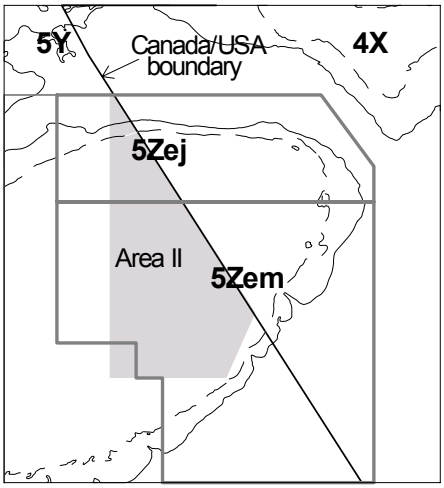
Eastern Georges Bank Haddock

Background

The haddock, a bottom dwelling species in the cod family, is found on both sides of the North Atlantic. In the western Atlantic, haddock range from Greenland to Cape Hatteras, with a major concentration on eastern Georges Bank.

Georges Bank haddock feed primarily on small invertebrates and are most commonly caught at depths of 45 to 240 meters (25 to 130 fathoms). Adult haddock appear relatively sedentary but seasonal movements occur. On Georges Bank, young haddock grow rapidly at first, reaching over 50 centimeters (20 inches) by age 3, but grow slowly thereafter, reaching about 75 centimeters (30 inches) by age 10. Many haddock mature by age 2 but it is uncertain if these young fish spawn successfully.

Georges Bank haddock have supported a commercial fishery since prior to 1900. Bottom trawlers have been the principal gear since their introduction in the 1920s. Landings from Georges Bank, which include the eastern Georges Bank component and the Great South Channel component, averaged about 46,000t between 1935 and 1960 and increased to over 100,000t in the 1960s under heavy exploitation. Subsequently, during the early 1970s, spawning season/area closures were introduced as a means of controlling effort and are still in use today. Following the extension of jurisdiction to 200 miles by coastal states in 1977, only Canada and the USA have fished this stock. Both Canada and the USA impose minimum fish size and mesh size regulations. Additionally, Canada establishes quotas to achieve a target exploitation rate of roughly 20% or lower of the harvestable population and the USA has instituted a year-round closure of Area II.



Summary

- Combined Canada and USA catches in 2001 were about 7,300 t.
- Biomass has increased since 1993 but remains below the 1930-55 average.
- Adult biomass (ages 3+) was about 40,000 t in 2001 and 2002 and is expected to increase considerably by 2003.
- The 2000 year-class is about equal in strength to the good 1975 and 1978 year-classes and the 1998 year-class is the second strongest since the 1978. There are early signs of a weak 2001 year-class.
- The age structure in both the fishery catch and the population continues to broaden.
- Exploitation has been below $F_{0.1}$ since 1995.
- Survivorship to age 1 is generally higher than that observed during the 1980s.
- The combined Canada/USA yield at $F_{0.1}$ in 2002 would be about 10,700 t. At this yield, the biomass is expected to increase considerably.

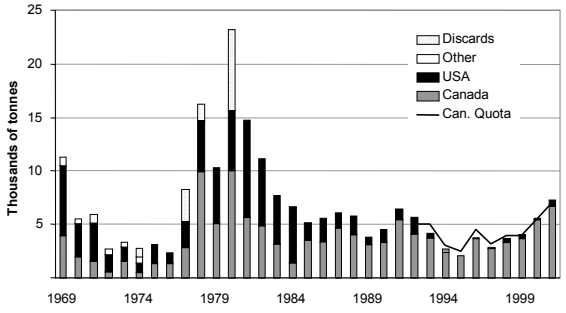
The Fishery

Catches (thousands of tonnes)

Year	1970-79 Avg.	1980-89 Avg.	1990-97 Avg.	1998	1999	2000	2001
TAC[1]	-	-	3.9	3.9	3.9	5.4	7.0
Canada	2.7	4.4	3.4	3.4	3.7	5.4	6.7
USA	2.8[3]	4.8[3]	0.6[3]	0.3[3]	0.4	0.2	0.6
TOTAL	6.1[2]	9.2[2]	4.0	3.7	4.0	5.6	7.3

[1]Canadian quota only
[2]Includes foreign catches
[3]Includes discard estimates

Under restrictive management measures, **combined Canada/USA catches** declined from over 6,400 t in 1991 to a low of about 2,100 t in 1995, fluctuated between about 3,000 t and 4,000 t until 1999 and has since increased to over 7,000t. Greater catches in the late 1970s and early 1980s, ranging up to about 23,000 t, were associated with good recruitment. Substantial quantities of small fish were discarded in those years. Catches subsequently declined and fluctuated around 5,000 t during the mid to late 1980s.



