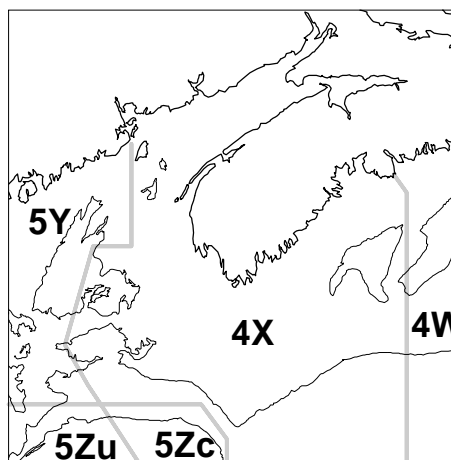




## Southern Scotian Shelf And Bay Of Fundy Haddock



### Background

Haddock are found on both sides of the North Atlantic. In the west Atlantic, they occur from southwest Greenland to Cape Hatteras. A major stock exists in the southern Scotian Shelf and Bay of Fundy area. This bottom-dwelling species is a member of the cod family and feeds mainly on small invertebrates. It is most common at depths ranging from 25-75 fathoms (46-137 m) and in bottom temperatures above 2°C. Although seasonal migrations are evident within the stock area, there is relatively little exchange between adjacent haddock stocks.

Young haddock in this stock are relatively fast growing, reaching 17 inches (43 cm) and 1.7 pounds (0.8 kg) by age 3 on average. Growth slows thereafter and haddock reach only about 26 inches (66 cm) in length by age 10. Haddock in the Bay of Fundy grow more rapidly than those on the southern Scotian Shelf. Approximately 50% of female haddock are mature by age 3; however the number of eggs produced by a female of this age is low and increases dramatically with age. Browns Bank is the major spawning area for the stock and peak spawning may occur from April to June.

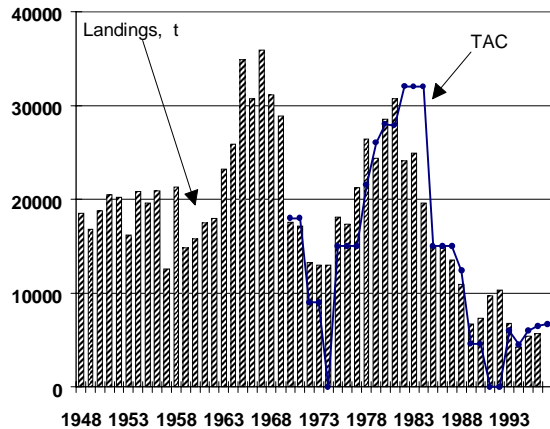
Reported annual landings have been as high as 36,000t and the long-term average is about 20,000t. Landings have been below 11,000t since 1988. This fishery has been dominated by mobile gear historically. During 1990-93 the proportion of landings taken by fixed gear was greater; however mobile gear landings has been greater than 50 percent since 1994. Quotas for this stock were introduced in 1970 and a spawning season/area closure has been in place since that time. Scientific advice is presented on the basis of a target capture rate of approximately 20% of the population and maintaining a large spawning stock biomass to enhance the probability of good recruitment.

### The Fishery

Landings (thousands of tonnes)

Year	70-79 Avg.	80-89 Avg.	1993	1994	1995	1996	1997
TAC	14.7	21.4	6.0	4.5	6.0	6.5	6.7
TOTAL	18.2	18.9	6.8	4.3	5.4	5.7	

Reported landings of 4X haddock in 1996 were 5,690t, relative to a TAC of 6,500t. This shortfall is due primarily to landings reported from 4Xs (427t) and 5Y (94t), areas which are not considered part of the 4X haddock stock unit but which are included by quota monitoring in a 4X/5Y quota group. Haddock landings from these areas have usually been less than 100t in the past. The 1997 TAC is 6,700t.



