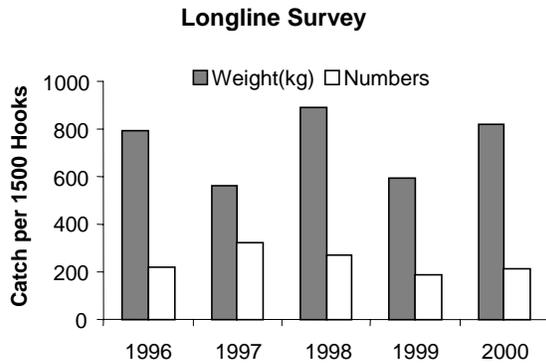
(February) since 1986. All three research surveys appear to demonstrate similar trends with a consistent spatial distribution by season. Adult (age 3+) biomass declined between 1990-92 and showed some modest recovery since 1995. The 2001 DFO spring survey shows a substantial decrease over 2000. The most recent NMFS spring and fall surveys remain at low biomass levels in the last year.



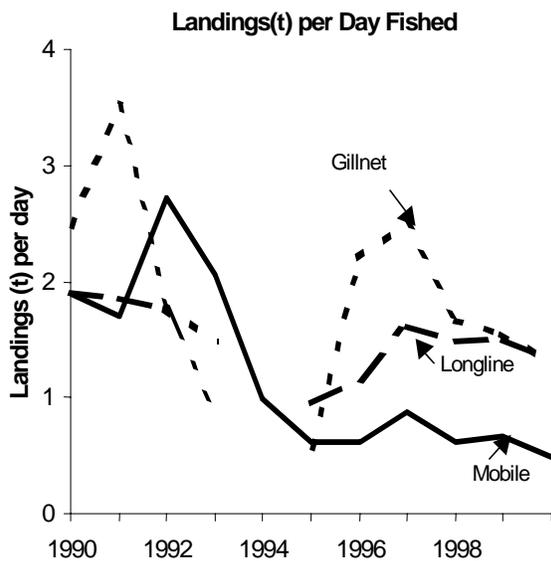
The age two index of year-class strength has been well below the long-term average since the 1990 year-class and the 1997-1999 year-classes appear to be very low. The 1995 and 1996 year-classes were the highest since 1990.



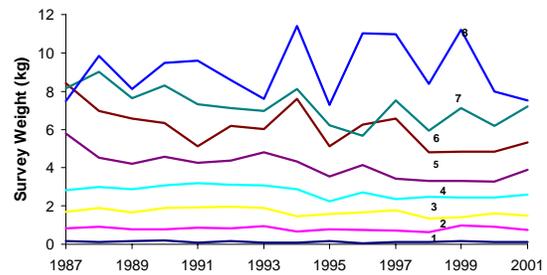
Results of a fixed-station **longline survey** conducted by five fishing vessels using standardised fishing practices and initiated in 1996, shows overall interannual variation without trend. This survey covers only the Canadian zone in 5Zj,m. This index shows promise and will be reviewed in the next assessment.



Commercial fishery catch rate (CPUE) for longline, mobile gear and gillnets decreased between 1997 and 1998 and was stable between 1998 and 2000. However, fishers indicated that their recent catch rates are not reflective of cod abundance because of management restrictions and therefore CPUE is not used in the assessment.



The DFO spring survey **weight-at-age** was used to calculate population biomass at the beginning of the year, while fishery weight-at-age was used to forecast fishery yield. Survey weights-at-ages 4 and younger shows no trend but a modest trend of lower weight-at-age for some older ages is evident.

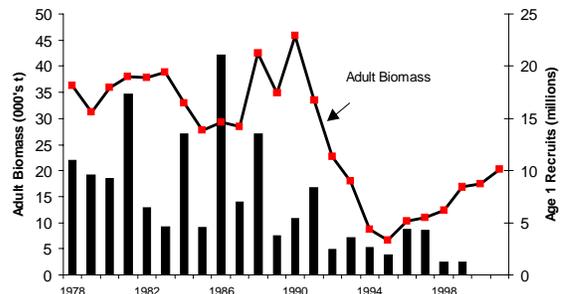


A decline in maturity at age in research vessel surveys has been noted and requires further evaluation.

Stock status evaluations were based upon an assessment using landings statistics, age composition of the commercial catch and trends in abundance from three bottom trawl research surveys. The NMFS fall survey is lagged by one year for comparison of indices (ie. fall 1977 age one vs. spring 1978 age two) with the NMFS and DFO spring surveys.

