



## ASSESSMENT OF ATLANTIC HALIBUT ON THE SCOTIAN SHELF AND SOUTHERN GRAND BANKS (Div. 3NOPs4VWX5Zc)

### Context

Atlantic halibut (*Hippoglossus hippoglossus*) is the largest of the flatfishes and ranges widely over Canada's East Coast. The management unit definition (3NOPs4VWX5Zc) is based largely on tagging results that indicated Atlantic halibut move extensively throughout the Canadian North Atlantic with smaller fish moving further than larger fish.

Landings of Atlantic halibut have been recorded since 1883, and until 1988 the Atlantic halibut fishery was not regulated by total allowable catch (TAC). An industry/DFO longline halibut survey on the Scotian Shelf and Southern Grand Banks (3NOPs4VWX) was initiated in 1998 to provide estimates of abundance and distribution for Atlantic halibut, which are used for the annual assessment.

While the DFO research vessel (RV) survey is thought to provide information on incoming recruitment (< 81cm), estimates of adult (≥81cm) abundance are considered unreliable; consequently, the industry survey is essential to the assessment of this species. The industry/DFO survey provides an indicator of the direction of change in abundance of the halibut population for the Scotian Shelf and Southern Grand Banks, and also provides estimates of population size structure, including indications of incoming recruitment.

Advice has been requested by Fisheries and Aquaculture Management (FAM) on the stock status of 3NOPs4VWX5Zc Atlantic halibut to determine a TAC for the 2008/2009 fishery that is consistent with the management plan. Specifically, FAM has asked for an evaluation of:

- current removals, including surveys, and commercial bycatch of Atlantic halibut,
- recent catch rate and distribution trends from the Atlantic halibut industry survey, and
- whether or not these trends indicate positive or negative stock status, including trends for small (<81cm) and large (≥81cm) fish.

Given that a new assessment framework is currently under development, and it is not anticipated to be completed until 2009, assessment advice for 2008 is based on the previous assessment framework. The Science Special Response process has been used to provide an update to the previous halibut assessment conducted in 2006 (DFO 2006; Armsworthy *et al.* 2006). This is considered to be interim advice until the new assessment framework is complete and an assessment has been conducted using this framework.

This assessment was conducted through the Science Special Response process. Results were reviewed by DFO Maritimes Science and FAM only; no external reviewers or industry participants were included in the review.

## Background

### Biology

Atlantic halibut (*Hippoglossus hippoglossus*) is the largest of all flatfish and ranges widely over Canada's East Coast (Bigelow and Schroeder, 1953). They are demersal, living on or near the bottom, at temperatures within a few degrees of 5°C (Neilson *et al.*, 1993; Bowering, 1986). Atlantic halibut are most abundant at depths of 200-500 m in the deep-water channels running between the banks and along the edge of the continental shelf, with larger individuals moving into deeper water in winter (Bowering, 1986). The management unit definition (3NOPs4VWX5Zc, Figure 1) was based largely on tagging results that indicated that Atlantic halibut move extensively throughout the Canadian North Atlantic with smaller fish moving further than larger fish (Stobo *et al.*, 1988). Migrations of larger fish are thought to be related to spawning. Studies have shown that the Browns Bank area may be an important rearing area for juvenile halibut and that there is a north-eastward movement of fish as they grow (Stobo *et al.*, 1988). The geographic range of Atlantic halibut in the Northwest Atlantic extends from the coast of Virginia in the south to the waters off Disko Bay, Greenland in the north (Scott and Scott, 1988; Bowering, 1986). A recent study suggests that there is some migration from the US side of the Gulf of Maine into Canadian waters (Kanwit, 2007).

