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

Quebec Region

Canadian Science Advisory Secretariat
Science Advisory Report 2023/036

STOCK ASSESSMENT OF GULF OF ST. LAWRENCE (4RST) ATLANTIC HALIBUT IN 2022

Atlantic halibut (Hippoglossus hippoglossus)
Photo: DFO, Claude Nozères.

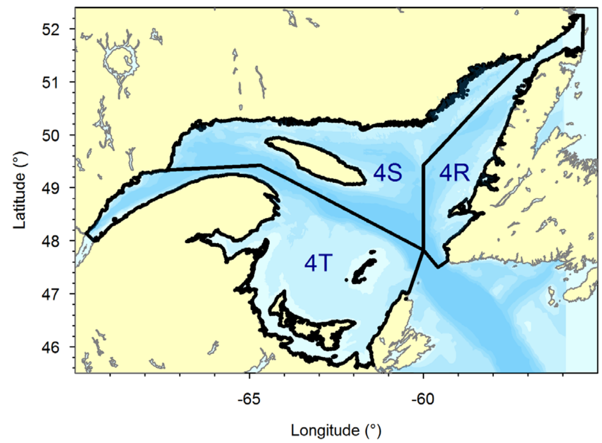

Figure 1. Atlantic halibut stock management area in the Gulf of St. Lawrence (NAFO 4RST).

Context:

The Atlantic halibut commercial fishery in the Gulf of St. Lawrence began at the end of the 19th century. During the first half of the 20th century, this resource was exploited by American and Canadian fleets. Since the second half of the 20th century, the species has been exploited almost exclusively by the Canadian fleet from the four Atlantic provinces as well as Quebec. From over 650 t during the 1960s, landings steadily decreased until the early 1980s, totaling 91 t in 1982. Landings increased again in the late 1990s and are now around 1,500 t, the highest level recorded in the past 60 years.

The current Gulf Atlantic halibut stock management unit (Figure 1), Northwest Atlantic Fisheries Organization (NAFO) divisions 4RST, was defined in 1987. In 1988, Fisheries Management introduced the first total allowable catch (TAC), followed in 1997 by a minimum legal size. The Atlantic halibut directed fishery is carried out by using longlines under a competitive management regime or by individual transferable quota (ITQ).

Assessment of the resource is conducted every two years in order to highlight changes in the status of the resource that would justify adjustments to the conservation measures and management plan. The current assessment puts into perspective the available information from fishery statistics, commercial catch sampling and scientific survey data.

This Science Advisory Report is from the March 6–7, 2023 regional peer review meeting on the Assessment of the Gulf of St. Lawrence (4RST) Atlantic Halibut stock. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

SUMMARY

- Atlantic halibut landings have been increasing since the early 2000s and have reached the highest values since 1960. For the 2021-2022 and 2022-2023 management years, preliminary landings are 1,526 t and 1,407 t respectively.
- The biomass indices of commercial-sized Atlantic halibut (greater than 85 cm) from trawl surveys in 2021 and 2022 are among the highest in historical series.
- Abundance indices of Atlantic halibut pre-recruits (65 to 85 cm) from trawl surveys show high values since the mid-2000s.
- The catch per unit effort of the Atlantic halibut in the directed longline fishery increased from the early 2000s to the mid-2010s. Since then, it has been high and stable at about 450 kg per 1,000 hooks.
- The average size and weight of landed Atlantic halibut are increasing since 2006.
- Adjustment of a delay-difference type assessment model, integrating DFO monitoring, longline survey and capture-mark-recapture, shows that the biomass of the commercial-sized stock is growing to reach 94,482 t in 2022.
- A limit reference point is set at 40% of the theoretical biomass at the maximum sustainable yield (B_{MSY}), i.e. 25,291 t. A upper stock reference point (USR) is proposed at 80% of the B_{MSY}, i.e., 50,582 t, and would place the stock in the healthy zone of the precautionary approach. However, the results of the model are sensitive to the adjustment parameters chosen.
- The exploitation rates estimated by the model have been low for 15 years and are consistent with the values observed from capture-mark-recapture work and the relative exploitation rates obtained from the minimum trawlable biomass of DFO surveys.
- The model's 2-year projections show that a significant increase in removals is not expected to cause a decrease of the stock biomass, which would remain within the healthy zone under the proposed USR. These projections are robust to different modelling scenarios.

BACKGROUND

Atlantic halibut can be found throughout the lower estuary and Gulf of St. Lawrence (GSL). Figure 2 shows the distribution of catches made during fishery-independent mobile gear surveys which took place between July and September from 1985 to 2020. The probability of capture is higher on the channel banks at depths near 200 m, and around the 35 m isobath. Atlantic halibut generally seem to avoid the cold intermediate layer where temperatures are less than 1 C, typically located between 50 m and 100 m depth. Some Atlantic halibut have been observed to undertake seasonal migrations, moving from shallow areas in the summer (less than 50 m) to deeper channels in the winter. Potential breeding areas were identified through geolocation by modelling locations where tagged fish made rapid vertical migrations likely associated with spawning. These behaviours were observed between mid-January and mid-March at depths greater than 300 m in the GSL channels.

