



STOCK STATUS UPDATE OF ATLANTIC HALIBUT (*HIPPOGLOSSUS HIPPOGLOSSUS*) ON THE SCOTIAN SHELF AND SOUTHERN GRAND BANKS IN NAFO DIVISIONS 3NOPS4VWX5ZC FOR 2022

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 fully established in 1995. 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 Atlantic Halibut. In 2017, a new Stratified Random Halibut Survey was initiated that extended the longline survey into areas and depths that were not well sampled by the Fixed Station Halibut Survey. One hundred Fixed Stations continued to be fished to calibrate the 153-station Stratified Random Halibut Survey and provide an index for TAC advice (DFO 2020). A new assessment model was adopted in 2021 to inform Resource Management of the status of the Halibut resource and closed-loop simulation was used to evaluate harvest control rules (Johnson et al. In preparation)¹. Harvest level advice will be based on the exploitable biomass index from the Stratified Random Halibut Survey. The abundance index from the DFO Summer RV Survey (NAFO Divs. 4VWX) is monitored as an index of recruitment.

DFO Resource Management asked Science to update and evaluate Atlantic Halibut abundance, the status of the stock, as well as the resulting TAC advice. This response provides 2023-2024 TAC advice based on the articulated harvest control rule adopted at the Scotia-Fundy Groundfish Advisory Committee (SFGAC) meeting in March 2022.

¹ Johnson, S., Hubley, B., Cox, S.P., den Heyer, C.E., and L, Li. In preparation. Framework Assessment of Atlantic Halibut on the Scotian Shelf and Southern Grand Banks (NAFO Divs. 3NOPS4VWX5Zc) Model Update. DFO Can. Sci. Advis. Sec. Res. Doc. Presented and reviewed at the November 23–26, 2021 (Part 1) and March 1–4, 2022 (Part 2) Framework Review for Atlantic Halibut.

This Science Response Report results from the Regional Peer Review of December 6–7, 2022 on the Update of Stock Status for Atlantic Halibut in 3NOPs4VWX5Zc.

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, United States of America (USA), in the south to the waters off northern Greenland.

Female Atlantic Halibut grow faster than the males and attain a much larger maximum size. Females reach 50% maturity at about 119 cm (total length) while males reach 50% maturity at about 77 cm. Age at 50% maturity (A_{50}) is estimated to be at 5.5 for males and 11.5 for females (Li et al. In preparation)².

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 are fished mainly by longline. The fishery initially occurred along the edges of the continental shelf and then expanded to the entire shelf. Until 1988, the fishery was unregulated. A TAC of 3,200 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 1995, management plans and license conditions require the release of Atlantic Halibut < 81 cm. Beginning in 1999, the TAC has increased and peaked at 5,507 t in 2020 with a slight decline in the last two years (Table 1, Figure 2). Every year since 2017, 100 t of the TAC were set aside to cover catches by United States (US) and France within the stock area.

² Li, L., Hubley, B., Harper, D.L., Wilson, G., and C.E. den Heyer. In preparation. Scotian Shelf and Southern Grand Banks (NAFO Divs. 3NOPs4VWX5Zc) Atlantic Halibut Data Inputs for 2022 Assessment. DFO Can. Sci. Advis. Sec. Res. Doc. Presented and reviewed at the November 23–26, 2021 (Part 1) Framework Review for Atlantic Halibut.