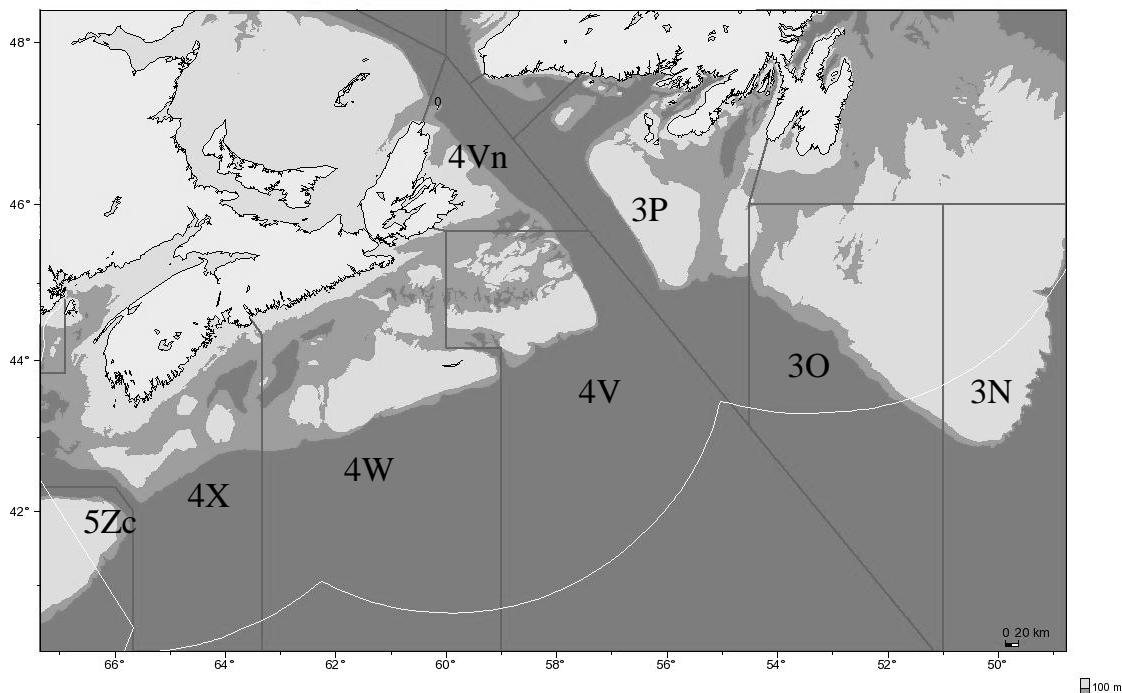


Figure 1: Management unit definition (3NOPs4VWX5Zc).

Although the growth and maturity cycles of Atlantic halibut require further study, it appears that females grow faster than males, and attain a much larger maximum size (Trumble *et al.*, 1993). It has been a long held view that within 3NOPs4VWX female halibut reach 50% maturity at about 115cm, while males reach 50% maturity at about 75cm, however, Beacham (1982) reports maturities for halibut from the Scotian Shelf (1970-1979) at 70cm for females and 66cm for males. In the absence of current reliable growth information, age at maturity for 3NOPs4VWX remains uncertain. Halibut are voracious feeders and up to a length of 30cm, food consists almost exclusively of invertebrates (Kohler, 1967). Between 30cm and 66cm, both invertebrates and fish are consumed, while halibut over this size eat fish almost exclusively.

## The Fishery

Landings of Atlantic halibut have been recorded for the east coast of Canada since 1883. Average landings from 1960 to 2007 for this region have been approximately 1900t annually. Until 1988, the fishery was not regulated by a TAC. A TAC of 3200t was introduced in 1988 and held in place until 1994, when it was reduced to 1500t, followed by a further reduction in 1996 to 850t (Table 1, Figure 2). Reductions in the TAC were implemented in response to an eight year decline in landings. In 1999, recommendations made by the Fisheries Resource Conservation Council (FRCC) resulted in increases to the TAC for this stock from 850 to 1000t; two further increases were implemented in 2001 and 2003 to reach a TAC of 1300t. In 2005, 75t was added to the TAC and in 2007, following the Larocque ruling, 100t previously established as a cap on survey landings was added, resulting in the current TAC level of 1475t. Landings for the 2006-07 fishing season were 1371t (Table 1).