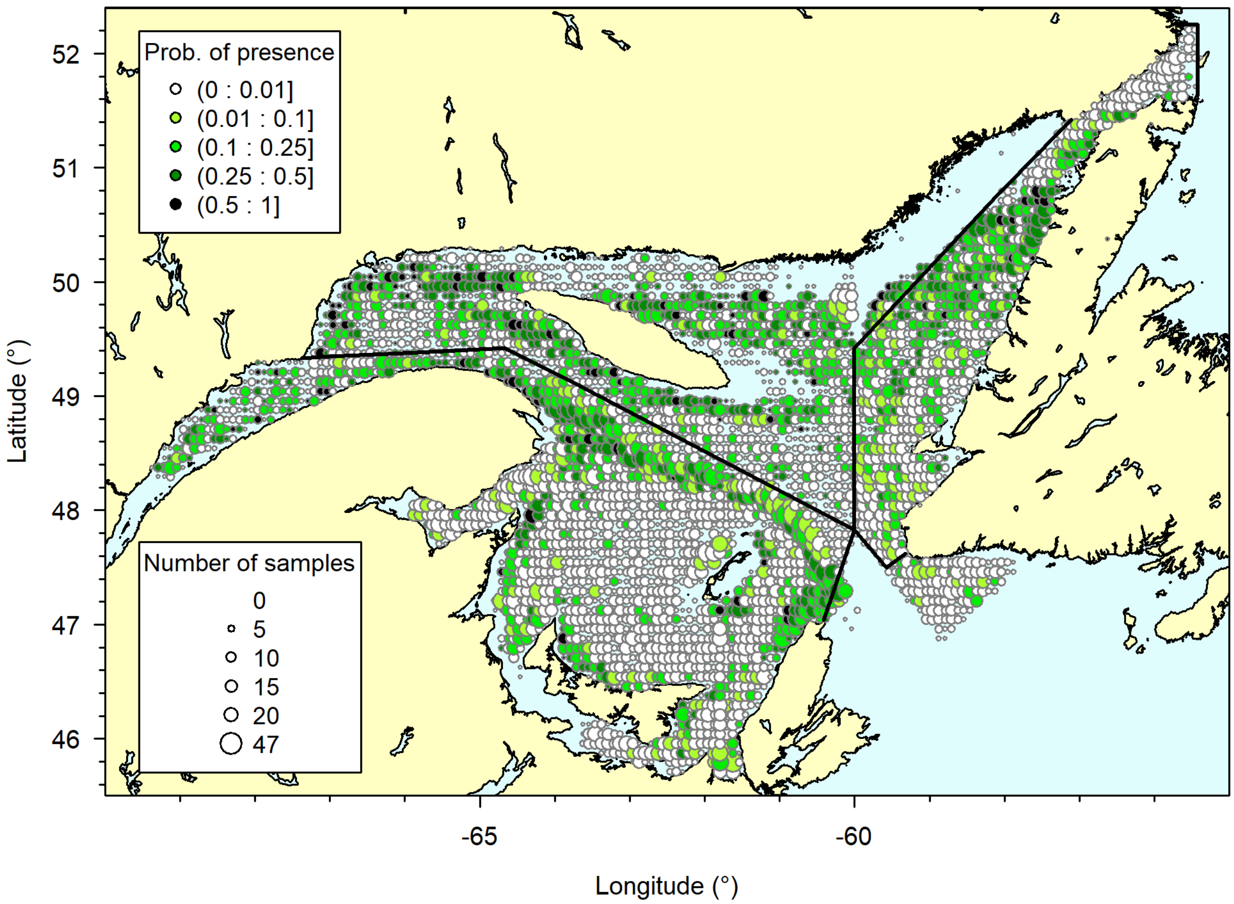

Figure 2. Probability of occurrence of Atlantic halibut in catches made during mobile gear research surveys, per 5-minute squares. All available years for each survey conducted during different periods between 1985 and 2022 are shown.

The ecosystem of the GSL has undergone significant changes in recent decades, including warming of deeper waters, where record high temperatures were observed in 2022, and the return of high redfish (*Sebastes sp.*) abundances. The temperatures observed in deeper waters are not expected to negatively impact the survival or development of Atlantic halibut, as they do not exceed the documented preferred temperatures for the species. Research on the prey of Atlantic halibut and redfish in the estuary and northern Gulf of St. Lawrence (nGSL) has shown that the diet of Atlantic halibut older than three years differs from that of redfish. The impact of competition for prey between redfish and Atlantic halibut younger than three years still needs to be assessed.

Annual landings of Atlantic halibut were on the order of 600 t in the early 1960s (Figure 3). Landings then decreased to a historical low of 91 t in 1982. TACs were established in 1988 and were reached on only four occasions between 1988 and 2004. Annual landings reached their highest level in 60 years in 2021 and 2022 at around 1,500 t. Since 2017, a 50 t to 60 t allocation has been taken from the TAC and set aside under section 10 of the *Fisheries Act* to support the longline survey project and the annual tagging conducted by DFO in partnership with the industry. The remaining quota is distributed among 12 fleets in Quebec and the four Maritime provinces, including eight inshore fixed-gear fleets involved in the directed fishery. Atlantic halibut are caught as bycatch by other fleets, mostly by the Greenland halibut

(*Reinhardtius hippoglossoides*) gillnet fleet. Over the past five years, landings of Atlantic halibut by Greenland halibut gillnet fleet accounted for 2.6% of overall landings, on average, in comparison with 96.2% for the directed longline fishery for Atlantic halibut.

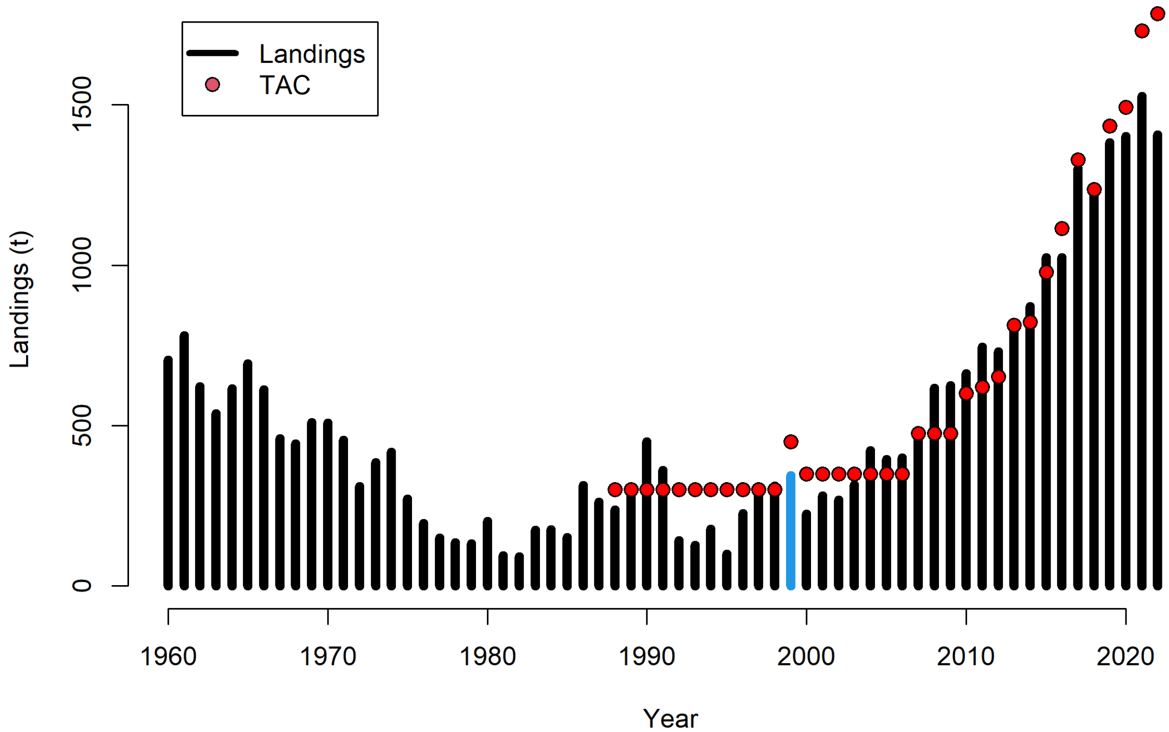

Figure 3. Atlantic halibut landings (t) and TACs (after revision) by fishery management cycle for NAFO divisions 4RST. Landings in 1999 (blue) were reported on an exceptional basis for a period of one year and 135 days due to a change in the definition of the management year. Data for 2017 to 2022 are preliminary.

A number of management measures have been implemented over the years to protect Atlantic halibut. In 1997, a minimum legal size (MLS) of 81 cm was incorporated into commercial fishing license conditions. The MLS was increased to 85 cm in 2010. All Atlantic halibut smaller in size must be returned to the water. There are other existing management measures, such as a dockside commercial catch monitoring program (100%), at-sea coverage by observers (percentage varies by fleet), mandatory logbooks (except for vessels < 10.67 m in Newfoundland), predetermined fishing periods, limits on the size and maximum number of hooks allowed per line, small fish and bycatch protocols and, for the majority of Quebec fleets, a vessel monitoring system (VMS). A quota reconciliation program has been in effect since the 2011 fishing season. Any quota overruns in a given year are counted toward the established quota for the following season(s). The carry forward of uncaught quotas of Atlantic halibut from the previous year may be authorized for up to 15% of the initial quotas.

