COMPILATION OF SCIENTIFIC ADVICE FOR EASTERN GEORGES BANK COD AND HADDOCK FOR FISHING YEAR 2026

BACKGROUND

Starting in 2025, the process for the Integration of Science Advice for Transboundary Species (ISATS) supports the management of eastern Georges Bank (EGB) cod and haddock, and Georges Bank (GB) yellowtail flounder. This process includes a Technical Science Coordination (TSC) meeting of stock assessment leads where the outcomes from U.S. and Canadian domestic assessments are compiled into a joint document to provide scientific advice for the shared transboundary stocks.

This document is the product of a Technical Science Coordination (TSC) meeting of the Fisheries and Oceans Canada (DFO) and NOAA Fisheries (NMFS) stock assessment leads, held virtually on July 16, 2025. During the meeting, DFO and NMFS staff presented and discussed the results from their domestic assessments, and summarized the science advice herein. The documents supporting this summary (stock assessment reports, apportionment report, and allocation shares report) are included in the Appendix. The GB yellowtail flounder management track assessment will take place in September 2025; therefore, the assessment results for this stock were not available for review during the meeting and are not reported in this document.

TABLE 1a. Short term projections from DFO eastern Georges Bank (EGB) Cod and NMFS Georges Bank (GB) Cod stock assessments. SSB=spawning stock biomass; F=fishing mortality; mt=metric tonnes. All SSB values are estimated. Catch values in plain text are estimated, and catch values in italics are fixed values based on realized catch. F values in plain text are fixed at F reference points, F values in italics are calculated based on the fixed values of realized catch.

Model	Parameter	2024 Value	2025 Value	2026 Value
DFO EGB Cod Model Values (terminal year of data = 2024)	SSB (mt)	10,900	7,899	6,462
	F	*0.030*	*0.041*	0.052
	Catch (mt)	*378*	*452*	473
NMFS GB Cod 2024 Model Values (terminal year of data = 2023)	SSB (mt)	2,486 (929 – 6,653)	2,089 (499 – 8,739)	1,658 (277 – 9,937)
	F	*0.152*	0.233	0.233
	Catch (mt)	*417*	518	419
	Apportioned catch (mt) in EGB for 2026			419

TABLE 1b. Short term projections from DFO eastern Georges Bank (EGB) Haddock and NMFS Georges Bank (GB) Haddock stock assessments. SSB=spawning stock biomass; F=fishing mortality; mt=metric tonnes. All SSB values are estimated. Catch values in plain text are estimated, and catch values in italics are fixed values based on realized catch. F values in plain text are fixed at F reference points, F values in italics are calculated based on the fixed values of realized catch.

Model	Parameter	2024 Value	2025 Value	2026 Value
DFO EGB Haddock Model Values (terminal year of data = 2024)	SSB (mt)	27,342	23,713	15,180
	F	*0.311*	*0.534*	0.339
	Catch (mt)	*6,219*	*7,410*	2,480–3,850[1]
NMFS GB Haddock 2024 Model Values (terminal year of data = 2023)	SSB (mt)	34,180 (14,038 - 83,225)	34,516 (10,532 - 113,116)	36,029 (8,534 - 152,117)
	F_{5-7}	*0.316 (0.116 - 0.859)*	0.264	0.264
	Catch (mt)	*9,627*	8,034 (2,430 - 26,570)	8,177 (1,956 - 34,188)
	Apportioned catch (mt) in EGB for 2026			6,133

TABLE 2. Apportionment percentages for eastern Georges Bank stocks and allocation shares. N/A=not applicable.

Stock	EGB Apportionment Percentages	Allocation Shares Values	
	For U.S. GB stocks	Canada	U.S.
Eastern Georges Bank Cod	100%	68%	32%
Eastern Georges Bank Haddock	75%	79%	21%
Georges Bank Yellowtail	N/A	46%	54%

[1] Catch range based on 25% to 75% risk of exceeding the Fref of 0.339.

OVERVIEW OF DFO AND NMFS ASSESSMENT MODELS AND RESULTS

DFO EGB Cod Model

Based on the June 2025 Canadian Science Advisory Secretariat (CSAS) peer review of the Stock Assessment of Atlantic Cod on eastern Georges Bank (EGB), the 2024 spawning stock biomass (SSB) is at 42% of the limit reference point (24.9 kt). Under the DFO Precautionary Approach Framework this means the stock is in the critical zone with a very high probability (>98%). The 2024 SSB is 10.9 kt, which represents a small increase from the series low of 7.96 kt in 2022. Fishing mortality (F) has remained below 0.05 since 2017 and the 2024 estimate is 0.03. Over the last three years, recruits (per unit of SSB) have been the highest since 1978, within the context of record low spawning stock biomass. However, this has not resulted in sustained increases in the number of fish at ages 3+. Estimated loss of aged 4+ fish continues to be high, with natural mortality (M) inferred to be the primary cause.

The June 2025 assessment was the first application of the new assessment framework developed for EGB Cod (framework peer review meetings completed in May 2025). The new modelling framework implemented a Woods Hole Assessment Model (WHAM) for the EGB Cod management area. The model data inputs include three fleets, Canadian and U.S. reported fisheries (landings and discards from both), as well as a misallocated U.S. catch fleet, and three surveys (DFO winter survey, Northeast Fisheries Science Center [NEFSC] bottom trawl spring and fall surveys). During the June 2025 peer review of the assessment there were some changes made to the inputs for the DFO winter survey. The DFO winter survey was conducted in 2022 with a new vessel and new gear. Conversion factors to make the 2022 data comparable to other years were not available until this assessment. Length-based calibration factors were applied based on a peer reviewed approach. Additionally, during the June 2025 peer review a decision was made to include data from DFO winter survey stratum 5Z9 (2010–2024). This survey stratum is a deepwater stratum that falls within the EGB management area. The decision was made to include the data from this stratum in the assessment going forward.

The model indicates that a high number of adult fish are disappearing from this stock in excess of fishery removals. This disappearance is attributed to natural mortality (M). There are no indications that the high level of M will decrease in the near future and appears to be the main factor limiting productivity for this stock. Long-term projections for biomass indicate that it is unlikely that stock status will improve under the current productivity dynamics, even in the absence of fishing. The contributing factors to the high level of M are unknown, but a shift in the ecosystem to higher temperatures and increased predation is commonly identified. It is also suggested that the observations of older fish in deeper waters at an earlier time than observed in the past is related to the shifting ecosystem conditions.

NMFS Georges Bank Cod Model

Based on the 2024 Management Track (MT) assessment of Georges Bank Atlantic cod conducted by NOAA Fisheries, the stock was overfished and overfishing was not occurring in 2023, the terminal year of the assessment. This assessment was the first MT following the 2023 Research Track assessment and implemented a Woods Hole Assessment Model (WHAM) for the total Georges Bank cod footprint. The model included one fleet (combined U.S. landings and discards as well as Canadian landings and

discards), three surveys (DFO winter survey, NEFSC bottom trawl spring and fall surveys), and assumed age- and time-invariant M (0.29). SSB was low over the terminal four years of the assessment (2019-2023) with the terminal year estimate at an all-time low (SSB=2,668 mt in 2023). Recruitment is the largest source of uncertainty in this assessment. Recent (2018–2023) recruitment estimates were higher than those through most of the 2000–2010s. However, these relatively higher recruitment estimates did not result in higher SSB estimates which declined from 2018–2023 and the 2023 recruitment estimate was the second lowest over this period. Both suggest that lower SSB is likely to persist in the short term. Short term projections support this conclusion, but these are also driven by assumed fishing mortalities (F=0.152 in 2024 bridge year and FMSY proxy=0.233 in subsequent years) that are higher than those estimated in recent years (F=0.13 in 2023). Insufficient port sampling, gaps in surveys and age truncation in terminal years of the NEFSC fall survey contribute to increased uncertainty when characterizing age composition for this stock.

DFO EGB Haddock Model

Based on the June 2025 CSAS peer review of the Stock Assessment of Haddock on eastern Georges Bank, the estimated SSB has declined from 81,453 mt in 2016 to 27,342 mt in 2024; however, SSB is above the median of the time series. The 2020 and 2021 year-classes continue to contribute the most to the fishery and survey catches. The model estimates of age-1 recruitment in 2020 and 2021 are 90 million and 69 million, respectively. F was estimated to be 0.48 on average over the last five years with a decrease to 0.31 for 2024. The model estimated M (0.502) in recent years (2010–2024) continues to be high.

For the most recent assessment, 5Z9 survey stratum data were included for the DFO winter survey model inputs, which resulted in improved model diagnostics (e.g., reduced residual patterns in the survey age composition data, and improved retrospective patterns for SSB, F, and recruitment). This was suggested as an improved modeling approach for use in the short term, until a new assessment modelling framework can be developed.

M remains an uncertainty for the EGB Haddock stock. The expectation was that with the exit of the 2013 year-class and the reduction in overall stock biomass, the model-estimated M would decrease. Contrary to expectations, model-estimated M remains high. However, our understanding of the factors leading to high M in recent years is incomplete and is likely reflecting potential changes in additional factors including movement, catch reporting errors, ageing error, and misspecification of selectivity.

The DFO model assumes a low M in the historical time period followed by a high M estimated in a single time block from 2010–2024. The updated assessment incorporates both fishery and survey data up to 2024 and now includes the DFO survey in 2022 completed with a new vessel and gear. The F_{ref}, based on F40%SPR, is calculated using a lower M (M=0.2), which differs from what is assumed in the model and projections (M=0.502).

NMFS Georges Bank Haddock Model

The 2024 MT Assessment of Georges Bank Haddock led by NOAA Fisheries concluded that the stock was not overfished and overfishing was not occurring in 2023, the terminal year of data available for the

assessment. The assessment used the Woods Hole Assessment Model (WHAM) framework based on work completed in the 2022 Research Track (RT) Assessment for Haddock, and updates the previous MT assessment completed in 2022. This MT implemented refinements in the WHAM model and updated commercial fishery catch data, research survey indices of abundance, weights and maturity at age, and reference points through 2023, as well as stock projections through 2027. SSB in 2023 was estimated to be 32,730 mt which is about 135% of the biomass target (SSB_{MSY} proxy=24,225 mt). The 2023 average fishing mortality on ages 5–7 was estimated to be 0.17 which is about 65% of the overfishing threshold proxy (F_{MSY} proxy=0.26). As strong year classes that have sustained the population in the last decade age out of the population, abundance has returned to levels last observed in the early 2000s and the stock's spatial distribution has contracted. The current assessment estimates that this stock has left the boom phase and is heading in the bust direction. Current estimates of the 2020 year class are near the time series average, which may slow the current decline in the near term; the 2020 year class accounts for 47% of SSB in 2023. Important sources of uncertainty in this assessment include dynamics in the plus group (ages 9+), future recruitment, and future assumptions about weights and selectivity at age.