Within the management unit, halibut is fished mainly by longliners using bottom hook-and-line gear. Since 1994, management plans have required the release of halibut less than 81cm by condition of license. The halibut fishery catches halibut as part of a suite of species, which includes most notably, white hake, cusk, and cod. The relative proportions of these vary with location and time of year.

Table 1: Total reported Canadian and foreign landings (t) of Atlantic halibut from 3NOPs4VWX5Zc<sup>1</sup>.

Sub Areas/Divisions	Avg 1960-69	Avg 1970-79	Avg <sup>2</sup> 1980-89	Avg <sup>3</sup> 1990-99	2000 <sup>4</sup>	2001	2002	2003	2004	2005	2006
TAC (3NOPs4VWX5Zc) <sup>6</sup>				1855	1000	1150	1150	1300	1300	1375	1475
3NOPs	996	487	955	503	397	641	682	982	554	484	452
4VWX	1464	851	1561	790	541	761	768	819	873	825	909
5Zc <sup>5</sup>			50	30	6	11	10	14	12	9	10
3NOPs4VWX5Zc Landings	2595	1352	2536	1323	944	1413	1460	1815	1439	1318	1371

<sup>1</sup> Landings from NAFO Table 21A dated 17 January 2008.

<sup>2</sup> Landings prior to 1999 based on January - December calendar year

<sup>3</sup> Landings in 1999 based on 15 months - January 1999 - March 2000

<sup>4</sup> Landings from 2000 onwards based on April - March fishing year

<sup>5</sup> Landings for 5Zc first listed 1986

<sup>6</sup> The TAC is set for April through March

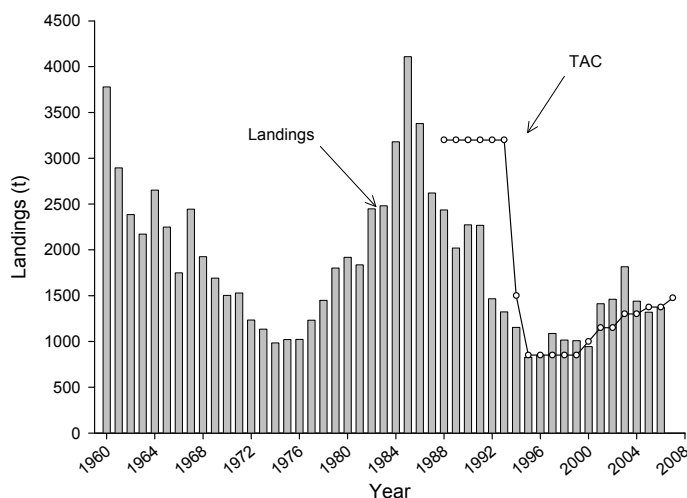


Figure 2: Landings and TAC for 3NOPs4VWX5Zc Atlantic halibut.

## Surveys

Information on Atlantic halibut has been gathered by the DFO summer research vessel (RV) bottom-trawl survey since 1970, but halibut are rarely caught in this survey. Since RV survey estimates for adult ( $\geq 81$ cm) halibut abundance are considered to be unreliable, an industry/DFO longline halibut survey on the Scotian Shelf and Southern Grand Banks (3NOPs4VWX) was initiated in 1998. The industry/DFO halibut long line survey provides more reliable estimates of abundance and distribution for Atlantic halibut that are used as input for annual assessments of this species. This survey also generates estimates of population size structure, including indications of incoming recruitment.

The survey is composed of two types: a fixed station survey and a commercial index survey. The fixed station survey utilizes a stratification system designed to produce a stratum-weighted estimate of mean catch rate, where strata were based on the distribution of observed landings by trip for the period 1993 – 1997 (Zwanenburg and Wilson, 2000a). Three strata were defined using high ( $> 250$  kg), medium (50 – 249 kg) and low ( $< 49$  kg) landings. The area of each stratum was estimated using potential mapping with a radius of influence for each observation sufficient to define a stratum for all areas of the survey area. During the fixed station survey, pre-selected locations are fished using prescribed survey fishing protocols (hook-size, number of hooks, and minimum soak times). During the commercial index survey, participants fish with their own fishing protocols and locations of their choosing (see Zwanenburg and Wilson, 2000a; 2000b; 2003; for detailed description of survey protocols). The results of this survey form the basis of this report.

