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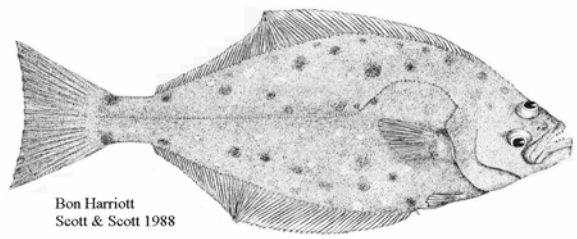
Science Advisory Report 2010/006

ASSESSMENT OF ATLANTIC HALIBUT ON THE SCOTIAN SHELF AND SOUTHERN GRAND BANKS (NAFO DIVISIONS 3NOPs4VWX5Zc)



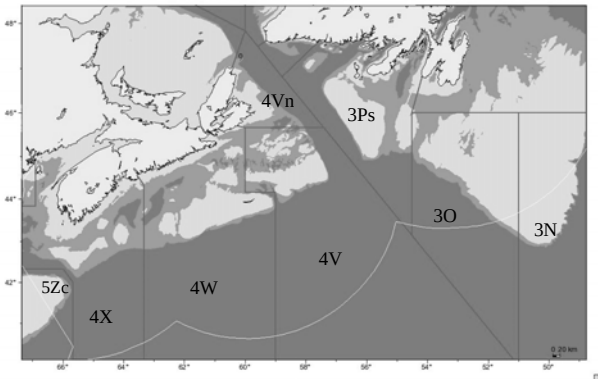


Figure 1. Atlantic halibut management unit 3NOPs4VWX5Zc.

Context:

Atlantic halibut (Hippoglossus hippoglossus) is the largest of the flatfishes and ranges widely in the waters off 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 using a fixed-station design (hereafter referred to as the "halibut survey") on the Scotian Shelf and Southern Grand Banks (3NOPs4VWX5Zc) was initiated in 1998 to provide estimates of abundance and distribution for Atlantic halibut, which are used for the assessment. A commercial index is conducted in conjunction with the fixed station halibut survey.

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 halibut survey provides an index of 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.

A tagging study was initiated in 2006, in which both recruits and commercial size fish were tagged and released. Recoveries were used to estimate exploitation rate in 2006, 2007, and 2008. Catch and tagging data were used to estimate catchability, absolute biomass, and productivity.

The last assessment of Atlantic halibut was conducted in early 2009 for 2008 (DFO 2009). A review of the assessment framework is expected to be completed in 2010. The current assessment was requested to determine halibut removals (including surveys and bycatch of Atlantic halibut), the recent catch rate, and distribution trends from the halibut survey.

SUMMARY

- Four catch rate analyses of the halibut survey show recent increases in the exploitable population of 3NOPs4VWX5Zc Atlantic halibut. Standardizing the catch rate with a general linear model (GLM) is considered the most credible analysis. When vessels effects are not accounted for, there is no trend in catch rates. When vessels effects are accounted for, there is a significant positive trend in catch rates over the past 12 years.

- Based on the catch rate analyses of the halibut survey, there appears to be stability or potential increase in the population of 3NOPs4VWX5Zc Atlantic halibut in the past 3 to 4 years.

- The catch rate in the commercial index in 4VWX is the highest since first being recorded in 1998. However, the commercial index catch rate does not show a linear trend over the survey time series.

- Recruitment has increased over the past five years in the halibut survey, has declined in the research vessel (RV) survey over the last two years, but remains above the long term mean. This recruitment is starting to show up as exploitable biomass, and the 2009 catch rates in the halibut survey are the highest on record.

- The 2008 exploitation rate of the exploitable biomass (>81cm) was estimated to be 15.0% (90% Confidence Interval: 13.3–16.8%) based on the tagging results, although this value is expected to increase as more tags are sent in. As noted in DFO (2009), this exploitation rate is higher than natural mortality (10%) and $F_{0.1}$ (9%), and it is not known whether this rate is sustainable.