CROSS-MODEL COMPARISONS

During the TSC discussions, several common themes were identified as contributing to differences in outputs from assessment models of the same species. Those themes include: (a) differences in spatial footprint of the assessments (i.e., GB vs EGB) with a variety of implications and impacts on the modeling and outputs, (b) differences in data inputs and model structure that affect scaling of the model results, (c) differences in projection assumptions and methods that affect projection outputs, and (d) differences in how "catch" is estimated and projected, including what the catch value represents. Below we summarize key points under each of these themes in comparisons of the two cod and two haddock assessments, as well as provide a high-level summary of the most influential differences.

Cod Models Comparison

Summary: The most influential differences between the two cod models appear to be the impact of different spatial footprints on the fundamental dynamics being modeled and differences in how the catch value that is reported is estimated and what it represents.

Spatial footprint: The GB and EGB models have different spatial footprints and are capturing different dynamics of the population and fisheries. DFO GB model exploration during the DFO 5Z Framework review indicated that the bulk of the biomass was on EGB in recent years, while fishing pressure for the full GB was quite different from EGB fishing pressure. Thus, the dynamics being modeled by the GB and EGB models are quite different, and likely influence the differences in scale. Notably, the SSB estimated by the EGB cod model is greater than the SSB estimated by both the US GB cod model and the exploratory DFO GB cod model. The DFO EGB and exploratory GB cod models had nearly identical model structure, so scaling differences between those models were thought to be primarily influenced by different spatial footprints. Consequently, the difference in scale between EGB and GB models is likely also influenced by their spatial footprints and the underlying dynamics being modeled based on those different spatial footprints.

Scaling: Several factors are likely contributing to scaling differences between the model estimates, including the impact of different footprints on the models as described above. In addition, differences in M assumptions in the GB and EGB cod models may contribute to differences in scale. Finally, structural differences between the two models related to how uncertainty around data gaps is handled contribute to differences in model outputs.

Projections: Different assumptions in projections between assessments are layered on top of the scaling differences described above to result in different outputs reported in the Table 1a. Notably, the recruitment stanzas vary between the GB and EGB cod models, as does the propagation of process error (random effects) into the projection years.

Catch estimation: The values reported for catch in Table 1a for 2026 are derived from fundamentally different metrics. For the EGB cod model, the catch presented is the catch that results in an F of preventable decline. That F is the maximum F associated with a very low probability (<5%) of preventable decline (decline relative to F=0 scenario) within two generations. The EGB cod reference point work and peer review indicated that there was no F that could bring the stock out of the critical zone, and therefore the reference point F for preventable decline was chosen. For the GB cod model, the catch reported in 2026 is the catch that results in an F equal to the Fmsy proxy (F40%). That GB cod catch value in 2026 is then apportioned to EGB by applying the apportionment percentage, which in the case of cod is 100%.

Haddock Models Comparison

Summary: The most influential differences between the two haddock models appear to be the impact of adding 2024 data and assumptions regarding M.

Spatial footprint: The GB and EGB haddock models have different spatial footprints and are capturing different dynamics of the population and fisheries. However, haddock does not have the benefit of having two models that are similar other than spatial footprint to allow the kind of comparison and inference available from the Canadian exploration of GB and EGB cod models. Thus, it is difficult to ascertain any specific impacts of spatial footprint on the model results. It is worth noting that the GB and EGB haddock models have different survey data inputs, which are influenced by spatial footprint. Specifically, the GB haddock model is not always able to use the DFO survey due to limited coverage for the GB footprint.

Scaling: Several factors contribute to differences in scaling between the two models. An influential factor appears to be the impact of the addition of 2024 data to the EGB haddock model. Notably, the estimated magnitude of the 2020 and 2021 year classes in the EGB haddock assessment decreased with the addition of the 2024 survey data, which contributes to the lower scale of the 2025 SSB estimates for EGB. In addition, the models differ structurally in key assumptions and formulations. The EGB model estimates a relatively higher M for recent years, whereas the GB model assumes a constant M. The GB model also implements a mechanism to account for natural variability in numbers-at-age over time. Those two structural differences of M assumptions and treatment of variability in numbers-at-age are likely the most influential structural differences that contribute to differences in model scale. The

combination of these two differences impact survivorship of fish in the model and in turn result in scaling differences. Another factor impacting scaling is the implementation of the lognormal bias adjustment, which differs between the two models.

Projections: Different assumptions in projections between assessments are layered on top of the scaling differences described above to result in different outputs reported in Table 1b. Notably, the EGB model estimated M is higher than the M applied in the GB model, which assumes a lower value over the projection time. Also, the two models apply different selectivity patterns in their projections. Finally, the inherent highly variable recruitment in haddock introduces uncertainty in both models and in projections derived from those models.

Catch estimation: The values reported for catch in Table 1b for 2026 represent different metrics. For the EGB haddock model, the reported values represent the catch that results in 25-75% risk of exceeding the F reference point, which is calculated based on F40%. For the GB haddock model, the catch reported in 2026 is the catch that results in an F equal to the Fmsy proxy, (also based on F40%), and the range reflects the uncertainty in that catch estimate - not the probability of exceeding the Fmsy proxy. While the underlying reference points (F40%) are similar between models, the reported values differ in what they represent: one reflects a range of risk (EGB) and the other reflects an estimate with uncertainty (GB). Additionally, the inputs for the estimation also differ in terms of selectivity patterns and stanzas used to derive F40%, as well as differences in the overall model scale. As with cod, the GB haddock catch value in 2026 is then apportioned to EGB by applying the apportionment percentage, which in the case of haddock is 75%.

ALLOCATION SHARES CALCULATION

The sharing allocation agreement for the transboundary resources of Atlantic Cod, Haddock, and Yellowtail Flounder on Georges Bank uses the 2024 DFO and NMFS survey results to update the calculation for the 2026 fishing year allocations. For Atlantic Cod and Haddock, the sharing agreement is limited to the Eastern Georges Bank management unit (DFO Statistical Unit Areas 5Zj and 5Zm; U.S. Statistical Areas 551, 552, 561, and 562). The management unit for Yellowtail Flounder encompasses the entire Georges Bank east of the Great South Channel (DFO Statistical Unit Areas 5Zh, 5Zj, 5Zm, and 5Zn; U.S. Statistical Areas 522, 525, 551, 552, 561, and 562).

The resource distributions in 2024 were: 31% U.S., 69% Canada, for Atlantic Cod; 19% U.S., 81% Canada, for Haddock; and 49% U.S., 51% Canada, for Yellowtail Flounder. The 2026 fishing year allocations (calendar year for Canada; May 1, 2026 to April 30, 2027 for the U.S.), updated with the 2024 resource distributions, resulted in shares for Atlantic Cod of 32% U.S., 68% Canada, for Haddock of 21% U.S., 79% Canada, and for Yellowtail Flounder of 54% U.S., 46% Canada (Table 2).

APPORTIONMENT PERCENTAGE CALCULATIONS

In the 2025 management cycle, a revision was made to GB haddock apportionment methods to incorporate several additional WGB strata and fully align apportionment calculations with the survey footprint used in the U.S. domestic assessment for this stock. GB cod apportionment was calculated

using the standard method with no revisions. The resulting apportionment percentages for 2026 are 100% for GB cod and 75% for GB haddock (Table 2).

APPENDICES

- STOCK ASSESSMENT FOR ATLANTIC COD (*GADUS MORHUA*) ON EASTERN GEORGES BANK IN 2024
- GEORGES BANK ATLANTIC COD – 2024 MANAGEMENT TRACK ASSESSMENT REPORT
- STOCK ASSESSMENT OF EASTERN GEORGES BANK HADDOCK (*MELANOGRAMMUS AEGLEFINUS*) IN 2024
- GEORGES BANK HADDOCK – 2024 MANAGEMENT TRACK ASSESSMENT REPORT
- APPORTIONMENT RESULTS FOR GEORGES BANK HADDOCK AND ATLANTIC COD 2025
- ALLOCATION SHARES FOR CANADA AND THE USA OF THE TRANSBOUNDARY RESOURCES OF ATLANTIC COD, HADDOCK, AND YELLOWTAIL FLOUNDER ON GEORGES BANK THROUGH FISHING YEAR 2026

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Science Advisory Report 2025/nnn

STOCK ASSESSMENT FOR ATLANTIC COD (*GADUS MORHUA*) ON EASTERN GEORGES BANK IN 2024

CONTEXT

The Fisheries Management Branch of Fisheries and Oceans Canada (DFO) has requested a review of resource status for eastern Georges Bank Atlantic Cod (*Gadus morhua*) in support of the decision-making process for the 2026 fishery. This Science Advisory Report results from the regional peer review of June 10–12, 2025 on the Stock Assessment of Atlantic Cod and Haddock on Eastern Georges Bank. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

SCIENCE ADVICE

Status

- The 2024 spawning stock biomass (SSB, 10.9 kt) is at 42% of the limit reference point (LRP; 24.9 kt), placing the stock in the critical zone with a very high probability (>98%).

Trends

- The 2024 SSB is 10.9 kt, which represents a small increase from the series low of 7.96 kt in 2022.
- Fishing mortality (F) has remained below 0.05 since 2017 and the 2024 estimate is 0.03.
- Over the last three years, recruits (per unit of SSB) have been the highest since 1978, within the context of record low spawning stock biomass. However, this has not resulted in sustained increases in the number of fish at ages 3+.
- Estimated loss of aged 4+ fish continues to be high, with natural mortality (M) inferred to be the primary cause.

