Fisheries and Oceans Canada | Pêches et Océans Canada
Ecosystems and Oceans Science | Sciences des écosystèmes et des océans

Canadian Science Advisory Secretariat
Maritimes Region **Science Response 2019/017**

STOCK STATUS UPDATE OF ATLANTIC HALIBUT (*HIPPOGLOSSUS HIPPOGLOSSUS*) ON THE SCOTIAN SHELF AND SOUTHERN GRAND BANKS IN NAFO DIVISIONS 3NOPS4VWX5ZC

Context

Atlantic Halibut (*Hippoglossus hippoglossus*) is the largest of the flatfishes and ranges widely over Canada's East Coast. The management unit definition, Northwest Atlantic Fisheries Organization (NAFO) Divisions 3NOPs4VWX5Zc, is based largely on tagging results that 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 established in 1994. The Fisheries and Oceans Canada (DFO) Summer Research Vessel (RV) Survey provides an index of abundance for incoming recruitment for the stock. An Industry-DFO Longline Halibut Survey (Fixed Station Halibut Survey) on the Scotian Shelf and southern Grand Banks (NAFO Divs. 3NOPs4VWX5Zc) was initiated in 1998 to provide an index of exploitable (≥81 cm total length) Atlantic Halibut on the Scotian Shelf and southern Grand Banks. A new assessment model and assessment procedures were adopted in November 2014 (Cox et al. 2016) to inform Resource Management of the status of the Halibut resource and to provide harvest level advice based on standardized catch rates from the Halibut Survey and stratified mean numbers-per-tow from the DFO Summer RV Survey (NAFO Divs. 4VWX). Science advice provided in December 2014, 2015, 2016, and 2017 used this new procedure (DFO 2015, 2016, 2017, 2018). In 2017, following the recommendations outlined in the 2014 Assessment Framework, a new Stratified Random Halibut Survey was initiated that extended the survey into areas and depths that were not well sampled by the Fixed Station Survey. To calibrate the Stratified Random Survey with the Fixed Station Survey and provide TAC advice, 100 Fixed Stations will continue to be fished for at least three years (2017-2019). The next Framework review is currently scheduled for 2020.

Resource Management asked Science to update and evaluate Atlantic Halibut abundance indicators, landings and fishing mortality estimated from tagging data. This response provides 2019-2020 TAC advice based on the Objectives and Harvest Strategy adopted at the Scotia-Fundy Groundfish Advisory Committee (SFGAC) meeting in March 2015.

This Science Response Report results from the Science Response Process of December 5, 2018, on the Stock Status Update of Atlantic Halibut in NAFO Division 3NOPs4VWX+5.

Background

Biology

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.

Female Atlantic Halibut grow faster than the males and attain a much larger maximum size. Atlantic Halibut grow rapidly (approximately 10 cm 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).

Description of the Fishery

The management unit definition (NAFO Divs. 3NOPs4VWX5Zc, Figure 1) was based largely on tagging results that indicated that Atlantic Halibut move extensively throughout the Canadian North Atlantic. Within the management unit, Atlantic Halibut is fished mostly along the edges of the continental shelf and mainly by longline. Until 1988, the fishery was unregulated. A TAC of 3200 tonnes (t) was first established in 1988 and in response to an eight year decline in landings was reduced to a low of 850 t in 1995. Since 1994, management plans and license conditions require the release of Atlantic Halibut <81 cm. Beginning in 1999, the TAC has been increased several times and was last set at 4164 t in 2018 (Table 1; Figure 2).

The NAFO statistics are used to describe removals up to 2017 because landings occur in two DFO regions (Maritimes Region and Newfoundland and Labrador Region), and other countries including Portugal, Spain, France, and the US take Halibut within the stock area, but outside Canada's Exclusive Economic Zone (EEZ). Only the Canadian landings (Maritime Fishery Information System (MARFIS)) are reported for 2018, and these numbers are preliminary. The majority of landings in 2017 occurred on the Scotian Shelf (NAFO Divs. 4VWX) and were very similar to those of 2016. Foreign catches for 2017 were similar to those reported in 2016 with an increase of approximately 2%. It should be noted that, in some years, Canadian quota carry forward provisions and foreign catches result in total landings above the TAC.