- The surplus production to catch ratio is expected to remain approximately the same as in 2008 (3:1), and the longer-term consequences of utilizing this ratio should be evaluated in the context of stock management objectives, reference points, and a risk management framework.

- Based on the abundance indices presented here, there is no basis to advise on a change in harvest level in 2010/2011.

- Atlantic halibut can move large distances creating some uncertainty in stock structure. Other sources of uncertainty including vessels, bait, and temperature effects on the halibut survey and commercial index, have not been fully analyzed. A lack of a population model and biological reference points make it impossible to know whether the stock is rebuilt or what is a precautionary harvest level.

INTRODUCTION

Biology

Atlantic halibut (*Hippoglossus hippoglossus*) is the largest of all flatfish and ranges widely in the waters off Canada's East Coast. They are demersal, living on or near the bottom, at temperatures within a few degrees of 5°C. 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. 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. 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.

Female Atlantic halibut grow faster than the males and attain a much larger maximum size. Although the maturity cycle require further study, it appears that females reach 50% maturity at about 120cm while males reach 50% maturity at about 80cm, with corresponding ages of 11-12 years for females and 7-8 years for males. Natural mortality is assumed to be approximately 0.1.

Information on Atlantic halibut has been gathered by DFO summer research vessel (RV) trawl surveys since 1970. The RV survey tends to catch 40 to 70 small (30 to 70cm) halibut per year. Since the RV survey estimates for halibut abundance ≥81cm are considered to be an unreliable estimate of exploitable biomass, an industry / DFO longline halibut survey on the Scotian Shelf and Southern Grand Banks (3NOPs4VWX5Zc) was initiated in 1998. The halibut survey, which runs from May 22nd – July 22nd, provides an index of abundance and generates estimates of population size structure, including indications of incoming recruits. A commercial index is performed at the same time as the survey, where participants fish with similar protocols and at locations of their choosing.

Rationale for Assessment

Advice has been requested by Fisheries and Aquaculture Management (FAM) on the stock status of 3NOPs4VWX5Zc Atlantic halibut. Specifically, FAM has asked for an evaluation of:

- the current removals, including surveys and commercial bycatch, of Atlantic halibut; and
- the recent catch rate and distribution trends from the Atlantic halibut industry survey.

The Fishery

Until 1988, the fishery was unregulated. A total allowable catch (TAC) of 3,200mt was set in 1988, was reduced to 1,500mt in 1994, and was further reduced to 850mt in 1995 (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 resulted in increases to the TAC for this stock from 850 to 1,000mt. In 2009, the TAC was increased from 1,475mt to 1,700mt for the 2009/2010 fishing year. Annual TACs since 2000 are provided in Table 1. Average landings from 1960 to 2008 for this region have been approximately 1,800mt annually (Table 1; Figure 2). Landings for 2009 are incomplete and are not shown in Table 1 and Figure 2. There is often a delay in reporting because Northwest Atlantic Fisheries Organization (NAFO) statistics are used, which take a year or more to become fully updated. NAFO statistics are used because removals occur in two DFO regions (Maritimes and Newfoundland and Labrador) and outside Canada's Exclusive Economic Zone (EEZ). Within the management unit, halibut is fished mostly along the edges of the continental shelf and mainly by longliners using bottom hook-and-line gear. Since 1994, management plans and license conditions require the release of halibut less than 81cm.

Table 1. Total reported Canadian and foreign landings (mt) of Atlantic halibut from 3NOPs4VWX5Zc[1].