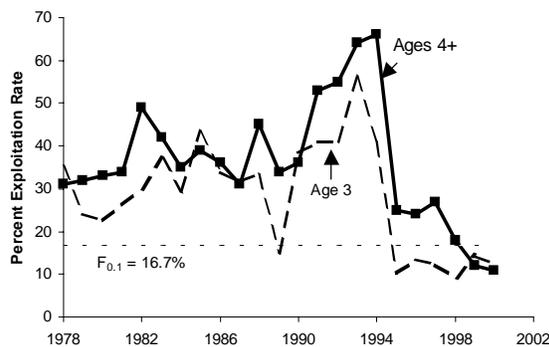
Previous assessments of this resource used ages 1-8 while this current assessment includes ages 9 and 10. Consequently, yields and stock trends reported in previous assessments are not directly comparable with those reported here.

There has been a substantial decline in age 3+ **adult biomass** from about 46,000t in 1990 to about 7,000t in 1995, the lowest observed. The biomass has increased since 1995 to about 20,000t in 2001. However, almost all of this increase has been the result of growth and survival to ages 5+ of the 1992, 1995 and 1996 year-classes.

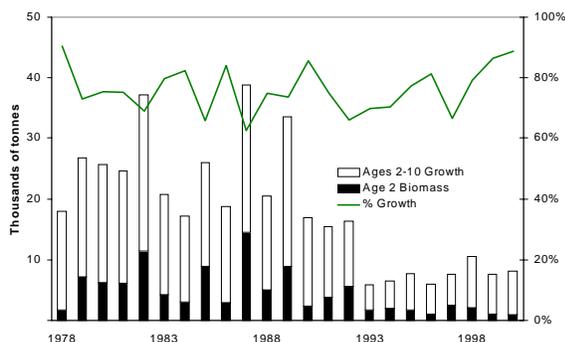


Recruitment has been below the 1978-98 average of 7.5 million since the 1990 year-class. The 1995 and 1996 year-classes appear to be similar in size to the 1992 year-class with the 1996 year-class somewhat stronger than previous estimates.

The **exploitation rate for ages 4+** increased rapidly between 1989 and 1993 to 65%, three and a half times the $F_{0.1}$ reference level. In 1995, it declined to near the $F_{0.1}$ level, and has remained near $F_{0.1}$ since 1995. The 1999 and 2000 exploitation rates were less than $F_{0.1}$. Exploitation rate at age 3 shows a similar trend to that of ages 4+ but has not declined to the same extent since 1995.



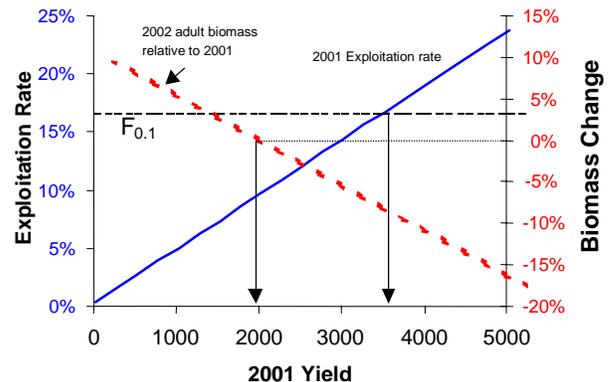
Over the long term, most (60-90%) of the cod stock **production** has been derived from growth of ages 2-8 with the rest coming from recruitment. In recent years, due to weak recruitment, the amount due to growth has increased and now is over 90% of the total.



Retrospective analysis indicates a pattern of inconsistencies with a tendency to over or under estimate fishing mortality, biomass and abundance at age 1 relative to the terminal year estimate.

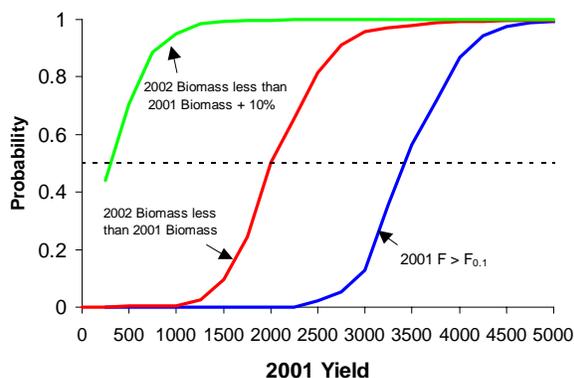
Outlook

Yield projection at $F_{0.1}$ for 2001 indicates a **combined** Canada/USA yield of about 3,500t. At the $F_{0.1}$ yield, **adult biomass** is expected to decrease by about 9% at the beginning of 2002. A stable biomass is expected to occur with a 2001 yield of about 2,000t but even with no catch in 2001, the 2002 biomass only increases by about 10%.