In 1995 to 1999 and 2001, **Canadian catches** were below the quota due to closure of some fleet sectors, when the cod quotas were reached. The 2000 catch of 5,402 t was slightly above the Canadian quota of 5400 t. During 1994 to 2001, all Canadian groundfish fisheries on Georges Bank remained closed from January to early June to protect spawning concentrations.

Weight of all Canadian landings were monitored at dockside. At-sea observers monitored 10% of the 889 trips, which accounted for 14% of the total haddock landed. In 2001, samples were collected by DFO, observer and by two industry groups, Scotia Fundy Mobile Gear Fishermen's Association (SFMGFA) and High Liner Foods (HLF). Comparison of samples from at sea observations against landings indicated that there was little discarding or highgrading. Discarding and misreporting have been considered negligible since 1992.

In recent years, the Canadian fishery has been primarily conducted by vessels using otter trawls and longlines with some handlines and gillnets. During 2001, all vessels over 65 ft operated on enterprise allocations, otter trawlers under 65 ft and fixed gear vessels 45-65 ft operated on individual quotas while fixed gear vessels under 45 ft operated on community quotas administered by local boards. Most haddock were caught by otter trawlers less than 65 ft and longliners less than 65 ft. The highest catches by otter trawlers and longliners occurred in June.

The size and age composition of the 2001 Canadian fishery was characterised using port, at sea and industry samples from all principle gears and all seasons. The size composition of catch in the Canadian fisheries peaked at 51 cm (20 in) for otter trawlers and at 58 cm (23 in) for longliners. Gill-netters caught few haddock but they were larger. No sampling was available for discards of haddock by-catch in the Canadian scallop fishery, though in previous years, the amount caught has not been large.

USA catches for 2001 were derived from logbooks coupled with dealer reports, as was done for 1994-99. Effort in the USA fishery was regulated using closed areas and days-at-sea limits. To curtail targeting of haddock, a 500 lb trip limit was introduced in 1994 and raised to 1,000 lb in July 1996. The trip limit resulted in an increase in the discard rate. The trip limit has been adjusted periodically and is currently 5,000 lb/day

and a maximum of 50,000 lbs/trip. The combination of area closures, effort restrictions, and trip limits has precluded most operators from making long trips to 5Zjm, with the result that USA catches from 5Zjm have been low since 1993. While Area II remained closed in 2001, landings from 5Zjm increased to 604 t and discards again were low because the day and trip possession limits remained high.

USA port samples and ageing data from eastern Georges Bank were used to characterise the size and age composition of the USA fishery catch from eastern Georges Bank.

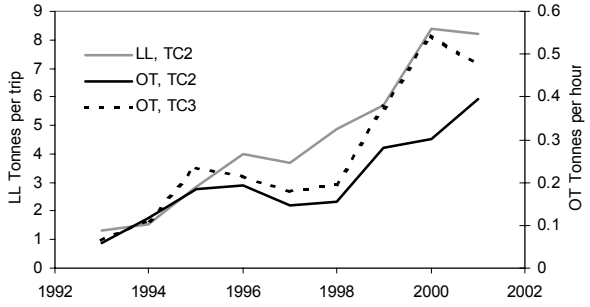
For the **combined Canada/USA fishery catch**, the 1998 year-class (age 3) dominated the 2001 catch. In comparison to the age composition of the catch during periods when year-classes were quickly fished down, the older age groups (ages 7+) continued to contribute significantly to the 2001 catch. The percentage of age 2 fish in 2001 was well below historical averages. The low percentage of younger ages in the recent catches has been due in part to the type of gear used and to avoidance of areas with small fish.

Environmental Conditions

In recent years (1998-2001), water temperatures on Georges Bank have generally been about 1°C above normal. This is in contrast to the Scotian Shelf where temperatures in 2001 were colder than normal and lower than 2000. Vertical mixing on Georges Bank, as indicated by the annual mean difference in water density between 0 and 50m, has remained relatively constant as it has been for the past 20 years. Both the shelf/slope front and Gulf Stream were further offshore in 2001 compared to 2000. While the shelf/slope front had moved seaward of its long-term (1971-2000) mean position, the Gulf Stream remained landward of its long-term mean. Although not covering Georges Bank, information from the July groundfish surveys (July) and satellite ocean colour data (full year), suggest the chlorophyll levels in surface waters were similar in 2001 to 2000 and similar to the long-term mean. Connections between the oceanographic conditions and the status of assessed fish stocks within 5Z are still elusive and remain under investigation.