## **Analysis**

### Stock Trends and Current Status

Survey coverage in Divisions 3NOPs has been inconsistent throughout the survey period; consequently analyses have been performed primarily on data from Divisions 4VWX.

Four analyses were used to examine the catch rate of Atlantic halibut in the fixed station survey: 1) all 4VWX stations, 2) 4VWX stations done in each and every year of the survey ( $n = 54$ ), 3) stations done in more than 5 years of the survey (3NOPs4VWX), and 4) a general linear model (GLM) using stations in 3. The GLM used a negative binomial error distribution and estimated separate coefficients for each year and station.

All analyses showed some inter-annual variation, but no overall trend. (Figure 3). Similarly, catch rates calculated individually for the three strata varied from year to year, but showed stability overall. The commercial index catch rate shows variation over the duration of the survey with a general decline in the catch rate (Figure 4).

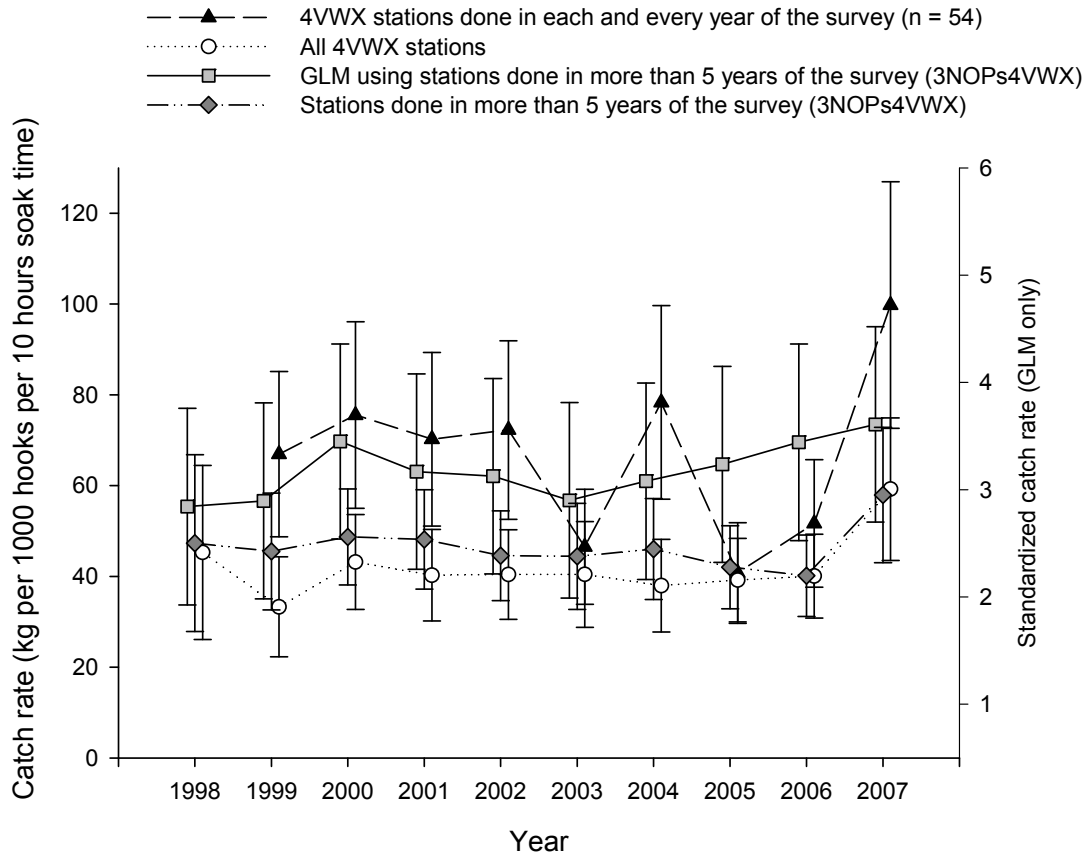


Figure 3: Fixed station survey catch rates.