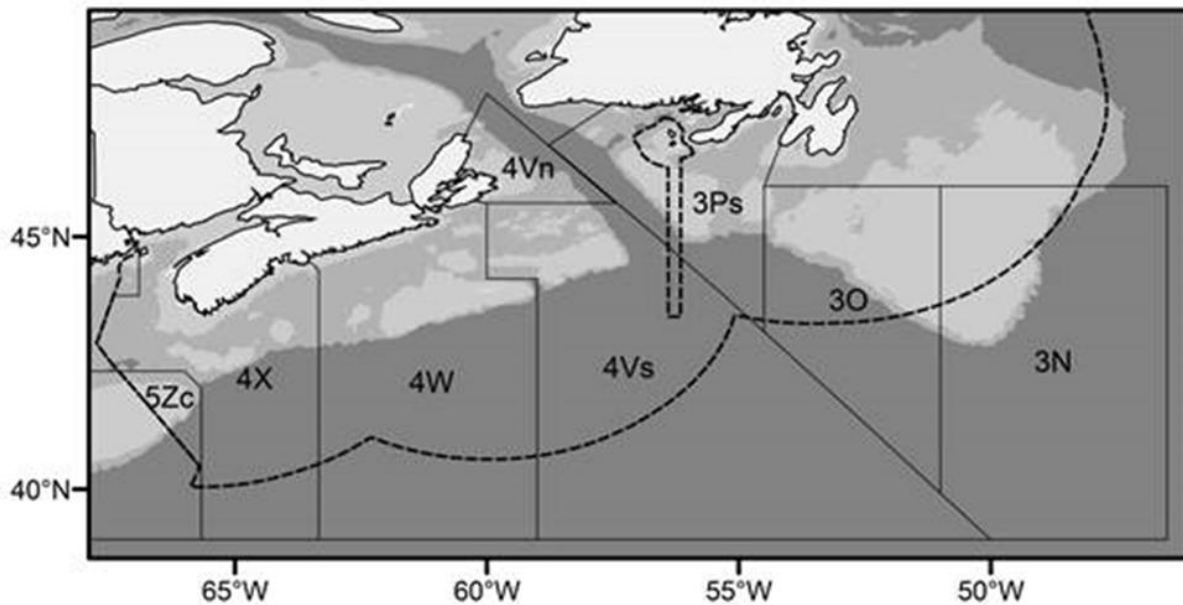


Figure 1. Management unit Northwest Atlantic Fisheries Organization Divisions 3NOPs4VWX5Zc for the Atlantic Halibut fishery.

The NAFO statistics are used to describe removals up to 2022 because landings occur in two DFO regions (Maritimes Region and Newfoundland and Labrador [NL] Region), and other countries including Portugal, Spain, France, and the US that take Halibut within the stock area, but outside Canada's Exclusive Economic Zone (EEZ). Landings from the Maritimes Fisheries Information System (MARFIS) database and NL are reported as preliminary Canadian landings for 2022. The majority of landings in 2021 occurred on the Scotian Shelf (NAFO Divs. 4VWX) and were the greatest on record. Foreign catches for 2021 were lower than reported in 2020 and 2019.

**Science Response: Stock Status Update
of Atlantic Halibut for 2022**

Maritimes Region

Table 1. Total reported Canadian and foreign landings (tonnes) of Atlantic Halibut from Northwest Atlantic Fisheries Organization Divisions 3NOPs4VWX5Zc¹ and TAC for these divisions. 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 were extracted from the NAFO 21A database on Nov 22, 2022. A dash (-) indicates data are not available.

Year	Canadian Landings			Foreign Landings			3NOPs4VWX5Zc	
	3NOPs	4VWX5Zc ¹	Total	3NOPs	4VWX5Zc ¹	Total	Landings	TAC
1960-1969	638.4	1,520.9	2,159.3	492.2	62	554.2	2,713.5	-
1970-1979	427.8	874	1,301.8	73.7	15.4	89.1	1,390.9	-
1980-1989 ²⁻³	738.2	1,624.6	2,362.8	217	13.8	230.8	2,593.6	-
1990-1999	323.2	815.4	1,138.6	179.6	4.3	183.9	1,322.5	1,855
2000-2009	460.9	878.1	1,339	147.8	0.1	147.9	1,486.9	1,340
2010	464	1,296	1,760	131	1	132	1,892	1,850
2011	373	1,346	1,719	218	1	219	1,938	1,850
2012	531	1,491	2,022	200	1	201	2,223	2,128
2013	562	1,836	2,398	205	1	206	2,604	2,447
2014	839	1,811	2,650	312	1	313	2,963	2,563
2015	693	2,174	2,867	395	1	396	3,263	2,738
2016	626	2,186	2,812	393	1	394	3,206	3,149
2017	759	2,353	3,112	403	1	404	3,516	3,621
2018	699	3,171	3,870	343	0	343	4,213	4,164
2019	841	3,414	4,255	480	3	483	4,738	4,789
2020	1,142	3,692	4,834	492	1	493	5,327	5,507
2021	1,342	3,741	5,083	363	1	364	5,447	5,445
2022 ⁴	1,232	3,026	4,258	-	-	-	-	4,807