Resource Status

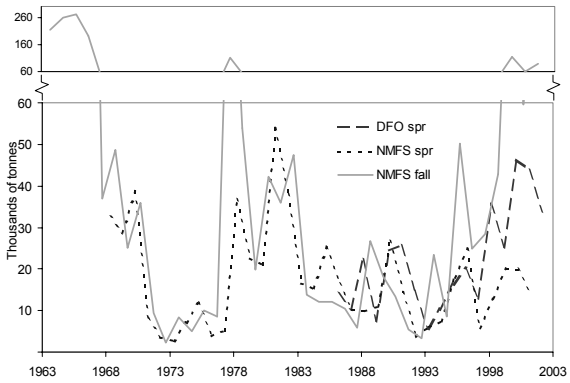
Catch rates from the Canadian commercial fishery for selected trips by tonnage classes 2 and 3 otter trawlers and longliners have generally increased since 1993. Changes to regulations, gear modifications and varying fishing practices in recent years make comparison of catch rates from year to year difficult to interpret. Therefore, these were not used as indices of abundance.



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 Fisheries and Oceans Canada (DFO) each spring (February) since 1986. The spatial distribution of catches for the most recent survey of each series was similar to the distribution over the previous 5 year period.

The **indices for ages 3-8 survey biomass** peaked at record highs during the early

1960s. After declining to a record low in the early 1970s, they peaked again in the late 1970s, though at a lower level, and again during the mid to late 1980s at about half the level of the 1970s peak. Biomass generally increased during the 1990s, and has fluctuated somewhat in recent years.

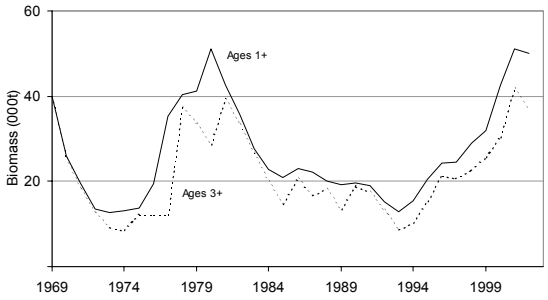


Survey recruitment indices for ages 0, 1 and 2 indicate that the abundance of the 2000 year-class is comparable to the good 1975 and 1978 year-classes, with the 1998 year-class being the second strongest since the 1978. Early indications from survey results suggest that the 2001 year-class is weak.

Although fishery weights at age for ages 2 and 3 are higher since 1993/1994, reflecting the change in gear selectivity which occurred, there have been no persistent trends in population **weight at age** derived from the DFO surveys. The survey weights at age for 2002, while within the range of observation, were notably lower than for 2001.

Stock status evaluations were based on a Virtual Population Analysis (VPA) using catch statistics, sampling for size and age composition of the commercial catch, and trends in abundance from three bottom trawl research surveys.

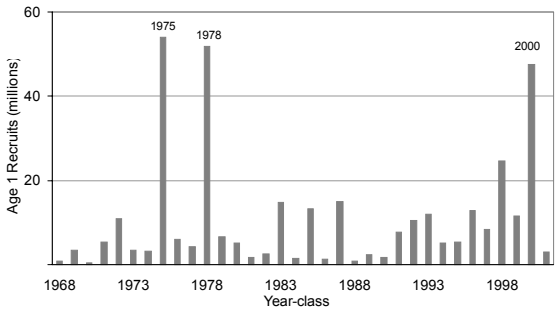
Population biomass (ages 3+) has steadily increased from near an historical low of about 10,000 t in 1993 to about 40,000 t at the beginning of 2001 and 2002. The 12% drop from 2001 to 2002, was due in part to lower weights at age. The recent increase has been due to more consistent and improved recruitment and was enhanced by increased survivorship and by reduced capture of small fish in the fisheries. Since the 1991 year-class, no year-classes have been below 5 million fish. Between the 1978 and 1991 year-classes, 7 of the 14 year-classes were below 5 million fish. The biomass increase is expected to be sustained by the 2000 year-class. Total biomass (ages 1+) trend is similar to the ages 3+ trend.



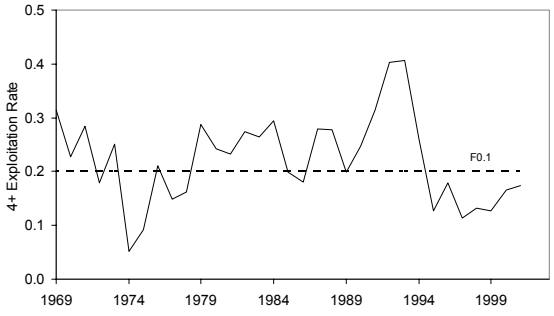
Population biomass during the late 1970s and early 1980s was about 50,000 t, due to recruitment of the strong 1975 and 1978 year-classes whose abundance was estimated at about 50 million. However, biomass declined rapidly in the early 1980s as subsequent recruitment was poor and these two year-classes were fished intensely at a young age.

