



# STOCK STATUS UPDATE OF ATLANTIC HALIBUT (*HIPPOGLOSSUS HIPPOGLOSSUS*) ON THE SCOTIAN SHELF AND SOUTHERN GRAND BANKS IN NAFO DIVISIONS 3NOPS4VWX5ZC FOR 2023

## Context

Atlantic Halibut (*Hippoglossus hippoglossus*) is the largest of the commercial 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 ( $\geq 81$  cm total length) was fully established in 1995. The Fisheries and Oceans Canada (DFO) Maritimes Summer Ecosystem Research Vessel (RV) Survey provides an index of abundance for incoming recruitment for the stock. An Industry-DFO Halibut Longline 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 Industry-DFO Halibut Longline Survey (hereafter referred to as the Stratified Random Halibut Survey) was initiated extending 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 2022 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. 2024). Harvest level advice will be based on the exploitable biomass index from the Stratified Random Halibut Survey (Figure 1). The abundance index from the DFO Summer Ecosystem RV Survey (NAFO Divs. 4VWX) is monitored as an index of recruitment.

DFO Resource Management asked Science to update the Atlantic Halibut stock status and provide 2024–2025 TAC advice based on the articulated harvest control rule adopted at the Scotia-Fundy Groundfish Advisory Committee (SFGAC) meeting in March 2022.

This Science Response Report results from the regional peer review of December 6, 2023 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

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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 length at 50% maturity at about 119 cm (total length) while males reach length at 50% maturity at about 77 cm (Li et al. In prep)<sup>1</sup>.

**Description of the Fishery**

The management unit definition (NAFO Divs. 3NOPs4VWX5Zc) 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. 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 (Table 1, Figure 2). Every year since 2017, 100 t of the TAC have been set aside to cover catches by USA and France within the stock area.

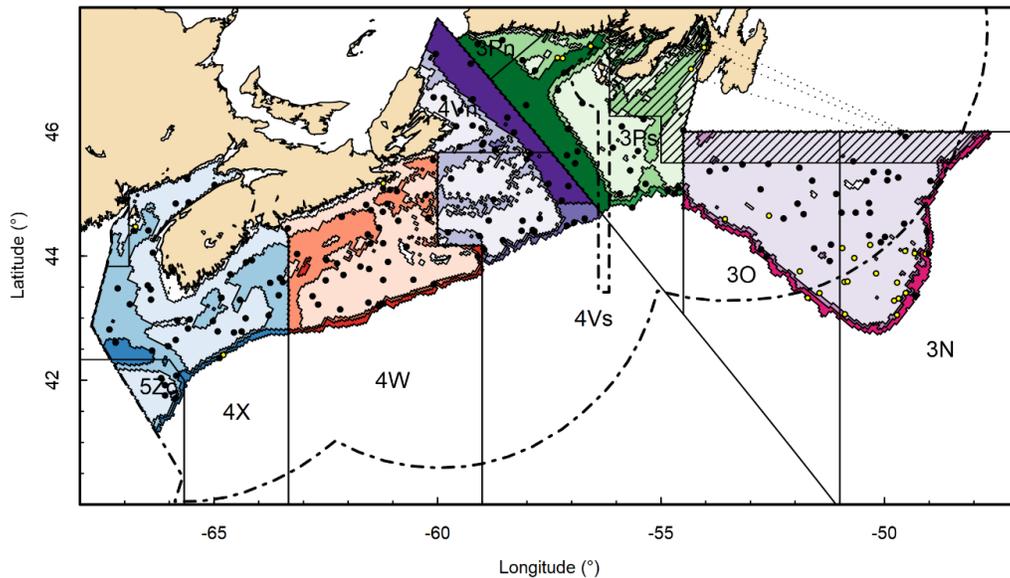


Figure 1. The Stratified Random Industry-DFO Halibut Longline survey area is separated into five zones across the Scotian Shelf (SS) and southern Grand Banks (GB) represented by different colours. Each zone is further separated into three depth strata, shown in different shades of each colour. The hatched area is a new strata with lower station allocation introduced in 2023. The survey area includes division 3Pn, which is not part of the management unit. Two hundred stations were assigned in the 2023 survey, black dots indicate completed stations and yellow dots indicate incomplete stations. Solid black lines represent Northwest Atlantic Fisheries Organization Division boundaries, while international boundaries are marked with dashed lines.