Areas	Avg 1960-69	Avg 1970-79	Avg 1980-89	Avg[2] 1990-99	2000[3]	2001	2002	2003	2004	2005	2006	2007	2008	2009
TAC[4] (3NOPs4VWX5Zc)				1855	1000	1150	1150	1300	1300	1375	1475	1475	1475	1700
3NOPs	996	488	955	503	397	641	682	982	554	483	452	558	450	
4VWX	1464	850	1561	790	541	761	768	819	873	825	916	944	979	
5Zc[5]			20	30	6	11	10	14	12	9	10	32	29	
3NOPs4VWX5Zc Landings	2460	1338	2536	1323	944	1413	1460	1815	1439	1317	1378	1534	1458	

[1] Landings calendar years 1960 - 2008 from NAFO Fisheries Catch Statistics 21A database dated 2 September 2009
[2] Landings in 1999 based on 15 months; January 1999 - March 2000.
[3] Landings from 2000 onward are from NAFO, are based on calendar year, and do not correspond to the April-March fishing year.
[4] Total Allowable Catch (TAC) from 2000 onward is set for the April through March quota period. Prior to 2000, TAC was set for the calendar year.
[5] Landings for 5Zc first listed in 1986.

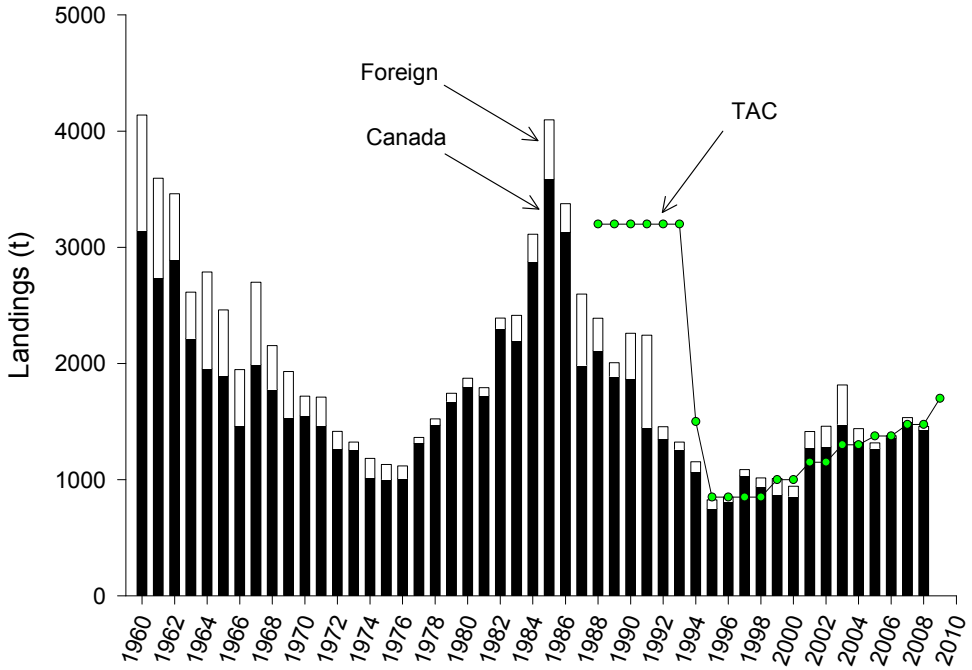


Figure 2. Canadian (black) and foreign (grey) landings (metric tonnes) and Canadian TAC for 3NOPs4VWX5Zc Atlantic halibut.

Catches in the halibut survey are provided in Table 2. These catches are included in the landings provided above (Table 1). Since 2007, these catches have also been counted against the TAC.

Table 2: Halibut survey and commercial index catches (mt).

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Halibut Survey	12.1	8.6	10.6	8.9	9.1	9.0	10.7	8.7	2.9	6.1	8.2	8.8
Commercial Index	72.4	70.0	89.6	77.7	79.6	78.6	87.5	57.3	62.5	80.1	125.1	125.7
Total	84.5	78.6	100.2	86.6	88.7	87.6	98.2	66.0	65.5	86.2	133.3	134.5

ASSESSMENT

Stock Trends and Current Status

Four analyses were used to examine the **catch rate of Atlantic halibut in the halibut survey**: 1) all stations in 4VWX, 2) a general linear model (GLM) using all stations in 3NOPs4VWX that were completed in 5 or more years, 3) 4VWX stations done in every year from 1999 onward (n = 50), and 4) a GLM applied to the 50 stations identified in 3) (Figure 3).