ASSESSMENT

Assessment of the Atlantic halibut stock status is based on commercial fishery data and analysis of fishery-independent research surveys. Commercial fishing data are taken from three different sources: purchase slips, fishers' daily logbooks, and biological samples of commercial catches collected at sea and dockside. Research survey data are derived from three bottom trawl surveys conducted annually between July and September and one longline survey conducted in September. Mark-recapture work has been carried out since 2017. A delay-difference type of population dynamics model relates these data. The fitting of this model estimates the biomass of the commercial size stock (B85) and relates it to a limit reference point (LRP) and a proposed upper reference point (USR).

Commercial Fishery

Atlantic halibut catches (Figure 4) were made mainly along the Esquiman, Anticosti, and Laurentian channels as well as on the north side of Prince Edward Island, on the Miscou bank, and around the Magdalen Islands. For some NAFO subdivisions, up to 165 t of Atlantic halibut (annual average) could not be associated with a geographic location, notably along the west coast of Newfoundland.

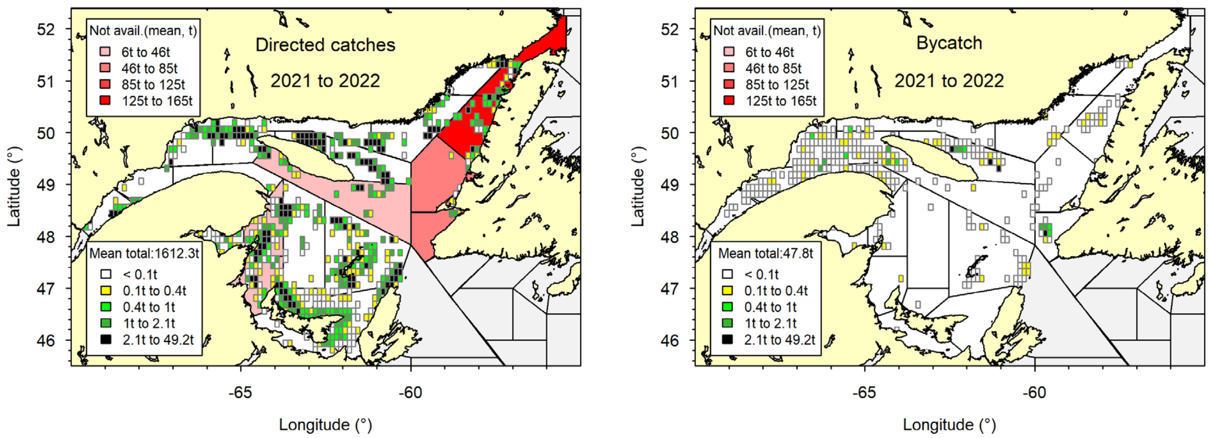

Figure 4. Spatial distribution of Atlantic halibut catches from directed fishery and by-catch per 7.5-minute square. Landings non-geolocated are reported to the NAFO subdivision (in red) and the average annual amount is show as Not avail. Data are preliminary.

The catch per unit effort (CPUE) corresponds to the annual average of observed CPUE for each individual landing divided by the effort required to obtain it. Annual CPUE is standardized to take into account changes in the fishing season (months), differences between NAFO divisions, and the size of the fishing vessels involved. Figure 5 shows the CPUE for all the NAFO divisions 4RST from 2003 to 2022. Commercial CPUE values were trending upward (from 100 kg/1000 hooks to 450 kg/1000 hooks) until mid-2010, and have remained relatively high and stable since. However, variations in the quality of the effort measure (temporal and spatial) were observed, particularly in NAFO division 4R (details in the “Sources of uncertainty” section). Fishing behaviour may have changed over time, namely due to the influence of financial incentives to target smaller commercial fish, a change in the MLS, and an increase in seal depredation of hooked Atlantic halibut.

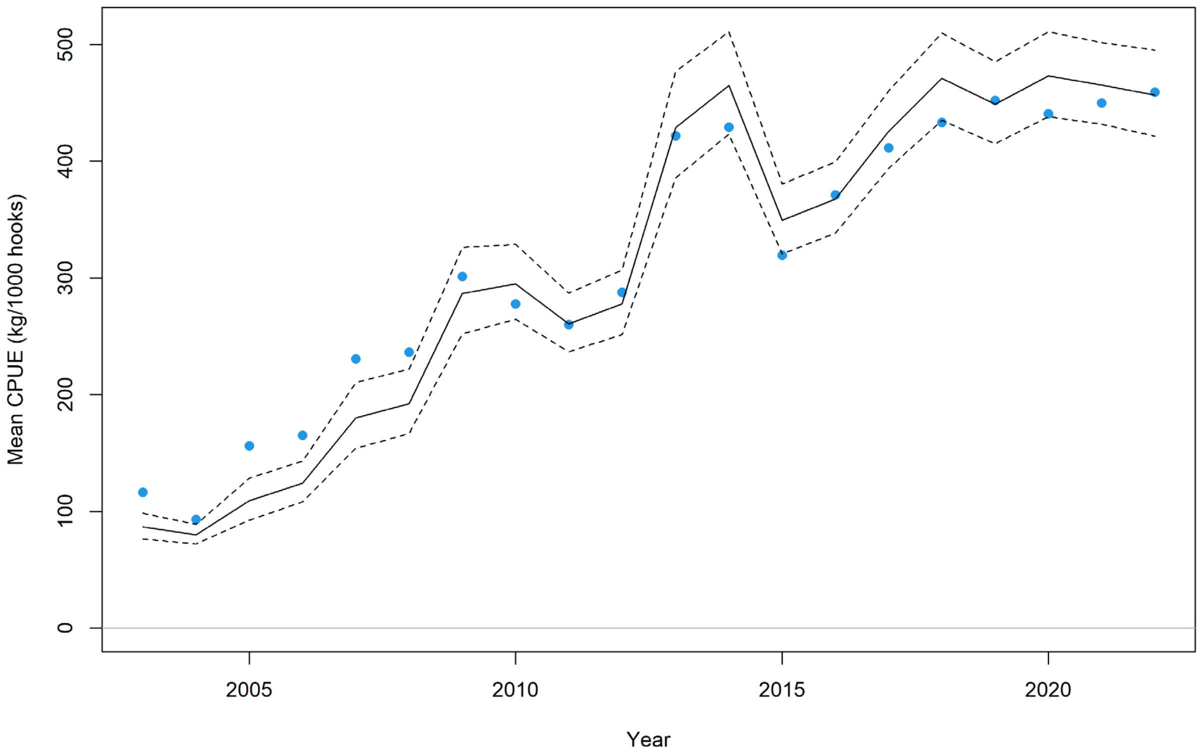

Figure 5. Catch per unit effort for the Atlantic halibut commercial longline fishery. The blue dots represent the average of the observed values (before standardization), and the solid line indicates the average predicted values after standardization. The dotted lines indicate the 95% confidence interval.

A DFO sampling program to gather biological data on Atlantic halibut landed at dockside and at processing plants has been in place since 1990. A second sampling campaign, conducted under the at-sea observer program, is carried out onboard fishing vessels and has been providing data since 1996. The information supplied by at-sea observers provides greater detail than what can be obtained from fishery monitoring documents submitted by fishers. Catches of all species, whether they are kept or released, are recorded. Figure 6 shows the sizes of Atlantic halibut captured in the commercial fishery and sampled at sea and at dockside, as well as the presumed growth trajectories of five cohorts (1994, 2002, 2006, 2012 and 2018). The sizes of Atlantic halibut sampled at dockside indicate that fish smaller than the MLS are virtually absent from the landings.

