draft working paper for peer review only

Atlantic halibut

2024 Management Track Assessment Report

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, Massachusetts

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This assessment of the Atlantic halibut (Hippoglossus hippoglossus) stock is a Level 1 Management Track assessment of the existing 2022 plan B assessment (Rago, 2018). This assessment updates commercial fishery catch data, commercial and survey indices of abundance, and the First Second Derivative (FSD) model through 2023. Reference points are unknown and have not been updated.

State of Stock: Based on this updated assessment, Atlantic halibut (*Hippoglossus hippoglossus*) stock status cannot be determined analytically due to a lack of biological reference points associated with the FSD method. Biomass (SSB) in 2023 was unknown. The 2023 fully selected fishing mortality was unknown.

Table 1: Catch and status table for Atlantic halibut. All weights are in (mt). The Catch Advice for 2025 from this assessment is calculated from the Catch Multiplier and the Total Catch in year 2023. Catch advice is implemented in years where Management Track assessments occur.

	2016	2017	2018	2019	2020	2021	2022	2023
				Data				
Commercial discards	32	29	48	76	36	22	15	16
Commercial landings	68	64	54	50	47	39	31	37
CA landings	34	35	46	54	157	119	92	71
Total Catch	134	127	148	180	241	180	137	125
				Model Results				
Catch Multiplier	1.019	1.02	0.942	0.835	0.91	0.855	0.98	0.848
Catch Advice in Year+2	136	129	139	150	220	154	135	106

Table 2: There are no current reference points for Atlantic halibut which is on a 'plan B' assessment that does not allow for the estimation of reference points. Therefore the status of the stock relative to overfishing and overfished status is unknown. based on this assessment. Note: based on NOAA policy, the Agency has has maintained the previously determined overfished stock status.

	2022	2024
F_{MSY} *proxy*	NA	
SSB_{MSY} (mt)	NA	
MSY (mt)	NA	
Overfishing	Unknown	Unknown
Overfished	Unknown	Unknown

Projections: Short term projections are not possible using the FSD approach. The FSD approach is based on applying a multiplier to the catch from the previous year and cannot be projected beyond the catch time series. The catch multiplier for 2023 resulting from the FSD model is 0.848 and the estimated catch for 2023 is 125 mt, which results in catch advice of 106 mt for 2025. The FSD model is explained in (Rago, 2018) and additional information is available in a document called 'AtlanticHalibutMTextras.pdf', both are available at SASINF.

Special Comments:

- What are the most important sources of uncertainty in this stock assessment? Explain, and describe qualitatively how they affect the assessment results (such as estimates of biomass, F, recruitment, and population projections).

  The assessment model (FSD) used for Atlantic halibut is a 'plan B' assessment method. It uses recent trends in 3 abundance indices as well as recent changes in those trends to to calculate catch advice from the final model year of observed catch. For example, if the abundance indices are increasing, the catch will be

adjusted up. If that increasing trend in abundance is increasing in magnitude over time, the adjustment to catch will be commensurately higher. The FSD method was rigorously tested in simulation (Rago, 2018) and should perform well for Atlantic halibut in the US. Sources of uncertainty in the FSD method include process error related to potential changes in stock productivity over time, the choice of relative weights for the control parameters used in the model and the lag in information inherent in using change in trend as one of the control parameters, which requires dropping one data point from the regression fit to generate a comparison. Other sources of uncertainty include the observation error in the abundance indices. The FSD method also relies on the assumption that abundance can be described with linear dynamics, but that assumption should be relatively unimportant if the stock abundance is well below theoretical carrying capacity.

- Does this assessment model have a retrospective pattern? If so, is the pattern minor, or major?
  The FSD model does not support retrospective analysis.

- Based on this stock assessment, are population projections well determined or uncertain?
  The FSD model provides catch advice two years from the terminal year of the input data (because the assessment is conducted in the interim year). It is not intended to project further than this, and doing so would require strong assumptions about the catch multiplier (constant average slope in subsequent years).