Based on the catch rate analyses of the halibut survey, there appears to be stability or increases in the population of 3NOPs4VWX5Zc Atlantic halibut in the past 3 to 4 years.

Standardizing the catch rate with a general linear model (GLM) is considered the most credible analysis. When vessels effects are not accounted for, there is no trend in catch rates. When vessels effects are accounted for, there is a significant positive trend in catch rates over the past 12 years.

The **commercial index catch rate** for 4VWX is the highest since first being recorded in 1998. However, the commercial index catch rate does not show a linear trend over the survey time series. This index is more difficult to interpret than the halibut survey abundance indices because it is non-standardized, and not all sources of variability have been considered at this point (i.e., hook number, soak time, bait, vessel, temperature effects).

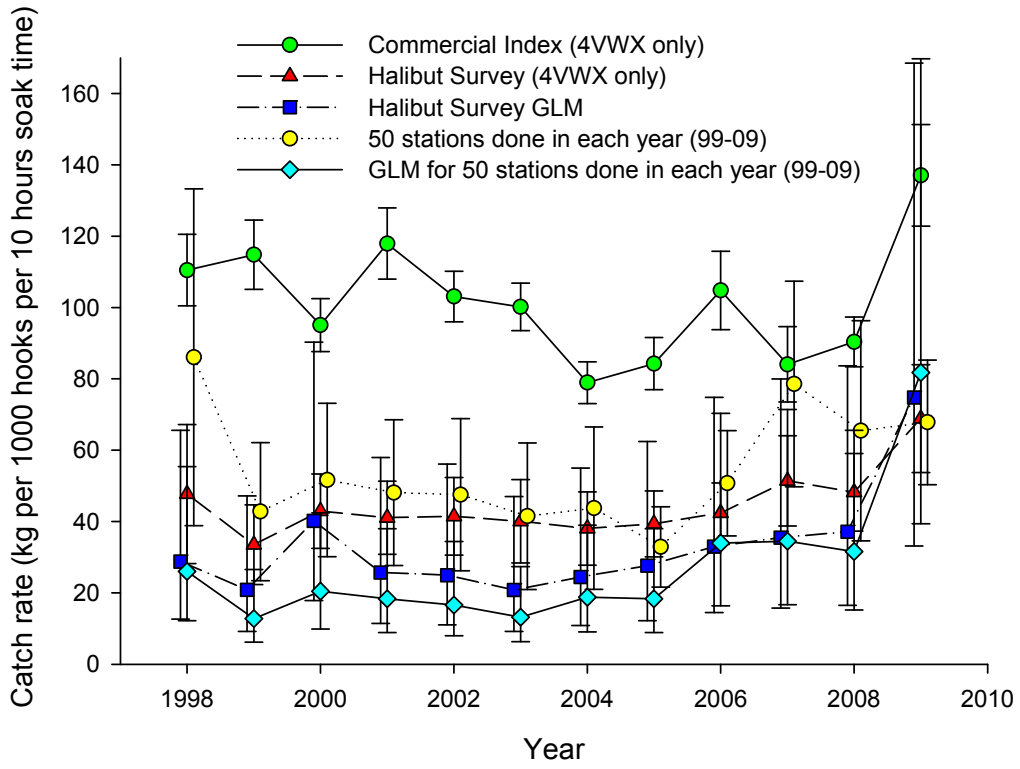


Figure 3. Trends in the catch rate (+/- 2 standard error) of Atlantic halibut in the halibut survey and commercial index.

