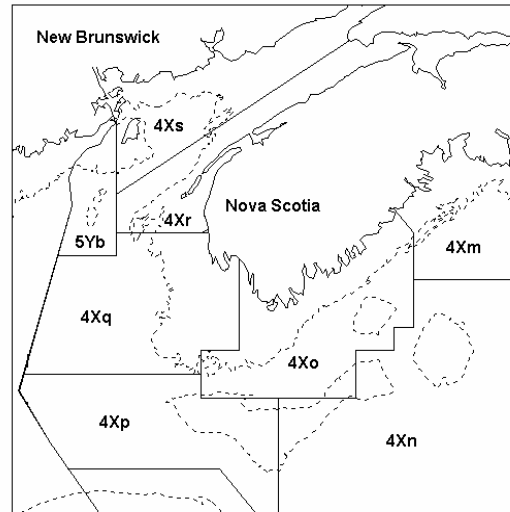




HADDOCK ON THE SOUTHERN SCOTIAN SHELF AND BAY OF FUNDY (DIV. 4X/5Y)



Context

Haddock (Melanogrammus aeglefinus) 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 of 25-125 fathoms (46-228m) 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.

Haddock on the southern Scotian Shelf reach 15 inches (38 cm) and 1.1 pounds (0.5 kg) by age 4 on average. Growth slows thereafter and haddock reach only about 19 inches (48 cm) and 2.4 pounds (1.1 kg) 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. Major spawning grounds are found on Browns Bank and peak spawning occurs in April/May.

Reported annual landings have been as high as 43,000t and the long-term average is about 18,000t. Landings have been below 11,000t since 1988. Historically this fishery has been dominated by mobile gear except during 1990-93 when the proportion of landings taken by fixed gear was greater. Quotas for this stock were introduced in 1970 and a spawning season/area closure has been in place since that time.

SUMMARY

- Landings of 4X/5Y haddock in the fishing year ending March 31, 2005 were 5,946t relative to a quota of 10,000t.
- The 1998, 1999, 2000 and 2003 yearclasses are all strong.
- Spawning stock biomass increased to 54,000t in 2003 and has decreased slightly in 2005.
- Since 1994, fishing mortality has been below $F_{0.1}$. Relative fishing mortality shows a declining trend on the Scotian Shelf but remains relatively stable in the Bay of Fundy. Exploitation in the Bay of Fundy may be too high and is hampering rebuilding.
- If catches are maintained at the current TAC of 8,000t, fishing mortality will remain below $F_{0.1}$ and spawning stock biomass will decrease from 2006 to 2007.
- Mean sizes-at-age in the RV survey have been decreasing since the mid-1970s and many ages are at or near the smallest size observed in the time series. Under the current growth regime, productivity is about two thirds of what it was in the 1970s. There would be no increase in yield by delaying harvest of this resource to older ages.
- The achievement of rebuilding objectives for cod and pollock may constrain the harvesting of haddock.

DESCRIPTION OF THE ISSUE

Rationale for Assessment

Advice was requested by Fisheries Management on the stock status of haddock in Div. 4X/5Y in order to determine a TAC that would be consistent with the management plan. Specifically:

- Evaluate the completeness and accuracy of fishery statistics for haddock in 4X/5Yb for 2004/05, commenting on implications for status determination.
- Given apparent changes in growth rate and productivity of the 4X haddock resource, describe the implications for harvest strategy.
- Determine if the biomass and fishing mortality rate of haddock has increased or decreased. Evaluate the prospects for rebuilding if catches are maintained at the current TAC of 8,000t. Provide details for the Bay of Fundy and Scotian Shelf separately.

The Fishery

Landings* (000s t)

Year	1970-1979 avg.	1980-1989 avg.	1990-1999 avg.	2000*	2001	2002	2003	2004	2005
TAC	14.7	21.4	5.1	8.1	8.1	8.1	10.0	10.0	8.0
TOTAL	18.6	19.6	7.2	7.8	7.4	8.0	8.6	5.9	

* Commencing in 2000, fishing year, landings and TAC refer to the period April 1st of the current year to March 31st of the following year.