The introduction of ITQs in the mobile gear sector in 1991 has resulted in significant changes in fishing practices. One effect has been an increase in haddock landings from 4Xqr in the Bay of Fundy. Mobile gear landings from 4Xqr have increased from 15 % of the total in 1989 to 32% in 1996. Haddock were reported to be distributed higher up in the Bay of Fundy in 1996 and this may explain the increase in haddock landings in 4Xs and 5Y. The use of square mesh in the mobile gear fleet seems to be minimizing the catch of small haddock. Mobile gear effort directed at haddock increased substantially in 4X in 1996. Fishermen reported that directing for haddock in the Bay of Fundy resulted in sufficient by-catch of cod and pollock to maintain quota balances.

Reports from the longline fleet of increased abundance of small haddock east of Browns Bank were widespread, in both 1996 and 1997. **At-sea surveillance samples** from boardings of longline vessels indicate catches of small haddock were common and were high at times. Roseway, LaHave and Baccarro Banks were closed during the summer of 1996 due to high catches of small cod and haddock and Roseway Bank was closed again for 2 weeks in August 1997. At-sea surveillance samples and port samples

from the longline fleet suggest that some discarding and high-grading of small haddock occurred in 1996 but levels could not be quantified. It was felt that discarding of small haddock was reduced in 1997. The introduction of community quotas in the fixed gear sector led to an increase in misreporting in 1995 and 1996 but the introduction of quota shares has alleviated this somewhat in 1997.

A comparison of the **size composition of commercial landings** of 4X haddock over time showed that there has been a steady increase in the mean length of mobile gear landings since the introduction of square mesh and ITQs in the early 1990s; however mean length in mobile gear landings dropped from 54.7cm in 1995 to 51.6cm in 1996. Mean length in fixed gear landings decreased from 54.1cm in 1990 to 49.4cm in 1993 and has remained relatively steady since. Mean length of landings in both sectors has remained about the same in 1997 half year landings as in 1996.

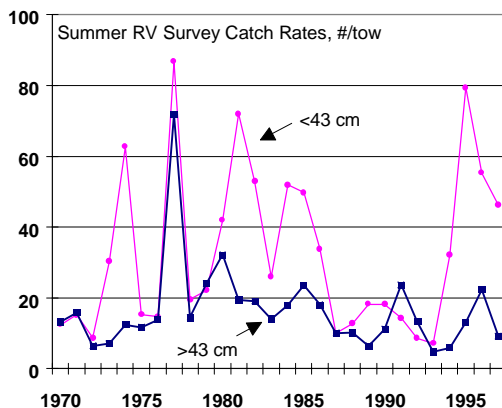
**Landings** in the first half of 1997 are only 2200t. This is likely a reflection of the late start of the fixed gear fishery this year due to difficulties in reaching agreement on a Management Plan by that sector. In addition, a number of fishermen now fishing quota shares in 1997 have chosen to catch that share later in the year.

### **Resource Status**

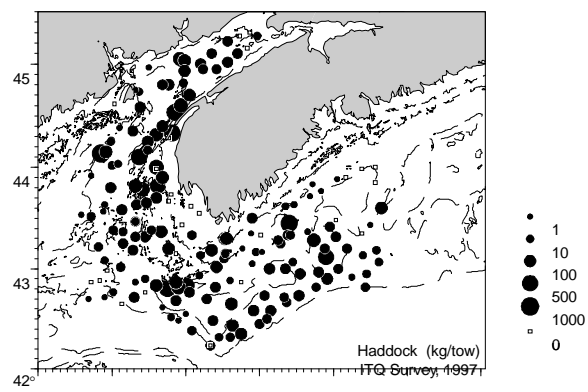
The stock status evaluation was based on an assessment using landing statistics, sampling of the age and size composition of the commercial catches, trends in abundance from the summer research vessel surveys, and the results of a joint resource survey conducted in 1995-97 by the ITQ fleet in cooperation with DFO Science.

**Ageing data**, using more accurate ageing criteria, are now available for commercial samples from 1988 to present. As revised ageing data were not available for samples of commercial catches from 1985-87, the research vessel survey ageing data were used, together with the size composition of the commercial catches, to estimate the age composition of the commercial catches in those years.