Uncertainty associated with results of the assessment can be related to the probability that the exploitation rate in 2001 will exceed the $F_{0.1}$ reference or that the 2002 biomass will be less than the 2001 biomass. These calculations do not include uncertainty due to variations in weight at age, partial recruitment, variations in natural mortality, systematic errors in data reporting or model mis-specifications.

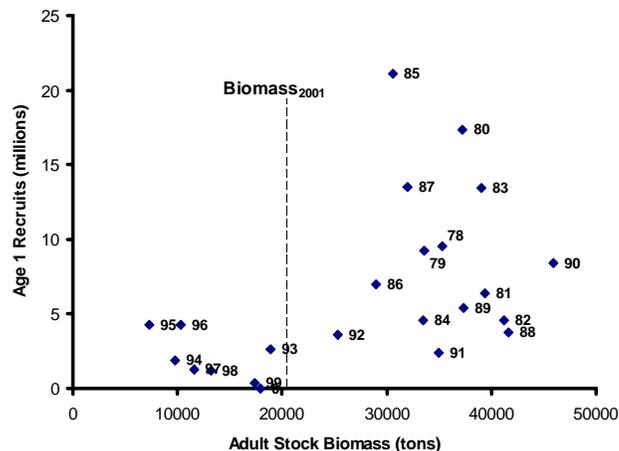
At a combined 2001 Canada/USA yield of about 3,000t, there is a low probability of exceeding $F_{0.1}$ but more than 90% probability of a decrease in adult biomass. At a 2001 yield of 2,000t, the probability of a decrease in adult biomass is about 50%.



The benchmark assessment assumes that the fishing mortality on age 10 is equal to the average over ages 5-9. There are indications that changes in recent fishing practices may have reduced the capture of larger, older cod. To investigate the sensitivity of the outlook, the assumption made in the benchmark assessment was relaxed so that fishing mortality on age 10 was taken as the average over ages 7-9. This analysis confirmed the tendency for a modest reduction in F at older ages. If the result from this analysis is carried forward through the projection phase, it suggests that yield in the range of 2,500t would result in about 50% probability of no change in biomass. This is a somewhat more optimistic view regarding biomass rebuilding.

Management Considerations

Comparison of adult biomass and resultant recruitment indicates that the relatively small post-1992 year-classes have been produced at biomass levels of 25,000t or less. The chance of **poor recruitment** (less than 5 million) is higher when the adult biomass is less than a 25,000t threshold.



It is projected that over 50% by weight of the 2001 yield at $F_{0.1}$ would be comprised of the 1995 and 1996 year-classes. Enhancing survivorship of these year-classes would benefit stock rebuilding. Subsequent poor recruitment will lead to reduced prospects for an increase in biomass towards a 25,000t threshold.

An analysis of 1992-2000 **biomass distribution** relative to the **international boundary** from research surveys shows a seasonal pattern. Virtually all cod of ages 2 and older were found on the Canadian side during the NMFS fall survey, while the proportion found during the DFO and NMFS spring surveys ranged between 40% and 95%.

Survey Year	Percent of Biomass in Canadian Zone		
	DFO February	NMFS March	NMFS October
1992	55	84	94
1993	47	41	100
1994	95	73	100
1995	48	88	94
1996	78	58	95
1997	66	63	100
1998	84	50	100
1999	70	53	100
2000	67	52	100
2001	95	N/A	N/A

Cod and haddock are often caught together in the Canadian groundfish fisheries.

However, their **catchabilities** to the fisheries differ and they are not necessarily caught in proportion to their relative abundance. Exploitation of haddock at $F_{0.1}$ levels with current fishing practices may compromise the achievement of rebuilding objectives for this cod stock.

References

Hunt, J.J., and B. Hatt. 2001. Status of Eastern Georges Bank cod (Unit Areas 5Zej, 5Zem) for 1978-2001. DFO CSAS Res. Doc. 2001/070.

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