STOCK STATUS UPDATE OF ATLANTIC HALIBUT ON THE SCOTIAN SHELF AND SOUTHERN GRAND BANKS (NAFO Divs. 3NOPs4VWX5Zc)

Context

The 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 which indicate that Atlantic Halibut move extensively throughout the Canadian North Atlantic with smaller fish moving further than larger fish.

The Atlantic Halibut fishery was unregulated until a total allowable catch (TAC) was implemented in 1988 and a legal size limit (≥81 cm total length) was set in 1994. While the Fisheries and Oceans Canada (DFO) research vessel (RV) survey provides a useful index of abundance for incoming recruitment, an index for exploitable biomass (≥81 cm total length) is not available since larger fish are captured infrequently. An industry-DFO longline halibut survey on the Scotian Shelf and southern Grand Banks (3NOPs4VWX5Zc) was initiated in 1998 to better estimate adult biomass. A commercial index is conducted in conjunction with the longline halibut survey. The longline halibut survey and commercial index generate indices for exploitable biomass of halibut from the Scotian Shelf and southern Grand Banks, as well as estimates of population size structure. A tagging study was initiated in 2006, in which both recruits and commercial sized fish were tagged and released. Recoveries are used to estimate exploitation rate.

The last assessment of Atlantic Halibut was conducted in November 2010 (DFO 2011). This assessment used a new assessment framework and produced estimates of spawning stock biomass (SSB) and fishing mortality (*F*). The consequences of different harvest levels and the risk to the productivity of the stock were assessed in 2012 (DFO 2012).

This stock status update was requested to inform Fisheries and Aquaculture Management and the Scotia-Fundy Groundfish Advisory Committee of the status of the Halibut resource. The objectives are to evaluate and update trends in abundance/biomass indicators, including: standardized catch rates from the halibut survey, standardized catch rates from the commercial index, and stratified mean numbers per tow from the ecosystem RV survey, and to evaluate landings and trends in *F* estimated from tagging data.

This Science Response Report results from the Science Response Process of December 10, 2013, on the Status Update of 3NOPs4VWX+5 Atlantic Halibut.

Background

Biology

Atlantic Halibut (Hippoglossus hippoglossus) is the largest of all flatfish and ranges widely over Canada's East Coast. They are demersal, living on or near the bottom. 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 northern Greenland. 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.