- Describe any changes that were made to the current stock assessment, beyond incorporating additional years of data and the affect these changes had on the assessment and stock status.
  The loss of a survey data point for the Fall Bottom Trawl in 2020 (Covid) resulted in the need to interpolate one survey index observation. The survey index value used in 2020 was equal to the average of the 2019 and 2021 values.
  The Fall Bottom Trawl Survey caught zero halibut in 2018 and 2019. Previous assessment updates treated these values as missing. Alternative treatment of those zeros was explored as part of this update, including centering the Fall Index so that all observations were positive; centering all 3 indices, adding a value just to the Fall 2018-2019 observations, as well as treating those observations as missing. Centering (adding a positive value to all years) dampened the estimated slopes, and the larger the value added the greater the dampening. Adding a value to Fall 2018-2019 (e.g., the time series minimum, or other small value) exaggerated the trend in estimated slope for the 5-year windows where 2018-2019 were included. Treating those observations as missing avoids the subjective decision of what value to add to zero observations. This exploration can be found at SASINF. Despite the additional analyses conducted, no changes were made to the current stock assessment beyond incorporating additional years of data.
  Catch efficiency studies and data are not used for the Atlantic halibut assessment because not enough Atlantic halibut are caught to provide a comparison between the gear types and produce estimate of catchability.

- If the stock status has changed a lot since the previous assessment, explain why this occurred.
  Stock status cannot be determined and remains unchanged. The stock is likely depleted relative to its virgin biomass based on estimates of historical landings, which were much higher than current landings. Rago in his 2018 report argued that overfishing was unlikely because the catch multiplier estimated in the FSD model had been greater than one for several years. The catch multiplier has now been less than one for six consecutive years, which would be consistent with recent overfishing. There is however, no way to determine stock status without reference points.

- Indicate what data or studies are currently lacking and which would be needed most to improve this stock assessment in the future.
  The Atlantic halibut assessment could be improved with more precise fishery independent indices of abundance, additional age and length composition data, and a better understanding of stock structure. These would allow for alternative assessment methods, and potential development of a more sophisticated stock assessment model.

- Are there other important issues?
  Canadian catch in 2022 and 2023 in area 5Z (eastern Georges Bank) has declined consistently since a peak in 2020 (see SASINF). The combination of declining Canadian catch, and the catch multiplier<1, has resulted in declining catch advice. It is important to note, however, that Canadian landings are not limited by

the catch advice from the US assessment, and this can impact catch advice in non-intuitive ways. For example, despite the catch multiplier being < 1 in 2018 and 2019, the catch advice increased for 2020 and 2021 because the observed Canadian landings increased (Table 1). Managers should be aware of this issue when recommending catch levels for Atlantic halibut.

A concern was raised by Maine Department of Marine Resources about the lack of Canadian discards in the model. Currently, only Canadian landings are included as discard estimates were not available. Indications from a recent analysis are that discards in 5YZ are negligible, although reported data for observer coverage indicate > 100% of sets were observed; these data discrepencies were not resolved (Bowlby et al. 2024). To illustrate the impact of including Canadian discards in the FSD model, several hypothetical discard proportions were assumed. These discard proportions were motivated by reported estimates over all areas (reported range of 1.2-5.8% for 2014-2020, Bowlby et al. 2024). Specifically, illustrations of how catch advice for 2025 responds to including discards that 0% (status quo), 1%, 5%, or 10% of landings were made. In all cases, the catch multiplier remains the same, because it is only affected by the slopes of the 3 indices. Adding Canadian discards increases Canada's observed catch, and therefore catch advice increases as the magnitude of Canadian discards increases. However, catch advice for the US commercial fleet is calculated by subtracting expected Canadian catch from the total catch advice. For this illustration, Canadian catch in 2025 was assumed to be the average of 2022-2023. As the assumed discard fraction increases, the Canadian proportion of total catch increases. Consequently, subtracting expected Canadian catch from the catch advice results in a smaller remaining quota for the US fleet. For the likely range of Canadian discarding (<10% of halibut landings), the decrease in catch advice for the US fleet was small (2mt). This illustration can be found at SASINF.