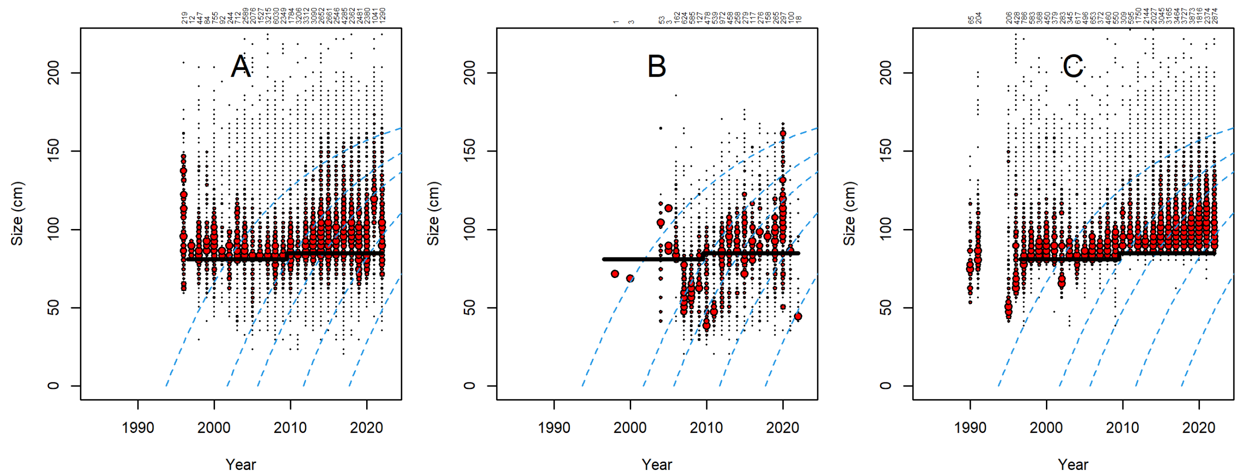

Figure 6. Distribution of Atlantic halibut size frequencies for at-sea sampling in the (A) longline and (B) gillnet fisheries as well as sampled at dockside for all fisheries (C). The diameter of each bubble is proportional to the number of individuals measured for the 3-cm size class and standardized by dividing by the number of measured individuals in the most abundant size class of the year. The total number of individuals sampled per year is indicated at the top of the graph. The dotted lines highlight the presumed trajectory of selected cohorts, and the minimum legal size in force is shown in black.

The measured size (cm) and mean estimated weight (kg) of Atlantic halibut caught with longlines have been increasing since 2005 (Figure 7). The mean weight of landed Atlantic halibut doubled between 2006 and 2022. The increase in the MLS in 2010 may have contributed to this rise. In addition to changes in fishing behaviour, a low exploitation rate (see below) allowing a greater number of Atlantic halibut to attain larger sizes could also account for this trend.

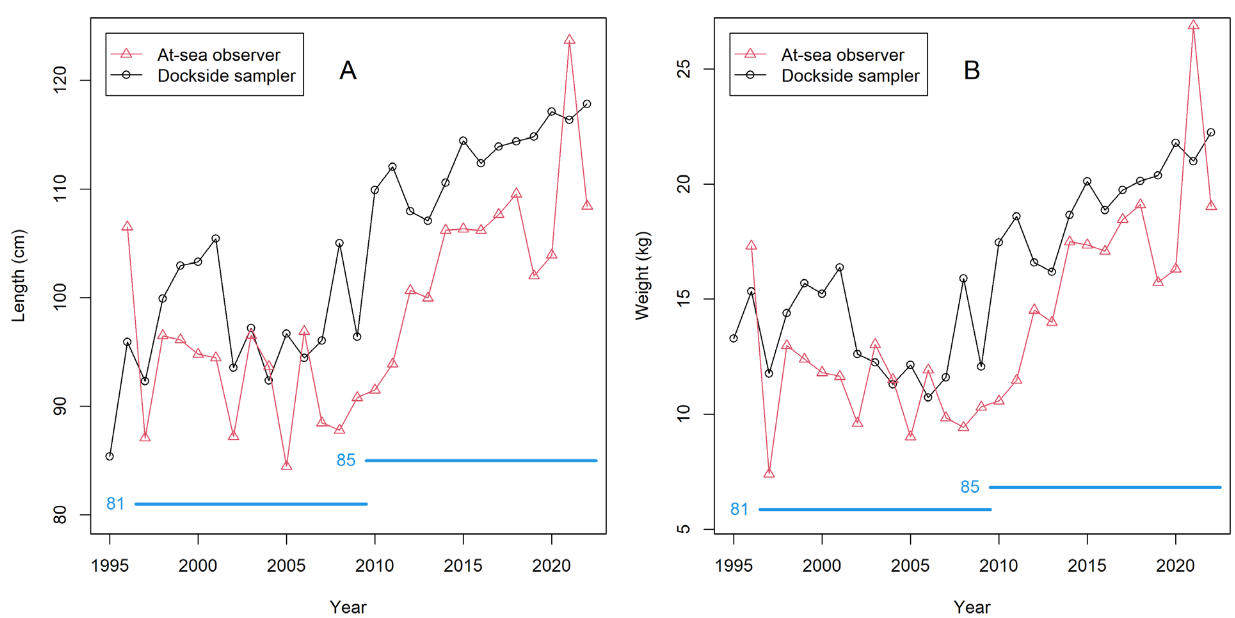

Figure 7. Mean size (A) of Atlantic halibut from the commercial longline fishery measured by at-sea observers and dockside samplers, from which mean weight is estimated (B). Periods with a different minimum legal size are indicated by a blue dash and labelled with the current value.

Research Trawl Surveys

The Atlantic halibut catch rates are from three research trawl surveys, the DFO research surveys in the nGSL and southern GSL (sGSL), and mobile gear sentinel fishery program in the nGSL. These indicators are disaggregated by size class in Figures 8 and 9. The size classes used make it possible to differentiate the fishable component (> 85 cm) from shorter-term recruitment (65–85 cm). In 2021 and 2022, the fishable biomass (also the biomass of the commercially sized stock, B85) of Atlantic halibut reached one of the highest values observed in each of the three surveys (Figure 8). Values for short-term recruitment (65–85 cm) were, in 2022, among the lowest observed in the past 15 years. However, they are considerably higher than the values seen in the 1990–2003 period (Figure 9). For all of the surveys, the large confidence intervals around the catch rates would usually prevent differences between years from being considered significant. However, the consistency among the various surveys suggests that the increase in catch rates over all the series is not a sampling artifact and instead reflects an increase in the abundance of the size classes monitored.