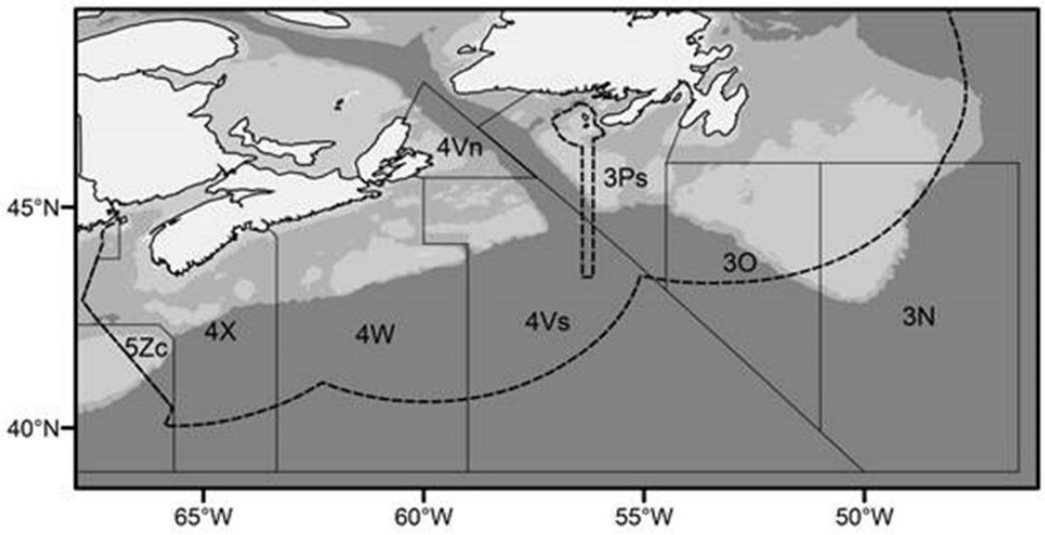

Figure 1. Management unit Northwest Atlantic Fisheries Organization Divisions 3NOPs4VWX5Zc.

Table 1. Total reported Canadian and foreign landings (tonnes) of Atlantic Halibut from Northwest Atlantic Fisheries Organization Divisions 3NOPs4VWX5Zc[1]. Ten-year annual average landings are presented for 1960 to 2009. The NAFO 21A table of landings by country are reported by calendar year; however, the TAC for the stock is set for the period of April-March. Data are from the July 18, 2018, update of the NAFO 21A database. Dash (-) indicates data not available.

		Canada			Foreign			3NOPs4VWX+5Zc	
	Year(s)	3NOPs	4VWX+ 5Zc[1]	Total	3NOPs	4VWX+ 5Zc[1]	Total	Grand Total	Canadian TAC
Decadal Avg.	1960-1969	638	1431	2070	492	73	565	2634	-
Decadal Avg.	1970-1979	428	874	1302	74	44	117	1419	-
Decadal Avg.	1980-1989[2,3]	738	1625	2363	217	28	245	2608	-
Decadal Avg.	1990-1999	323	815	1139	180	4	184	1323	1855
Decadal Avg.	2000-2009	461	878	1339	148	0	148	1487	1318
Annual	2010	464	1296	1760	131	1	132	1892	1850
Annual	2011	373	1346	1719	218	1	219	1938	1850
Annual	2012	531	1491	2022	200	1	201	2223	2128
Annual	2013	562	1836	2398	205	1	206	2604	2447
Annual	2014	839	1811	2650	312	1	313	2963	2563
Annual	2015	693	2174	2867	395	1	396	3263	2738
Annual	2016	626	2186	2812	393	1	394	3206	3149
Annual	2017	807	2351	3158	403	1	404	3562	3621[4]
Annual	2018	322	2921	3243[5]	-	-	-	-	4164[4]

[1]Canadian landings in 5Y are assumed to have been in the Canadian portion and are included in the 4VWX+5Zc value. Foreign/US landings in 5Y are not included.
[2]Landings were first listed in 5Zc in 1986; 5Zc and 5Ze are used to indicate same area.
[3]Prior to 1988 the Atlantic Halibut catch was unregulated.
[4]For 2017 and 2018, 100 t of the Canadian TAC were set aside to cover catches by US and France within the stock area.
[5]Landings from the Maritimes Fisheries Information System (MARFIS) for 2018 are preliminary, as of November 9, 2018.