The **number of pre-recruits** (fish < 81cm) in the DFO summer RV survey (1970-2009) is above the long-term mean (0.195 halibut per standard tow). Pre-recruits from the halibut survey have been increasing since 2004, while those from the summer RV survey have declined in the last

two years from the highest recorded level in 2007 (Figure 4). This pattern indicates a recruitment pulse as pre-recruits in the halibut survey are about 2 to 3 years older than those in the summer RV survey.

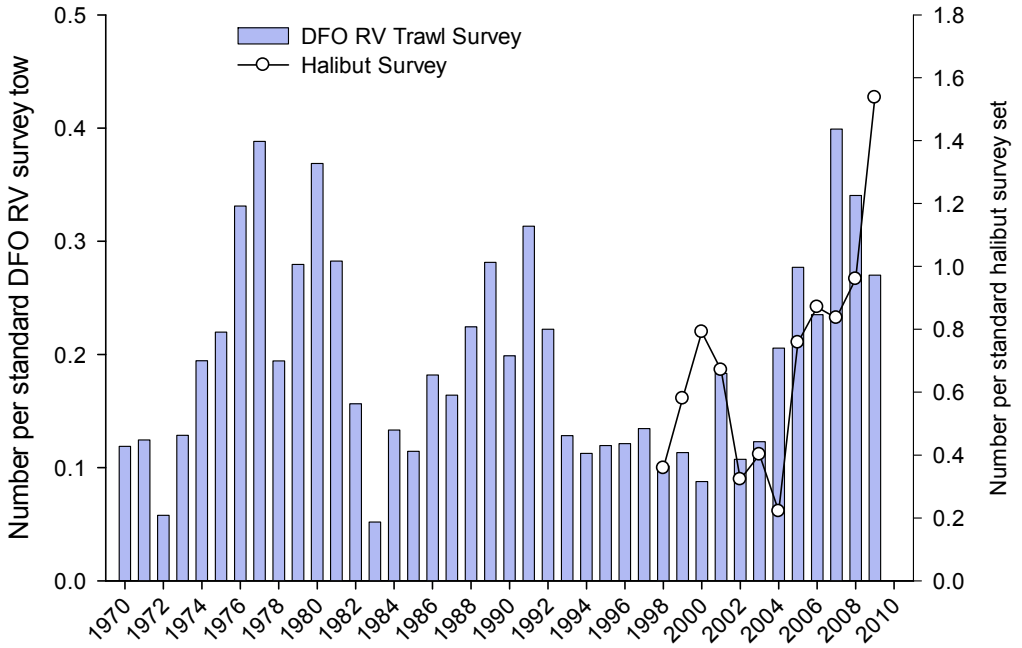


Figure 4. Atlantic halibut pre-recruit (< 81cm) catch from DFO summer RV survey (number per standard tow, bars) and from the 4VWX portion of the halibut survey (number per standard set, circles).

Over three years (2006-2008), 2,076 halibut ranging in size from 50 to 207cm were tagged with two pink spaghetti tags. By November 2009, 356 had been recaptured. The greatest numbers of tagged halibut were caught during times of intensive halibut fishing, such as during the halibut survey and during the spring fishery. The distance between release and recapture sites of tagged halibut ranged between 0 and 2,698km. Notably, two halibut traveled approximately 2,600km from the Grand Banks to Icelandic waters in about 2 years.

Exploitation rate of the exploitable biomass (> 81cm) was estimated from the tagging data. In 2006, 420 fish > 81cm were tagged and 45 recaptured (5 of which were not used in the estimation as they were recaptured within 2 months). In 2007, 653 fish > 81cm were tagged and 93 recaptured (6 within 2 months). In 2008, 544 fish > 81cm were tagged and 48 recaptured (6 within 2 months). From these values, exploitation rate was estimated to be 18.2% (90% Confidence Intrerval (CI): 16.1-20.3%) in 2006, 24.0% (90% CI: 21.4-26.9%) in 2007, and 15.0% (90% CI: 13.3-16.8%) in 2008. It is likely that the 2008 estimate will increase as additional tags are returned.