¹Canadian 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.

²Landings were first listed in 5Zc in 1986; 5Zc and 5Ze are used to indicate same area.

³Prior to 1988 the Atlantic Halibut catch was unregulated.

⁴Landings from the Maritimes Fisheries Information System (MARFIS) and NL landings for 2022 are preliminary, as of November 22, 2022.

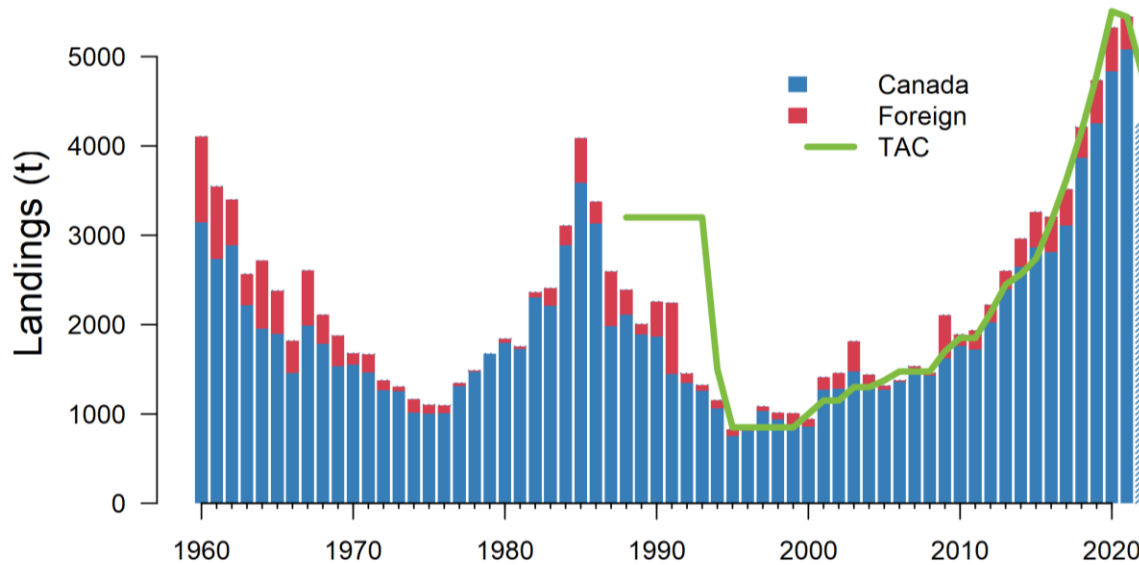


Figure 2. Northwest Atlantic Fisheries Organization (NAFO) reported Canadian (blue) and foreign (red) landings (tonnes) for 3NOPs4VWX5Zc Atlantic Halibut. Landings for 2022 (hashed bar) are preliminary, and taken from the Maritimes Fisheries Information System (MARFIS) and NL landing data as of November 22, 2022. 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 2021¹. This Framework used a new Spatially Integrated Statistical Catch-At-Length (SISCAL) model with sex and age structure to assess the stock status and provide Maximum Sustainable Yield (MSY) based reference points. The Limit Reference Point (LRP) was defined as 0.4 Spawning Stock Biomass (SSB) at MSY (SSB_{MSY}) and an Upper Stock Reference (USR) was defined as 0.8 SSB_{MSY} (Table 2). Mature females are used to represent the SSB for Atlantic Halibut. Additionally, closed-loop simulation was used to evaluate the impact of a suite of harvest strategies on the population trends and landings. In March 2022, the SFGAC adopted an articulated Harvest Control Rule (HCR) based on the biomass index of the Stratified Random Halibut Survey. The HCR has two steps, first a fishing mortality rate is applied based on the Stratified Random Halibut Survey biomass index, to calculate total allowable catch (TAC). Secondly, the percentage change from last year's TAC must