<sup>1</sup> Li, L., Hubley, B., Harper, D.L., Wilson, G., and C.E. den Heyer. In prep. Data Inputs for the Assessment Framework Review of Atlantic Halibut on the Scotian Shelf and Southern Grand Banks in Northwest Atlantic Fisheries Organization Divisions 3NOPs4VWX5Zc. DFO Can. Sci. Advis. Sec. Res. Doc. Presented and reviewed at the November 23–26, 2021 (Part 1) Framework Review for Atlantic Halibut.

**Maritimes Region**

The NAFO statistics are used to describe removals up to and including 2022 because landings occur in two DFO regions (Maritimes and Newfoundland and Labrador [NL]). Other countries including Portugal, Spain, France, and the United States of America harvest Atlantic Halibut from within the stock area as well, but outside Canada's Exclusive Economic Zone (EEZ). Landings from the Maritimes Fisheries Information System (MARFIS) database are reported as preliminary Canadian landings for 2023. These preliminary landings do not include landings in NL. The majority of landings occur on the Scotian Shelf (NAFO Divs. 4VWX).

*Table 1. Total reported Canadian and foreign landings (tonnes) of Atlantic Halibut from Northwest Atlantic Fisheries Organization (NAFO) Divisions 3NOPs4VWX5Zc<sup>1</sup> and total allowable catch (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 8, 2023. A dash (-) indicates where data are not available.*

Year	Canadian Landings			Foreign Landings			3NOPs4VWX5Zc	
	3NOPs	4VWX5Zc <sup>1</sup>	Total	3NOPs	4VWX5Zc <sup>1</sup>	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 <sup>a,b</sup>	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	1,614	3,027	4,641	317	1	318	4,959	4,807
2023 <sup>c</sup>	1,606	2,454	4,058	-	-	-	-	4,744

<sup>1</sup>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.

<sup>a</sup>Landings were first listed in 5Zc in 1986; 5Zc and 5Ze are used to indicate same area.

<sup>b</sup>Prior to 1988 the Atlantic Halibut catch was unregulated.

<sup>c</sup>Landings from the Maritimes Fisheries Information System (MARFIS) for 2023 are preliminary, as of November 8, 2023. Landings for NL in 2023 are not included as they are not yet available.