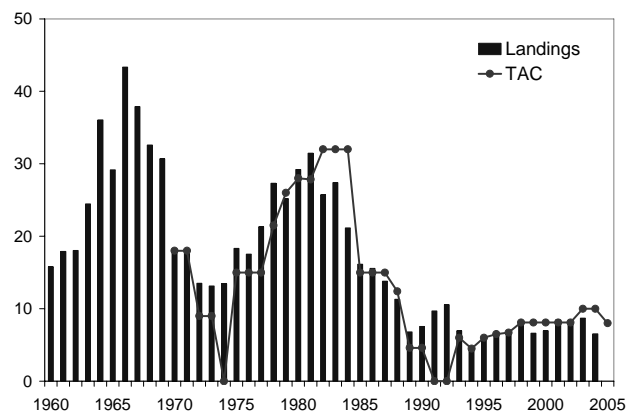


Figure 1. Landings* and TACs ('000t) for 4X/5Y haddock.

Landings of 4X/5Y haddock in the fishing year ending March 31, 2005 were 5,946t relative to a quota of 10,000t (Fig. 1). Following recommendation from industry, the quota in the 2005/06 fishing year was reduced to 8,000t. Landings for the current fishing year to October 27, 2005 were 3,265t, about the same as last year for the same period. Low fish prices and high fuel, insurance and bait costs have all contributed to the shortfalls. In 2005, there are reports from the mobile gear sector that there have been difficulties locating concentrations of large haddock in the Bay of Fundy.

Recent changes in the management of the fishery have had a significant impact on the timing of the fishery. The change to an April-March fishing year in 2000 resulted in an increase in the proportion of fish landed during January to March. Both the mobile gear and fixed gear sectors indicate this is due primarily to the ability to direct for haddock with a minimal bycatch of cod.

This change in timing of the fishery has also led to changes in the distribution of catches. The proportion of catches from 4Xn and 4Xp has been increasing in recent years. While the increase in 4Xn is largely a result of the increase in the winter fishery, the increase in 4Xp reflects directing for larger haddock in deeper water, which generally returns higher market value and also is an area in which the bycatch of cod is relatively low.

The 1998 and 1999 yearclasses made up more than half of the 2004 catch by weight. As these yearclasses dominate the fishery, the proportion of small (<43cm) fish in the catch has increased. Over the last three years, the proportion of small fish in landings has increased and more than 50% of second quarter landings from the Scotian Shelf were less than 43cm.

The high proportion of small fish being landed (based on port samples) and comparisons between port (shore) samples and observer (at-sea) samples indicates that discarding of small haddock is not occurring at this time. There are no other reasons to conclude that landings data for 4X haddock in 2004/05 are incomplete or inaccurate.

RESOURCE ASSESSMENT

Stock Trends and Current Status

Estimated **recruitment** in this stock was high through the 1970s and into the early 1980s (Fig. 2). This was followed by a ten year period of below average recruitment, from 1983-92, although the 1987 and 1988 yearclasses were near-average in strength. This has been followed by a period of relatively good recruitment. The 1998 yearclass is estimated to be the strongest since 1970 at 63 million at age 1, and the 1999 yearclass is estimated to be the third strongest. The 2000 yearclass is above average and the 2003 yearclass is also estimated to be strong.

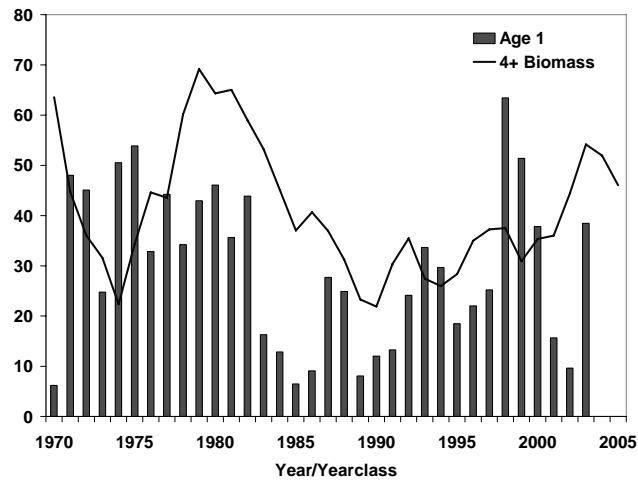


Figure 2. Spawning stock biomass (ages 4+) (000 t) and age 1 recruitment (millions) in the subsequent year for 4X/5Y haddock.

Research vessel (RV) and ITQ survey indices can be separated into Scotian Shelf and Bay of Fundy to provide a view of differences in population attributes between these areas (Fig. 3 and 4). Both surveys indicate that recruitment is typically stronger on the Scotian Shelf than in the Bay of Fundy. Comparison of survey recruitment indices by area indicate that several yearclasses, 1997-2000, appear strong on the Scotian Shelf but only the 1998 yearclass appears strong in the Bay of Fundy.