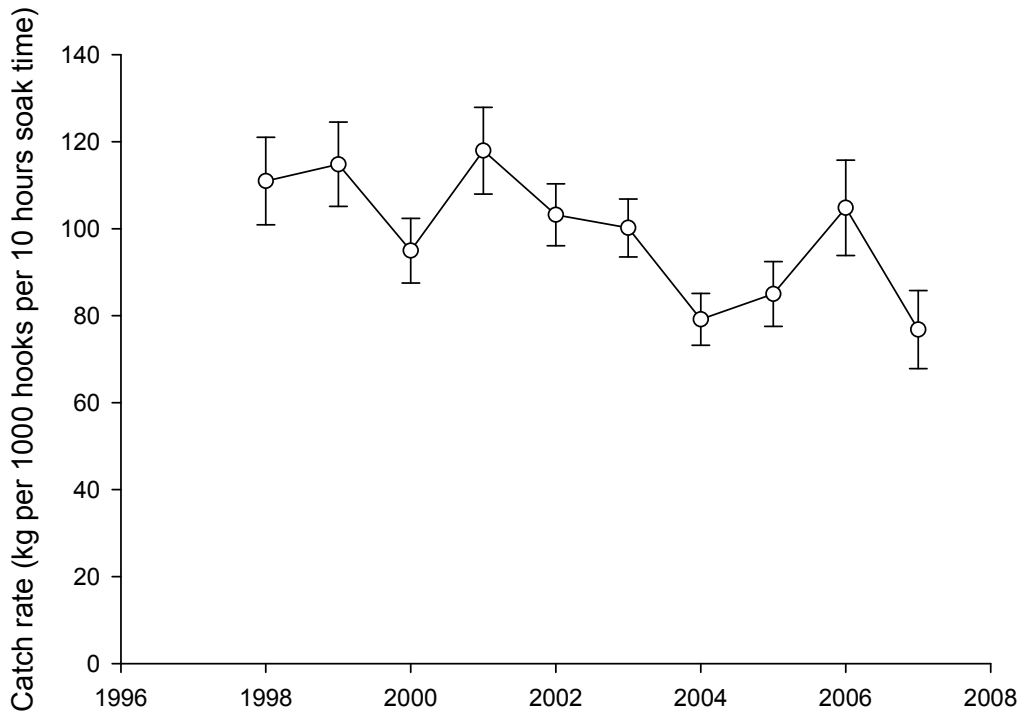


Figure 4: Commercial index catch rates for 4VWX.

The pre-recruit index (<81cm) from the fixed station survey has remained stable over the survey (Figure 5). Fishable sizes (≥81cm) from the fixed station survey are stable over the survey; however, the 54-station analysis shows an increase in 2006 and 2007.