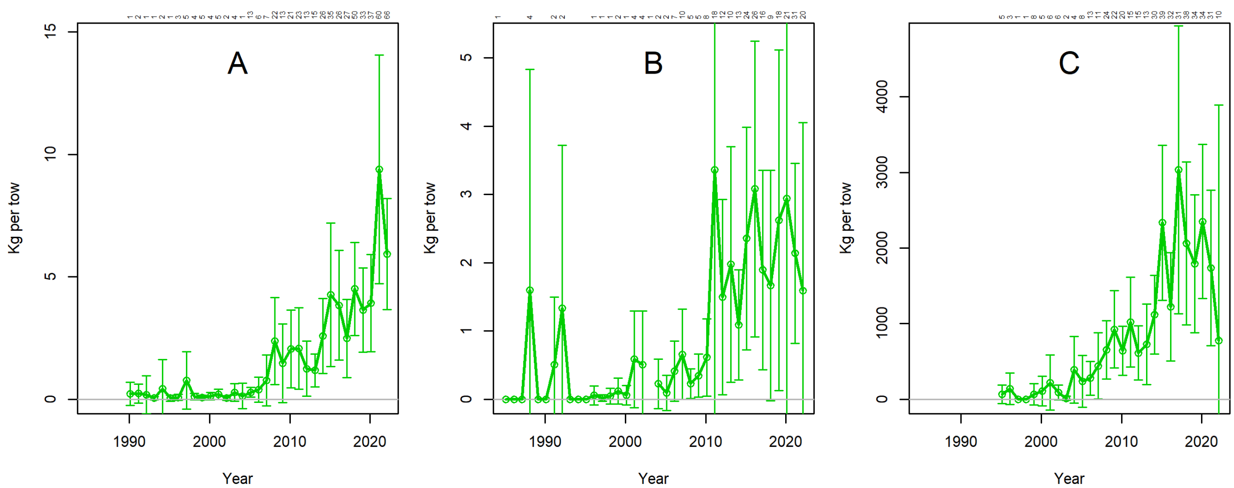

Figure 8. Average weight of Atlantic halibut per tow measuring larger than 85 cm in 3 fishery-independent trawl surveys: DFO research surveys in the nGSL (A) and sGSL (B) and the sentinel fishery program survey in the nGSL (C). The 95% confidence intervals are shown. The total number of individuals sampled per year is indicated at the top of the graph.

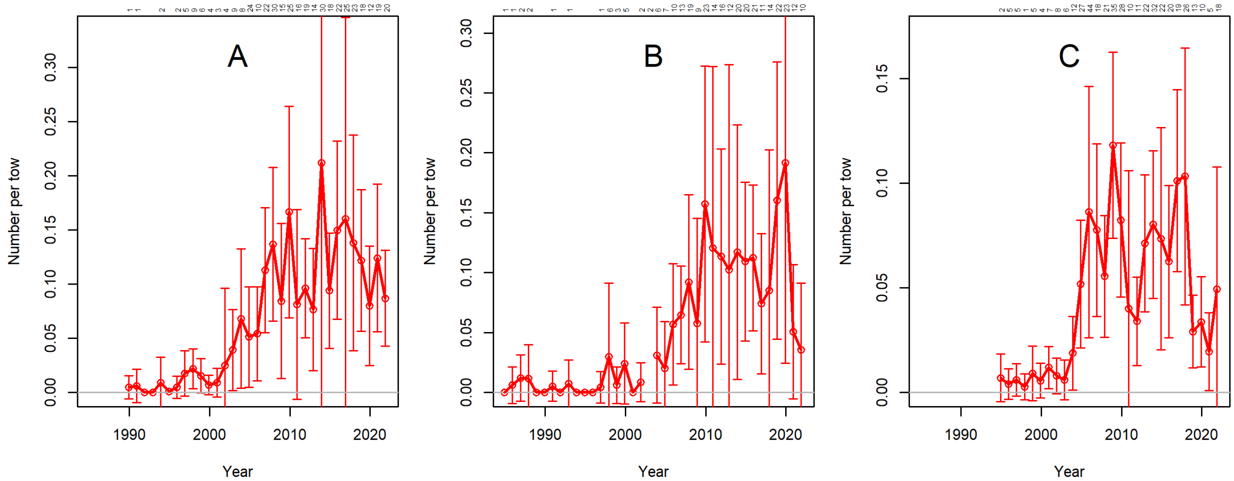

Figure 9. Average number of fish taken per tow measuring 65–85 cm as observed in 3 fishery-independent surveys: DFO research surveys in the nGSL (A) and sGSL (B) and the sentinel fishery program survey in the nGSL (C). The 95% confidence intervals are shown. The total number of individuals sampled per year is indicated at the top of the graph.

The size of the Atlantic halibut captured by two of the DFO surveys carried out in the nGSL and sGSL, as well as the sentinel fisheries program survey in the nGSL, consistently suggest the presence of cohorts of variable strength (Figure 10). The presumed growth trajectories of some cohorts indicated an average length increase of about 8.5 cm per year until recruitment to the fishery (85 cm) at approximately 10 years of age.

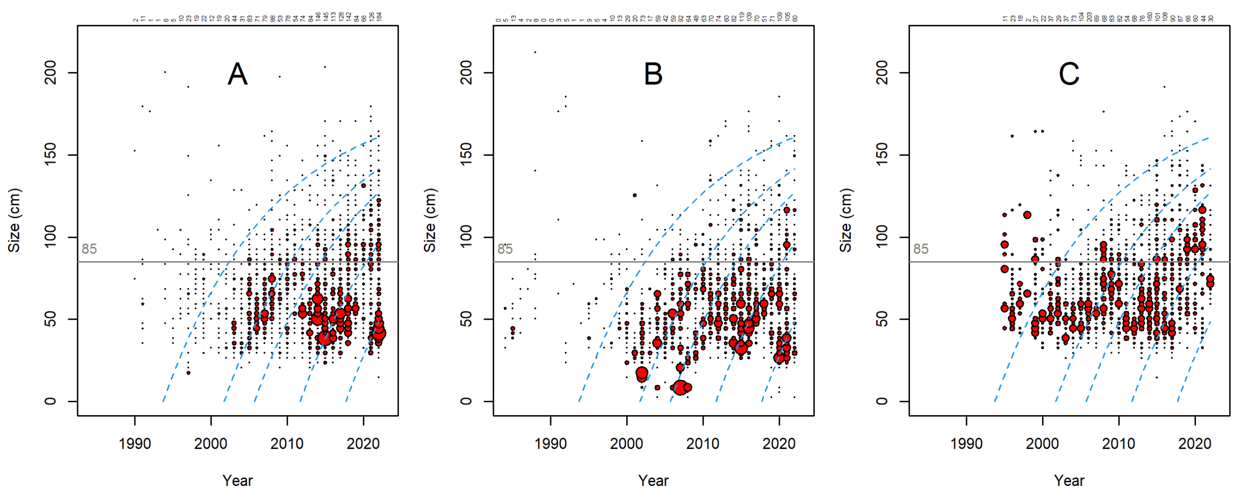

Figure 10. Atlantic halibut size frequency distributions for the trawl surveys conducted by DFO in the nGSL (A) and sGSL (B) and by the mobile gear sentinel fishery program in the nGSL (C). The diameter of each bubble is proportional to the number of individuals caught per 3-cm size classes (A and B) and standardized by dividing by the number of measured individuals in the most abundant size class of the year (C). The dotted lines highlight the presumed trajectories of selected cohorts, and the minimum legal size in effect in 2022, 85 cm, is shown in grey. The total number of individuals sampled per year is indicated at the top of the graph.