Ecosystem and Climate Change Considerations

- The most commonly identified contributors to natural mortality for Atlantic Cod in this region are high temperature and predation. Both have undergone substantial changes in recent years.
- The presence of older fish in deeper waters within the area indicates earlier movement off the bank post-spawning. Although the mechanism for this shift has not been identified, it is likely related to ecosystem changes (e.g., temperature, predation, competition).

Stock Advice

- Given the long-term projection of biomass, it is unlikely that the SSB will exceed the LRP within two generations, even in the absence of fishing. Projections for this stock are

provided for 2026 under various fishing scenarios, including no catch. There is no fishing level which will improve stock outlook under current productivity dynamics.

- Removals of 473 mt (F=0.052) correspond to the maximum F associated with a very low probability (<5%) of preventable decline in two generations (2032).

Other Management Questions

- A review of the May Test Fishery data found higher proportions of ripe and spawning Cod and Haddock in May compared to June through August. While an acceptable risk threshold for interactions with spawning Cod and/or Haddock has not been established, the results of the analysis demonstrate an earlier opening of the fishery would have a higher risk of interaction with spawning Cod and/or Haddock.

BASIS FOR ASSESSMENT

Assessment Details

Year Assessment Approach was Approved

2025 (Andrushchenko et al. In Prep a[1])

Assessment Type

Full assessment: Full peer-reviewed stock assessment.

Most Recent Assessment Date

1. Last full assessment: July 2018 (TRAC 2018; Andrushchenko et al. 2018)
2. Last interim-year update: July 2024 (DFO 2024)

Stock Assessment Approach

3. Broad category: single stock assessment model
4. Specific category: age structured state-space model

Stock Structure Assumption

Atlantic Cod on eastern Georges Bank is a single stock spanning United States of America (US) and Canadian waters. There is some mixing with adjacent stock units. In Canada, the stock is assessed as eastern Georges Bank (DFO statistical unit areas 5Zejm).

Reference Points

- Limit reference point (LRP): SSB below which surplus production is not significantly different from zero (Andrushchenko et al. In Prep b[2])

[1] Andrushchenko, I.V., H.P. Benoit, C.M. Clark, and E. Way-Nee. 5Z Cod Framework: Review of Modelling Approaches. DFO Can. Sci. Advis. Sec. Res. Doc. In Prep a.

[2] Andrushchenko, I.V., T.J. Barrett, N. Hebert, C.M. Clark, and E. Way-Nee. 5Z Cod Assessment Framework: Projections and Reference Points. DFO Can. Sci. Advis. Sec. Res. Doc. In Prep b.

- Upper stock reference (USR): Not yet determined
- Removal reference (RR): F=0.052 (F associated with a very low likelihood (<5%) of preventable decline)
- Target reference point (TRP): Not available

Data

- DFO Winter Ecosystem Research Vessel (RV) Survey (1987–2024)
- US National Marine Fisheries Service (NMFS) Spring RV Survey (1978–2024; except 2020 and 2023)
- US NMFS Fall RV Survey (1978–2024; except 2020)
- Canadian fishery data (1978–2024)
- US fishery data (total removals 1978–2024; catch-at-age 1978–2020)

Data changes since 2025 assessment framework review:

- DFO Winter RV Survey was conducted in 2022 with a new vessel and gear. Length-based calibration factors were applied to make the 2022 data comparable to other years.
- Inclusion of data from DFO Winter RV Survey stratum 5Z9 (2010–2024). This survey stratum is a deepwater stratum that falls within the EGB management area. The decision was made to include the data from this stratum in the assessment going forward.

ASSESSMENT

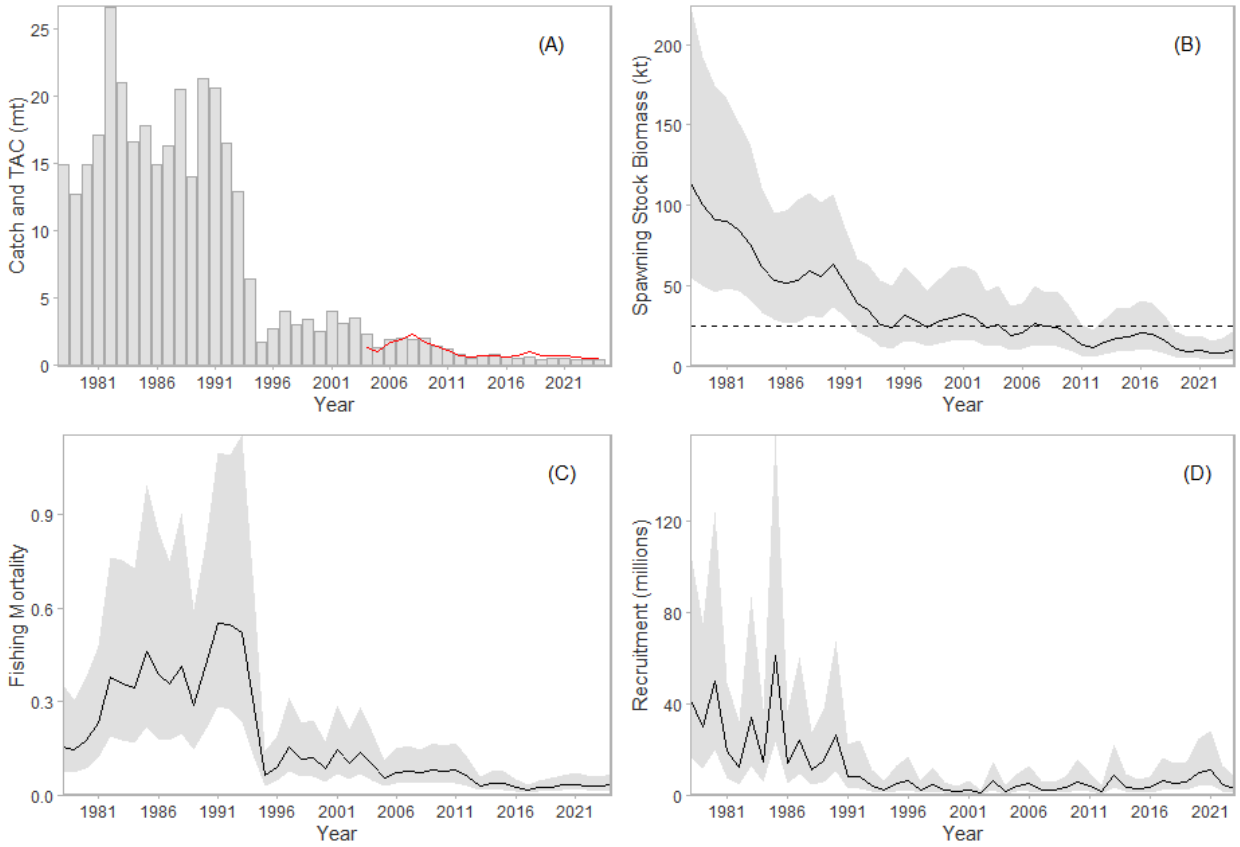

Figure 1. (A) Catch (bars) and total allowable catch (TAC, red solid line) for eastern Georges Bank Cod, (B) spawning stock biomass (kt=kilotonnes, solid black line) in relation to the 2024 limit reference point (24.9 kt, black dashed line), (C) instantaneous fully-selected fishing mortality (solid black line), and (D) recruitment (numbers in 000s, solid black line) for the eastern Georges Bank model. In panels B–D, the grey shading around the solid line represents 2.5 and 97.5 confidence intervals.

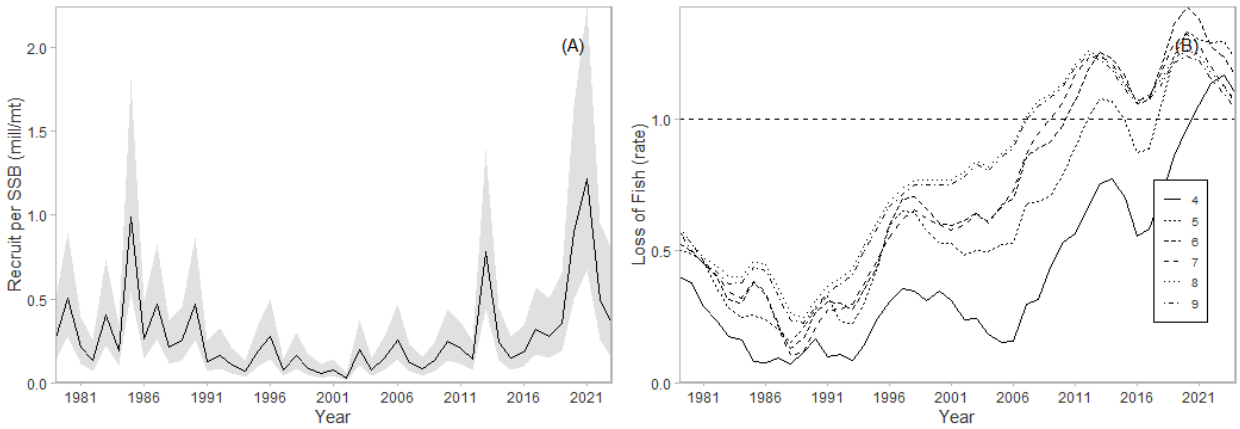

Figure 2. (A) Recruitment rate represented by solid black line (recruitment in millions over spawning stock biomass [SSB] in metric tonnes). Grey sharing represents 2.5 and 97.5 confidence intervals. (B) Instantaneous rate of fish loss at each age due to natural mortality and process error for ages 4+.

Stock Status and Trends

Biomass

Following a notable decrease in estimated SSB in the early 1990s, the stock has experienced a gradual decline and reached a series low in 2022 (7.96 kt). The SSB has since increased to 10.9 kt (2024), driven by a stronger year-class recruiting to the population. Another temporary increase in SSB throughout the mid-2010s appears to have been caused by an influx and subsequent departure of fish from outside of the assessment unit (Figure 1B).

Fishing Mortality

Estimated F was high in the 1980s (0.15–0.60), but declined throughout the 2000s and 2010s to a series low in 2017 (<0.02) and has since remained below 0.05. The 2024 value is estimated at 0.03 (Figure 1C). Currently, factors other than fishing are limiting stock productivity of eastern Georges Bank Cod (Figure 2B).