Recruitment, estimated by the VPA, indicate that the 2000 year-class (45 million at age 1) is about equal in strength to the

good 1975 and 1978 year-classes. The 1998 year-class (25 million at age 1) is the second strongest since that of 1978. The 1996 and 1999 year-classes were estimated to be about 13 million, comparable to the 1983, 1985 and 1987 year-classes, which were the strongest 3 year-classes over about a 20 year time span.

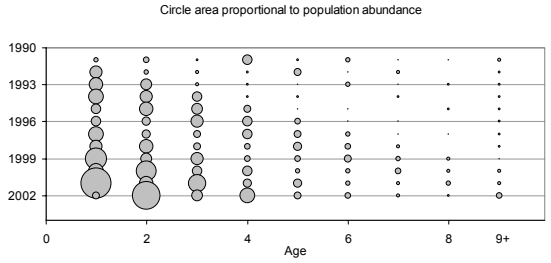


Exploitation rate for fully recruited ages 4+ has consistently been below that corresponding to $F_{0.1}$ (20%) since 1995. Historically, exploitation rate has generally exceeded that corresponding to $F_{0.1}$ and showed a marked increase between 1989 and 1993 to about 40%, the highest observed.

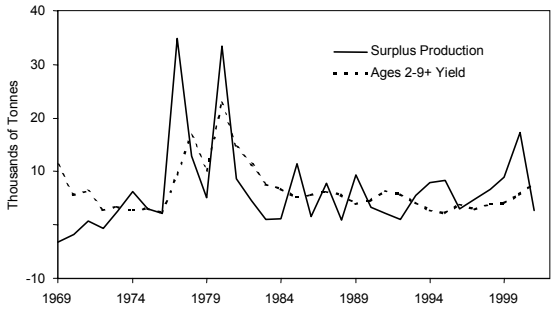


Reduced fishing mortality in recent years has resulted in increased survival of incoming year-classes. The number of haddock of the 1992 year-class surviving to age 8 was over four times that of the equally abundant 1983 year-class, and about the same as that of the 1975 or 1978 year-classes, which were more than 3 times as abundant. Avoidance of small fish has resulted in the number of fish of the 1998 year-class surviving to age 3 to be almost as many as survived to age 3 of the 1978 year-class which was twice as strong.

In both absolute numbers and percent composition, the **population age structure** displays a broad representation of age groups, reflecting improving recruitment and lower exploitation since 1995.



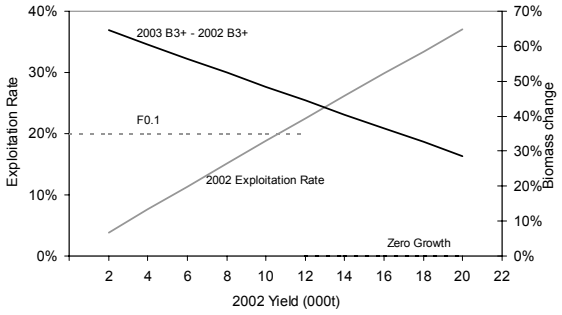
Except for 2001, since 1993 **surplus production** (biomass gains from growth and from recruitment, decremented by losses due to natural deaths) has exceeded the fishery harvest yield, resulting in net increase. Growth of fish is the dominant component of the biomass gain but recruitment accounts for significant portions when stronger year-classes enter to the population.



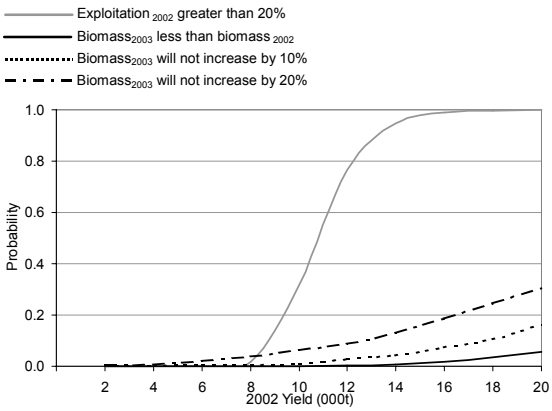
Assessments for several other stocks have identified a discrepancy between past and current estimates of stock status (retrospective pattern). This stock assessment does not suffer from a retrospective pattern.