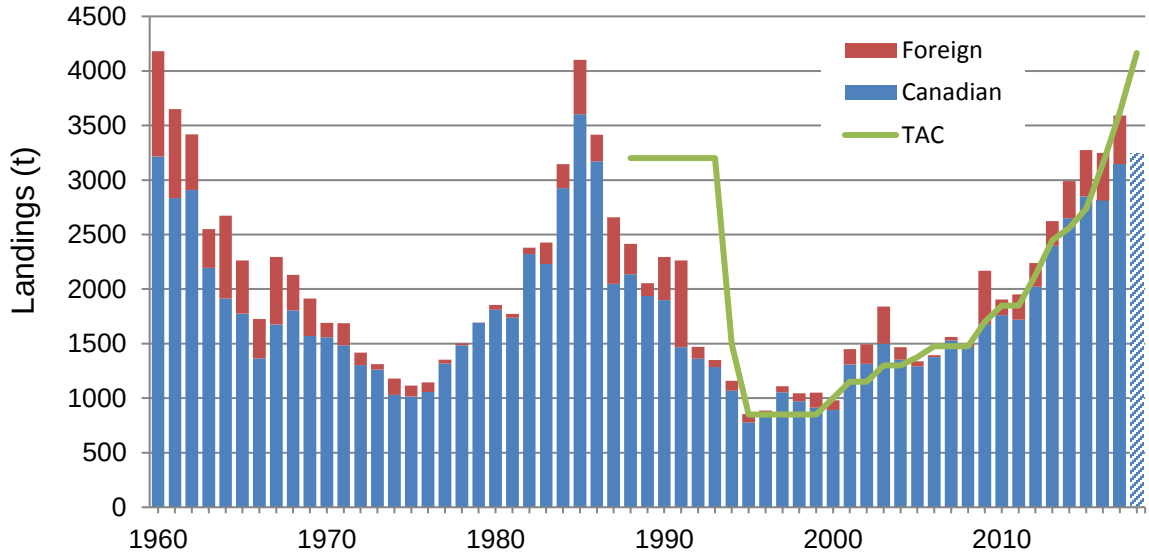

Figure 2. Northwest Atlantic Fisheries Organization (NAFO) reported Canadian (blue) and foreign (red) landings (tonnes) for 3NOPs4VWX5Zc Atlantic Halibut. Landings for 2018 (hashed bar) are preliminary, and taken from the Maritimes Fisheries Information System (MARFIS) as of November 13, 2018. The solid green line is the Canadian Total Allowable Catch (TAC). The NAFO 21A table of landings by country are reported by calendar year; however, the TAC for the stock is set for the period of April-March.

Assessment Framework

A new Assessment Framework was adopted in November 2014 (Cox et al. 2016). This Framework used a new Statistical Catch-At-Length (SCAL) model to assess the stock status and an operating model (HAL) to evaluate the impact of a suite of harvest strategies on the biomass/population trends and landings. In March 2016, the SFGAC adopted a Fishing Mortality (F) of F=0.14 harvest strategy with a cap on annual changes in TAC of 15%. Stock status in interim years is assessed based on the Halibut Survey index of exploitable biomass and the DFO Summer RV Survey (NAFO Divs. 4VWX). The next Assessment Framework review is currently scheduled for 2020. However, if the DFO Summer RV Survey (NAFO Divs. 4VWX) index falls below the long-term mean in three of the most recent five years, an earlier than anticipated framework review could be triggered. In interim years, Science advice on TAC is based on the 3-year mean Halibut Survey index of exploitable biomass.

Analysis and Response

DFO Summer RV Survey (4VWX)

The DFO Summer RV Survey (NAFO Divs. 4VWX) has been conducted every July since 1970. The median size of Halibut caught in the trawl survey is between 40 and 50 cm. The catch of Atlantic Halibut in this survey increased between 2000 and 2011 (Figure 3). Since 2011, catch rates have remained above the long-term mean. The 2018 DFO Summer RV Survey was curtailed by mechanical issues which resulted in only NAFO 4X being sufficiently sampled to allow for the development of a reliable estimate of mean numbers of halibut per tow (DFO 2019). In light of this, the mean numbers of Halibut per tow for 4X were calculated for the years 1970 to 2018 and compared to the 1970 to 2017 time series for 4VWX (Figure 3). The numbers of Halibut per tow for 4X were on average slightly higher than for the full 4VWX survey area, but the long term trends were very similar (Figure 3). The 95% confidence intervals for 4X, calculated as described in den Heyer et al. (2015), are wider than those for 4VWX, which is consistent with a smaller number of strata contributing to the mean. The mean number of Halibut per tow in 4X for 2018 was above the long term mean (Figure 3).

The biomass index from the abbreviated DFO Summer RV Survey is near the highest level in the time series (DFO 2019), reflecting the greater number of large fish in the survey. Although the 2016 and 2017 RV Survey did not catch halibut <38 cm, roughly 18% of the 2018 RV Survey catch in 4X was under 38 cm (DFO 2019), providing confidence that youngest cohorts are still present in the survey.