Recruitment

Recruitment has remained low for this stock since the mid-1990s (Figure 1D). Recruits per SSB in the last three years have been the highest since 1978, within the context of record low SSB (Figure 1B, Figure 2A). However, the higher recruitment has not resulted in sustained increases in the number of fish at ages 3+.

Natural Mortality

Loss of fish aged 4+ in the population continues to be estimated at a high rate, and M is inferred to be the primary cause. There are no indications that the high level of M will decrease in the near future and appears to be the main factor limiting productivity for this stock.

Current Status

The estimated 2024 median SSB (10.4 kt) is at 42% of the LRP (24.9 kt), and there is a very high (>0.98) probability that the stock remains in the critical zone.

The EGB Cod stock has declined since the 1990s and remains in the critical zone. Despite signs of improved recruitment and growth in the early 2020s, the productivity of the stock remains low with the annual rate of fish loss (combined annual natural mortality and process error) for older ages remaining above one. There is a very high probability that SSB remains in the critical zone in the projections under all fishing scenarios, including in the absence of fishing. Stock outlook is not expected to change in the future unless productivity improves.

History of Landings and Total Allowable Catch

Table 1. Canadian and US Landings and total allowable catch (TAC) for the eastern Georges Bank Atlantic Cod assessment unit. All landings and TAC are for calendar year (Jan 1–Dec 31) in metric tonnes (mt). Values in the 2004–2019 column are the annual average between 2004 and 2019.

Year	2004–2019	2020	2021	2022	2023	2024
TAC (mt)	1,118	650	635	571	520	520
Landings-Canada (mt)	799	377	431	326	329	327
Landings-US (mt)	273	67	41	38	32	51

Ecosystem and Climate Change Considerations

The model indicates that a high number of adult fish are disappearing in excess of fishery removals from this stock. This disappearance is attributed to M. The most commonly identified

contributors to M for Cod in this region are high temperature and predation (McBride and Smedbol 2022). Both of these have undergone substantial changes in recent years, with bottom temperature anomalies registering record highs on Georges Bank and the grey seal population which had increased considerably over the past several decades.

The presence of older fish in deeper waters within the area indicates earlier movement off the bank post-spawning. Although the mechanism for this shift has not been identified, it is likely related to ecosystem changes (e.g., temperature, predation, competition).

From 2015 to 2017, abundance suddenly increased across ages and is interpreted as movement of fish from outside of Georges Bank into and then out of the area.

Projections and Stock Advice

Given the long-term projection of biomass, it is highly unlikely that the estimated SSB will exceed the LRP, even in the absence of fishing. Consequently, there is no fishing level which will improve stock outlook under current productivity dynamics. Sporadic good recruitments (i.e. 2020 and 2021) and temporary influx of fish (i.e., 2015–2017) should be monitored for signs of improved productivity.

Projected SSB for 2025 is 7,899 mt. Projections assume that the 2025 TAC (452 mt) is removed in full during the 2025 fishing year, which equates to an F of 0.041. Projections for 2026–2027 are provided under various fishing scenarios (Table 2). Catch advice is only provided for 2026; projected SSB for 2027 is provided for information. Removals of 473 mt (F=0.052) correspond to the maximum F associated with a very low probability (<5%) of preventable decline (i.e., decline relative to F=0 scenario) in two generations (2032).

Table 2. Projected spawning stock biomass (SSB), catch for 2026, fishing mortality (F), and associated probability of preventable decline under the various fishing scenarios. Fpd is F associated with <5% of preventable decline. Frecent is the median F of the last six years. mt=metric tonnes.

F Scenario	SSB (mt) 2026	Catch (mt) 2026	F 2026	SSB (mt) 2027	Probability of Preventable Decline
Fpd	6,462	473	0.052	6,749	4.95%
Frecent	6,462	300	0.031	6,830	4.75%
No Fishing	6,462	0	0.000	6,949	0%

OTHER MANAGEMENT QUESTIONS

In 2018, an industry-led May Test Fishery began as an initiative to explore the possibility of opening the Georges Bank groundfish fishery before June 1. With six years of data available (2018–2019 and 2021–2024), Resource Management asked Science to provide advice on whether there is a conservation concern to an earlier opening than June 1st for the groundfish fishery in NAFO Division 5Z.

A review of the data was conducted as well as a literature search on the benefits of spawning closures (Clark et al, In Prep[3]). The analysis demonstrated higher proportions of ripe and spawning Cod and Haddock in May compared to June through August. While an acceptable risk

[3] Clark, C.M., I.V. Andrushchenko, and N. Hebert. Characterizing the May Test Fishery: 2018–2024. DFO Can. Sci. Advis. Sec. Res. Doc. In prep.

threshold for interactions with spawning Cod and/or Haddock has not been established, the results of the analysis demonstrate an earlier opening of the fishery would have a higher risk of interaction with spawning Cod and/or Haddock.

SOURCES OF UNCERTAINTY

Accounting for the movement of fish within the EGB management unit requires further work. Currently, the assessment assumes that there were no fish in deeper waters prior to 2010.

The absence of US fishery age composition since 2020 means the model assumptions are that the US fishery selectivity has not changed since then. It is uncertain whether that assumption is true and what the implications are on the model outputs.

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draft working paper for peer review only

Georges Bank Atlantic cod

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

Compiled 06-10-2024

This assessment of the Georges Bank Atlantic cod (Gadus morhua) stock is the first management track (MT) assessment following the 2023 research track (RT) assessment (NEFSC In Prep.) and adopts the new RT stock definition. This assessment updates the RT assessment model, catch and index data, and reference points through 2023. These updates included: recalibrated NEFSC indices, revised weight-at-age and Canadian commercial landings-at-age, and updating US landings and discards using the Catch Accounting and Monitoring System (CAMS). Additionally, short-term projections were updated through 2027.

State of Stock: Based on this updated assessment, the Georges Bank Atlantic cod (*Gadus morhua*) stock is overfished and overfishing is not occurring (Figures 1-2). Retrospective adjustments were not made to the model results because the retrospective pattern was minor. Spawning stock biomass (SSB) in 2023 was estimated to be 2,668 (mt) which is 32% of the biomass target (SSB_{MSY} *proxy* = 8,290; Figure 1). The 2023 fully selected fishing mortality was estimated to be 0.13 which is 56% of the overfishing threshold proxy (F_{MSY} *proxy* = 0.233; Figure 2).

Table 1: Catch and status table for Georges Bank Atlantic cod. All weights are in (mt) recruitment is in (000s) and F_{Full} is the fishing mortality on fully selected ages (9+). Model results are from the current updated WHAM assessment.

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
				Data						
US Landings	842	783	626	196	221	236	216	174	87	80
US Discards	9	22	19	9	7	3	9	10	11	7
Canadian Landings	430	472	428	474	510	388	362	420	309	321
Canadian Scallop Discards	15	13	9	7	5	5	11	5	10	8
Canadian Groundfish Discards	13	7	3	7	2	3	4	6	7	0
Combined total catch (US and Canada)	1,310	1,298	1,085	693	745	634	603	615	423	417
				Model Results						
Spawning Stock Biomass	4,528	4,365	6,519	9,598	9,065	5,783	3,984	3,490	3,111	2,668
F_{Full}	0.3	0.28	0.182	0.066	0.081	0.107	0.137	0.156	0.131	0.13
Recruits	498	203	181	261	660	552	633	1,114	1,180	605

Table 2: Reference points estimated in the current Management Track assessment update. An $F_{40\%}$ proxy was used for the overfishing threshold and estimates are reported with 95% confidence bounds.

	2023	2024
F_{MSY} *proxy*		0.23 (0.22 - 0.25)
SSB_{MSY} (mt)		8290 (4678 - 14690)
MSY (mt)		1930 (1084 - 3438)
Median recruits (age 1) (000s)		646
Overfishing	Unknown	No
Overfished	Unknown	Yes

Projections: Short term projections of biomass and catch were conducted in WHAM (Stock and Miller, 2021) using the standard projection approach. Following the 2023 RT decision, projections used terminal year fishery selectivity and a recent 5 year average of the maturity ogive and weights-at-age. Interim catch in 2024 was assumed to be equal to catch in 2023 (417 mt), and fishing was projected at F_{MSY} *proxy* for 2025-2027. Retrospective adjustments were not applied in the projections because the retrospective pattern was minor.

Table 3: Short term projections of total fishery catch and spawning stock biomass for Georges Bank Atlantic cod based on a harvest scenario of fishing at F_{MSY} *proxy* between 2025 and 2027. Catch in 2024 was assumed to be 417 (mt).

Year	Catch (mt)	SSB (mt)	F_{Full}
2024	417	2486 (929 - 6653)	0.152

Year	Catch (mt)	SSB (mt)	F_{Full}
2025	518	2089 (499 - 8739)	0.233
2026	419	1658 (277 - 9937)	0.233
2027	400	1567 (170 - 14457)	0.233

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).

  Recruitment is the largest source of uncertainty for this assessment. There were persistent trends in recruitment residuals that could not be fully resolved in this assessment. Additionally, insufficent port sampling, gaps in surveys, and age truncation in the NEFSC fall index terminal years make it more difficult to characterize age composition for this stock.

- Does this assessment model have a retrospective pattern? If so, is the pattern minor, or major? (A major retrospective pattern occurs when the adjusted SSB or F_{Full} lies outside of the approximate joint confidence region for SSB and F_{Full}).

  The 7-year Mohn's ρ, relative to SSB, was 0.389 in the RT assessment and was 0.19 in 2023. The 7-year Mohn's ρ, relative to F, was -0.238 in the RT assessment and was -0.134 in 2023. The retrospective pattern was considered minor in this assessment because the ρ adjusted estimates of 2023 SSB (SSB_{ρ}=2242) and 2023 F (F_{ρ}=0.15) were within the approximate 90% confidence regions around SSB (1,528 - 4,660) and F (0.073 - 0.233). Therefore, a retrospective adjustment was not made for the determination of stock status or projections of catch. No retrospective adjustment of spawning stock biomass or fishing mortality in 2023 was required.

- Based on this stock assessment, are population projections well determined or uncertain? If this stock is in a rebuilding plan, how do the projections compare to the rebuilding schedule?

  The reliability of population projections for Georges Bank Atlantic cod, can not be determined because of major differences between the data and methods used in the prior RT and current MT assessments. This includes a change in the survival process error assumptions, which impact how these errors propagate in projections. This stock is not yet in a rebuilding plan.