References:

Bowlby, H.D., McMahon, M., Li, L., den Heyer, C.E., and Harper, D. 2024. Estimating Incidental Catch of Non-Target Species from the Commercial Fishery for Atlantic Halibut Maritimes Region. DFO Can. Sci. Advis. Sec. Res. Doc. 2024/003. iv + 80 p.

Rago, P.J. 2018. Halibut Assessment Report for 2017 for New England Fishery Management Council, January 24, 2018.Unpublished, online at SASINF

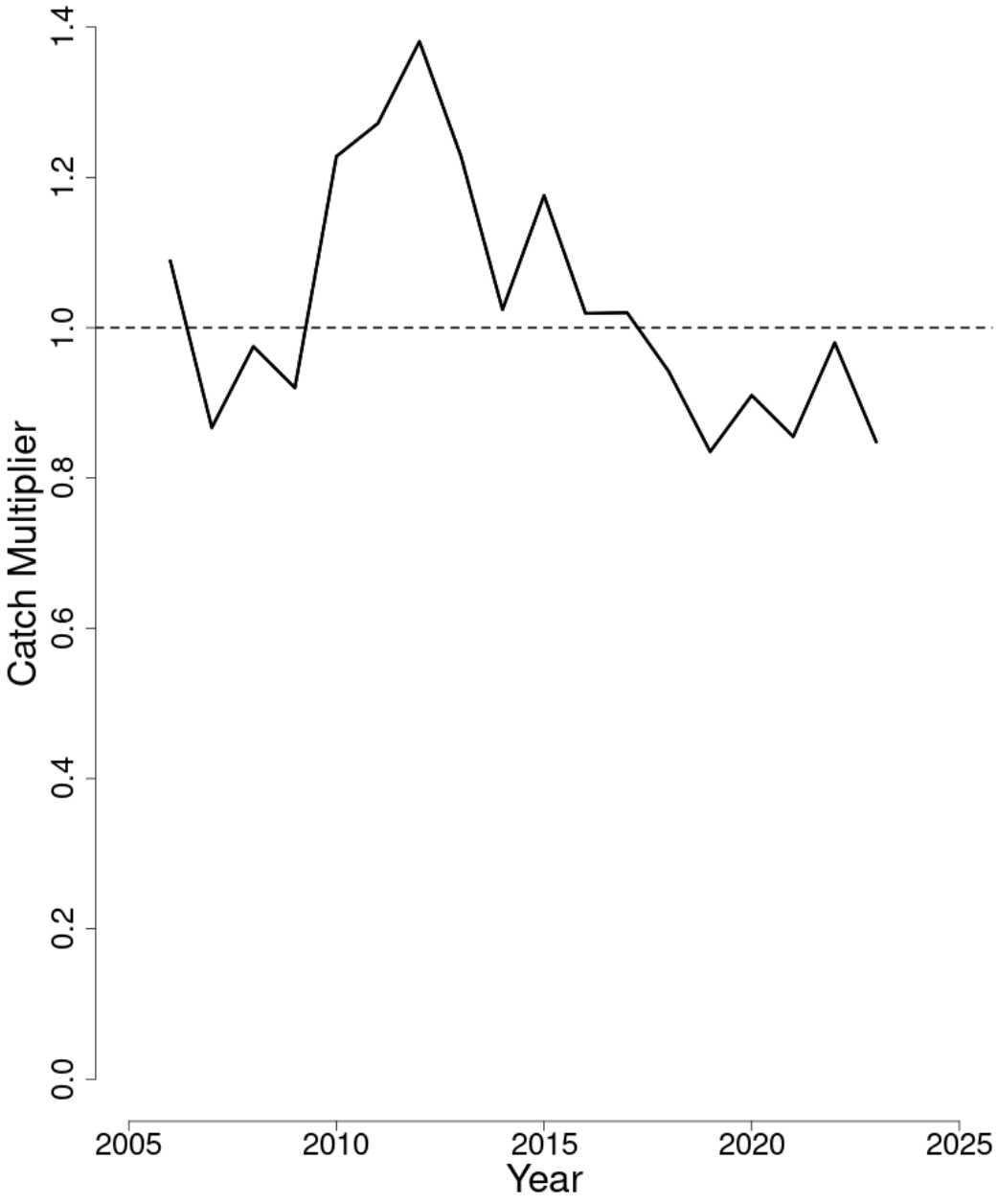

Figure 1: The catch multiplier resulting from the FSD model for Atlantic halibut between 2006 and 2023 from the current (solid line) assessment. A dashed line at 1 is added for reference.