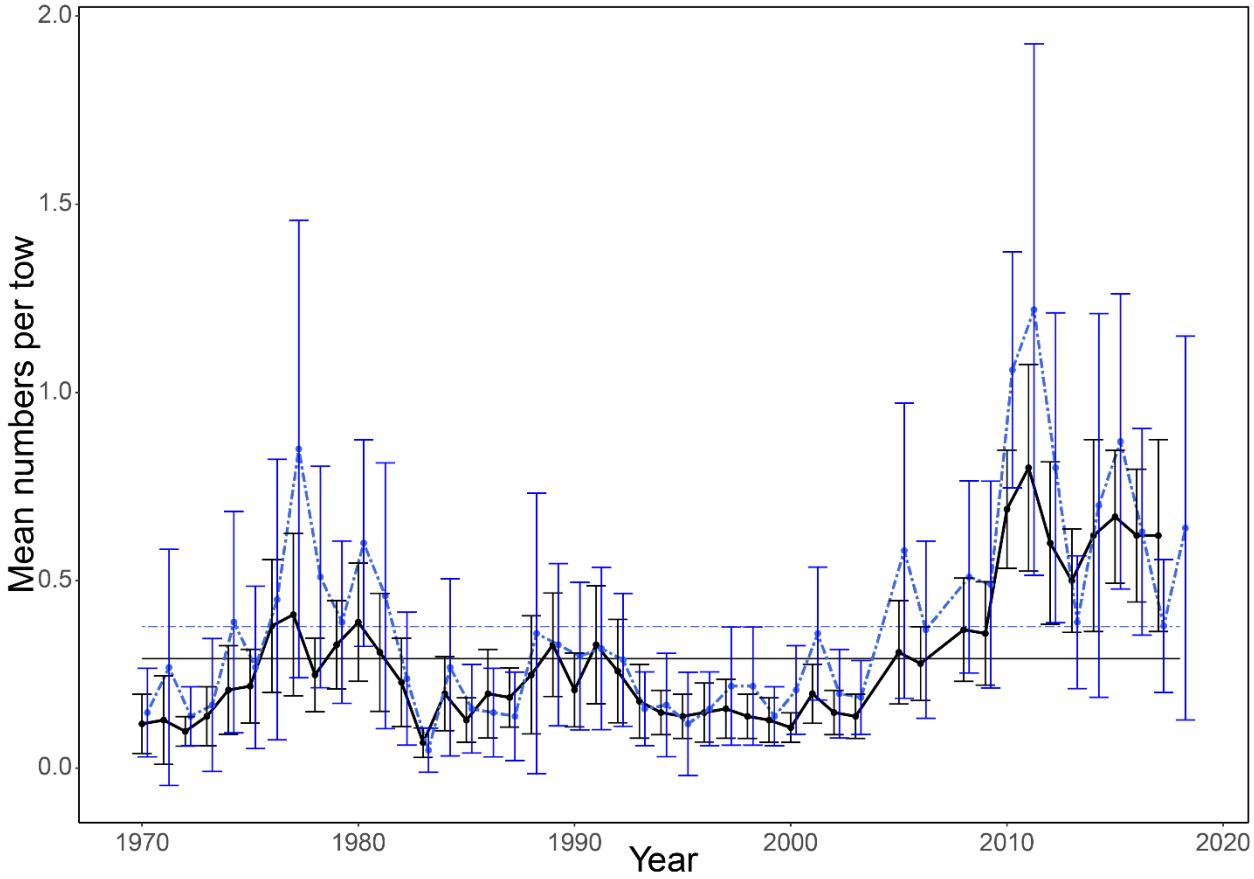

Figure 3. Plot of mean number of Atlantic Halibut per tow for DFO Summer RV Survey sets in 4VWX from 1970 to 2017 (black) and for 4X alone from 1970 to 2018 (blue). The solid black horizontal line is the long-term (1970-2017) mean for 4VWX (mean = 0.29 per tow) and the dashed blue line represents the same for 4X only (mean = 0.39 per tow). The vertical bars indicate 95% confidence intervals. The 4VWX and 4X only mean numbers of Atlantic Halibut per tow are plotted slightly offset for ease of interpretation.