RV survey age composition for the Scotian Shelf displays an expanding age range in recent years while the age range for the Bay of Fundy remains truncated.

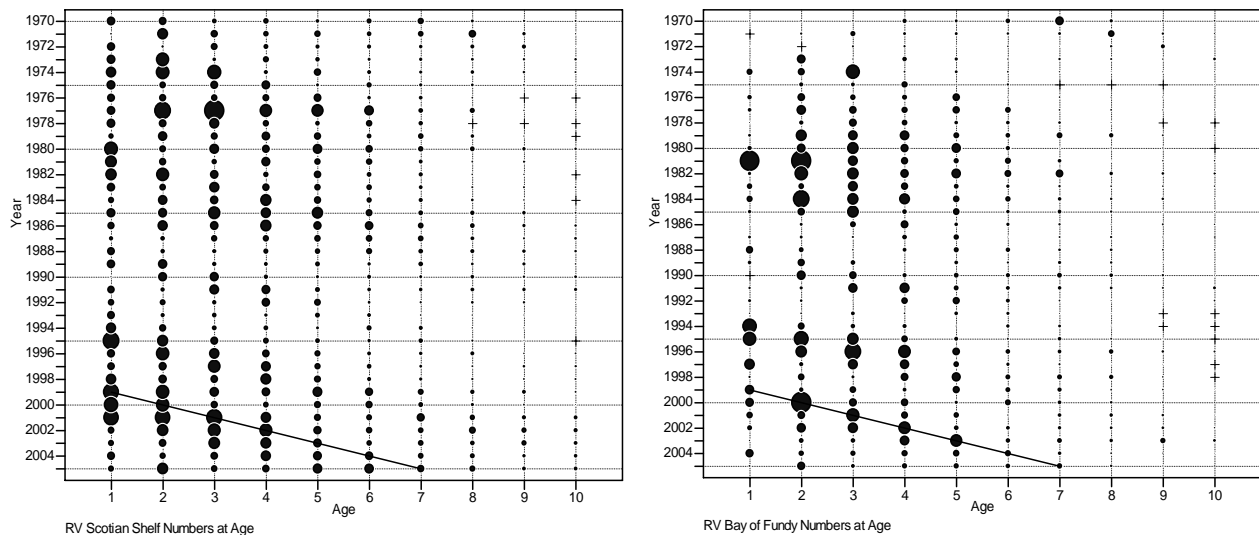


Figure 3. Age composition of RV survey indices by area (Scotian Shelf on left, Bay of Fundy on right) for 4X/5Y haddock. Solid line tracks 1998 yearclass.