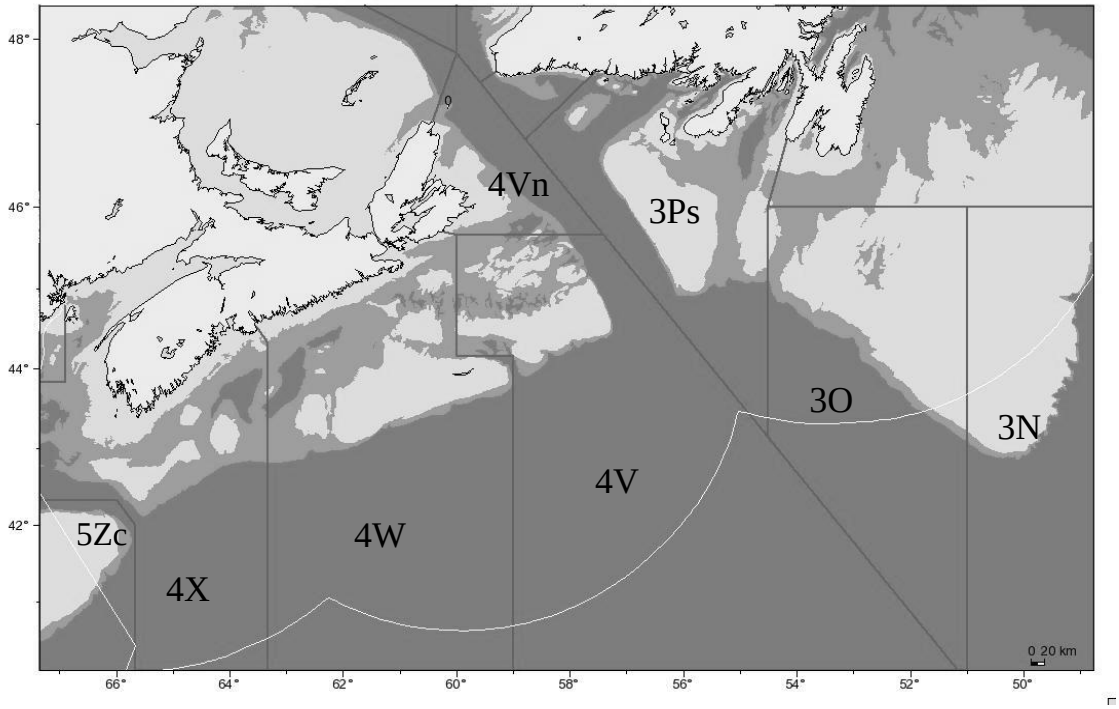

Figure 1. Management unit 3NOPs4VWX5Zc.

Female Atlantic Halibut grow faster than the males and attain a much larger maximum size. Atlantic Halibut grow rapidly (approximately 10cm per year) until the age of maturity, which for this region is estimated to be at 77 cm for males (age 5-6) and 119 cm for females (age 9-10).

Information on Atlantic Halibut has been gathered by DFO RV trawl surveys since 1970. The RV survey catches mostly smaller (30-70 cm) halibut. Since the RV survey abundance index is for halibut that are not of commercial size, an industry-DFO longline halibut survey on the Scotian Shelf and Southern Grand Banks (3NOPs4VWX5Zc) was initiated in 1998. The longline halibut survey provides an index of exploitable (≥ 81 cm TL) abundance that is used in the assessment model. A commercial index is performed at the same time as the longline halibut survey, where participants fish with similar protocols and at locations of their choosing.

Description of the Fishery

Until 1988, the fishery was unregulated. A TAC of 3,200 mt was first established in 1988 and was reduced to a low of 850 mt in 1995, in response to an eight year decline in landings. Beginning in 1999, the TAC has been increased several times and was set at 2,447mt in 2013. Average landings from 1960 to 2012 for this region have been approximately 1,800 mt annually (Table 1; Figure 2). NAFO statistics are used to describe removals, because landings occur in two DFO regions (Maritimes and Newfoundland) and outside Canada's Exclusive Economic Zone (EEZ) as well as other from countries including Portugal, Spain, and France. The 2011 and 2012 Nothwest Atlantic Fisheries Organization (NAFO) landings may be underestimated, as there is often a delay in reporting. Also, at the time of this report, the 2013 fishing season was ongoing, thus, the 2013 landings data are incomplete. Within the management unit, halibut is fished mostly along the edges of the continental shelf mainly by longline. Since 1994, management plans and licence conditions require the release of halibut less than 81 cm.

Table 1. Total reported landings Canadian and foreign (metric tonnes) of Atlantic Halibut from NAFO divisions 3NOPs4VWX5Zc[1]. Ten year annual average landings are presented for 1960 to 2009.

		Landings			Landings[3]	TAC[4]
	Year(s)	3NOPs	4VWX	5Zc[2]	3NOPs4VWX5Zc	3NOPs4VWX5Zc
Decadal Average	1960-69	996	1464	-	2460	-
Decadal Average	1970-79	487	851	-	1338	-
Decadal Average	1980-89	955	1561	50	2566	-
Decadal Average	1990-99	503	790	30	1286	1855
Decadal Average	2000-09	607	863	15	1484	1318
Annual	2010	556	1279	11	1846	1850
Annual	2011	475	1322	19	1816	1850
Annual	2012	639	1464	28	2131	2128
Annual	2013[5]	-	-	-	1627	2447

[1] Landings 1960-2012 from NAFO Table 21A as of September 9, 2013.
[2] Landings were first listed in 5Zc in 1986.
[3] NAFO Table 21A reported by calendar year.
[4] Total Allowable Catch (TAC) set for April-March fishing year for Canadian commercial fishery. Prior to 1988 the Atlantic Halibut catch was unregulated.
[5] Landings for 2013 are preliminary, from CAQR as of October 10, 2013.