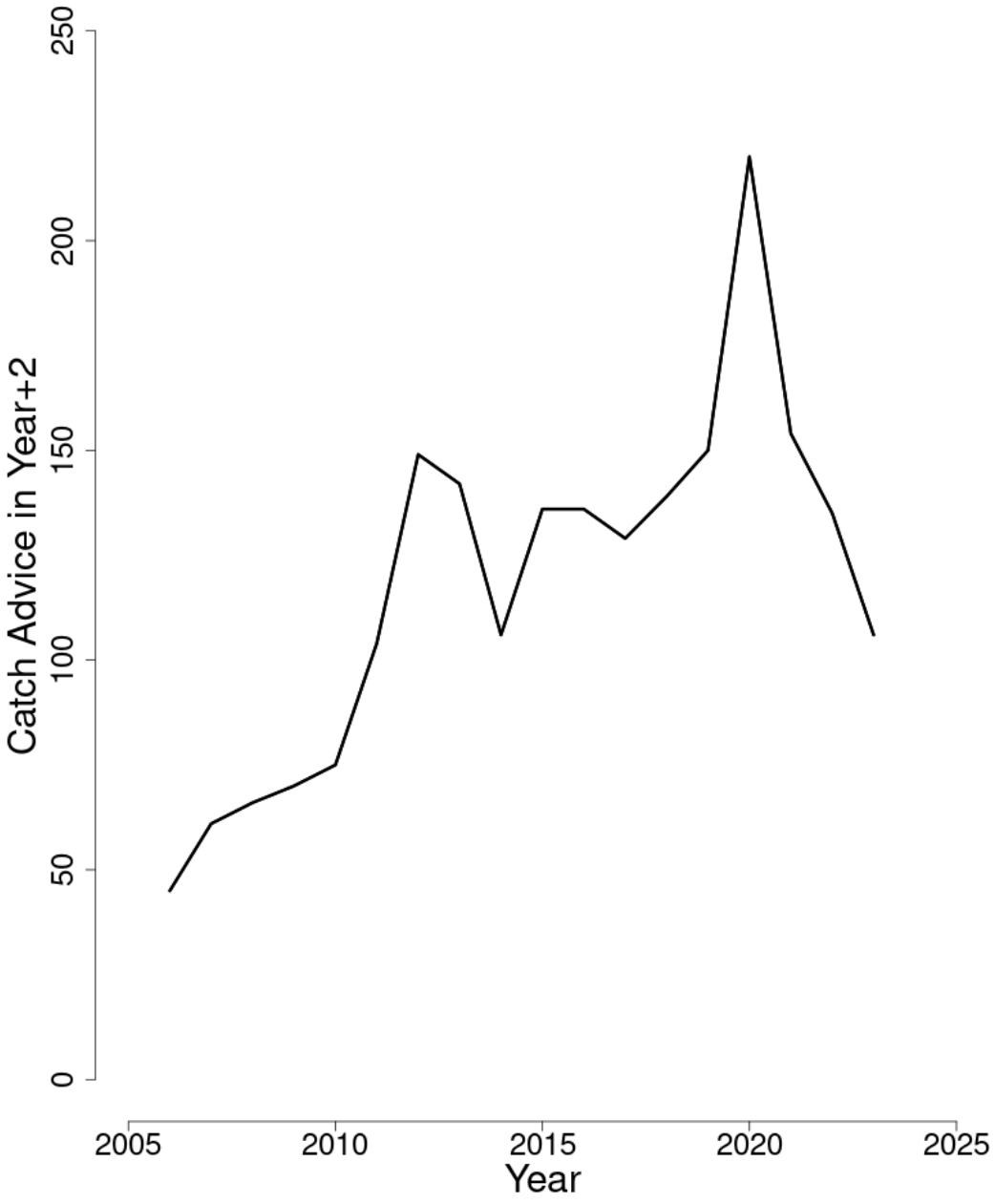

Figure 2: The catch advice resulting from multiplying catch and the catch multiplier from the FSD model for Atlantic halibut between 2006 and 2023 from the current assessment.