- Describe any changes that were made to the current stock assessment, beyond incorporating additional years of data and the effect these changes had on the assessment and stock status.

  Both spring and fall NEFSC bottom trawl indices were re-calibrated which had a large effect on model fit and diagnostics. Other updates with smaller effects included: updating US landings and discards in 2022-2023 from CAMS (including lobster discards) and revising WAA and Canadian commercial landings-at-age data for the entire time series. Specifications for estimating initial numbers-at-age and numbers-at-age random effects were also updated in this MT assessment. Exclusion of the lognormal adjustment for process and observation errors was adopted with minimal impacts on model fit, diagnostics and stock status, but had a relatively large impact on model results. In addition, the following data gaps occurred: the DFO spring index was not available in 2022 following a vessel change in that year, the NEFSC spring index was not available in 2023 due to sampling interruptions and insufficient nighttime sampling, and no US catch age composition was available in 2022-2023 due to insufficient port sampling so only Canadian catch composition was fit. All changes and their impacts on model fit and diagnostics are described at length in the supplemental materials.

- If the stock status has changed a lot since the previous assessment, explain why this occurred.

  This is the first MT assessment for the new Georges Bank Atlantic codstock definition, so official stock status was unknown prior to this assessment. However, the overfished status is consistent with the qualitatively determined stock status from the last Georges Bank cod MT assessment (NEFSC 2022) which was based on the prior stock definition.

- Provide qualitative statements describing the condition of the stock that relate to stock status.

  The Georges Bank Atlantic cod stock continues to show a truncated age structure and in the terminal two years of the assessment (2022-2023). All surveys indicate fewer old fish in recent years, but the age truncation is particularly evident in the NEFSC fall bottom trawl survey which did not observe any fish older than age 4 in the terminal two years of the assesesment. SSB estimates have remained low over the terminal four years of the assessment (2019-2023), with the 2023 estimate representing an all time low for the time series.

- Indicate what data or studies are currently lacking and which would be needed most to improve this stock assessment in the future.

  The Georges Bank Atlantic cod assessment could be improved with increased port sampling to characterize catch for all market categories.

- Are there other important issues?

  Survey sampling interruptions could be a potential problem if they persist in future years. Shifting the MT assessment timeline to spring (June) rather than fall (September) for this stock, resulted in shortened timeframes for compiling data and completing assessment models compared to prior years. If this timing is retained in future MT assessments, data delays may continue to limit model development.

References:

[NEFSC] Northeast Fisheries Science Center. In Prep. Research Track Assessment of Atlantic Cod. US Dept Commer, Northeast Fish Sci Cent Ref Doc. XX-XX; XXX p.

[NEFSC] Northeast Fisheries Science Center. 2022. Management Track Assessments Fall 2021. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 22-07; 53 p.

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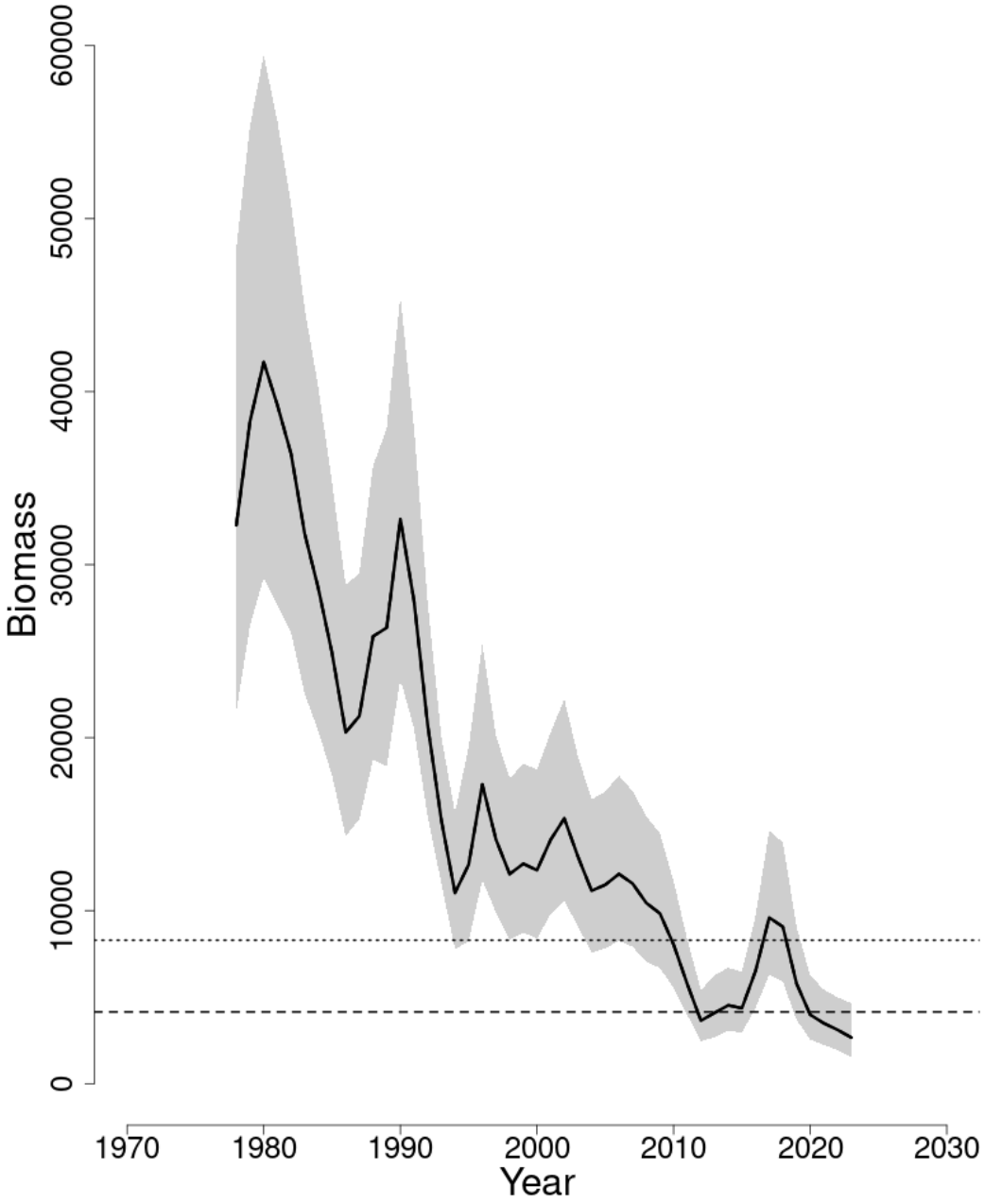

Figure 1: Trends in spawning stock biomass of Georges Bank Atlantic cod between 1978 and 2023 from the current Management Track (solid line). The corresponding $SSB_{Threshold}$ ($\frac{1}{2}$ SSB_{MSY} *proxy*; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY} *proxy*; horizontal dotted line) are based on the 2024 assessment. The approximate 90% lognormal confidence intervals are shown.

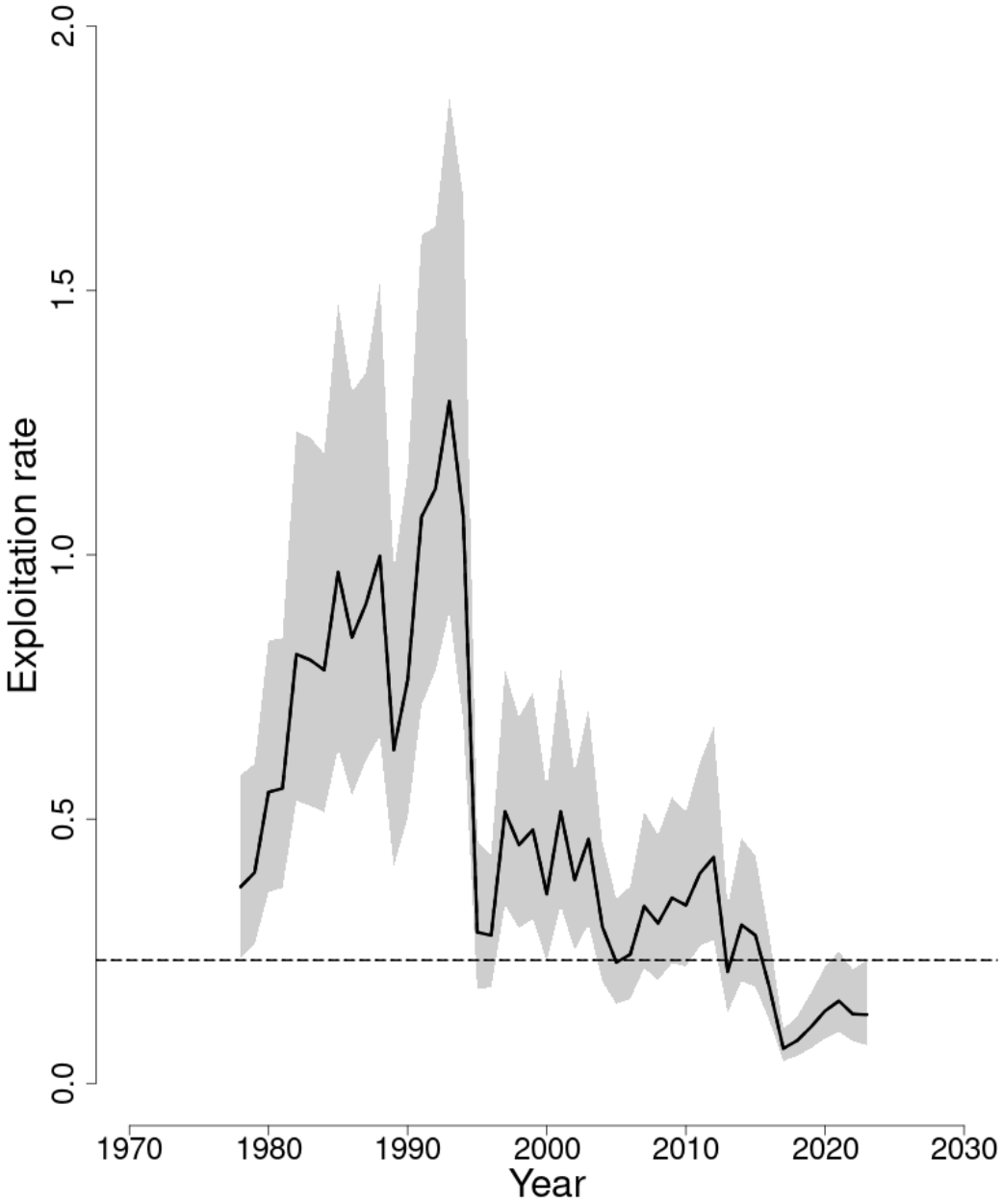

Figure 2: Trends in the fully selected fishing mortality (F_{Full}) of Georges Bank Atlantic cod between 1978 and 2023 from the current Management Track (solid line) and the corresponding $F_{Threshold}$ (F_{MSY} *proxy*=0.233; horizontal dashed line). The approximate 90% lognormal confidence intervals are shown.