**Abundance** decreased in the **summer research vessel survey** in both 1996 and 1997 from the high level in 1995 but showed a widespread geographic distribution in both years. Mean number per tow of small haddock (less than 43cm) decreased in 1996 and 1997 but is still above the long term mean; however number per tow of market-size haddock (greater than 43cm) is below the long term mean. The decrease in market-size haddock occurred primarily in the Bay of Fundy. Abundance of market-size haddock has been increasing on Browns Bank and the eastern banks in 4X since 1993 but decreased slightly on Browns Bank in 1997. The research vessel surveys indicate that the 1993 and 1994 year-classes are both well above average. The 1995 year-class appears relatively weak but the 1996 year-class may be average.

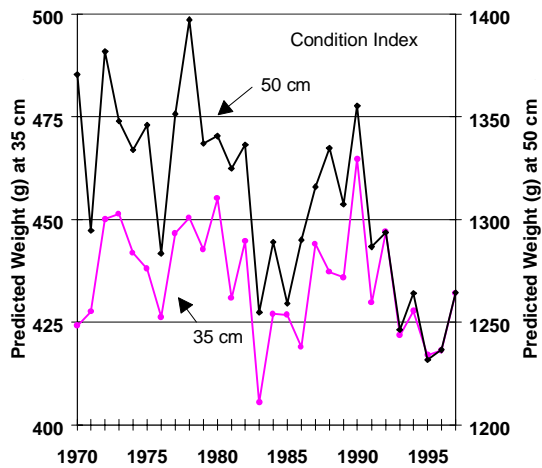


A **joint industry/DFO Science resource survey** of 4X was conducted in summer 1995-97 by the ITQ fleet. Survey coverage was increased to 177 standardized fishing sets in the last two years and now covers most of the 4X area. In addition to providing extensive coverage of the traditional research vessel survey strata, this survey provides coverage inshore of the traditional strata in an area where a substantial portion of the mobile gear fishery occurs. Overall distribution patterns were similar to those of the research vessel surveys and catch rates in the inshore area were high. Although similar in the first year, size composition in the inshore area has differed from the offshore region, with relatively fewer large fish. The results of the ITQ fleet surveys also indicate that the 1993 and 1994 year-classes are strong. The catch of market-size haddock in the ITQ survey has not changed significantly over the three years of the survey. This is in contrast to the RV survey results which indicate a sharp increase in 1996 followed by a sharp decrease in 1997.



**Condition** is the relative weight of the fish for their length i.e. their plumpness. An index of condition, developed from the summer research vessel surveys, was variable but indicated that condition has decreased since the late 1980s to low levels in 1995.

The cause of low condition in this stock is uncertain.

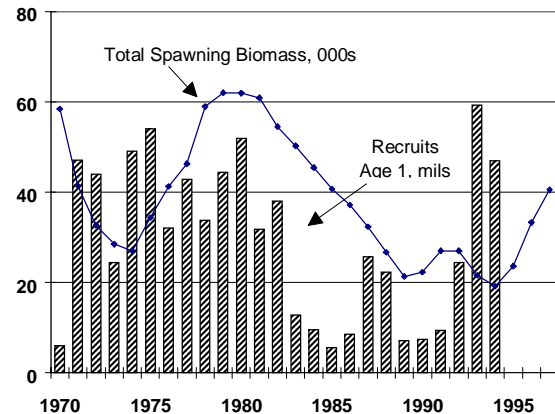


**Mean length-at-age** of haddock on Browns Bank and the eastern banks has decreased since the early 1980s, particularly at older ages. A similar and more extreme decrease in mean length-at-age has occurred in 4TVW haddock during the same period. There has not been a decrease of mean length-at-age of haddock in the Bay of Fundy.

**Oceanographic conditions** in 1996 and 1997 were examined and, unlike on the eastern Scotian Shelf, no conditions were identified in the bottom water that would adversely affect the distribution of haddock in 4X, with the possible exception of LaHave Bank where bottom temperature in 1997 was approximately 2°C. It was noted that water less than 2°C occurred at 50m over a substantial part of eastern 4X, but the significance of this in relation to haddock is unknown.