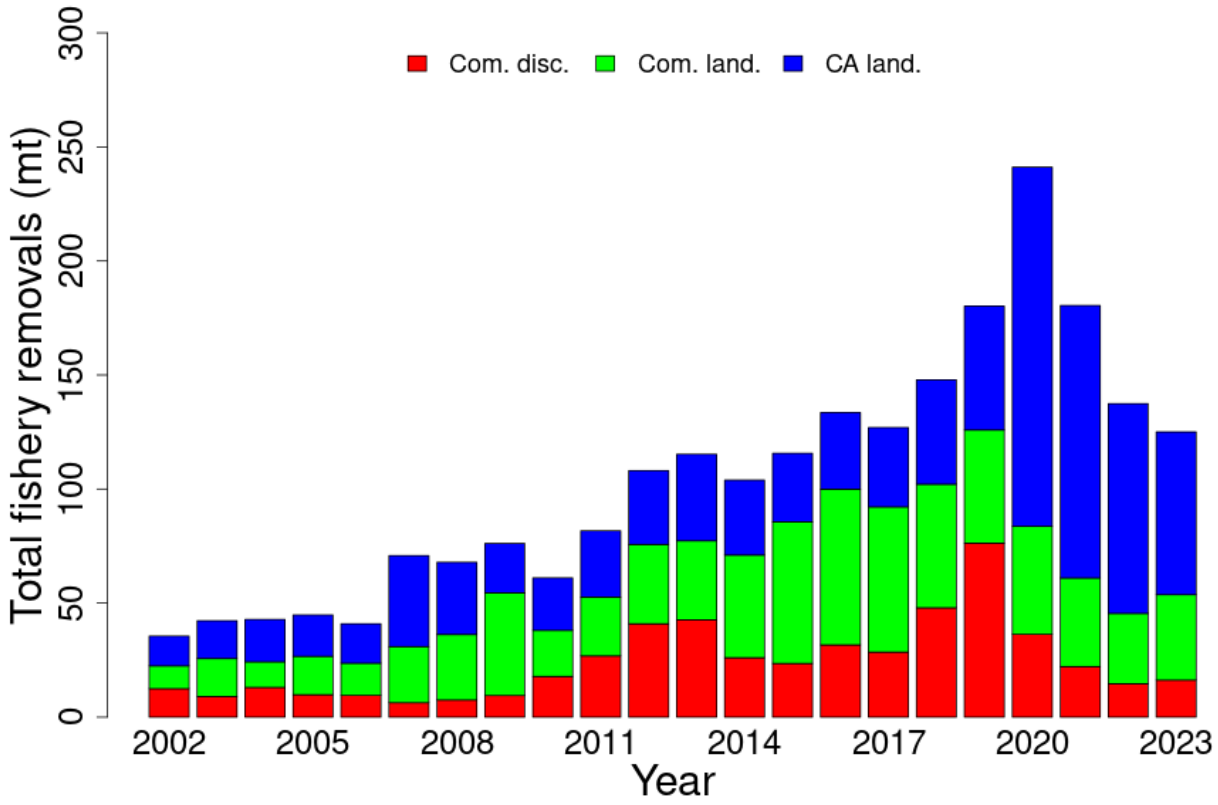

Figure 3: Total catch of Atlantic halibut between 2002 and 2023 by disposition (landings and discards).