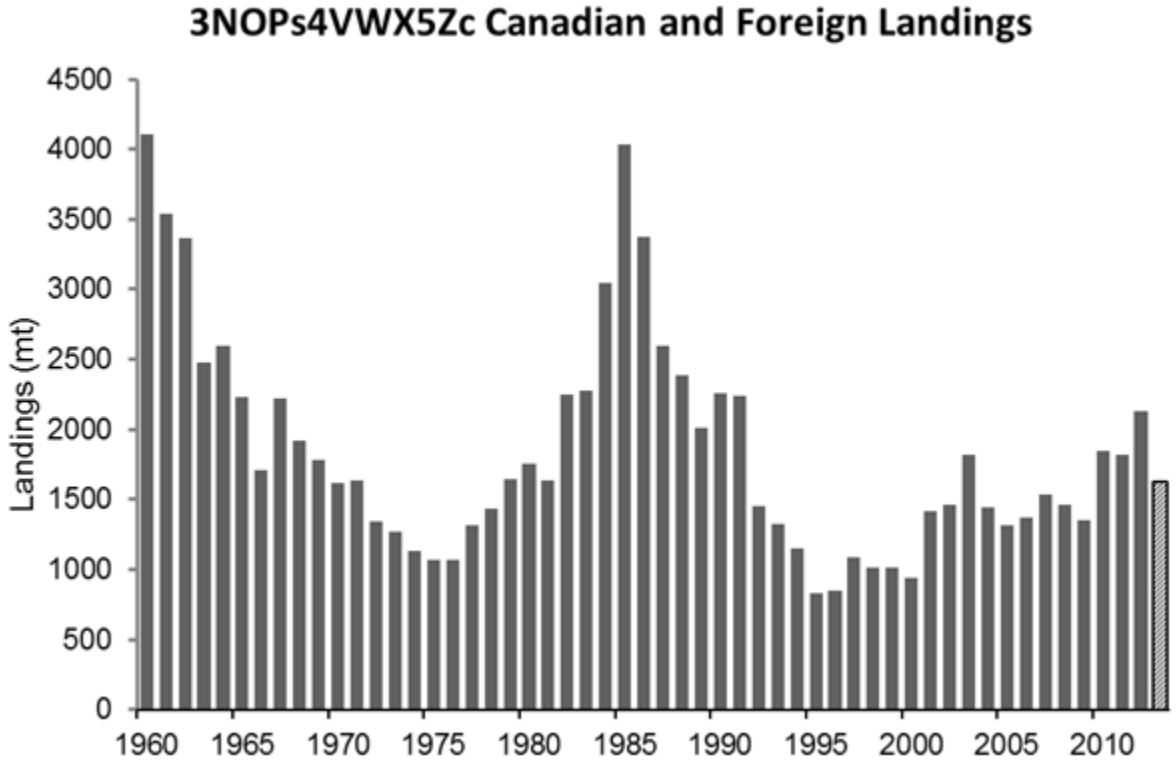

Figure 2. NAFO reported Canadian and foreign landings (metric tonnes) for 3NOPs4VWX5Zc Atlantic Halibut. See Table 1 for notes. The 2013 landings (hashed bar) are incomplete.