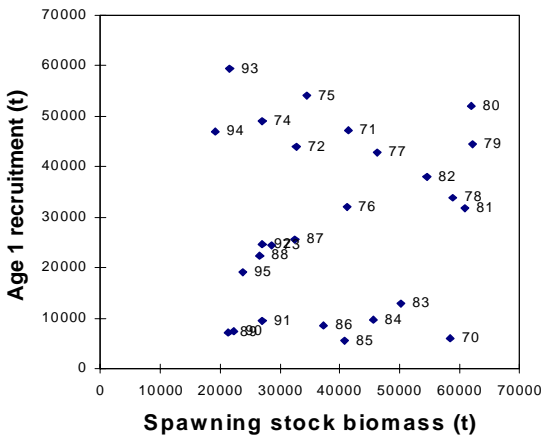
Past **assessments** of this resource have under-estimated exploitation and over-estimated population abundance in the current year, particularly when large year-classes occur. There was a significant improvement in this retrospective pattern in the current assessment.

**Spawning stock biomass** has been decreasing since 1980 and reached a low of 19,000t in 1994. It is estimated that spawning stock biomass has increased to 41,000t in 1997 as the 1993 and 1994 year-classes begin to mature.

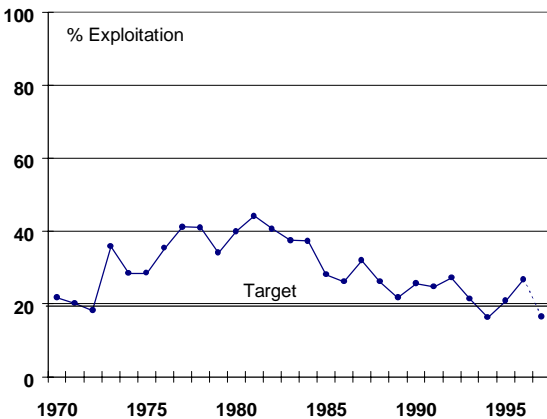


Except for the 1987 and 1988 year-classes, **recruitment** of the 1983-91 year-classes was below average; however the 1992 year-class is estimated to be of average strength. Both the 1993 and 1994 year-classes are estimated from the research vessel survey to be very high. In the past, there has been a tendency for the size of large year-classes to be over-estimated by the survey. This may be due to discarding or higher natural mortality on large year-classes. The relative sizes of these year-classes are uncertain. These year-classes were produced at a time when the spawning stock was at a record low level and condition of the fish was also at a record low. The estimate of the 1994 year-class from the VPA was adjusted downward to 47 million due to this tendency to over-estimate large year-classes. The 1993 year-class estimate from the VPA was not adjusted downward.

There appears to be no relationship between spawning stock biomass and recruitment over the biomass range observed.



The **exploitation rate** on ages 5-7 has been higher than the target since the early 1970s. Exploitation decreased from approximately 45% in the early 1980s and dropped below the target level in 1994, but has increased to 27% in 1996. If the TAC of 6,700t is reached in 1997, the exploitation rate will drop below the target level (20%,  $F_{0.1}=.25$ ) to 16%.



Ageing criteria for this resource have changed. In last year's assessment, revised age data for the research vessel survey from 1987-95 were available. These revised data resulted in a re-distribution of fish to older ages and a reduction in size-at-age. Revised age data were not available from commercial samples to calculate the catch-at-age at that time and the research vessel survey age data

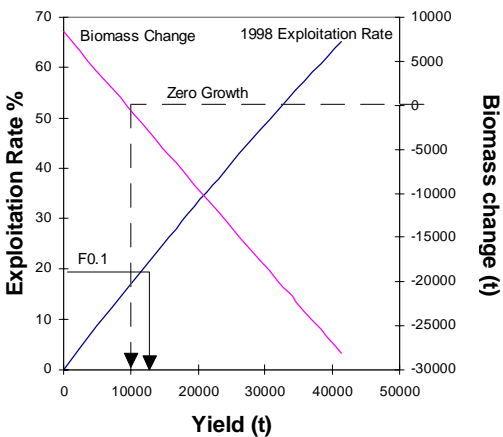
were used in last year's assessment instead. That analysis resulted in a substantial reduction in estimates of fishing mortality, relative to the previous age-based assessment, and an increase in estimates of population numbers.