Fixed Station Halibut Survey

The Fixed Station Halibut Survey provides an index of abundance of Atlantic Halibut ranging in size between 50 and 220 cm (den Heyer et al. 2015). The survey is completed by commercial fishermen with onboard observers between May and August. Halibut Survey catch rates were standardized using a Generalized Linear Model (GLM) including both station and year effects. In 2017, the number of stations surveyed during the Fixed Station Halibut Survey was reduced from the approximately 232 consistently fished stations to 100 Index Stations. This allowed more effort to be directed towards the new Stratified Random Survey, while providing adequate sampling to both provide an index of exploitable biomass and to calibrate the Stratified Random stations to the Fixed Stations. The catch rate has increased since 2004, and the 2018 standardized catch rate from the GLM fit to the 100 Index Stations is the greatest in the 21-year time series (Figure 4). The 2018 3-year mean of exploitable biomass from the Halibut Survey is 20% higher than 2017, and 82% higher than 2014, the last year the stock was assessed (Figure 5). The Upper Stock Reference (USR) point was set in the 2014 assessment as the highest Spawning Stock Biomass (SSB) in the 1982 to 2013 time series, which was the SSB in 2013 (Figure 5). Given that the total biomass has increased since 2013, unless the relationship

between total biomass and SSB has changed markedly, the 2018 SSB is likely above the USR point, putting the stock in the Healthy Zone.

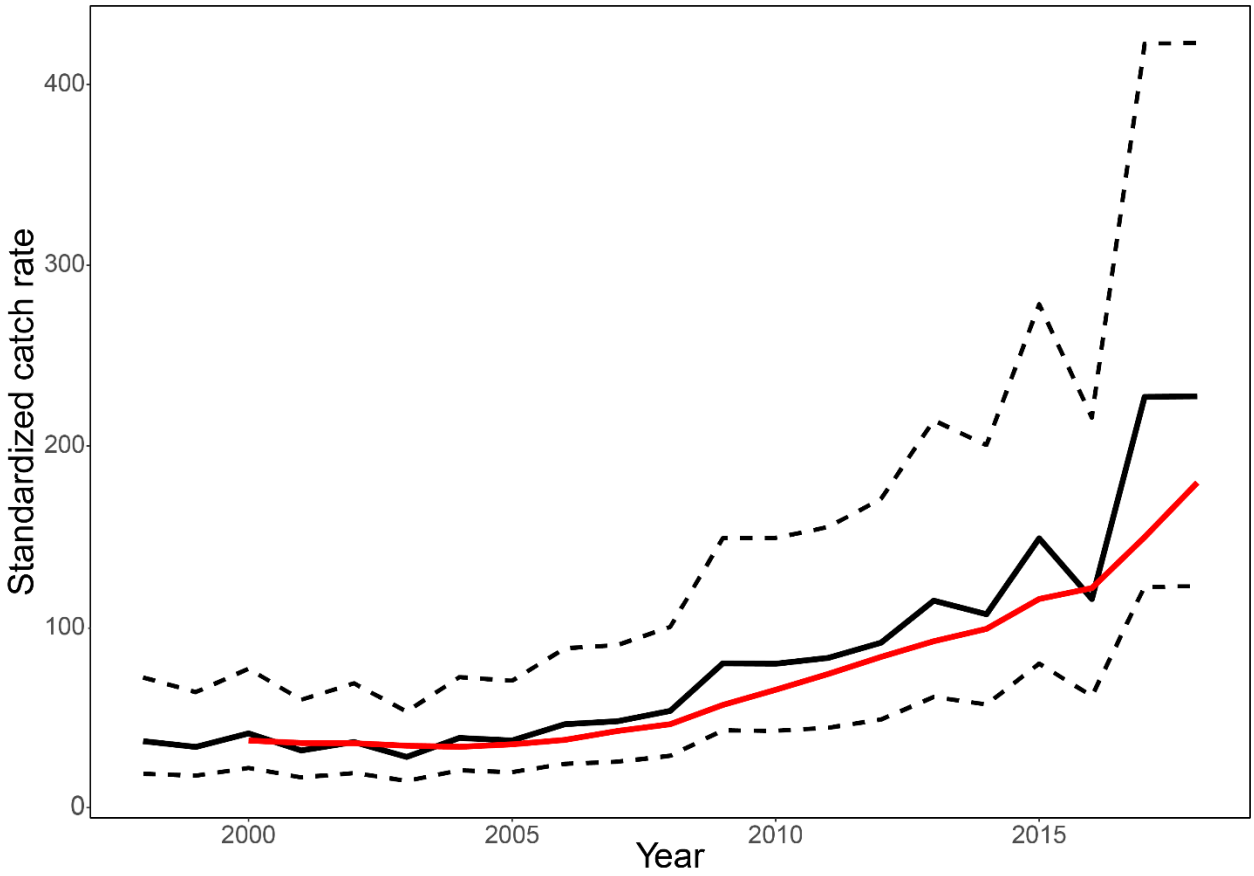

Figure 4. Plot of standardized catch rate of Atlantic Halibut (kg/1000 hooks/10 hrs) from the Generalized Linear Model (GLM) of 3NOPs4VWX Halibut Survey 100 Index Stations. The solid black line is predicted catch rate; the dashed lines indicate the 95% confidence interval. The 3-year mean of the index (solid red line) is also plotted.