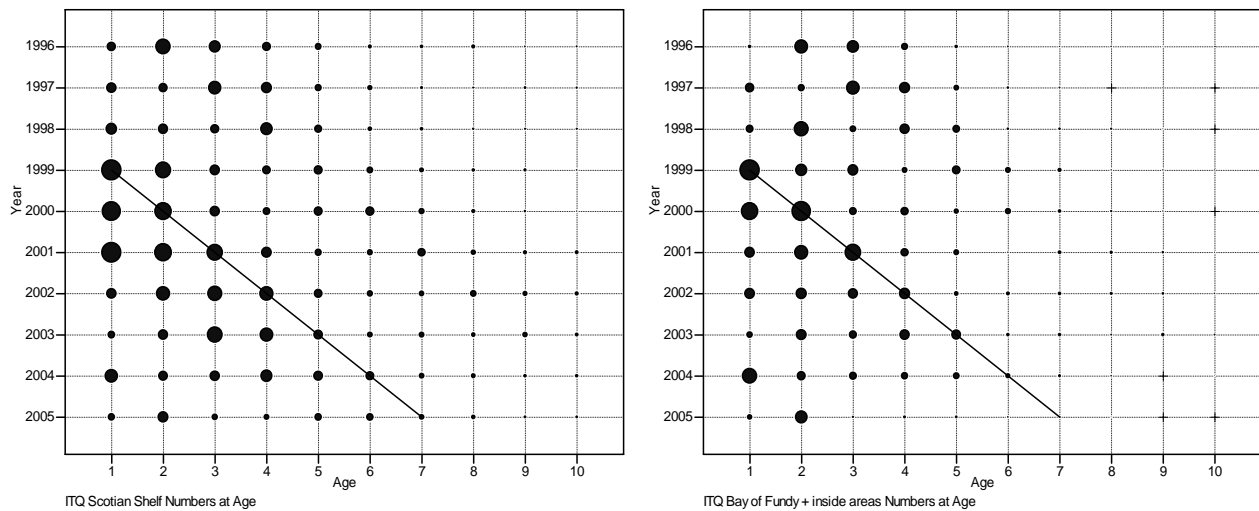


Figure 4. Age composition of ITQ survey indices by area (Scotian Shelf on left, Bay of Fundy on right) for 4X/5Y haddock. Solid line tracks 1998 yearclass.

Spawning stock biomass (ages 4+) decreased from a peak in 1979 and reached a low of 22,000t in 1990 (Fig. 2). Spawning stock biomass is estimated to have increased to 54,000t in 2003 and to have decreased slightly in 2005.

The RV and ITQ surveys suggest that the proportion of biomass in the Bay of Fundy is declining (Fig. 5) while the proportion of the commercial catch coming from the Bay of Fundy is increasing.

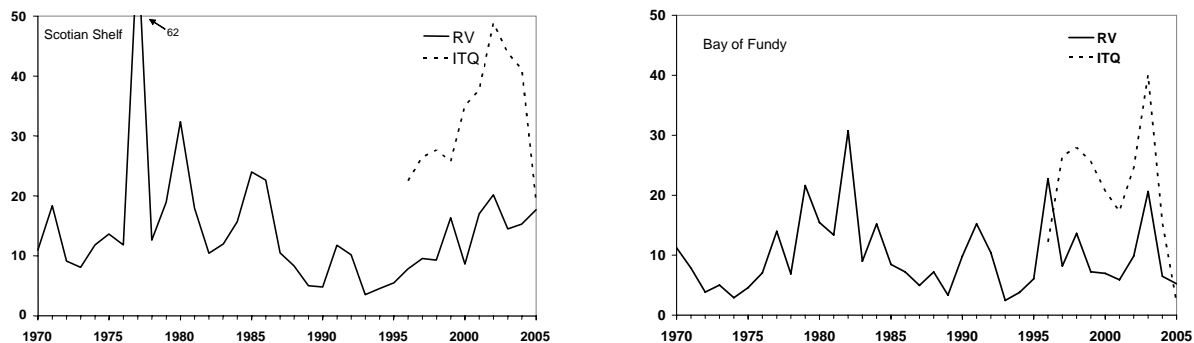


Figure 5. RV and ITQ survey 4+ biomass indices by area (Scotian Shelf on left, Bay of Fundy on right) for 4X/5Y haddock.

The **exploitation rate** on ages 5-7 (historically fully recruited) increased from the 1970s to approximately 50% in the early 1980s (Fig. 6). It declined to close to $F_{0.1}$ (20%, currently used value of $F_{0.1}=0.25$) in the late 1980s and dropped below $F_{0.1}$ in 1994 and has remained low.

Relative fishing mortality, calculated as total landings divided by ages 4+ RV survey biomass, shows a declining trend on the Scotian Shelf but remains relatively stable in the Bay of Fundy (Fig. 7).

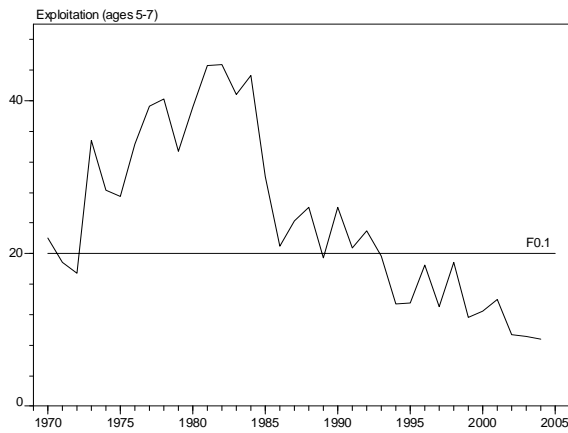


Figure 6. Exploitation rate (%) (ages 5-7) for 4X/5Y haddock.