Analysis and Response

The last assessment of Atlantic Halibut was conducted in November 2010 (DFO 2011). This assessment used a new length-based age-structured assessment model and produced estimates of SSB and *F*. The consequences of different harvest levels and the risk to the productivity of the stock were assessed in 2012 (DFO 2012). Based on model projections, 3NOPs4VWX5Zc Atlantic Halibut SSB was expected to increase and the population was concluded to be in a productive period due to high recruitment. It was also concluded that there was little risk in harming the productivity of the stock at harvest levels < 4,000 mt. Updated indices of abundance/biomass for Atlantic Halibut including the Scotia-Fundy RV survey (4VWX), the longline halibut survey, and the halibut commercial index are reported. Estimates of *F* from the tagging model accepted in 2011 (den Heyer et al. 2011) with updated data are presented along with an assessment of trends in *F* and abundance indices with respect to the model projections (DFO 2012). Other inputs to the stock assessment model that are collected on annual basis but not reported here include length composition of the landings.

Halibut Survey and Commercial Index

The industry-DFO longline halibut survey provides an important index of abundance of halibut ranging in size between 50 and 230 cm. The survey is completed by commercial fishermen with onboard observers. Between 1998 and 2012, the survey was conducted between May 22nd and July 22nd. In 2013, the survey was completed between June 22nd and August 11th. The survey has a fixed station stratified design. Since 2008, survey stations throughout the entire management unit have been sampled regularly, with only minor modifications to the station list to accommodate the declaration of closed and protected areas since 2008. Fishermen are asked to follow fishing protocols (e.g., minimum distance from a station, hook-size, number of hooks, and minimum soak times) (Zwanenburg and Wilson 2000), however there is still some variation in survey protocol, which could affect catch rates. While the halibut survey is underway, fishermen also participate in a commercial index where they fish at locations of their choosing. For these commercial index sets, participants tend to use the same protocol as the survey, but there is some important variation in protocol (e.g., putting out more hooks, longer soak times, variation in bait, etc.).

To date, the effects of variation in fishing practice during the halibut survey and commercial index on catch rates have not been fully examined. However, the effects of station coverage and the duration of vessel participation have been examined in the halibut survey (Trzcinski et al. 2009). Since 2006, the stratification scheme has not been used in calculating an overall index of abundance. Halibut survey catch rates were standardized using a generalized linear model (GLM) by estimating station effects (Figures 3 and 4) and the commercial index was standardized to 1000 hooks and 10 hours soak time (Table 2; Figure 4). As is customary for Atlantic Halibut assessments, the standardized catch rate of 50 stations that have been sampled every year since 2009 are also plotted.

Table 2. Standardized catch rates (Catch, kg/1000 hooks/10 hrs) and standard error (SE) by year from the halibut survey GLM predictions, 50 halibut survey stations and the Commercial Index.

Year	Halibut Survey		50 Stations		Commercial Index	
	Predicted catch	SE	Catch	SE	Catch	SE
1998	28.4	11.5	-	-	101.7	4.3
1999	18.6	7.5	46.5	9.1	110.7	4.8
2000	42.8	17	56.2	10.1	93.1	3.4
2001	23.7	9.5	47	8.7	117.4	5.0
2002	23.9	9.5	56.2	11.7	102.7	3.6
2003	21.7	8.7	43.4	10	99.8	3.4
2004	24.8	9.9	47.8	10	80.6	2.8
2005	27.8	11.2	44.7	7.9	87.2	3.6
2006	31.4	12.6	52.5	7	103.8	5.2
2007	33.3	13.2	74.5	12.3	96.6	5.9
2008	38.8	15.4	57.4	9.3	109.1	4.8
2009	56.6	22.5	70.9	8.5	158.4	7.7
2010	51.2	20.3	99.5	15	129.2	5.5
2011	73.6	29.2	91.8	18.7	129.6	5.2
2012	68.5	27.1	101.4	17.3	154.9	6.7
2013	87	34.4	110.1	14.3	122.2	5.5
1998 – 2012 mean	37.7		64.2		111.7	