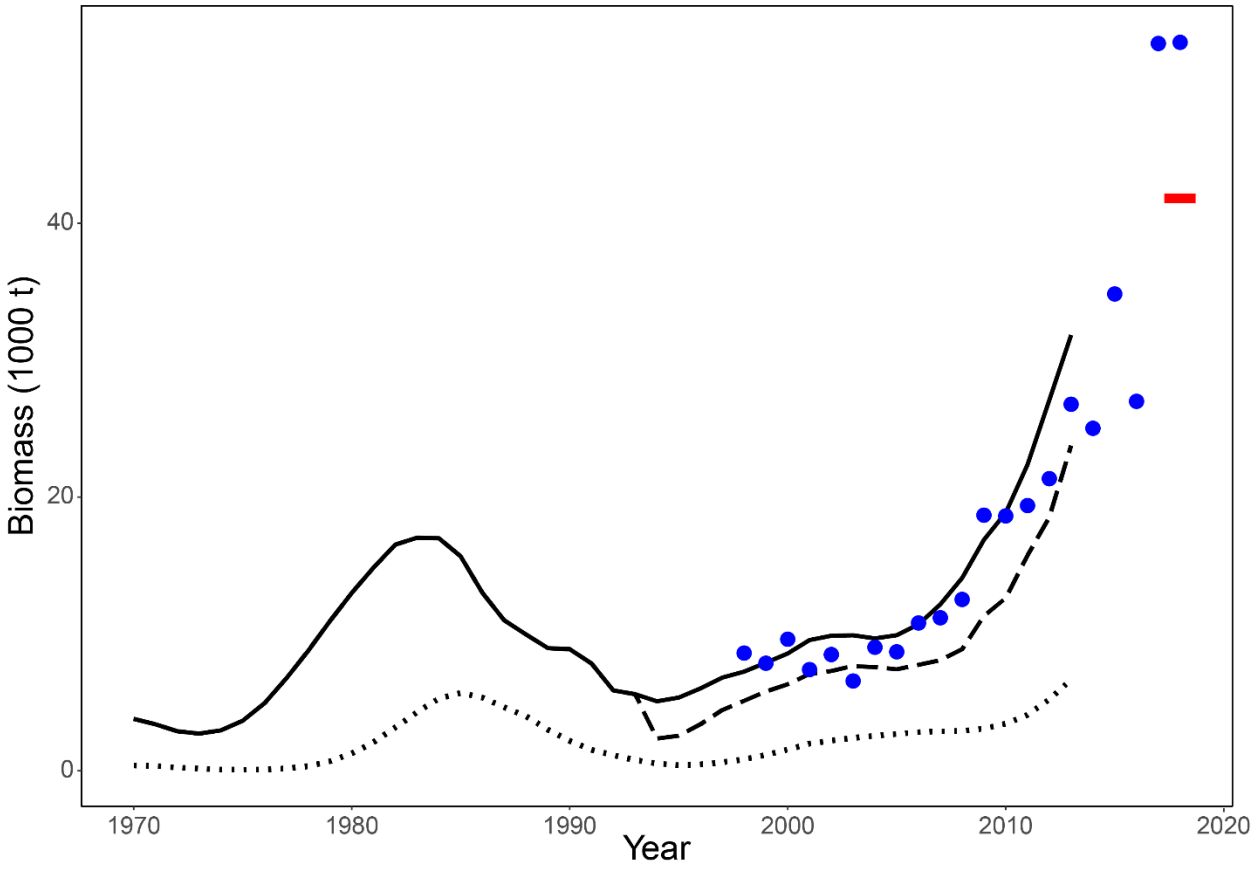

Figure 5. Plot of Atlantic Halibut biomass between 1970 and 2013 estimated from the stock assessment model (black lines) and the Halibut Survey 100 Index Stations (blue circles). The solid black line is total biomass, the dashed line is exploitable biomass (>81 cm), and the dotted line is spawning stock biomass. The solid red bar is the current 3-year mean of the Halibut Survey biomass index.