A surplus production analysis was conducted in 2008 (DFO 2009). The surplus production to catch ratio in 2009 is expected to remain approximately the same as in 2008 (3:1).

Bycatch

Bycatch and incidental catch was assessed in February 2009 (DFO 2009). Bycatch analysis was not updated for this report.

Sources of Uncertainty

Over the course of the halibut survey, station coverage has been irregular. Of approximately 300 stations, only 50 have been conducted every year since 1999. Because of this irregularity, a number of abundance indices have been developed, not all of which are consistent. This makes it more difficult to interpret the final year.

The stock structure is not well known. Atlantic halibut is currently being managed as two different stocks, 4RST and 3NOPs4VWX5Zc. Analyses using data from 4VWX are assumed to be representative of the whole 3NOPs4VWX5Zc management unit.

Information on size frequency distribution has not been incorporated into the current assessment.

Other sources of uncertainty including vessels, bait and temperature effects on the halibut survey and commercial index, have not been fully analyzed. A lack of a population model and biological reference points make it impossible to know whether the stock is rebuilt or what is a precautionary harvest level.

CONCLUSIONS AND ADVICE

Four catch rate analyses of the halibut survey show recent increases in the exploitable population of 3NOPs4VWX Atlantic halibut. Standardizing the catch rate with a GLM is considered the most credible analysis. When vessels effects are not accounted for, there is no trend in catch rates. When vessels effects are accounted for, there is a significant positive trend in catch rates over the past 12 years.

Based on the catch rate analyses of the halibut survey, there appears to be stability or potential increase in the population of 3NOPs4VWX Atlantic halibut in the past 3 to 4 years.

The catch rate in the commercial index in 4VWX is the highest since first being recorded in 1998. However, the commercial index catch rate does not show a linear trend over the survey time series. This index is more difficult to interpret than the halibut survey abundance indices.

Recruitment has increased over the past five years in the halibut survey, has declined in the RV survey over the past two years, but remains above the long-term mean. This recruitment is starting to show up as exploitable biomass, and the 2009 catch rates in the halibut survey are the highest on record.

The 2008 exploitation rate of the exploitable biomass (>81 cm) was estimated to be 15.0% (90% CI: 13.3–16.8%) based on the tagging results. It is likely that the 2008 estimate will increase as additional tags are returned. As noted in DFO (2009), this is higher than either natural mortality (10%) or $F_{0.1}$ (9%), and it is not known whether this rate is sustainable.

The surplus production to catch ratio is expected to remain approximately the same as in 2008 (3:1), and the longer-term consequences of utilizing this ratio should be evaluated in the context of stock management objectives, reference points, and a risk management framework.

Based on the abundance indices presented here, there is no basis to advise on a change in harvest level in 2010/2011.

A lack of a population model and biological reference points make it impossible to know whether the stock is rebuilt or what is a precautionary harvest level. A population model is needed to provide an estimate of sustainable catch levels.

OTHER CONSIDERATIONS

There are concerns over intermittent reductions in the number of halibut survey sets completed (such as in 2005). Reduced participation has arisen from increased cost of fishing operations, including higher fuel, bait, and labour costs, with no similar increase in the sale price of halibut. The halibut survey is essential to the assessment of this species. The importance of maintaining the stations that have been sampled every year can not be overemphasized, and increasing the number of stations occupied annually can only serve to increase the robustness of the survey. Improvements (e.g., increased participation and number of stations) have been made in the past few years.

SOURCES OF INFORMATION

DFO. 2009. Assessment of Atlantic Halibut on the Scotian Shelf and Southern Grand Banks (Div. 3NOPs4VWX5Zc). DFO Can. Sci. Advis. Sec. Sci. Resp. 2009/036.

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