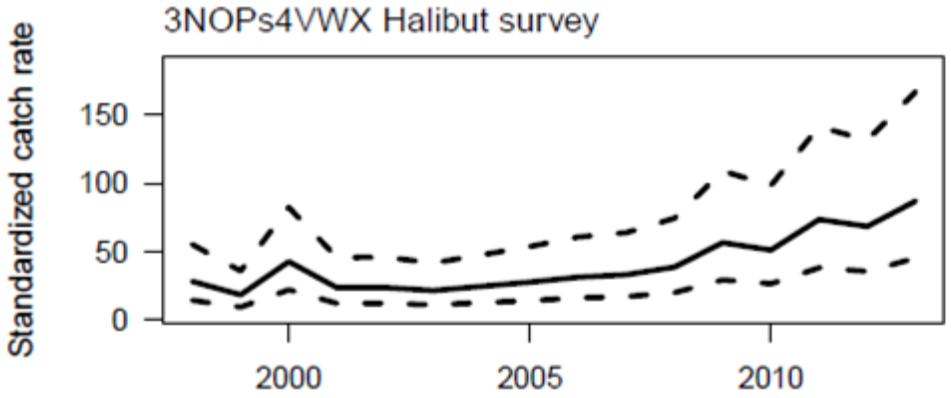

Figure 3. Plot of standardized catch rate (kg/1000 hooks/10 hrs) from GLM of 3NOPs4VWX halibut survey fixed stations completed in 5 or more years since the beginning of the survey. The solid line is predicted catch rate; the dash lines indicate 95% confidence interval.

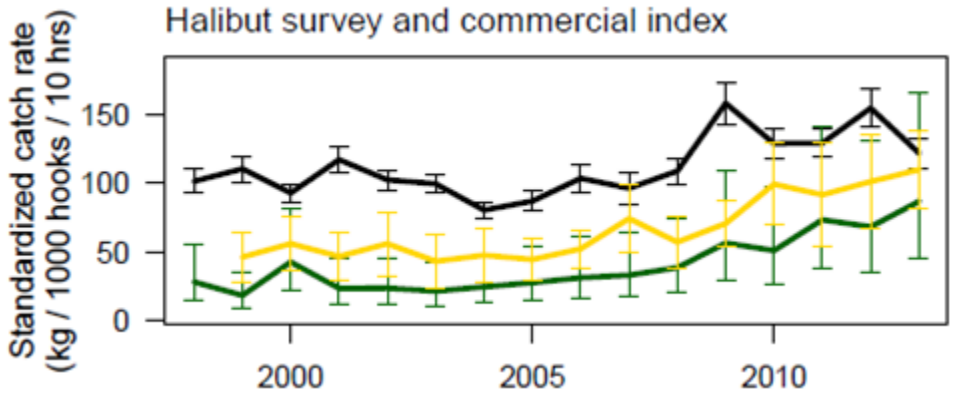

Figure 4. Plot of standardized catch rate (kg/1000 hooks/10 hrs) from commercial index sets (black line), GLM of 3NOPs4VWX halibut survey fixed stations completed in 5 or more years since the beginning of the survey (green line) and 50 stations that were fished every year since 1999 (yellow line). The horizontal bars indicate 95% confidence intervals.

Based on the catch rate analyses of the halibut survey, there is a small increase in the biomass of 3NOPs4VWX Atlantic Halibut in the past 5 years, with both the 2013 standardized catch rate from the GLM and the 50 stations being the highest in the time series.

The commercial index catch rate has been elevated since 2009. Although the 2013 standardized catch rate is the lowest in the last 5 years, it is still above the long term mean. 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 biomass indices because the fishing practices vary, and these important sources of variability have not been included in standardization.