Harvest Control Rule

Applying the F=0.14 strategy, with a maximum annual change of 15% from the 2018 TAC (4164 t) would result in a 2019-2020 TAC of 4789 t. This application of the harvest control rule, and the projections from the HAL model (DFO 2015), assume all removals from Canadian and international fisheries are included.

Multi-year Mark-recapture Tagging Model

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 Atlantic Halibut within the Scotian Shelf southern Grand Banks management unit (den Heyer et al. 2015). In this program, tagging occurs every other year, and no tagging was conducted in 2017. Between 2006 and 2016, 4871 Halibut were double tagged with T-bar anchor tags. As of December 31, 2017, 848 tagged Halibut were recaptured and reported with sufficient information to be used in the multi-year mark-recapture model. Assuming 80% tag reporting and 100% survival from tagging, F is declining from a high of 0.18 in 2008 to a low of 0.034 in 2017 (Figure 6). The absolute estimates of F from the tagging model are not directly comparable to the assessment model, but provide an indication of trend in interim assessment years.

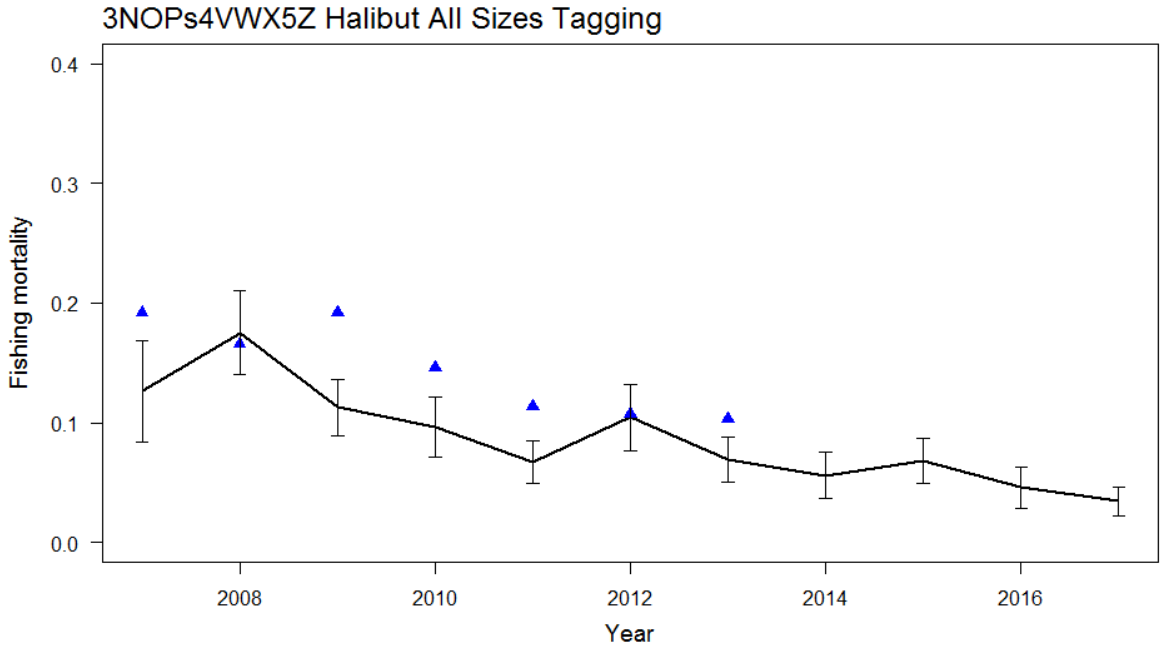

Figure 6. Plot of instantaneous fishing mortality for Atlantic Halibut estimated from the multi-year tagging model (solid black line) and the assessment model (blue triangles). The vertical bars indicate 95% confidence intervals.

Conclusions

The 3NOPs4VWX5Zc Atlantic Halibut stock has a history of overfishing that predates the time series used in the stock assessment model (i.e. prior to 1970). The assessment model indicates that the stock has increased from the depleted state observed in the early 1990s. The updated 3NOPs4VWX5Zc Halibut Survey index shows that abundance of exploitable (>81 cm) Halibut continues to increase with 2018 being the highest in the 21-year time series. The 2018 DFO Summer RV Survey (NAFO Divs. 4VWX) was incomplete because of mechanical issues, with only NAFO 4X having sufficient sampling to be used to develop an index. The 4X index was shown to serve as a good proxy for the entire 4VWX sampling area, and the mean number of halibut per tow in 4X was above the long term mean. Consistent with the rapid increase in biomass and a capped increase in TAC, the fishing mortality estimated from the multi-year mark-recapture model has declined slightly. The 3-year mean index of exploitable biomass for 2018 is 20% higher than last year. A 2019/20 TAC consistent with the Harvest Strategy adopted by the SFGAC is 4789 t, which is the maximum yearly change in TAC of 15% (625 t).