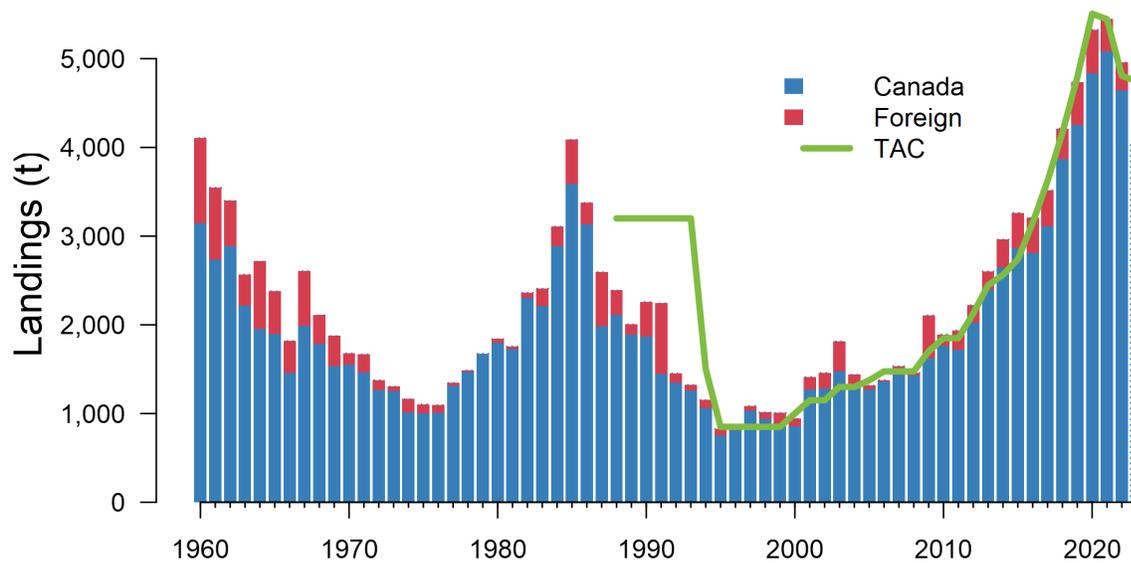


Figure 2. Northwest Atlantic Fisheries Organization (NAFO) reported Canadian (blue) and foreign (red) landings (tonnes) for 3NOPs4VWX5Zc Atlantic Halibut. Landings for 2023 (hashed bar) are preliminary, and taken from the Maritimes Fisheries Information System (MARFIS) as of November 8, 2023 (this does not include landings in Newfoundland which are not yet available). The solid green line is the Canadian total allowable catch (TAC). The NAFO 21A table of landings by country is 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 2022<sup>1</sup>. 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 female biomass, derived from the new assessment model using estimates of female age-at-maturity at 50% (11.5 years) and 95% (14.5 years), is used to estimate 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 index of exploitable biomass from the Stratified Random Halibut Survey (Figure 3). Although reference points have been defined based on SSB, reference points and control points for the HCR use the Stratified Random Halibut Survey biomass that correspond to SSB ( $LRP = 0.4 B_{MSY}$ ,  $USR = 0.8 B_{MSY}$ ,  $B_{MSY}$ , and  $1.2 B_{MSY}$ ; Table 2).

The HCR has two steps. First, a fishing mortality rate (F) is applied to the exploitable biomass estimated from the three-year mean of the Stratified Random Halibut Survey to calculate TAC. The articulated HCR includes three control points, the LRP, USR, and  $1.2 B_{MSY}$ . Below the LRP, F is capped at 0.05 and above the USR it is relative to  $F_{MSY}$  (i.e.,  $F = 0.8 F_{MSY}$  when  $B = 0.8 B_{MSY}$ ) up to the third control point ( $1.2 B_{MSY}$ ), above which it is capped at  $1.2 F_{MSY}$  (Figure 3). Second, the percentage change from last year's TAC is limited by the sliding inter-annual TAC change threshold, where the limit of change ranges from 15% at the USR to 100% at the LRP (Figure 3).

Stock status in interim years is assessed based on the three-year mean exploitable biomass index from the Stratified Random Halibut Survey. The next assessment framework review is currently scheduled for 2026. However, if the three-year mean index of exploitable biomass from the Stratified Random Halibut Survey falls above or below the 90% probability envelope from the closed-loop simulation for that index, a new framework will be triggered. Reference points based on the female spawning stock biomass (SSB) developed during the 2021 assessment<sup>1</sup> are reported here (Table 2), but are not used in the HCR.

Table 2. MSY-based reference points (limit reference point [LRP] and upper stock reference [USR]) and control points (LRP, USR, and 1.2 B<sub>MSY</sub>) for Atlantic Halibut spawning stock biomass (female) and Stratified Random Industry-DFO Halibut Longline 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/1,000 hooks) to the Stratified Random Halibut Survey Biomass (kt).