For this year's assessment, revised age data were available for commercial samples from 1988-97 to calculate the catch-at-age for that period. Age data from the research vessel survey were used to calculate the catch-at-age for 1985-87 in this year's assessment. Population numbers from this assessment are similar to those from last year's assessment; however estimates of fishing mortality since the early 1980s are considerably lower in this assessment. This change in fishing mortality results primarily from the changes in the catch-at-age this year that used the revised ageing data from commercial samples. This reduction in estimates of fishing mortality was largest in the early- to mid-1980s and is not consistent with effort trends over the same period. This may be due to the use of research vessel survey age data to calculate the catch-at-age for 1985-87, but discarding or misreporting may be a contributing factor.

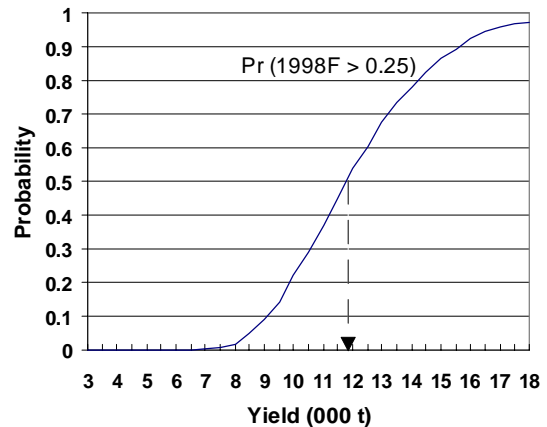
Estimates of **total mortality** calculated from the research vessel survey and of relative fishing mortality calculated from the landings and population numbers from the research vessel survey were compared with fishing mortalities from the VPA. These methods confirm the general trend in fishing mortality in the VPA but the VPA did not show an increase in 1991-92 to the degree that the previous assessment did. Overall this assessment is an improvement over last year. There is a change in the perception of exploitation levels of this resource since the early 1980s and in 1991-92 in particular.

## Outlook

Using an estimate of age 1 recruitment of 47 million for the 1994 year-class (reduced from the VPA estimate due to the tendency to over-estimate the size of large year-classes) and a mean from the recent past of 11.5 million for subsequent year-classes, the **projected yield** at the target exploitation rate (20%,  $F_{0.1}=0.25$ ) in 1998 would be 11,600t. Of this projected yield, 72% will come from the 1993 and 1994 year-classes. Spawning stock biomass would peak at 59,000t in 1998 and decrease to 57,000t at the beginning of 1999.



**Risk analysis** indicates that at a yield of 11,600t, which corresponds to a 50% risk of exceeding  $F_{0.1}$ , the spawning stock biomass has a 76% probability of decreasing for 1998; this probability of spawning stock biomass decreasing for 1998 declines to 50% at a yield of about 9,790t. The probability of exceeding  $F_{0.1}$  declines below 20% for harvests of 9,300t or lower.



There are several sources of **uncertainty** in the projected yield and spawning stock biomass. Mean weight-at-age in the research vessel survey decreased substantially at most ages in 1997. If this trend continues, then the projected yield and spawning stock biomass will be over-estimated.

This projection is very dependent upon the estimated strengths of the 1993 and 1994 year-classes. In the past, there has been a tendency to over-estimate large year-classes. If the estimate of the 1993 year-class is also reduced using the relationship based on previous year-classes, then the projected yield at the target exploitation rate in 1998 would be 9,500t.

### For more Information

Contact: Peter Hurley  
Marine Fish Division  
Bedford Institute of Oceanography  
P.O. Box 1006, Dartmouth  
Nova Scotia, B2Y 4A2

Tel: 902-426-3520

Fax: 902-426-1506

E-Mail: HurleyP@mar.dfo-mpo.gc.ca

## Reference

Hurley, P.C.F., G.A.P. Black, R. Mohn, and P. Comeau. 1997. Assessment of 4X haddock in 1996 and the first half of 1997. DFO Canadian Stock Assessment Secretariat Res. Doc. 97/108.

This report is available from the:

Maritimes Regional Advisory Process  
Department of Fisheries and Oceans  
P.O. Box 1006, Stn. B105  
Dartmouth, Nova Scotia  
Canada B2Y 4A2  
Phone number: 902-426-7070  
e-mail address: MyraV@mar.dfo-mpo.gc.ca

Internet address: <http://csas.meds.dfo.ca>

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