A relative exploitation rate is calculated by dividing observed landings by minimum trawlable biomass estimates for the fishable component. The minimum trawlable biomass is calculated for this stock by combining the results of the trawl surveys from DFO for the nGSL and sGSL (Figure 11A). The nGSL and sGSL surveys overlap over 3% of the total area covered. Figure 11A illustrates the contribution from the northern, southern and common components of both surveys. The average relative exploitation rate for the last 13 years is 0.067 (Figure 11B).

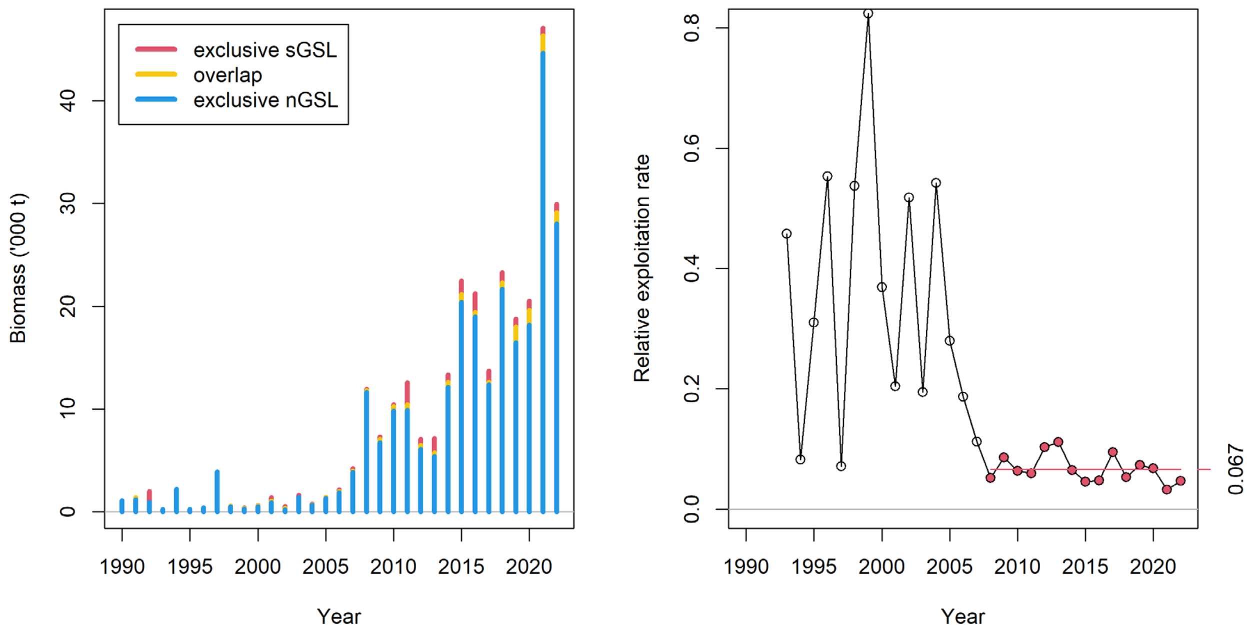

Figure 11. Minimum trawlable biomass for the fishable component as estimated by DFO trawl surveys (A) and corresponding relative exploitation rates (B). The biomass is described in terms of the contribution from the area covered by both surveys and the areas specific to each survey. The average relative exploitation rate for the last 15 years is represented by the horizontal red line.

Longline Research Survey

Starting in 2017, an annual scientific longline survey targeting Atlantic halibut has been carried out thanks to a collaboration between DFO and 6 fishing associations present in 4 of the eastern Canadian provinces. The survey aims to sample125 stations randomly distributed over the entire area occupied by Atlantic halibut in NAFO 4RST areas. The relatively short 6-year time series (Figure 12) does not yet make it possible to detect trends in catch rates and to infer the corresponding variations in spawning biomass.

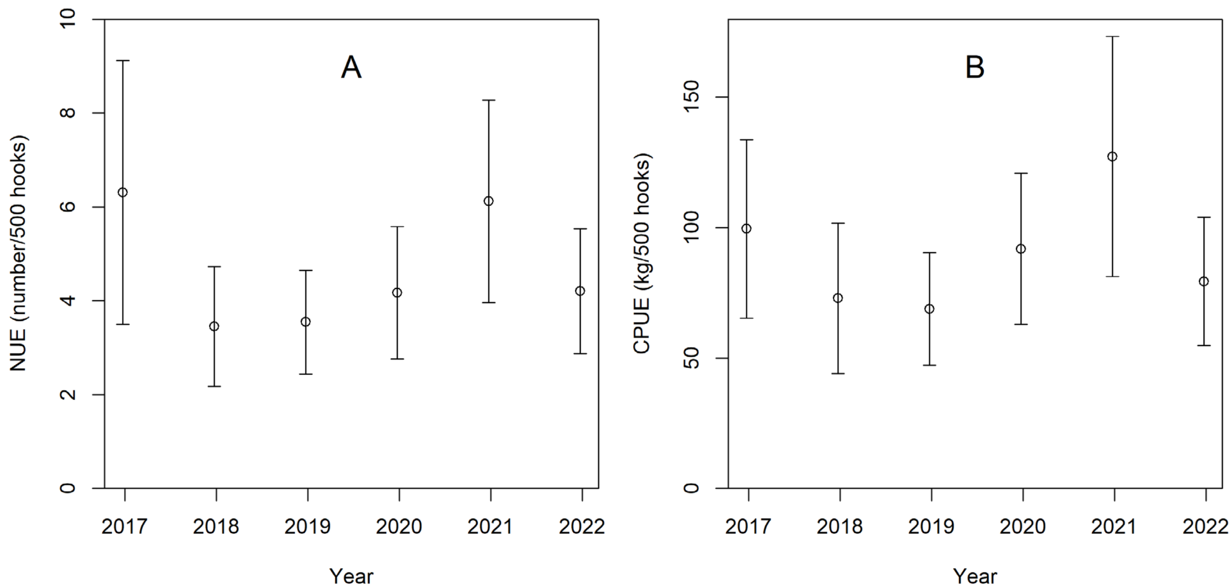

Figure 12. Stratified random mean of yields by number (A) and weight (B) of Atlantic halibut > 85 cm in the scientific longline surveys.

Mark-Recapture Project

Atlantic halibut are tagged during the longline research survey and of the 3,887 Atlantic halibut released since 2017, 120 recaptures have been reported to DFO. The information acquired from these recaptures by commercial fishermen made it possible to estimate instantaneous rates of fishing mortality. Assumptions regarding natural mortality, post-tagging mortality, and the rate of feedback from commercial fishers all influence fishing mortality estimates. The consequences of different assumptions, for a natural mortality set at 0.1 are presented in Table 1.

Table 1 Instantaneous fishing mortality (F) estimated annually by fitting a recapture model of tagged Atlantic halibut. A range of values for the tag return rate (TR) and the post-tagging survival rate (PTS) were used in the model. M= natural mortality, F= fishing mortality.