Model-estimated Biomass	LRP	USR	B <sub>MSY</sub>	1.2 B <sub>MSY</sub>	Catchability q
Spawning Stock Biomass (female) (SSB)	5.3 kt	10.6 kt	13.3 kt	16.0 kt	-
Stratified Random Halibut Survey Biomass (B)	10.9 kt	21.8 kt	27.3 kt	32.8 kt	0.002

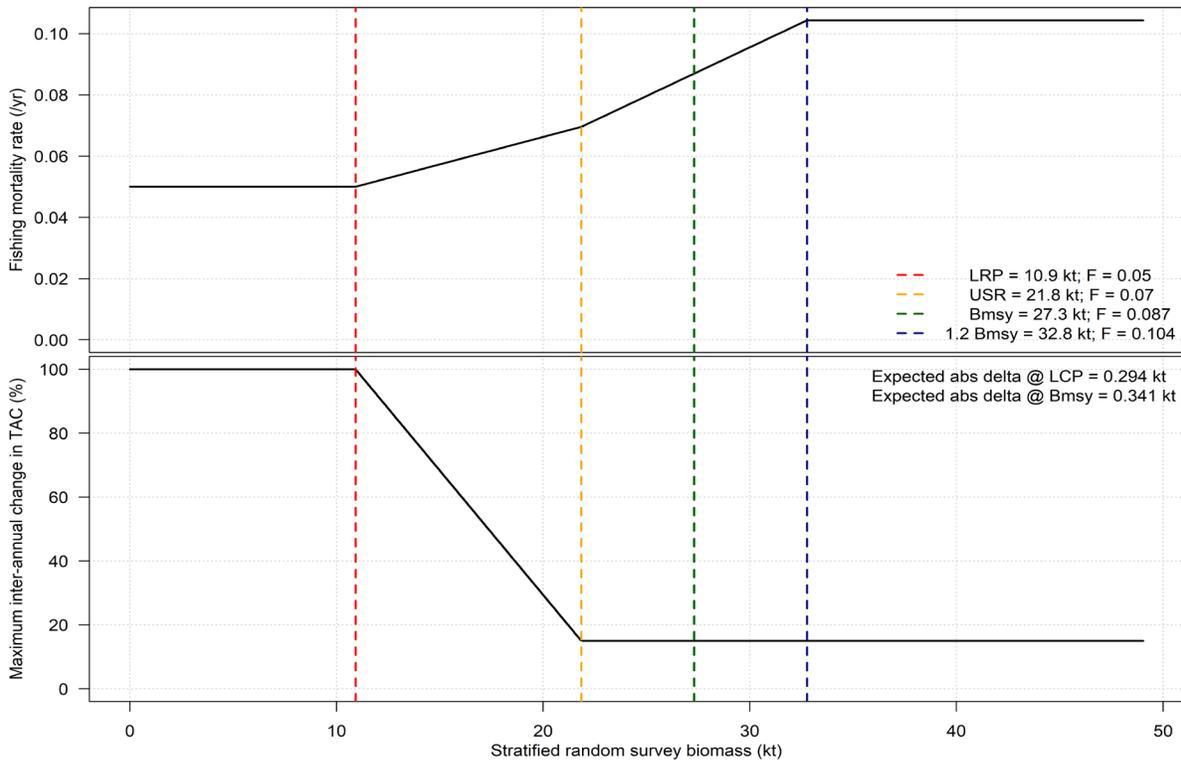


Figure 3. The articulated harvest control rules with reference points and control points used for determining target harvest rates for Atlantic Halibut based on biomass estimates from the Stratified Random Industry-DFO Halibut Longline Survey. LRP = limit reference point, USR = upper stock reference, F = fishing mortality rate, LCP = limit control point, B<sub>msy</sub> = Biomass at maximum sustainable yield.