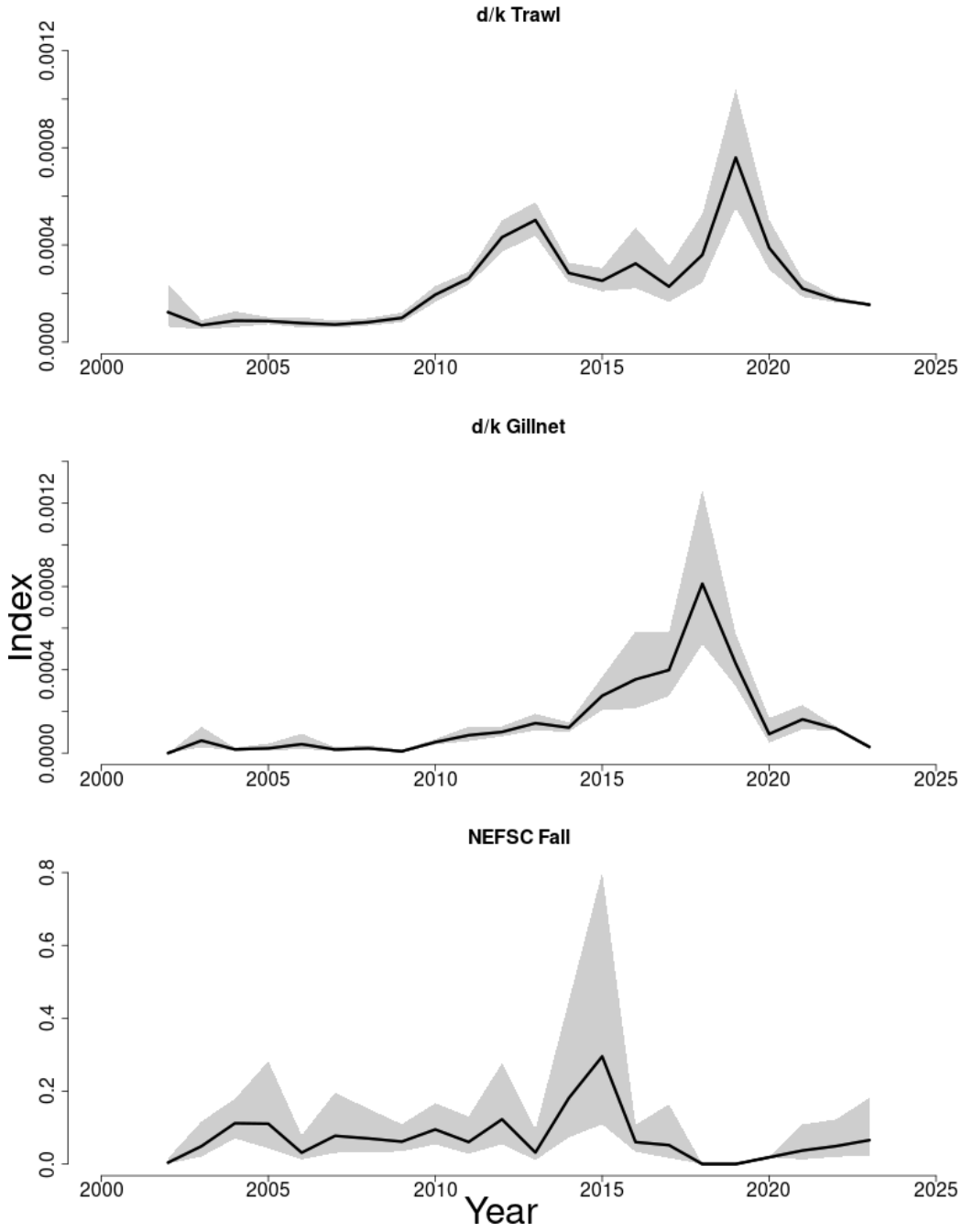

Figure 4: Indices of biomass for the Atlantic halibut between 2002 and 2023 for the Northeast Fisheries Science Center (NEFSC) fall bottom trawl survey and 2 discard ratio estimators (discarded halibut (d) to kept of all species (k)).Discard mortality is assumed to be 0.76 for trawl gear and 0.3 for gillnet gear. The 2020 NEFSC fall bottom trawl value was interpolated as the mean of the 2019 and 2021 values. The 90% lognormal confidence intervals are shown.