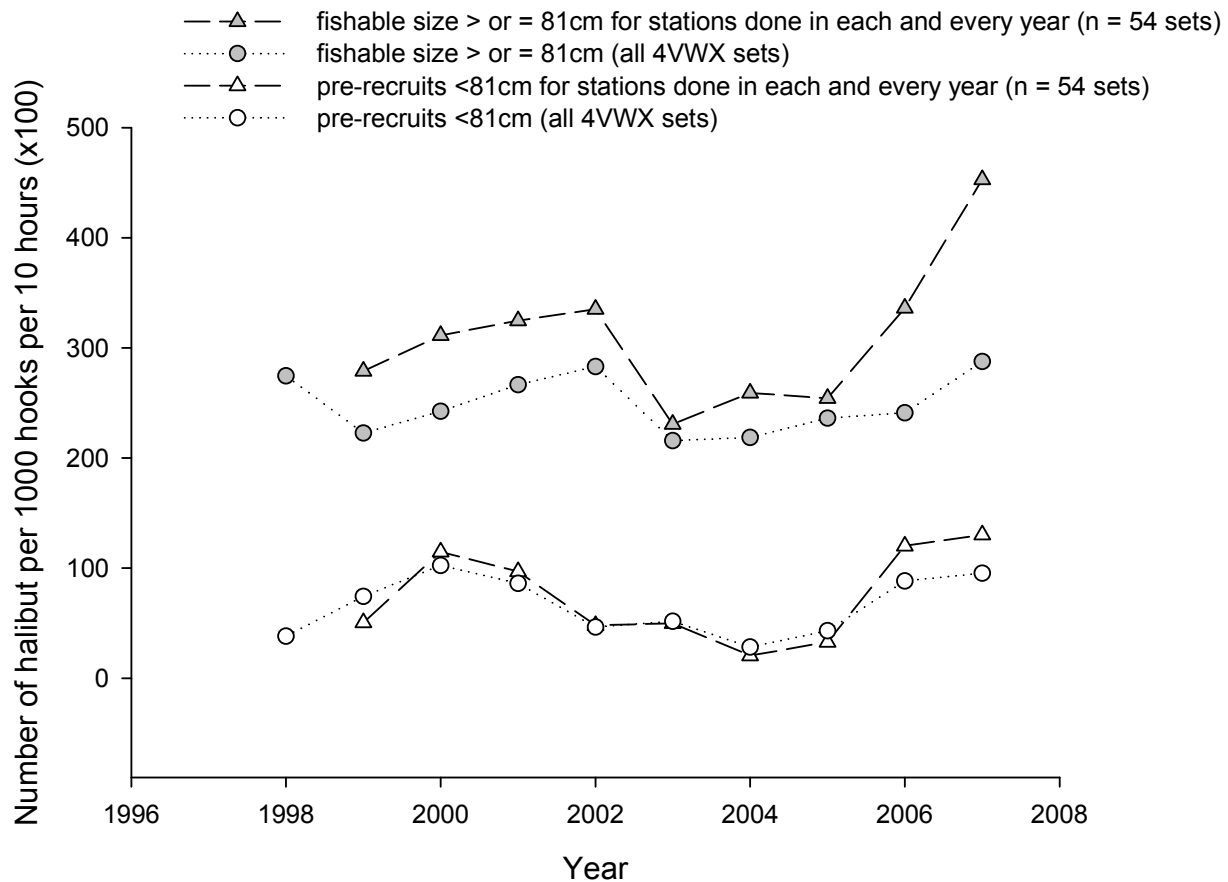


Figure 5: Fixed station survey catch rates (number) for 4VWX stations separated into pre-recruit (<81cm) and fishable (≥81cm) size classes.

The size composition of halibut caught in the fixed station and commercial index surveys (3NOPs4VWX) can be described by the median length (50<sup>th</sup> percentile) and the 95<sup>th</sup> percentile. In both the fixed station and commercial index surveys, while the median length of both males and females has remained stable, there appears to be an increase in the proportion of large female halibut (95<sup>th</sup> percentile, Figures 6 and 7).