## Analysis and Response

### DFO Summer Ecosystem RV Survey (4VWX)

The DFO Summer Ecosystem RV Survey (NAFO Divs. 4VWX) has been conducted typically between July–August since 1970. The RV survey provides an index of recruitment for Atlantic Halibut. The median size of Atlantic Halibut caught in the trawl survey is between 40–50 cm. The catch of Atlantic Halibut in this survey increased between 2000 and 2011 (Figure 4). This was followed by a decline. The mean numbers per tow in 2019 and 2020 were lower than they have been since 2011, but were still above the long-term mean. The 2018 and 2022 DFO Summer Ecosystem RV Survey did not cover all strata due to mechanical issues with the vessel; therefore, the abundance index from those 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). The abundance index for 2023 is the fifth highest value in the time series. The length composition and the index of abundance are reviewed annually, exclusively for context and do not directly contribute to the HCR outputs.

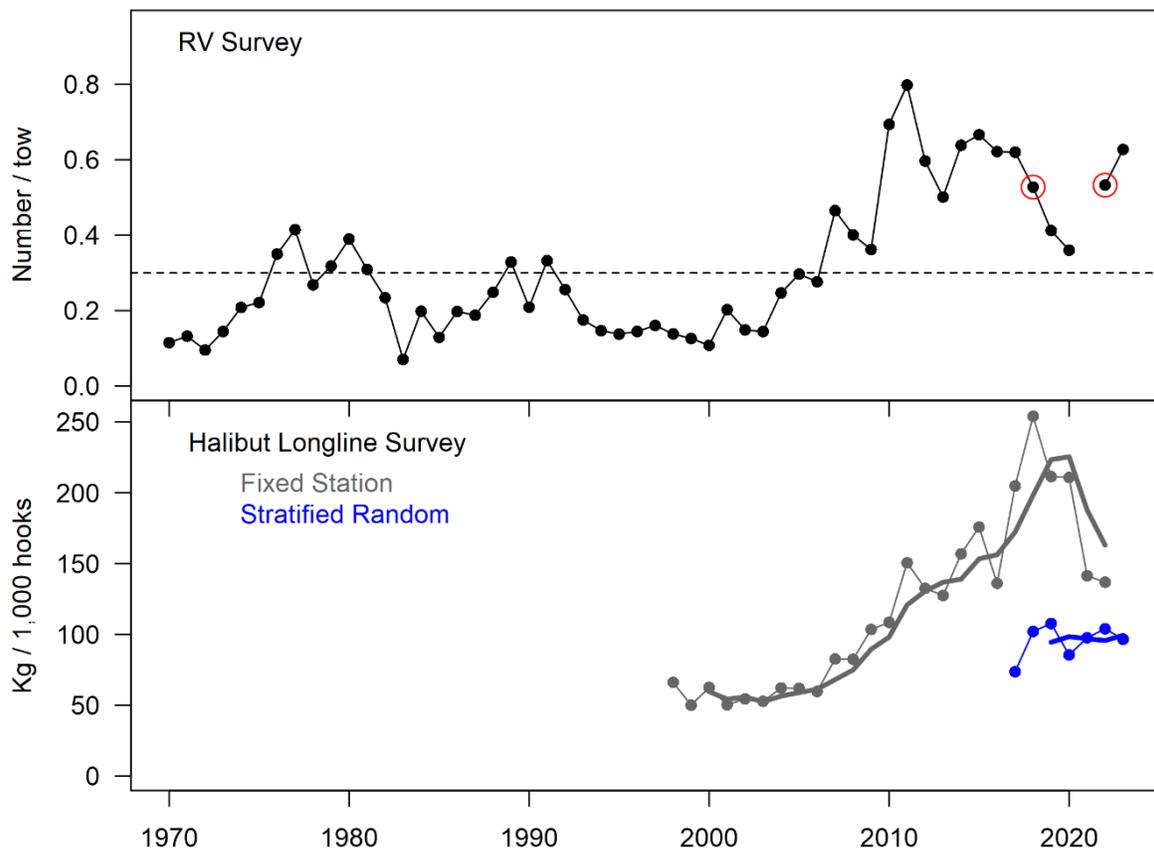


Figure 4. Mean number of Atlantic Halibut per tow for the DFO Summer Research Vessel Survey sets in 4VWX from 1970 to 2023 (top). Red circles indicate 2018 and 2022, where the survey had incomplete coverage, and 2021 is not shown as a conversion factor for the survey vessel has not yet been estimated. The dashed horizontal line is the long-term mean (0.30 per tow based on data from 1970–2023 except 2018 and 2022). Exploitable biomass indices in kg/1,000 hooks from the Fixed Station (grey) and Stratified Random (blue) Industry-DFO Halibut Longline Surveys with thick lines showing the three-year mean (bottom).

## Halibut Longline Survey

The Industry-DFO 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, and spans NAFO areas 3NOP4VWX5Zc. The biomass index from the previous Fixed Station Halibut Survey (1998–2022) peaked in 2018 and the three-year mean peaked in 2020, followed by a decline in the final two years of that survey (Figure 4). By contrast, inter-annual changes in the exploitable biomass index have been substantially smaller in the Stratified Random Halibut Survey (Figure 4). With the switch to an exclusively stratified random design in 2023, there was also a change in the allocation of stations and stratification of the stock area. A new stratum was introduced in an area in the northeast where there has been little to no catch of Atlantic Halibut in the Stratified Random Halibut Survey since 2017 (Figure 1). Allocation of stations in the new