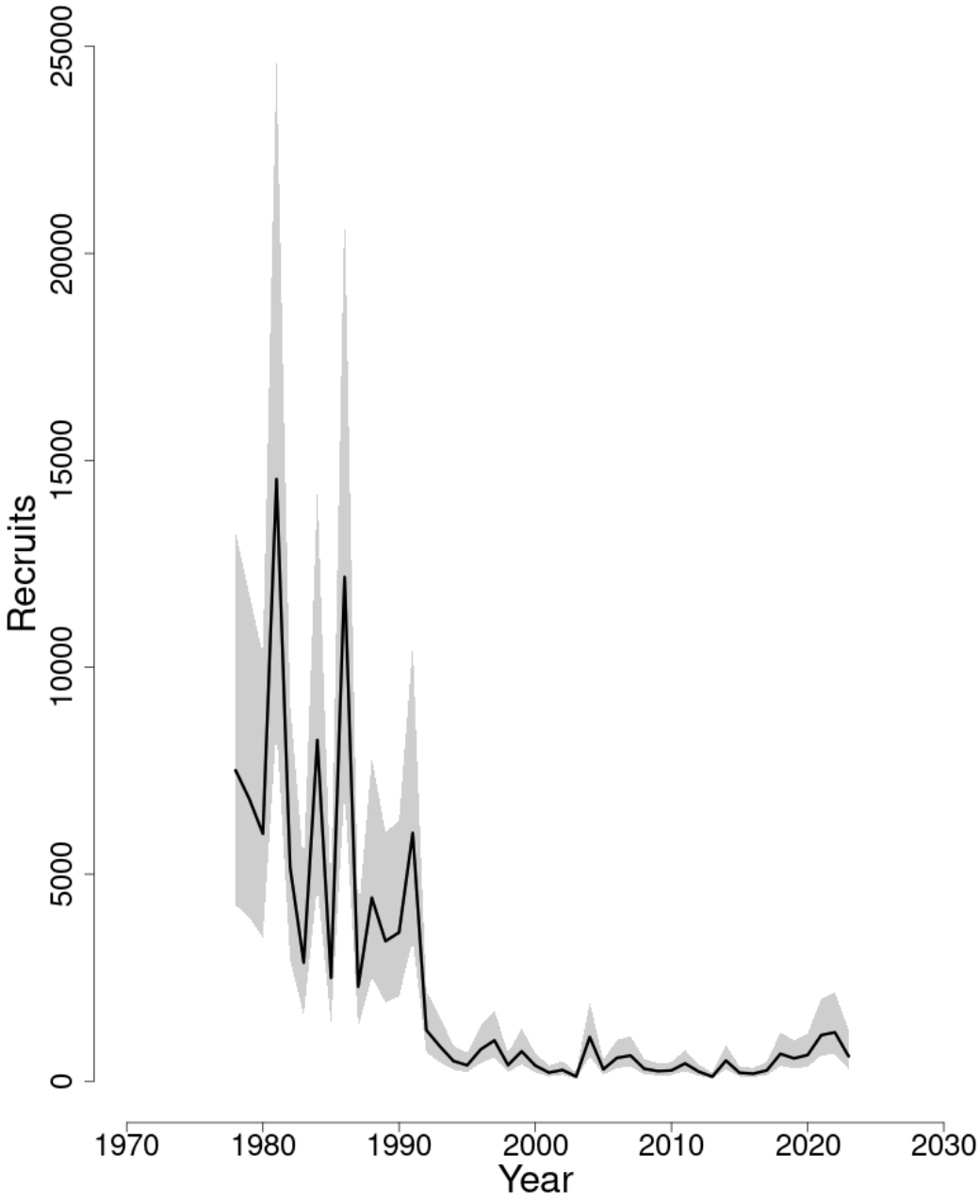

Figure 3: Trends in Recruits (000s) of Georges Bank Atlantic cod between 1978 and 2023 from the current Management Track (solid line). The approximate 90% lognormal confidence intervals are shown.

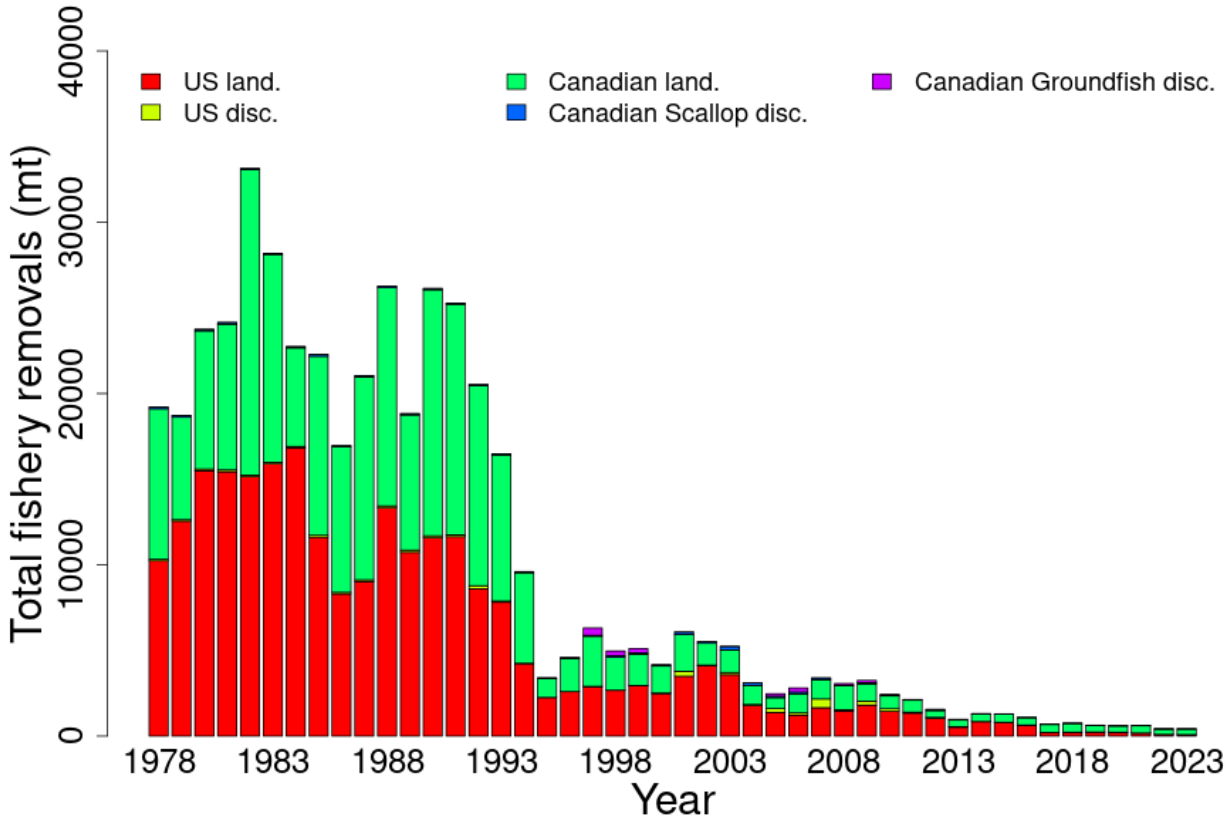

Figure 4: Total catch of Georges Bank Atlantic cod between 1978 and 2023 by fleet component (commercial US and Canadian) and disposition (landings and discards).