correspond with sliding inter-annual TAC threshold, with a sliding inter-annual TAC change limit going from 100% at the LRP to 15% at the USR (Figure 3). The articulated HCR includes three control points, the LRP or Limit Control Point (LCP), USR, and 1.2 Biomass at MSY (B_{MSY}), with a harvest rate higher than F_{MSY} (0.087) when biomass is above SSB_{MSY} (Figure 3). Stock status in interim years is assessed based on the biomass index from the Stratified Random Halibut Survey and the index of recruitments from the DFO Summer RV Survey (NAFO Divs. 4VWX). In interim years, science advice on TAC is based on the 3-year mean index from the Stratified Random Halibut Survey. The next Assessment Framework review is currently scheduled for 2026. However, if the 3-year mean index from the Stratified Random

Halibut Survey falls above or below the 90% probability envelope for that index from the closed-loop simulation, a new framework will be triggered.

Table 2. MSY- based reference points (LRP and USR) and control points (LRP, USR, and 1.2 B_{MSY}) for Atlantic Halibut spawning stock biomass (female) and Stratified Random Halibut Survey Biomass. Survey biomass estimates are derived from model equilibrium survey biomass at long-term fishing mortality rates that produce the corresponding female spawning stock biomass estimates shown. Catchability q is used to convert the index of exploitable biomass from the Stratified Random Halibut Survey (kg/1000 hooks) to the Stratified Random Halibut Survey Biomass (kt).

Model-estimated Biomass	LRP	USR	B _{MSY}	1.2 B _{MSY}	Catchability q
Spawning Stock Biomass (female)	5.3 kt	10.6 kt	13.3 kt	16.0 kt	-
Stratified Random Halibut Survey Biomass	10.9 kt	21.8 kt	27.3 kt	32.8 kt	0.002