stratum was reduced, while for the rest of the strata allocation was proportional to area. Due to challenges with survey completion and the low number of stations in two strata on the shelf edge of the southern Grand Banks, two small strata were combined to allow for the calculation of exploitable biomass from the survey this year. The 2023 index of exploitable biomass was close to the index observed in 2021. The three-year mean remained relatively stable with a slight increase in 2023.

## Stock Status Relative to the Reference Points

The LRP is  $0.4 B_{MSY} = 10.9$  kt and the USR is  $0.8 B_{MSY} = 21.8$  kt (Table 2). The 2023 biomass from the Stratified Random Halibut Survey was estimated using a catchability of 0.002 (Table 2) to be 48 kt (95% confidence interval: 36, 61). Based on the three-year mean (Figure 4), the exploitable biomass index from the Stratified Random Halibut Survey for 2023 is 50 kt which is  $1.8 B_{MSY}$ , and substantially higher than the USR (Table 2), putting this stock in the healthy zone.

## Harvest Control Rule

As the 2023 three-year mean exploitable biomass based on the Stratified Random Halibut Survey is higher than  $1.2 B_{MSY}$  (32.8 kt, Table 2), the highest fishing mortality,  $1.2 F_{MSY}$  (0.104), would be applied using the articulated HCR. This results in a TAC advice for 2024–2025 of 4,927 t. As this is within the maximum annual change of 15% from the 2023–2024 TAC (4,744 t), the 2024–2025 TAC advice is 4,927 t. This application of the HCR assumes all removals from Canadian and international fisheries are included.

## Conclusions

The 3NOPs4VWX5Zc Atlantic Halibut stock experienced 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 2023 three-year mean exploitable biomass based on the Stratified Random Halibut Survey is  $1.8 B_{MSY}$  and higher than the USR, putting this stock in the healthy zone. Based on the articulated HCR adopted by the SFGAC and the three-year mean exploitable biomass index from the Stratified Random Halibut Survey, the TAC advice for 2024–2025 is 4,927 t; this is 183 t (4%) more than last year's TAC.

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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.
- Johnson, S., Hubley, B., Cox, S.P., den Heyer, C.E., and Li, L. 2024. [Framework Assessment of Atlantic Halibut on the Scotian Shelf and Southern Grand Banks \(NAFO Divisions 3NOPs4VWX5Zc\)](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2024/013. iv + 58 p.

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