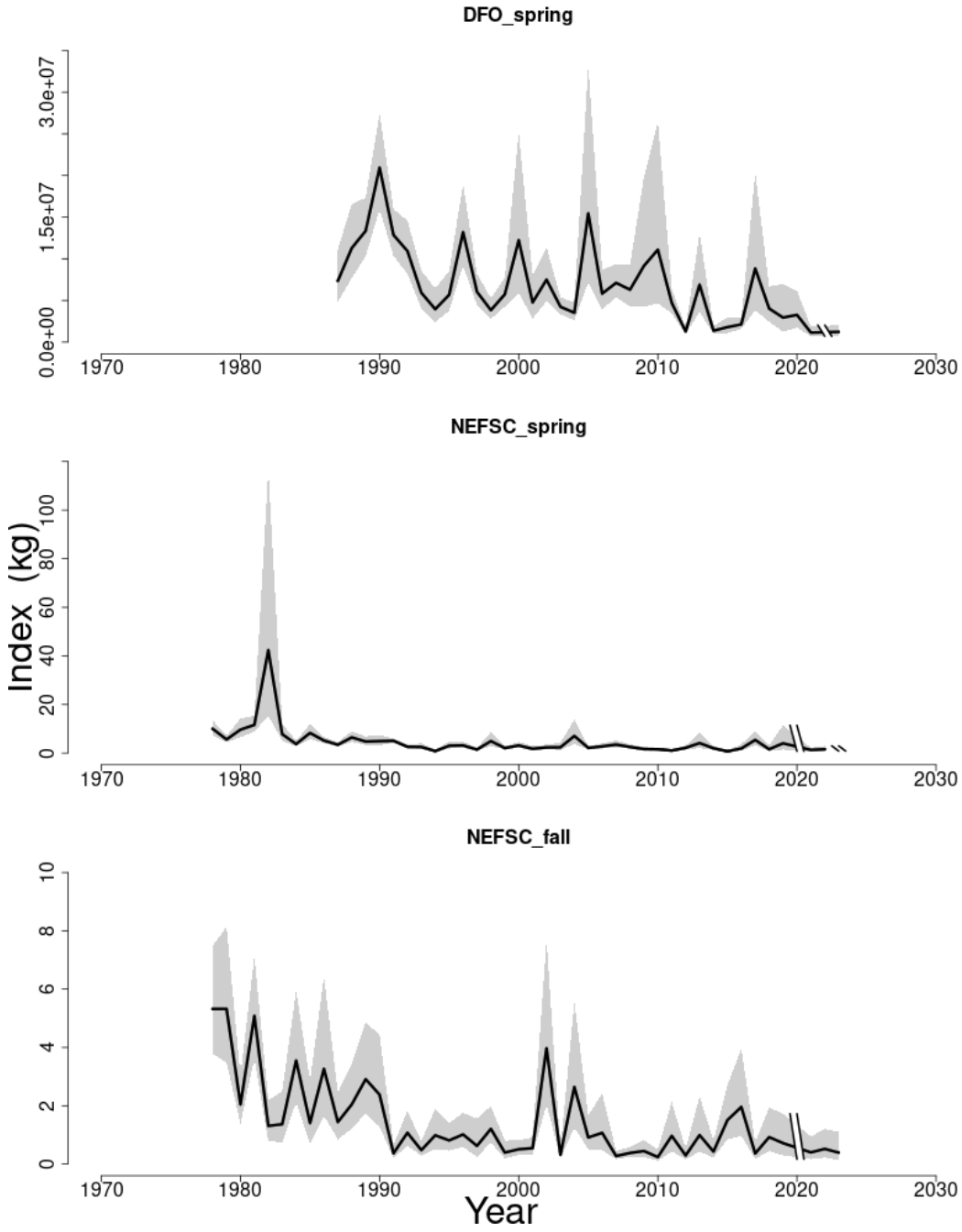

Figure 5: Indices of biomass for the Georges Bank Atlantic cod between 1978 and 2023 for the Department of Fisheries and Oceans Canada (DFO) spring (top), Northeast Fisheries Science Center (NEFSC) spring (middle) and fall (bottom) bottom trawl surveys. Gaps where data is not available are indicated by parallel breaks in the time series. The approximate 90% lognormal confidence intervals are shown.

Fisheries and Oceans Canada | Pêches et Océans Canada
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Maritimes Region

Canadian Science Advisory Secretariat
Science Advisory Report 2025/nnn

STOCK ASSESSMENT OF EASTERN GEORGES BANK HADDOCK (*MELANOGRAMMUS AEGLEFINUS*) IN 2024

CONTEXT

The Fisheries Management Branch of Fisheries and Oceans Canada (DFO) requested advice for eastern Georges Bank (EGB) Haddock (*Melanogrammus aeglefinus*) in support of the decision making process for the 2026 fishing season. This Science Advisory Report results from the regional peer-review of June 10–12, 2025, on the Stock Assessment of Cod and Haddock on Eastern Georges Bank. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

SCIENCE ADVICE

Status

- The 2024 model-estimated spawning stock biomass (SSB; 27,343 mt) is above the LRP with a probability of 100% and above the USR with a probability of 70%, placing the stock in the healthy zone.

Trends

- The estimated SSB has declined from 81,453 mt in 2016 to 27,342 mt in 2024; however, SSB is still above the median of the time series.
- The model estimates of age-1 recruitment in 2020 and 2021 (90 million and 69 million, respectively) are above median recruitment of 8.8 million.
- Fishing mortality (F) was estimated to be 0.48 on average over the last five years with a decrease to 0.31 for 2024.
- The model-estimated natural mortality rate (M; 0.502) in recent years (2010–2024) continues to be high.

Ecosystem and Climate Change Considerations

- Higher M estimates have been attributed to both density-dependent impacts of the 2013 year-class, and changes in spatial distribution related to environmental conditions.
- Haddock presence in deeper water strata off EGB indicates increased movement off the bank throughout the year, likely corresponding with ecosystem changes.

Stock Advice

- Catch advice for 2026 ranged from 2,480–3,850 mt based on the 25–75% risk of exceeding F_{ref}.

BASIS FOR ASSESSMENT

Assessment Details

Data from the 5Z9 stratum for the DFO Winter RV Survey were added to the assessment model, improving some of the poor model diagnostics of the base model. Additional improvements to the model were discussed in the meeting, and suggested to be explored in the future.

Year Assessment Approach was Approved: 2025 (Barrett and Barrett, In Prep[1])

Assessment Type: Full assessment

Most Recent Assessment Date:

1. Last full assessment: 2024 (DFO 2024)

Stock Assessment Approach:

1. Single stock assessment model
2. Statistical catch-at-age

Stock Structure Assumption

Based on the physical and oceanographic characteristics of Georges Bank, larval dispersal and adult movement are thought to be limited (Kronlund et al. 2023). Tagging studies have suggested seasonal mixing of Haddock between the Bay of Fundy, Gulf of Maine, Great South Channel, and Georges Bank, with movement varying yearly (Brodziak et al. 2008). When abundance is high, boundaries may become more continuous (Sosebee and Cadrin 2006). Based on the most recent review of stock structure (Kronlund et al. 2023), Haddock on Georges Bank are assumed to be a single stock. EGB Haddock are currently assessed as a single unit, although some mixing may exist with adjacent stock units.

[1] Barrett, M.A. and T.J. Barrett. 2025. Stock Assessment of Haddock (*Melanogrammus aeglefinus*) on Eastern Georges Bank. DFO Can. Sci. Advis. Sec. Res. Doc. 2025/nnn. iv.+ 36 p.

Reference Points

- Limit reference point (LRP): $B_{recover}$ (minimum model-estimated SSB between 1991–1996 [SSB_{1993}]; Wang and Carruthers 2025)
- Upper stock reference (USR): Rago-Razor method (minimum model-estimated SSB for which further increases in SSB did not produce markedly improved recruitment, applied to recruitments up to 2019)
- Fishing mortality reference (F_{ref}): 0.339 based on $F_{40\%SPR}$ (fishing mortality rate at 40% spawner per recruit; TRAC 2022)

Data

- DFO Winter Ecosystem Research Vessel (RV) Survey index (1986–2024)
- National Marine Fisheries Service (NMFS) Spring Survey (1968–2024, except 2020 and 2023)
- NMFS Fall Survey (1963–2024, except 2020)
- Canadian commercial fishery data (1969–2024)
- USA commercial fishery data (1969–2024)

Data changes: The DFO Winter RV Survey was conducted in 2022 with a new vessel and gear. Length-based calibration factors were applied to convert the 2022 survey data to be comparable to survey data collected by the previous vessel and gear. Data from 5Z9 were included from 2010–2024 for the DFO Winter RV Survey.

ASSESSMENT

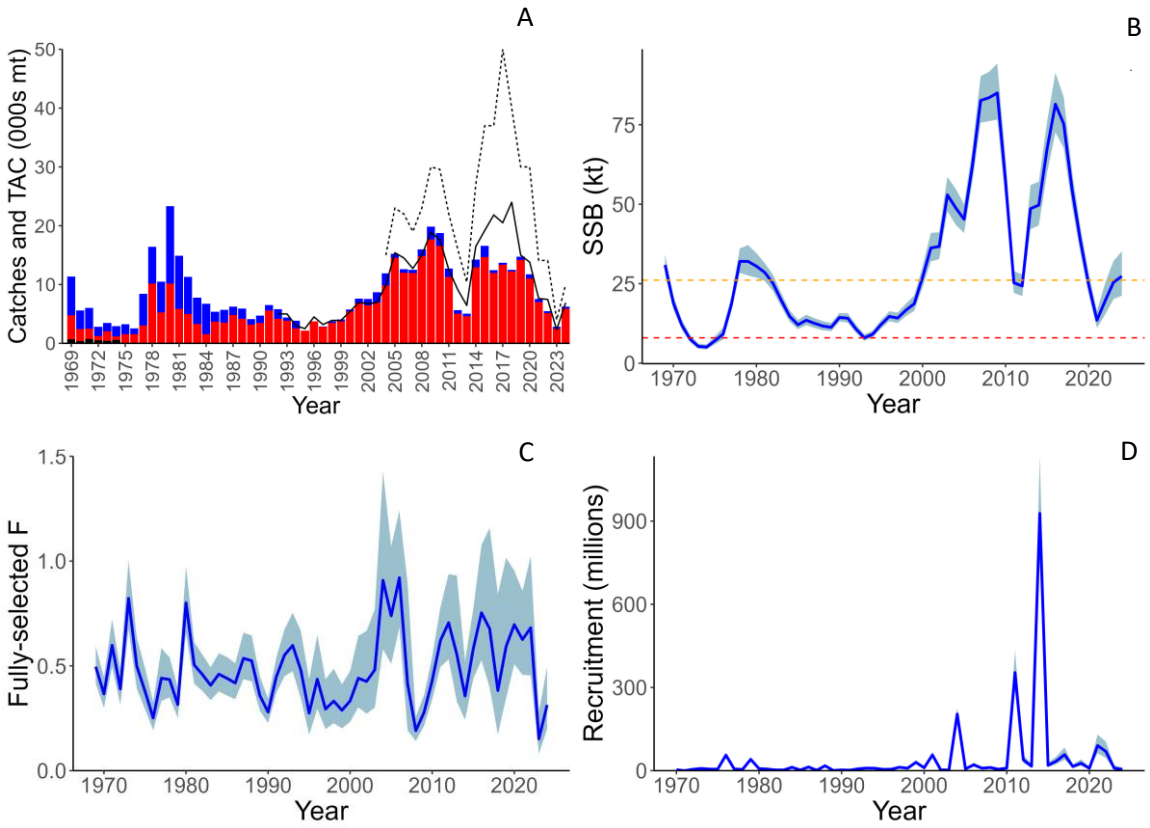

Figure 1. (A) Catch and total allowable catch (TAC) by country, where blue is USA, red is Canada, and black is foreign. TAC is represented by the black line (dashed for total, solid for Canadian). (B) Spawning stock biomass (SSB), the dashed red line is the limit reference point and the dashed orange line is the upper stock reference point. (C) Fully-selected instantaneous fishing mortality rate (F). (D) Recruitment (numbers at age-1; millions). 95% confidence intervals provided in light blue shading for Figures B–D.