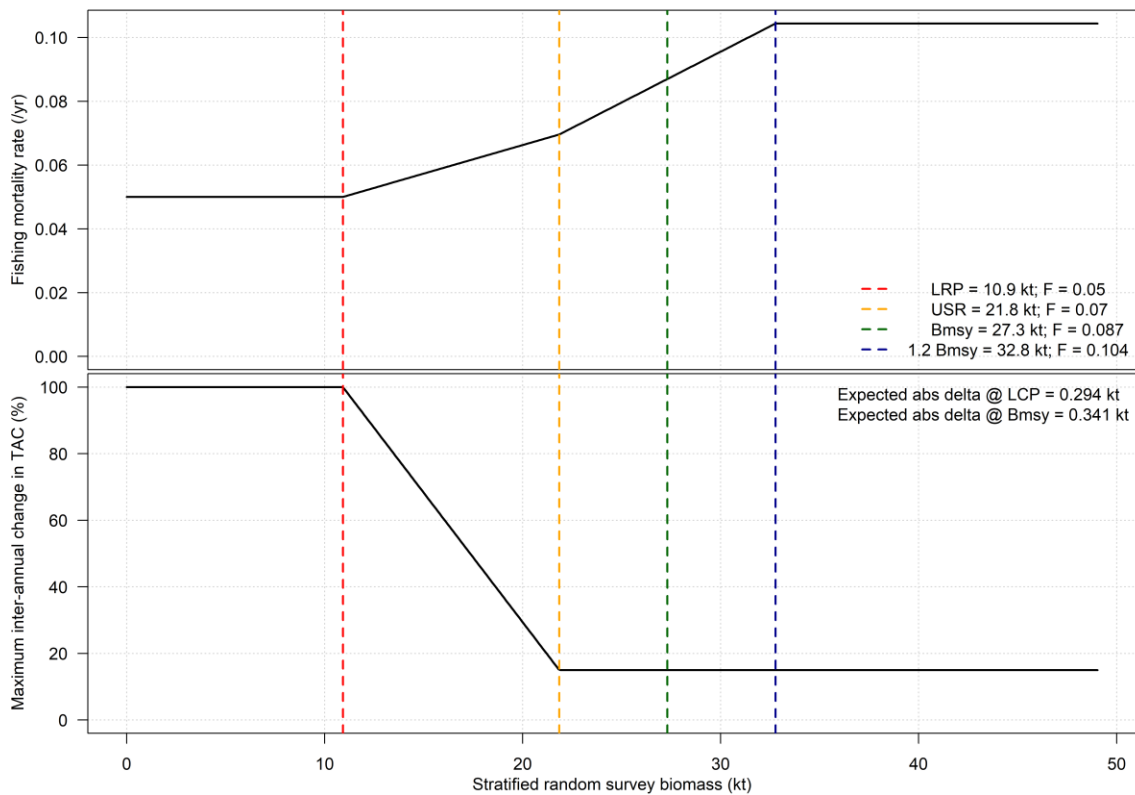


Figure 3. The articulated harvest control rules with reference points and control points used for determining target harvest rates for Atlantic halibut based on estimates of Stratified Random Halibut Survey biomass.

Analysis and Response

DFO Summer RV Survey (4VWX)

The DFO Summer RV Survey (NAFO Divs. 4VWX) has been conducted typically July–August 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 4). Since 2011, catch rates (number/tow) have declined and then reached the second peak in 2015. The mean numbers per tow in 2019 and 2020 were lower than they have been since 2011 but still above the long-term mean. The 2018 and 2022 DFO Summer RV Survey did not cover all strata due to mechanical issues with the vessel. Therefore, the abundance index of the two years cannot be compared with other years. Additionally, an abundance index cannot be estimated for 2021 because the RV survey was completed using a new vessel with a new fishing net and the conversion factor has not been developed (Figure 4).