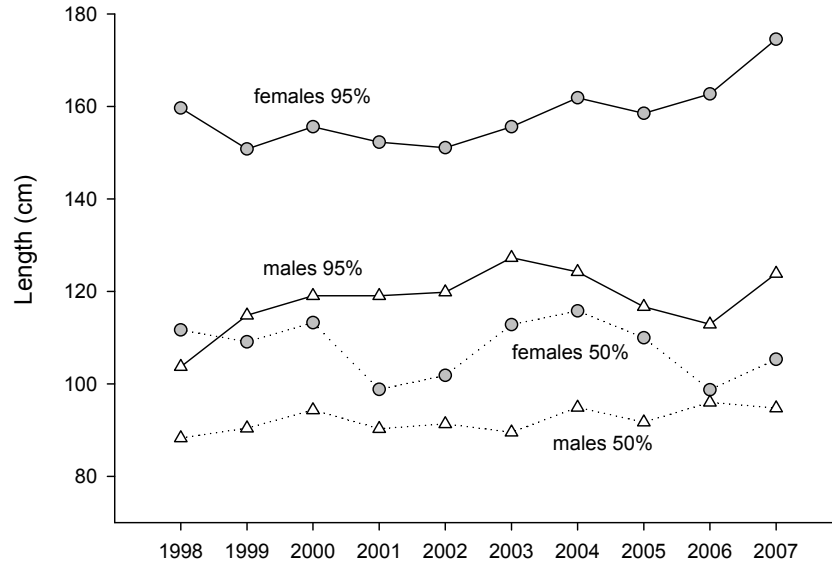


Figure 6: Size composition of halibut caught in the 3NOPs4VWX fixed station survey, expressed as the median (50%) and 95th percentiles.

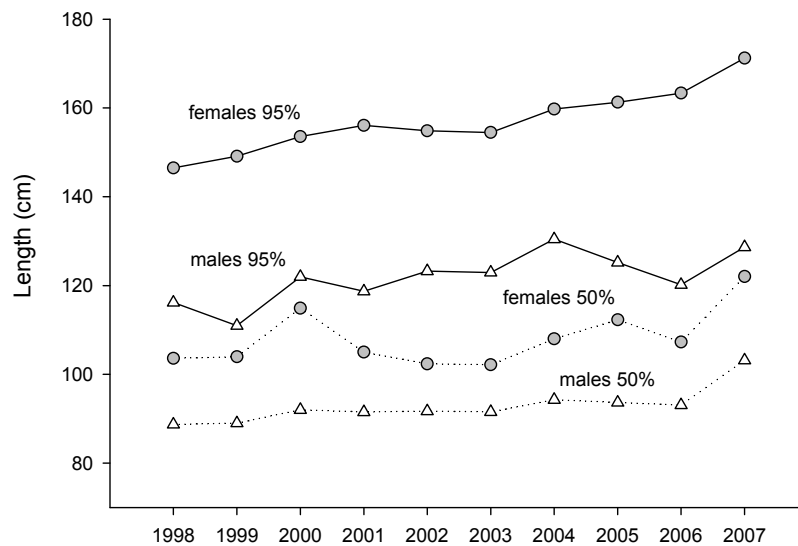


Figure 7: Size composition of halibut caught in the 3NOPs4VWX commercial index survey, expressed as the median (50%) and 95th percentiles.

### Sources of Uncertainty

Survey coverage in NAFO sub area 3NOPs has not been conducted consistently throughout the Industry/DFO long line survey period; consequently, advice for 3NOPs is based on analyses for data from sub area 4VWX. Also, due to fishing restrictions, there has been limited survey coverage of subdivision 3Ps that precludes an understanding of halibut abundance in 3Ps.

Over the course of the Industry/DFO long line survey, station coverage in the fixed station survey has been irregular. Of approximately 300 stations, only 54 have been completed in all years of the survey. To understand the influence that intermittent station sampling has had on

fixed station catch rates, several types of analyses have been conducted, all with slightly different trends.

The fixed station and commercial index catch rate trajectories are not in agreement. The disparity between the two catch rates indices might be explained by examining factors affecting catch rate in the commercial index. Potential effects of fishery operations on commercial index catch rates, including changes in skippers, number of crew, amount of gear in the water, variability in soak time, and a shift in effort within NAFO areas, are being examined in the ongoing framework assessment.

### Other Considerations

The number of completed survey sets has been variable over time. Reduction in participation has resulted from the increasing cost of fishing operations, including higher fuel, bait, and labour costs, without a corresponding increase in the sale price of halibut. The Industry/DFO survey is essential to the assessment of this species. Maintaining the stations that have been sampled every year is extremely important, and increasing the number of stations occupied annually can only serve to increase the robustness of the survey.