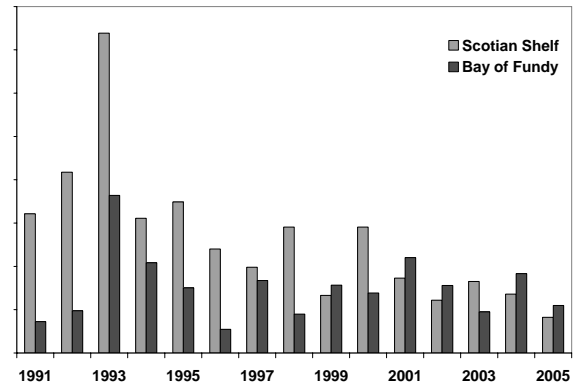


Figure 7. Relative fishing mortality by area in recent years for 4X/5Y haddock.

An examination of the **length composition** of the RV survey abundance indicates that the population is dominated by small fish (<43cm) (Fig. 8). In 2005, 84% of haddock (by number) caught on the Scotian Shelf were <43cm, well above the long term mean, while 57% of the haddock caught in the Bay of Fundy were <43cm, slightly above the long term mean.

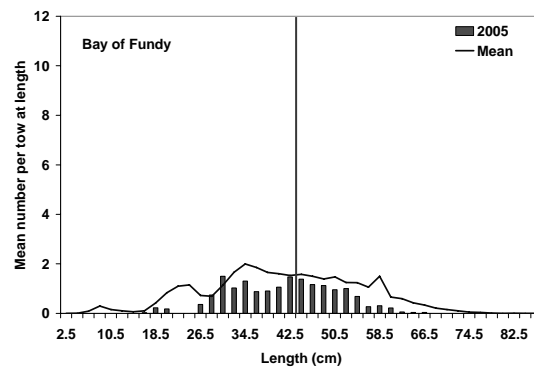
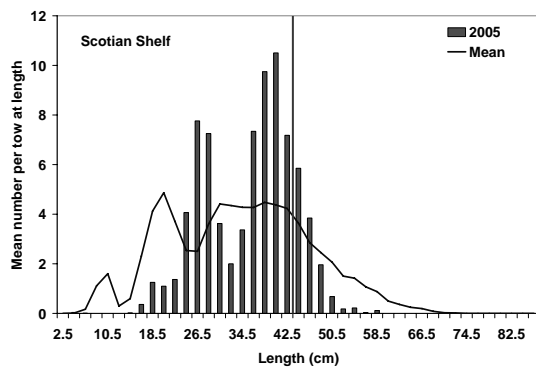


Figure 8. Length composition of 2005 RV survey catch (mean number per tow) compared to the long term mean (1970-2004). Vertical line indicates 43cm.

Mean lengths-at-age in the RV survey have been decreasing since the mid-1970s on the Scotian Shelf, particularly at older ages (Fig. 9). **Mean weights-at-age** show similar trends. Many ages are at or near the smallest size observed in the time series (Fig. 9). Although sizes-at-age are larger in the Bay of Fundy and the decreases are less extreme, older ages are also at or near the smallest sizes observed in 2005.

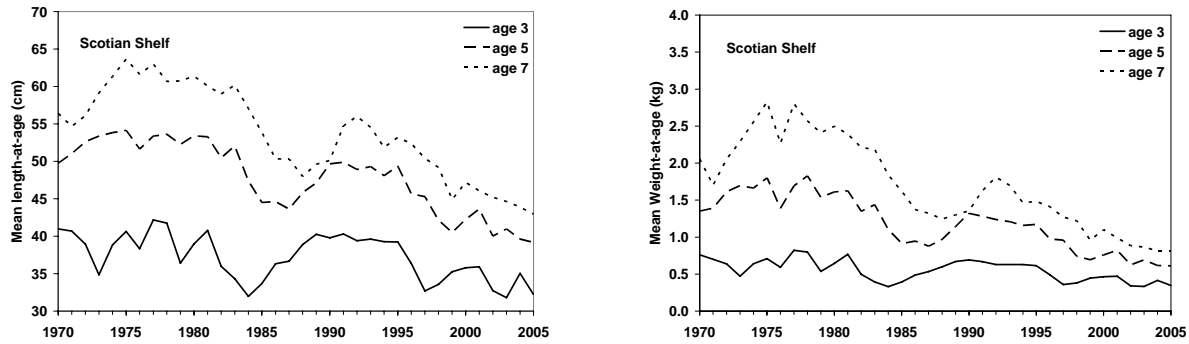


Figure 9. RV survey mean length-at-age (cm) (left) and mean weight-at-age (kg) (right) for 4X/5Y haddock.