Model		M	F				
TR	PTS		2018	2019	2020	2021	2022
0.5	0.9	0.1	0.034	0.025	0.046	0.034	0.043
0.5	0.99	0.1	0.031	0.023	0.042	0.031	0.039
0.7	0.9	0.1	0.024	0.018	0.033	0.024	0.030
0.7	0.99	0.1	0.022	0.016	0.030	0.022	0.027
0.9	0.9	0.1	0.019	0.014	0.025	0.019	0.023
0.9	0.99	0.1	0.017	0.013	0.023	0.017	0.021

Modeling

In order to integrate information from DFO monitoring, trawl and longline surveys, and mark-recapture work, a delayed-difference population dynamics model was fit to the data. This type of model is an intermediary between simple surplus production models and complex age-structured models. The fit of the model estimated, for 2022, a B85 of 94,482 t (Figure 13A), which had gradually increased from the low values estimated at the start of the series. In 2022, the estimated instantaneous fishing mortality rate was 0.017 (Figure 13B), and has been stable for the last 15 years at this relatively low level.

The results of the model adjustment make it possible to derive reference points, including a theoretical biomass at equilibrium varying according to the rate of removal, and to calculate a maximum theoretical removal, the maximum sustainable yield (MSY). In Figure 13A, the stock trajectory is related to the equilibrium biomass allowing MSY (B_{MSY}). Levels of 0.4*B_{MSY} (LRP) and 0.8*B_{MSY} (proposed USR) are indicated in red and green, and correspond to reference points according to the fisheries decision-making framework incorporating the precautionary approach.

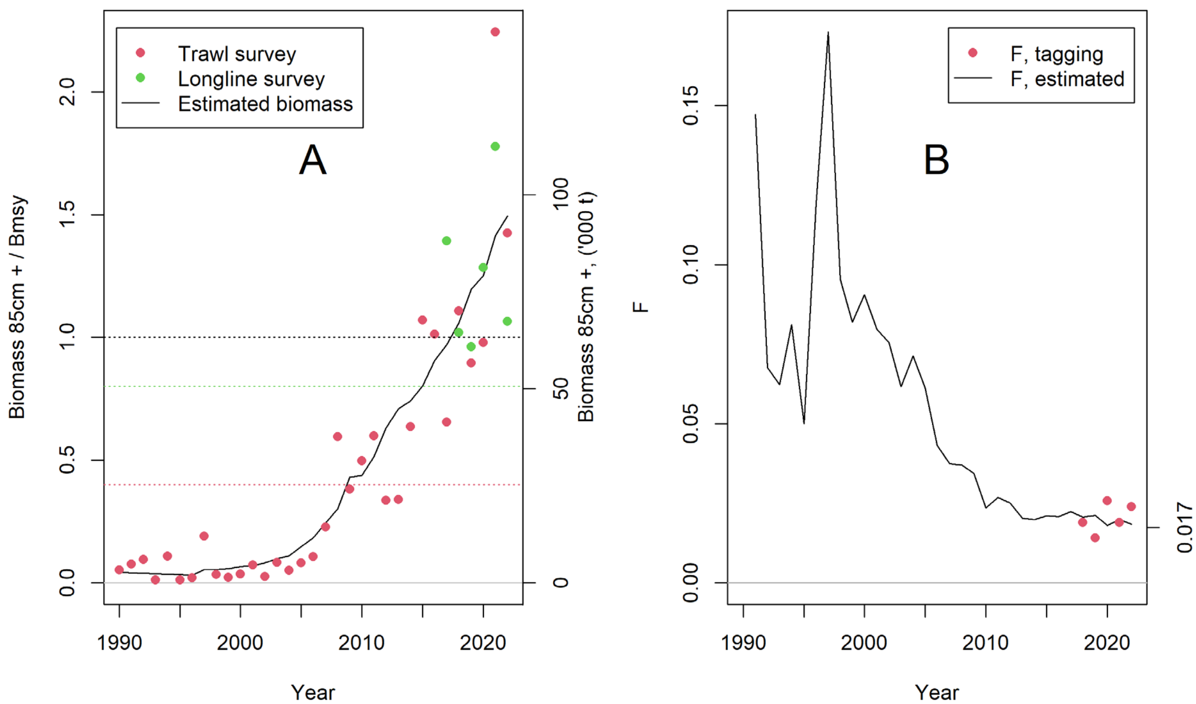

Figure 13. Adjustment of the estimated Atlantic halibut B85 to the abundance indicators (A) and the instantaneous rate of fishing mortality to the results of the analysis of the tag returns (B). The dotted lines in A indicate potential reference points according to the fisheries decision-making framework incorporating the precautionary approach.

Projections

The B85 was projected over two years for different harvest levels using the results of the model fitting and considering an average recruitment representative of the estimates of the last 10 years (Figure 14). The range of scenarios considered for 2023 and 2024 were made with respect to the 2022 TAC and included a rollover of the 2022 TAC (1,716 t and 1,716 t), an annual increase in TAC of 15% (1,973 t and 2,269 t), an increase in TAC of 25% for only 2023 (2,145 t and 2,145 t), and an increase in TAC to 200% in the first year only (3,432 t and 3,432 t). According to these projections, these removal scenarios do not lead to a decrease in B85.

The projections were sensitive to the fitted parameters estimated by the model. However, none of the hypotheses considered modified the conclusion stated above, namely that none of the removal scenarios explored lead to a decrease in B85. This conclusion can thus be considered robust to the different assumptions of the models.

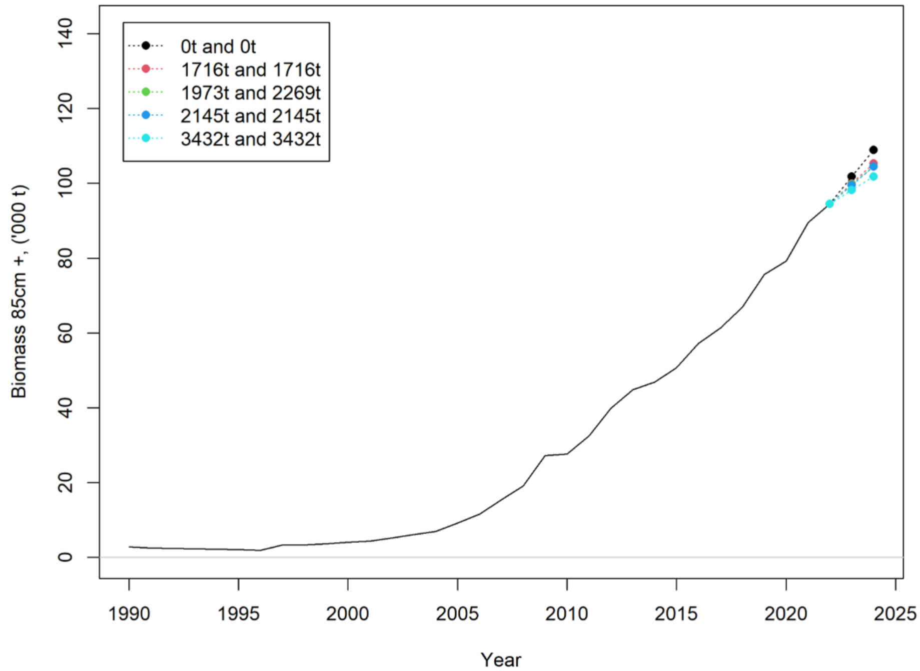

Figure 14. Projections of Atlantic halibut B85 according to different catch scenarios for 2023 and 2024.

Reference Points

A first limit reference point (LRP) was developed for this stock and is set at 25,291 t, or 40% of the estimated B_{MSY} value (63,228 t). This approach is based on the recommendation of the fisheries decision-making framework incorporating the precautionary approach. Similarly, an upper stock reference (USR) was proposed for this stock at 50,582 t, or 80% of the estimated B_{MSY} value. Discussions with stakeholders will be necessary to determinate the USR.