## **Conclusions**

Overall there is relative stability in the population of 3NOPs4VWX Atlantic halibut within the fixed station survey. In both the fixed station and commercial index surveys, the median length of both males and females (4VWX) has also remained stable. The commercial index catch rate (4VWX) shows a general decline; however, the commercial index survey is more complex than the fixed station survey and not all sources of variability have been considered at this point. Numbers of pre-recruits and fishable size halibut (4VWX) from the fixed station survey have remained stable over the survey. Results emerging from the Atlantic halibut aging study and mark recapture project will provide a better understanding of the population status, and are anticipated for 2009. There is no basis to advise a change in the catch level for 2008-09 (current TAC is 1475 mt).

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## Sources of Information

- Armsworthy, S.L., S. Wilson, and R. Mohn. 2006. Atlantic Halibut on the Scotian Shelf and Southern Grand Banks (Div. 3NOPs4VWX5Zc) – Industry/DFO Longline Survey Results to 2005. DFO Can. Sci. Advis. Sec. Res. Doc. 2006/065.
- Beacham, T.D. 1982. Median Length at Sexual Maturity of Halibut, Cusk, Longhorn Sculpin, Ocean Pout, and Sea Raven in the Maritimes Area of the Northwest Atlantic. Can. J. Zool. 60:13526-1330.
- Bigelow, H.B., and W.C. Schroeder. 1953. Fishes of the Gulf of Maine. Fishery Bulletin of the Fish and Wildlife Service, No. 74:577p.
- Bowering, W.R. 1986. The Distribution, Age and Growth, and Sexual Maturity of Atlantic Halibut (*Hippoglossus hippoglossus*) in the Newfoundland and Labrador Area of the Northwest Atlantic. Can. Tech. Rep. Fish. Aquat. Sci. 1432:34p.
- DFO. 2006. Atlantic Halibut on the Scotian Shelf and Southern Grand Banks (Div. 3NOPs4VWX). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/038.
- Kanwit, J.K. 2007. Tagging Results from the 2000-2004 Federal Experimental Fishery for Atlantic Halibut (*Hippoglossus hippoglossus*) in the Eastern Gulf of Maine. J. Northw. Atl. Fish. Sci. 38:37-42.
- Kohler, A.C. 1967. Size at Maturity, Spawning Season, and Food of Atlantic Halibut. J. Fish. Res. Bd. Canada, 24(1): 53-66.
- Neilson, J.D., J.F. Kearney, P. Perley, and H. Sampson. 1993. Reproductive Biology of Atlantic Halibut (*Hippoglossus hippoglossus*) in Canadian waters. Can. J. Fish. Aquat. Sci. 50:551-563.
- Scott, W.B., and M.G. Scott. 1988. Atlantic Fishes of Canada. Can. Bull. Fish. Aquat. Sci. 219:731p.
- Stobo, W., J.D. Neilson, and P. Simpson. 1988. Movements of Atlantic Halibut (*Hippoglossus hippoglossus*) in the Canadian North Atlantic: Inference Regarding Life History. Can. J. Fish. Aquat. Sci. 45:484-491.
- Trumble, R.J., J.D. Neilson, W.R. Bowering, and D.A. McCaughran. 1993. Atlantic Halibut (*Hippoglossus hippoglossus*) and Pacific Halibut (*H. stenolepis*) and Their North American Fisheries. Can. Bull. Fish. Aquat. Sci. 227:84p.
- Zwanenburg, K.C.T., and S. Wilson. 2003. Halibut on the Scotian Shelf and Southern Grand Banks – Overview of the Industry/DFO Longline Survey and Results to 2003. DFO Sci. Fish. Status Rep. 2003/01:30p.
- Zwanenburg, K.C.T., and S. Wilson. 2000a. Scotian Shelf and Southern Grand Banks Atlantic Halibut (*Hippoglossus hippoglossus*) Survey – Collaboration Between the Fishing and Fisheries Science Communities. Theme Session on Cooperative Research with the Fishing Industry: Lessons Learned. ICES 2000 Annual Science Conference.
- Zwanenburg, K.C.T., and S. Wilson. 2000b. Halibut Survey on the Southern Grand Banks and Scotian Shelf. Participants Manual: 30p.

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