Outlook

Projected total Canada/USA yield at an exploitation rate corresponding to $F_{0.1}$ in 2002 would be about 10,700 t. If fished at that rate in 2002, the adult biomass is projected to increase considerably from about 40,000 t to 54,000 t by the beginning of 2003, largely due to recruitment of the 2000 year-class. The 1998 year-class (age 4) is expected to comprise the highest proportion of the total 2002 yield, accounting for about 40%.



Uncertainty about year-class abundance generates uncertainty in forecast results. This was expressed as risk of achieving reference levels. For example, a combined Canada/USA catch of 8,000 t in 2002 would be required to obtain a low probability (less than 10%) that fishing mortality rate will exceed $F_{0.1}$. At this yield, there is a negligible probability of not achieving a 10% or 20% biomass increase.

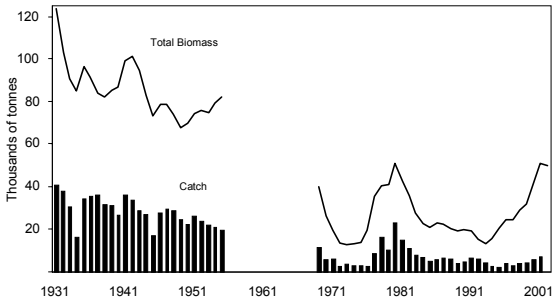


These uncertainties are dependent on the model assumptions and data used in the analyses. Though these assumptions were deemed most suitable, there may be other plausible assumptions. These calculations do not include uncertainty due to variations in weight at age, partial recruitment to the fishery, natural mortality, systematic errors in data reporting or the possibility that the model may not reflect the stock dynamics closely enough. The risk profiles provide a general sense of the associated uncertainties and can assist in assessing the consequences of alternative actions.

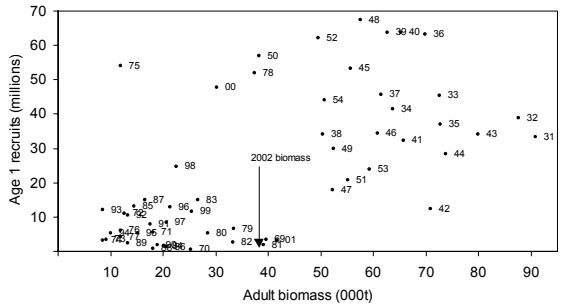
Management Considerations

The Canadian quota of 6,985 t in 2001 was expected to result in a negligible chance of exceeding $F_{0.1}$ but there was a low chance of achieving 10% growth. The Canadian catch in 2001 was very near the quota and resulted in an exploitation rate of about 17% and a decrease in adult biomass of about 12% from 2001 to 2002.

Data were available to approximate the age composition of the catch from unit areas 5Zj and 5Zm in order to reconstruct an illustrative population analysis for the period between 1930 and 1955 suitable for comparison of productivity. Total catches during the 1930s to 1950s ranged between 15,000 t and 40,000 t, averaging about 25,000 t. Catches probably attained record high levels of about 60,000 t during the early 1960s. Since the early 1970s, catches have been substantially lower, generally fluctuating between 5,000 t and 10,000 t. Although biomass has been increasing and is the highest it has been in about 30 years, it remains below the average biomass during 1930-55, when productivity was higher.



The pattern of recruitment indicates that the chance of a strong year-class is significantly reduced for adult biomass below about 40,000 t. Since 1969, only the 1975, 1978 and 2000 year-classes have been above the average abundance of year-classes observed during the period 1930-55.



Examination of the recruits per adult biomass ratio suggests that survivorship to age 1, for several years during the 1980s, may have been lower than the norm. The present survivorship appears comparable to that of the 1930s to 1950s period, suggesting that higher recruitment might result if the biomass increases.

Exploitation rate and biomass can be used to compare consequences of alternative harvest yields. The projections above show those results. Other attributes like recruitment, age structure and spatial distribution reflect possible fluctuations in the productive potential and can be used to qualify reference points and acceptable risk. While conditions have improved, maintaining exploitation rate at current levels would enhance further rebuilding.

Consistent management by Canada and the USA is required to ensure that conservation objectives are not compromised.

Cod and haddock are often caught together in Canadian groundfish fisheries. However, their catchabilities to the fisheries differ and they are not necessarily caught in proportion to their relative abundance. With current fishing practices, exploitation of haddock at $F_{0.1}$ may compromise the achievement of rebuilding objectives for cod.

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ISSN 1480-4913

La version française est disponible à l'adresse ci-dessus.

Correct citation for this publication

DFO, 2002. Eastern Georges Bank Haddock. DFO Science Stock Status Report A3-08(2002).