An index of **fish condition**, predicted weight at 50cm calculated from the RV survey, has shown a decreasing trend since the early 1980s (Fig. 10). This index indicates that as well as getting smaller at age, fish are also getting “slinkier”. Although the Scotian Shelf index has shown some increase in the last three years, the Bay of Fundy index is now lower.

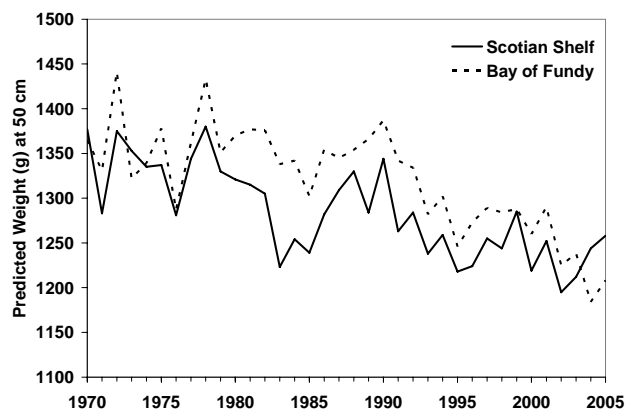


Figure 10. RV survey fish condition indices (predicted weight (g) at 50cm) by area for 4X/5Y haddock.

Sources of Uncertainty

The presence of separate stock components in this resource, which may have different dynamics, increases the uncertainty of analyses. Past assessments of this resource have exhibited a retrospective pattern. The pattern in exploitation estimates is variable but does not show a consistent over- or under-estimation. The biomass estimates exhibit a general tendency of over-estimation of population abundance in the most recent year, particularly when strong yearclasses occur. The 2003 yearclass is estimated to be strong and it is likely that this yearclass has been over-estimated by the current analysis.

ADDITIONAL STAKEHOLDER PERSPECTIVES

Handliners are seeing an absence of haddock in the shoal water (as for cod) throughout most of the traditional inshore fishing areas. There were observations from the mobile gear fleet that haddock were hard to find in the Bay of Fundy in 2005 but it was suggested that this may be related to a lack of large haddock that would be selected by 130mm square mesh.

Industry noted that given the high cost of bait and fuel, low catch rates and small fish size, the economics are not there for fishing haddock in 4X.

Concern was expressed in the decline in the weight-at-age.

Industry was generally in agreement with the haddock data presented by Science at the RAP Data Input Meeting.

CONCLUSIONS AND ADVICE

Harvest Strategy and Reference Points

A fishing mortality reference point of $F_{0.1}=0.25$ has been used as a harvest strategy for this resource. New reference points have not been determined.

Outlook

Adjusting for the likely over-estimation of the 2003 yearclass, the projected yield at $F=0.25$ (currently used for $F_{0.1}$) for the 2006 fishing year is 9,600t (Fig. 11) and the projected spawning stock biomass (ages 4+) at the beginning of the 2006 fishing year is 37,000t.

If catches are maintained at the current TAC of 8,000t, fishing mortality will remain below $F_{0.1}$ and spawning stock biomass will decrease from 2006 to 2007 (Fig. 11 and 12). Part of this decrease is attributable to the progression of the recent strong yearclasses through the population. The reference to “rebuilding” in the remit requires clarification as the biomass is estimated to be near expected levels given current growth and moderate fishing. For populations where the abundance and biomass are near the equilibrium level associated with the F reference, fluctuations in biomass are expected and may not be of concern.

The recruitment indices, age structure and partial F s by area suggest that exploitation in the Bay of Fundy may be too high and is hampering rebuilding and expansion of the age structure of the population in this area.