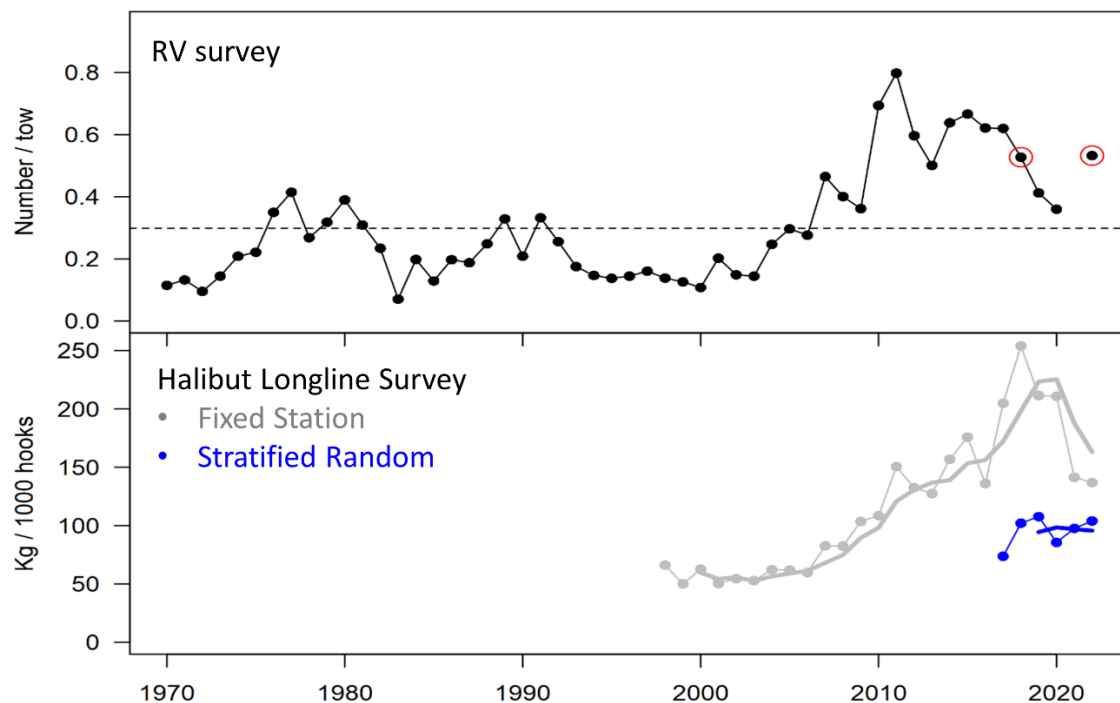


Figure 4. Plot of mean number of Atlantic Halibut per tow for the DFO Summer Research Vessel Survey sets in 4VWX from 1970 to 2020 (top). Red circle indicates 2018 and 2022 where the survey had incomplete coverage and 2021 is not shown as a conversion factor for the survey vessel has not yet been estimated. The dashed horizontal line is the long-term mean (0.30 per tow based on data from 1970–2020 except 2018). The bottom figure plots the biomass indices in kg/1000 hooks from the Fixed Station (grey) and Stratified Random (blue) Halibut Surveys with thick lines showing the three-year mean.

Halibut Longline Survey

The Halibut Longline Survey provides an index of exploitable biomass of Atlantic Halibut. The survey is conducted by commercial fishermen with onboard observers between May and August with a Fixed Station Survey since 1998 and with a Stratified Random Halibut Survey since 2017.

The biomass index from the Fixed Station survey peaked in 2018 with the 2022 index close to the 2021 index and the three-year mean peaked in 2020 and declined in the last two years (Figure 4). By contrast, inter-annual changes in the biomass index have been substantially smaller in the Stratified Random Halibut Survey (Figure 4). The 2022 index was close to the highest index in 2019. The three-year mean remained relatively stable with a slight decline in 2022.

Stock Status Relative to the Reference Points

The LRP is $0.4 SSB_{MSY} = 5.3$ kt and the USR is $0.8 SSB_{MSY} = 10.6$ kt with conversion to the Stratified Random Halibut Survey biomass (Table 2). Based on the three-year mean index of exploitable biomass from the Stratified Random Halibut Survey (Figure 4) and catchability of 0.002 (Table 2), the 2022 biomass is near record levels at 52 kt (95% confidence interval: 36, 68), which is $1.9 B_{MSY}$ and substantially higher than the USR (21.8 kt), putting this stock in the Healthy Zone.

Harvest Control Rule

As the 2022 three-year mean biomass based on the Stratified Random Halibut Survey is higher than the $1.2 B_{MSY}$ (32.8 kt, Table 2), the highest fishing mortality, $1.2 F_{MSY}$ (0.104), would be applied based on the articulated HCR, resulting in a preliminary 2023–2024 TAC of 4,744 t. As this is within the maximum annual change of 15% from the 2022–2023 TAC (4,807 t), the 2023–2024 TAC is finalized as 4,744 t. This application of the harvest control rule assumes all removals from Canadian and international fisheries are included.

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 stock has increased from the depleted state observed in the early 1990s. The 2022 three-year mean biomass based on the Stratified Random Halibut Survey is $1.9 B_{MSY}$ and higher than the USR, putting this stock in the Healthy Zone. Based on the articulated harvest control rule adopted by the SFGAC and the 3-year mean index from Stratified Random Halibut Survey, a 2023/2024 TAC is 4,744 t, only 63 t (1%) less than last year.

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Sources of Information

DFO. 2020. [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. 2020/017.

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