4VWX RV Survey

The Scotia-Fundy groundfish RV survey has been conducted every July since 1970. Each year, approximately 231 fishing stations are sampled from the Upper Bay of Fundy to the northern tip of Cape Breton and offshore to the 400 fathom contour (approximately 700m) (Branton and Black 2004). The median size of halibut caught in the trawl survey was between 40 and 50 cm. There has been some variation in the survey from year to year such as the number of strata covered, the length of the survey, and vessel used. Potentially the most important, was the change in fishing gear from a Yankee-32 to a Western-IIA in 1982. While this variation was known to have important effects on the catchability and catch rates of cod and haddock, it appears to have had little effect on halibut. There was no discontinuity in either the number or the size of halibut caught before and after 1982.

The catch of Atlantic Halibut in the 4VWX RV survey increased between 2000 and 2011 (Figure 5). Since 2011 catch rates appear to be declining, but the 2012 and 2013 catch rates remain among the 4 highest in the time series and above the long term mean. Further the RV catch in 2012 and 2013 was above the long-term mean for almost all 3-cm groups including the smallest size groups (DFO 2013).

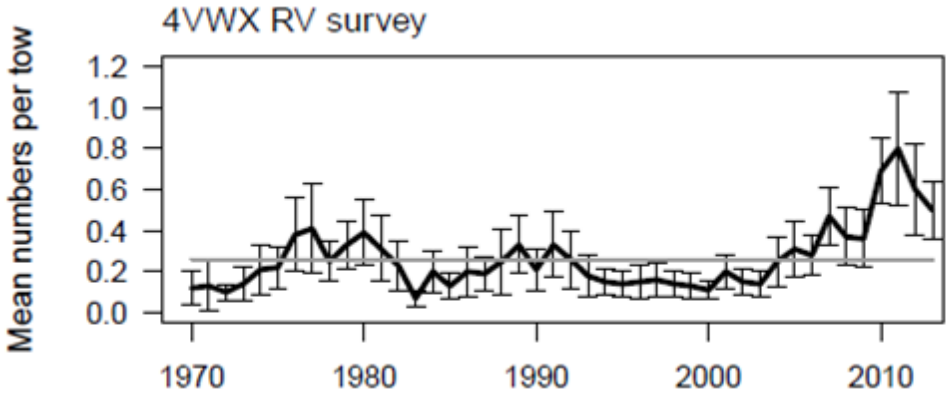

Figure 5. Plot of standardized mean number per tow for Scotia-Fundy RV Groundfish Survey sets in 4VWX between 1970 and 2013. The grey horizontal line is the long term (1970-2012) mean (mean=0.26 per tow). The vertical bars indicate 95% confidence intervals.

Multiyear Tagging

In 2006, DFO and the Atlantic Halibut Council (AHC) began the Halibut All Sizes Tagging (HAST) program to estimate population size, exploitation rate and evaluate the distribution of halibut within the Scotian Shelf southern Grand Banks management unit. More than 3000 halibut were double tagged with t-bar anchor tags during the industry-DFO 2006, 2007, 2008, 2010, and 2012 halibut surveys. As of November 7, 2013, 1326 tagged halibut were recaptured and reported.

A multiyear mark-recapture model was developed to estimate *F* of Atlantic Halibut from the tagging data (den Heyer et al. 2011). This model also estimates tag loss, a constant natural mortality (*M*), and the *F* in the first 6 months of release, when fish behavior might be altered and would bias estimates of *F*. Fitting this model only to the recapture of exploitable halibut at time of release (TL ≥ 81 cm), tag loss is estimated at 23% per year in the first year and 5% per year in the second and subsequent years. Assuming 90% tag reporting and 80% survival from tagging, instantaneous *M* for halibut greater than 81 cm was estimated to be 0.18 (SE=0.03), and instantaneous *F* was estimated to be 0.18 (SE=0.03) in 2007, 0.26 (SE=0.03) in 2008, 0.16 (SE=0.02) in 2009, 0.14 (SE=0.02) in 2010, 0.10 (SE=0.02) in 2011, 0.18 (SE=0.03) in 2012, and 0.08 (SE=0.03) in 2013. As commercial fishing continues, the 2013 reports are incomplete and the 2013 F is underestimated. While these estimates of *F* are not directly comparable to the assessment model estimates of *F* (Trzcinski et al. 2011) and the established reference points (DFO 2012), they indicate that despite the increase in quota (Table 1), *F* has been stable or slightly reduced between 2007 and 2012 (Figure 6). This is consistent with a recruitment pulse seen both in the catch composition of the landings (Trzcinski et al. 2011) and the high RV survey catch rates (Figure 5).