Contributors

Name	Affiliation
Brendan Wringe (Lead)	DFO Science, Maritimes Region
Donald Clark	DFO Science, Maritimes Region
Kirsten Clark	DFO Science, Maritimes Region
Irene Andrushchenko	DFO Science, Maritimes Region
Ryan Martin	DFO Science, Maritimes Region
Allan Debertin	DFO Science, Maritimes Region
Yanjun Wang	DFO Science, Maritimes Region

Melanie Barrett	DFO Science, Maritimes Region
Quinn McCurdy	DFO Science, Maritimes Region
Virginia Noble	DFO Science, Maritimes Region
Jamie Emberley	DFO Science, Maritimes Region
Catriona Régnier-McKellar	DFO Science ,Maritimes Region
Cornelia den Heyer	DFO Science, Maritimes Region
Heath Stone	DFO Science, Maritimes Region
Lottie Bennett	DFO Science, Maritimes Region
Alida Bundy	DFO Science, Maritimes Region
Monica Finley	DFO Science, Maritimes Region
Fonya Irvine	DFO Science, Maritimes Region
Ellen MacEachern	DFO Science, Maritimes Region
Jennifer Ford	DFO Science, Maritimes Region
Caira Clark	DFO Science, Maritimes Region
Daphne Themelis	DFO Science, Maritimes Region
Brendan Wringe	DFO Science, Maritimes Region
Penny Doherty	DFO Resource Management, Maritimes Region

Approved by

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

Date: January 16, 2019

Sources of Information

Cox, S.P., Benson, A., and den Heyer, C.E. 2016. Framework for the Assessment of Atlantic Halibut Stocks on the Scotian Shelf and Southern Grand Banks. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/001. v + 57 p.

den Heyer, C.E., Hubley, B., Themelis, D., Smith, S.C., Wilson, S., and Wilson, G. 2015. Atlantic Halibut on the Scotian Shelf and Southern Grand Banks: Data Review and Assessment Model Update. DFO Can. Sci. Advis. Sec. Res. Doc. 2015/051. v + 82 p.

DFO. 2015. 2014 Assessment of Atlantic Halibut on the Scotian Shelf and Southern Grand Banks (NAFO Divisions 3NOPs4VWX5ZC). DFO Can. Sci. Advis. Sec. Sci. Advis. Resp. 2015/012.

DFO. 2016. Stock Status Update of Atlantic Halibut on the Scotian Shelf and Southern Grand Banks (NAFO Divs. 3NOPs4VWX5Zc). Sci. Advis. Sec. Sci. Advis. Resp. 2016/010.

DFO. 2017. Stock Status Update of Atlantic Halibut on the Scotian Shelf and Southern Grand Banks (NAFO Divs. 3NOPs4VWX5Zc). Sci. Advis. Sec. Sci. Advis. Resp. 2017/021.

DFO. 2018. Stock Status Update of Atlantic Halibut (*Hippoglossus hippoglossus*) on the Scotian Shelf and Southern Grand Banks in NAFO Divisions 3NOPs4VWX5Zc. Sci. Advis. Sec. Sci. Advis. Resp. 2018/022.

DFO. 2019. 2018 Maritimes Research Vessel Survey Trends on the Scotian Shelf and Bay of Fundy. DFO Can. Sci. Advis. Sec. Sci. Resp. 2019/012.

This Report is Available from :

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

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

ISSN 1919-3769

Correct Citation for this Publication:

DFO. 2019. Stock Status Update of Atlantic Halibut (*Hippoglossus hippoglossus*) on the Scotian Shelf and Southern Grand Banks in NAFO Divisions 3NOPs4VWX5Zc. DFO Can. Sci. Advis. Sec. Sci. Resp. 2019/017.

Aussi disponible en français :

MPO. 2019. Mise à jour de l'état du stock de flétan atlantique (Hippoglossus hippoglossus) du plateau néo-écossais et du sud des grands bancs dans les divisions 3NOPs4VWX5Zc de l'OPANO. Secr. can. de consult. sci. du MPO, Rép. des Sci. 2019/017.