Sources of Uncertainty

In NAFO division 4R, the fishing effort associated with a catch and the position of that catch is less well documented than in other areas. At-sea observer and dockside sampling coverage is also close to nonexistent, whereas this information is collected in divisions 4S and 4T. Data from at-sea observers and dockside samplers are central to the stock dynamic model used and inter-regional disparities in the availability of this information could lead to a bias in the interpretation of the results.

Certain model assumptions, including natural mortality, growth data, and tag return rate, strongly influence the B85 values and the projected harvest outcome. Sensitivity analyzes show that B85 trends remain unchanged regardless of the assumptions considered. The result of the projections is variable, but the hypotheses considered do not invalidate the conclusion that the removal scenarios explored do not lead to a drop in B85.

The influence of the model assumptions on the MSY estimation is large and it is envisaged that the corresponding reference points must be updated during the revision of the model fitting (planned for winter 2025). This revision could take advantage of the availability of two additional years of monitoring and tag returns, obtaining age data and updating the corresponding growth curves, and the use of maturity ogives to more accurately determine spawning biomass.

CONCLUSIONS

A delayed-difference type population dynamics model was fit for the first time to different data available for this stock. This modeling made it possible to determine the evolution of the biomass of Atlantic halibut over 85 cm and to identify reference points consistent with the decision-making framework for fisheries incorporating the precautionary approach.

The fit of the model established the B85 at 94,482 t in 2022, up from the low values of the 1990s. A theoretical biomass at maximum sustainable yield (B_{MSY}) was determined, a limit reference point was established at 40% of this biomass and an upper reference point was proposed at 80% of this same biomass. The corresponding values are 25,291 t and 50,582 t. In this context, the stock would be above the proposed upper reference point in the healthy zone of a precautionary approach.

The exploitation rates obtained from capture-mark-recapture work and the relative exploitation rates obtained from the minimum trawlable biomass of DFO surveys are low and stable over the past 10 to 15 years. Modeling validates this trend and projections over 2 years show that the stock can sustain an increase in the removals without causing a decrease in biomass. These projections vary greatly depending on the values used for the modelling, but the conclusion is robust to these choices up to removals twice the current levels.

LIST OF MEETING PARTICIPANTS

Name	Affiliation	March 6	March 7
Beaudry-Sylvestre, Manuelle	DFO – Science	x	x
Bois, Samantha	ACPG	x	x
Bouchard, Donald	Essipit First Nation	x	x
Boudreau, Sophie	DFO – Science	x	x
Boulanger, Marie-Pier	DFO – Science	x	x
Bourbonnière, Jean-Patrick	Fisher	x	x
Bourdages, Hugo	DFO – Science	x	x
Bourgeois, Andrew	Gulf Nova Scotia Fishermen’s Coalition	x	x
Brûlé, Caroline	DFO – Science	x	x
Chamberland, Jean-Martin	DFO – Science	x	x
Chlebak, Ryan	DFO – Science Ottawa	x	x
Couture, John	Oceans North	x	x
Cormier, Julien	DFO – Fisheries management – Gulf region	x	x
Cyr, Charley	DFO – Science	x	x
Dennis, Olivia	Prov. NL	x	x
Desgagnés, Mathieu	DFO – Science	x	x
Dubé, Sonia	DFO – Science	x	x
Duplisea, Daniel	DFO – Science	x	x
Émond, Kim	DFO – Science	x	x
Ferguson, Louis	MFU-UPM	x	x
Gauthier, Charlotte	UQAC	x	x
Giffin, Melanie	Prince Edward Island Fishermen’s Assoc.	x	x
Hardy, Keven	Fisher		x
MacMillan, Robert	Prov. PEI	x	x
Martin, Lucas	UQAR-ISMER	x	x
Monger, Julie	LNSFA	x	-
Nadeau, Paul	LNSFA	-	x
Ouellette-Plante, Jordan	DFO – Science	x	x
Pelletier, Claude	Prov. NB	x	x

Name	Affiliation	March 6	March 7
Plourde, Stéphane	DFO – Science	x	x
Pond, Nancy	DFO – Fisheries management – NL region	x	x
Rigg Power, Jodi	DFO – Fisheries management – NL region	x	x
Sandt-Duguay, Emmanuel	AGHAMW	x	x
Senay, Caroline	DFO – Science	x	x
Simard, Émilie	DFO – Science	x	x
Smith, Andrew	DFO – Science	x	x
Solberg, Abe	FFAW	x	x
Tamdrari, Hacène	DFO – Science	x	x
Trottier, Steeve	DFO – Fisheries management – Quebec region	x	x
Vascotto, Kris	Atlantic Groundfish Council	x	x
Way, Loomis	FFAW	-	x

SOURCES OF INFORMATION

This Science Advisory Report is from the March 6–7, 2023 regional peer review meeting on the Assessment of the Gulf of St. Lawrence (4RST) Atlantic Halibut stock. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

Bourdages, H., Brassard, C., Chamberland, J.-M., Desgagnés, M., Galbraith, P., Isabel. L. and Senay, C. 2022. Preliminary results from the ecosystemic survey in August 2021 in the Estuary and northern Gulf of St. Lawrence. DFO Can. Sci. Advis. Sec. Res. Doc. 2022/011. iv + 95 p.

DFO, 2006. A Harvest Strategy Compliant with the Precautionary Approach. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/023.

Galbraith, P.S., Chassé, J., Dumas, J., Shaw, J.-L., Caverhill, C., Lefaivre, D. and Lafleur, C. 2022. Physical Oceanographic Conditions in the Gulf of St. Lawrence during 2021. DFO Can. Sci. Advis. Sec. Res. Doc. 2022/034. iv + 83 p.

Gatti, P., Robert, D., Fisher, J.A.D., Marshall, R.C., and Le Bris, A. 2020. Stock-scale electronic tracking of Atlantic halibut reveals summer site fidelity and winter mixing on common spawning grounds. *ICES J. Mar. Sci.,* Vol. 77 (7-8) : 2890–2904.

Ouellette-Plante, J., Chabot, D., Nozères, C. and Bourdages, H. 2020. Diets of demersal fish from the CCGS Teleost ecosystemic surveys in the estuary and northern Gulf of St. Lawrence, August 2015-2017. Can. Tech. Rep. Fish. Aquat. Sci. 3383: v + 121 p.

THIS REPORT IS AVAILABLE FROM THE:

Centre for Science Advice (CSA)
Quebec Region
Fisheries and Oceans Canada
Maurice Lamontagne Institute
P.O. Box 1000, Mont-Joli
Quebec, Canada
G5H 3Z4

E-Mail: dfo.csaquebec-quebeccas.mpo@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas-sccs/

ISSN 1919-5087
ISBN 978-0-660-67749-1 N° cat. Fs70-6/2023-036E-PDF

Correct Citation for this Publication:

DFO. 2023. Stock assessment of Gulf of St. Lawrence (4RST) Atlantic halibut in 2022. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2023/036.

Aussi disponible en français :

MPO. 2023. Évaluation du stock de flétan atlantique du golfe du Saint-Laurent (4RST) en 2022. Secr. can. des avis sci. du MPO. Avis sci. 2023/036.