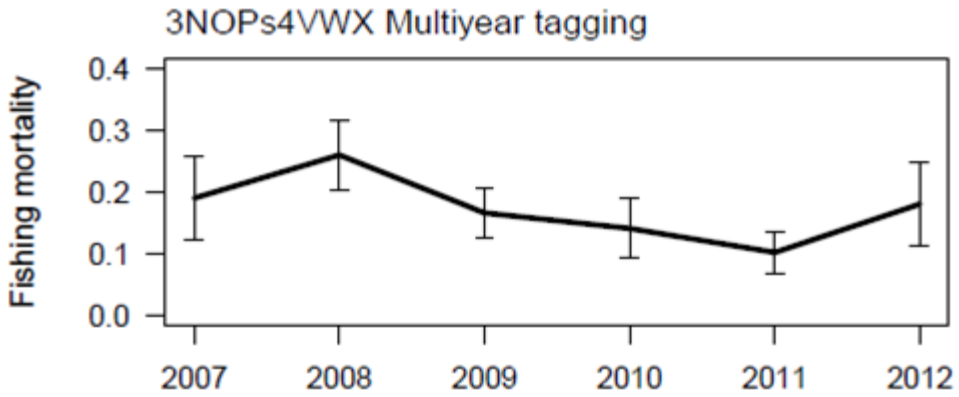

Figure 6. Plot of instantaneous fishing mortality estimated from the multiyear tagging model of exploitable Atlantic halibut tagged between 2006 and 2012 and recaptured and reported between 2006 and November 7, 2013.

Conclusions

In 2012, based on model projections, 3NOPs4VWX5Zc Atlantic halibut was concluded to be in a productive period due to high recruitment (DFO 2012). The SSB was expected to increase, and it was concluded that there was little risk in harming the productivity of the stock at harvest levels < 4,000 mt. The updated 2012 and 2013 abundance indices, including the 4VWX RV survey, the halibut survey and the commercial index standardized catch rates, indicate that abundance of both pre-recruits and recruits continue to be high. Over the past few years the TAC has increased, with the 2013 TAC at 2,447 mt, which is still well below 4,000 mt. Fishing mortality estimated from the multiyear tagging study indicates that *F* has been stable or slightly reduced between 2007 and 2012. The abundance indices and trends in landings and *F* are consistent with model projections (DFO 2012). Despite moderate increases in TAC the Atlantic halibut stock appears to be increasing. The 4VWX RV survey standardized catch rates remain well above the long term mean and suggest that the fishery will continue to benefit from high recruitment in the next couple of years. However, if the declining trends in the 4VWX RV survey catch rates continue and the stock returns to a state of lower productivity, the TAC will have to be reconsidered.

Sources of Uncertainty

Prior to 2008, station coverage was irregular and new stations were added to improve coverage in 4Vn and 3NOP. Other sources of uncertainty including vessels, bait, and temperature effects on the halibut survey and commercial index catch rates have not been fully analyzed. Further, the impact of the delayed start of the 2013 halibut survey and commercial index fishing has not been assessed.

The stock structure is not well known. Atlantic halibut in Canadian waters is currently being managed as two different stocks, 4RST and 3NOPs4VWX5Zc. The population model and interpretation of abundance indices assume that 3NOPs4VWX5Zc is a single stock.

The mark-recapture model assumes M, tag reporting rate, and initial tag survival are constant over time. Further, we have limited information to choose the assumed initial tag survival and reporting rate.