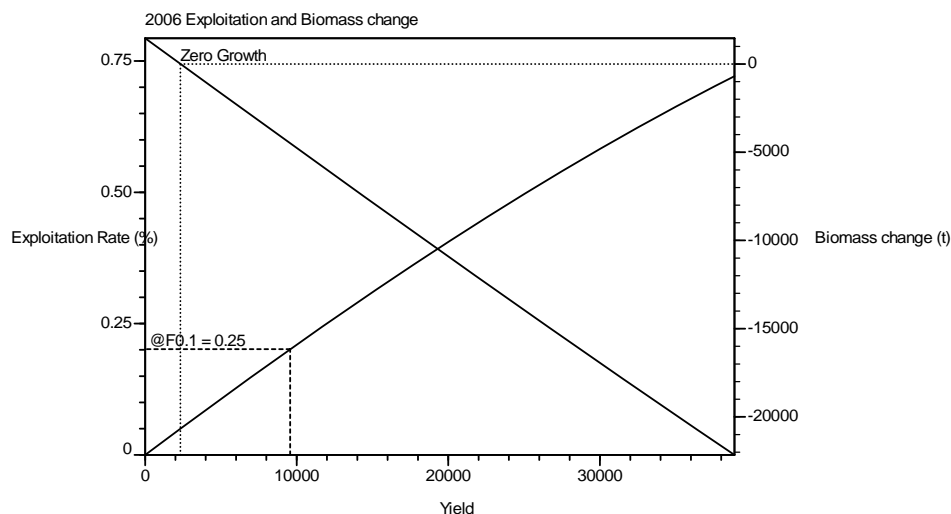


Figure 11. Exploitation rate (%) and change in spawning stock biomass (ages 4+) (t) at levels of yield of 4X/5Y haddock projected for the 2006/07 fishing year.

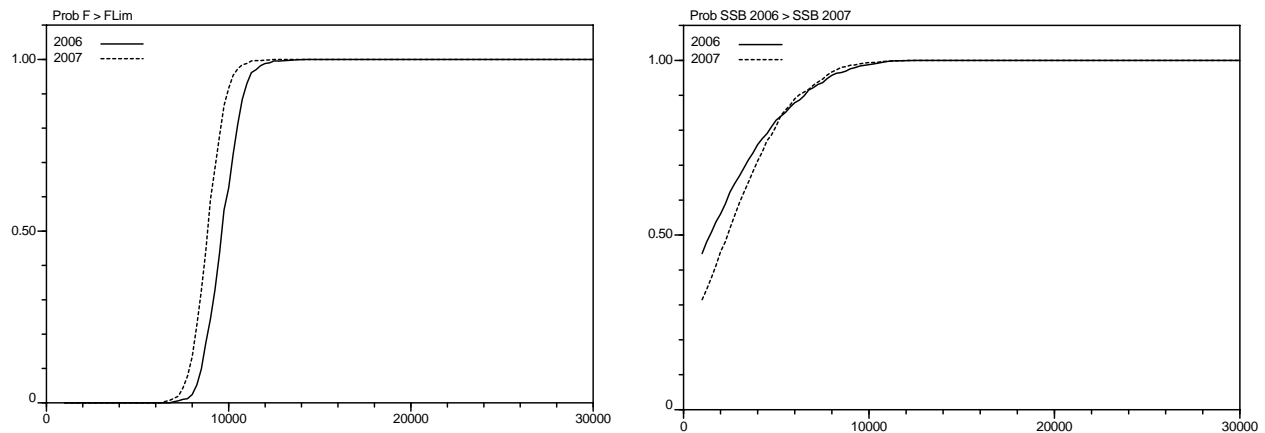


Figure 12. Probability that $F_{0.1}$ will be exceeded (left) and that spawning stock biomass (ages 4+) will decrease (right) at levels of yield of 4X/5Y haddock projected in the 2006/07 and 2007/08 fishing years.

OTHER CONSIDERATIONS

Cod, pollock and haddock are often caught together in groundfish fisheries, although their catchabilities to the fisheries differ and they are not necessarily caught in proportion to their relative abundance. With current fishing practices and haddock/other species catch ratios, the achievement of rebuilding objectives for cod and pollock may constrain the harvesting of haddock. Additional efforts to protect the 2003 cod yearclass which, from first indications, is estimated to be larger than has been seen in recent years are warranted. An imbalance in quotas creates potential for discarding and may require improved monitoring. Modifications to fishing gear and practices, with enhanced monitoring, may mitigate these concerns.

A surplus production analysis showed that productivity in this resource is presently about two-thirds of what it was in the 1970s, caused mainly by the decrease in growth. A yield per recruit analysis indicated that, under the current growth regime, there would be no increase in yield by delaying harvest of this resource to older ages; however the harvesting of small fish would have implications to future spawning stock biomass and other aspects of production.

SOURCES OF INFORMATION

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ISSN 1480-4913 (Printed)

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CORRECT CITATION FOR THIS PUBLICATION

DFO, 2005. Haddock on the Southern Scotian Shelf and Bay of Fundy (Div. 4X/5Y). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2005/056.