The interpretation of trends assumes no changes in important vital rates such as survival or fecundity that would impact the dynamics of the population. It is not known if or how vital rates

and population growth rate will change with increasing stock size and/or variable environmental conditions.

Without estimates of biomass and *F* from the assessment model, stock status with respect to the adopted reference points cannot be assessed.

Contributors

Cornelia den Heyer (Lead)	DFO Science, Maritimes
Scott Wilson	DFO Science, Maritimes
Sean C. Smith	DFO Science Maritimes
Kurtis Trzcinski	DFO Science, Maritimes
Christie Whelan (Chair)	DFO Science, Maritimes
Steve Campana (reviewer)	DFO Science, Maritimes
Brad Hubley (reviewer)	DFO Science, Maritimes
Heath Stone (reviewer)	DFO Science, Maritimes
Lottie Bennett	DFO Science, Maritimes
Gabrielle Wilson	DFO Science, Maritimes
Verna Docherty	DFO Fisheries and Aquaculture Management, Maritimes

Approved by

Alain Vézina
Regional Director of Science, DFO Maritimes Region
Dartmouth, Nova Scotia
Ph. 902-426-3490

Date: December 20, 2014

Sources of Information

Branton, R., and G. Black. 2004. 2004 Summer Groundfish Survey Update for Selected Scotia-Fundy Groundfish Stocks. DFO Can. Sci. Advis. Sec. Res. Doc. 2004/108. 64p.

den Heyer, C., C. Schwarz, and K. Trzcinski. 2011. Atlantic Halibut Fishing Mortality Estimated from Tagging on the Scotian Shelf and the Southern Grand Banks. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/001: vi + 24 p.

DFO, 2011. Assessment of Atlantic Halibut on the Scotian Shelf and Southern Grand Banks (NAFO Divisions 3NOPs4VWX5Zc). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/001.

DFO. 2012. Projections of the Atlantic Halibut Population on the Scotian Shelf and Southern Grand Banks (NAFO Divisions 3NOPs4VWX5Zc). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/027.

DFO. 2013. Maritimes Research Vessel Survey Trends. DFO Can. Sci. Advis. Sec. Sci. Resp. 2013/017.

Trzcinski, M.K., S.L. Armsworthy, S. Wilson, R.K. Mohn, M. Fowler, and S.E. Campana. 2009. Atlantic Halibut on the Scotian Shelf and Southern Grand Banks (Divs. 3NOPs4VWX5Zc) – Industry/DFO Longline Survey and Tagging Results to 2008. DFO Can. Sci. Advis. Sec. Res. Doc. 2009/026. 49p.

Trzcinski, M.K., S.L. Armsworthy, S. Wilson, R.K. Mohn, and S.E. Campana. 2011. A Framework for the Assessment of the Scotian Shelf and Southern Grand Banks Atlantic Halibut Stock. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/002 vi + 112 p.

Zwanenburg, K.C.T., and S. Wilson. 2000. 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 CM 2000/W:20.

This Report is Available from the:

Center for Science Advice (CSA)
Maritimes Region
Fisheries and Oceans Canada
PO Box 1006, 1 Challenger Drive
Dartmouth, Nova Scotia
B2Y 4A2

Telephone: 902-426-7070
E-Mail: XMARMRAP@mar.dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas-sccs/

ISSN 1919-3769

Correct Citation for this Publication:

DFO. 2014. Stock Status Update of Atlantic Halibut on the Scotian Shelf and Southern Grand Banks (NAFO Divs. 3NOPs4VWX5Zc). DFO Can. Sci. Advis. Sec. Sci. Resp. 2014/016.

Aussi disponible en français :

MPO. 2014. Mise à jour de l'état du stock de flétan du plateau néo-écossais et du sud des Grands Bancs (divisions 3NOPs4VWX5Zc de l'OPANO). Secr. can. de consult. sci. du MPO, Rép. des Sci. 2014/016.