Stock Status and Trends

Spawning Stock Biomass:

Higher recruitment since 1990, lower exploitation, and reduced capture of small fish in the fishery have contributed to the SSB estimate increasing to 53,000 mt in 2003. A subsequent increase to 85,000 mt in 2009 was largely due to the strong 2003 year-class. When the strong 2010 and 2013 year-classes became sexually mature, the estimated SSB increased to 81,000 mt in 2016, followed by a continued decline in the subsequent years. Despite the recruitment being much higher for the 2010 and 2013 year-classes compared to the 2003 year-class, the SSB did not increase as much, hypothesized to be due to a higher M beginning in 2010. The current SSB estimate for 2024 is 27,343 mt, which is above the median SSB of 24,553 mt for the time series (1969–2024, Figure 1B).

Recruitment:

Model estimated recruitment at age-1 has fluctuated between 1.7 and 90 million since 1990, except for the strong year-classes. The recruitment of the 2003, 2010, and 2013 year-classes was 204, 353, and 928 million, respectively. The recruitment of the 2020 and 2021 year-classes was 90 and 69 million fish, exceeding the median recruitment of 8.8 million for the time series (Figure 1D).

Fishing Mortality:

Fully-selected F has varied throughout the time series, fluctuating between 0.18 in 2008 to 0.71 during the mid-2010s (Figure 1C). F was estimated to be 0.48 on average over the last five years with a decrease to 0.31 for 2024.

Natural Mortality:

The model estimates an increase in M from the assumed historical level of 0.2 to 0.502 in the recent time block (2010–2024). The high M in recent years likely reflects potential changes in additional factors including migrations, catch reporting errors, ageing error, and misspecification of selectivity.

Current Status:

The 2024 model-estimated spawning stock biomass (SSB; 27,343 mt) is above the LRP with a probability of 100% and above the USR with a probability of 70%, placing the stock in the healthy zone.

History of Landings and TAC

Combined Canada and USA catches for EGB Haddock were 6,219 mt in 2024 (Figure 1A, Table 1). In 2024, the total catch represented 62% of the combined (Canada and USA) quota.

The Canadian catch increased from 2,507 mt in 2023 to 5,908 mt in 2024. Discards of Haddock by the Canadian Scallop fishery were 9 mt in 2024, and have ranged between 4 mt and 186 mt over the time series. Canada caught 86% of its 6,900 mt allocation and the USA catches were 311 mt in 2024. USA landings in 2024 were 285 mt and discards were estimated to be 26 mt. The USA caught 10% of its 3,100 mt allocation.

The 2021 year-class (age 3) was a major contributor to the 2024 Canadian fishery catch (61% of the fish by number), followed by the 2020 year-class (age 4; 30% by number). Catches peaked at lengths of 40.5 cm, 46.5 cm, and 38.5 cm for otter trawl, longline, and scallop dredge gears in 2024.

Table 1. Landings and total allowable catch (TAC) in metric tons by Canada and the USA for the eastern Georges Bank Haddock fishery by calendar year (January 1– December 31). A dash (-) indicates data are not currently available.

Calendar Year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Canadian TAC (mt)	19,200	21,830	20,500	24,000	15,000	13,800	7,614	7,473	2,320	6,900	5,854
Canadian Landings (mt)	14,631	11,935	13,377	12,216	14,156	11,045	6,997	5,143	2,499	5,889	-
Canadian Discards (mt)	17	8	8	5	4	7	5	7	8	9	-
USA TAC (mt)	17,800	15,170	29,500	16,000	15,000	16,200	6,486	6,627	1,520	3,100	1,556
USA Landings (mt)	1,506	341	214	253	544	633	518	327	299	285	-
USA Discards (mt)	415	125	81	21	50	50	6	8	33	26	-
Total TAC (mt)	**37,000**	**37,000**	**50,000**	**40,000**	**30,000**	**30,000**	**14,100**	**14,100**	**3,840**	**10,000**	**7,410**
Total Catch (mt)	**16,569**	**12,409**	**13,679**	**12,495**	**14,735**	**11,735**	**7,526**	**5,485**	**2,840**	**6,219**	**-**

Ecosystem and Climate Change Considerations

Higher M estimates in the model have been attributed to both density dependent impacts of the 2013 year-class (e.g., reduced growth, condition, spatial distribution expanded) and changes in spatial distribution from environmental conditions (Friedland et al. 2015; Wang et al. 2021; Wang et al. 2024).

Haddock presence in deeper waters within the EGB management area indicates that fish movement off the bank may be occurring. Although the mechanism driving changes in movement has not been identified, it is likely related to ecosystem changes occurring in the EGB area (e.g., temperature, predation, competition). The 2024 assessment model includes the adjacent 5Z9 DFO Winter RV survey stratum data to account for changes in the distribution observed in the spring.

Projections

Table 2 shows the projected median estimates of recruitment, biomass, SSB, and F with an assumed 2025 catch of 7,410 mt. The 2020 and 2021 year-classes are projected to be the dominant contributors to fishery catch in 2026 (Barrett and Barrett In Prep).

Table 2. Projections from the assessment model with an assumed catch of 7,410 mt in the 2025 fishery (median value across 2,000 simulations) and F_{ref}=0.339. SSB=Jan 1st spawning stock biomass. A dash (-) indicates not applicable.

Year	Age 1 Recruitment (000s)	Biomass (mt)	SSB (mt)	Catch (mt)	Fishing Mortality (F)
2025	15,143	26,543	23,713	7,410	0.534
2026	19,397	19,794	15,180	2,990	0.339
2027	-	20,575	13,963	-	-

Catch Advice

Model-projected catch advice for 2026 ranged from 2,480–3,850 mt based on the 25–75% risk of exceeding F_{ref} (Table 3). The probabilities that the 2027 SSB is above the LRP ranged from 68–75% and above the USR ranged from 28–30%.

Table 3. Catch advice for eastern Georges Bank Haddock for 2026 for the assessment model which includes 5Z9 for the DFO survey. The probabilities are based on spawning stock biomass (SSB) as of Jan 1st, 2027, and takes into account the removal of catch in 2026. LRP=limit reference point. USR =upper stock reference point. F_{ref}=fishing mortality reference point.

Probability of exceeding F_{ref}	25%	50%	75%
2026 catch advice	2,480 mt	3,170 mt	3,850 mt
$P(SSB_{2027}>LRP)$	0.746	0.709	0.679
$P(SSB_{2027}>USR)$	0.298	0.290	0.281

Sources of Uncertainty

Natural mortality remains an uncertainty for the EGB Haddock stock. The expectation was that with the exit of the 2013 year-class and the reduction in overall stock biomass, the model-estimated M would decrease. Contrary to expectations, model-estimated M remains high. However, our understanding of the factors leading to high M in recent years is incomplete.

Poor model diagnostics led to the base model being adjusted with the addition of the 5Z9 stratum data. This was an interim decision to address the concerns identified in the model including the magnitude of retrospective patterns in F and recruitment. Additional uncertainties identified during the peer-review were related to potential misspecification of survey and fishery selectivity, and the disconnect between the M used in the F_{ref} calculation and M assumed in the projections.

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Georges Bank haddock

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

Compiled 09-09-2024

This assessment of the Georges Bank haddock (Melanogrammus aeglefinus) stock is a Level-2 operational update of the 2022 management track assessment, which used the WHAM framework. Prior to the 2021 research track, the last benchmark for this stock was in 2008 (Brooks et al., 2008). Based on the previous update assessment in 2022 (NEFSC, 2022), the stock was not overfished, and overfishing was not ocurring. This assessment updates commercial fishery catch data, research survey indices of abundance, weights and maturity at age, and the WHAM assessment model and reference points through 2023. Stock projections have been updated through 2027. This report (will) reflect(s) decisions made during the Peer Review September 16-19, 2024.

State of Stock: Based on this updated assessment, the Georges Bank haddock (*Melanogrammus aeglefinus*) stock is not overfished, and overfishing is not occurring (Figures 1-2). Retrospective adjustments were not made to the model results. Spawning stock biomass (SSB) in 2023 was estimated to be 32,730 (mt) which is 135% of the biomass target (SSB_{MSY} *proxy* = 24,225; Figure 1). The 2023 average fishing mortality on ages 5-7 was estimated to be 0.17 which is 65% of the overfishing threshold proxy (F_{MSY} *proxy* = 0.26; Figure 2). The F_{MSY} *proxy* is expressed as the average F on ages 5-7.

Table 1: Catch and status table for Georges Bank haddock. All weights are in (mt), recruitment is in (000s), and $\bar{F}_{5-7}$ is the average fishing mortality on ages 5 to 7. Model results are from the current updated WHAM assessment. A rho adjustment was not applied to values in this Table.

	2016	2017	2018	2019	2020	2021	2022	2023
				Data				
US Commercial discards	1,880	786	410	306	178	49	65	116
US Commercial landings	3,682	3,217	4,017	5,252	6,648	3,641	2,419	2,604
Canadian Catch	11,713	13,384	12,222	14,160	11,052	7,001	5,150	2,507
Catch for Assessment	17,274	17,387	16,647	19,719	17,878	10,691	7,634	5,226
				Model Results				
Spawning Stock Biomass	139,072	165,807	97,565	77,985	54,624	33,405	32,885	32,730
$\bar{F}_{5-7}$	0.36	0.24	0.22	0.3	0.37	0.33	0.3	0.17
Recruits (age 1)	72,880	74,535	12,773	15,603	7,688	60,112	29,528	17,848

Table 2: Comparison of reference points estimated from the 2022 WHAM assessment and from the current 2024 WHAM assessment update. An $F_{40\%}$ proxy was used for the overfishing threshold. The medians and 95% probability intervals are reported for MSY, SSBMSY, and RMSY, based on WHAM projections with fishing mortality fixed at $F_{40\%}$.

	2022	2024
F_{MSY} *proxy*	0.25	0.26
SSB_{MSY} (mt)	120,580	24,225 (13,101 - 44,793)
MSY (mt)	25,494	5,766 (3,115 - 10,670)
Median recruits (age 1) (000s)	25,607	16,841 (468 - 605,926)
Overfishing	No	No
Overfished	No	No

Projections: Short term projections were conducted in WHAM, which propagates uncertainty in the processes of recruitment and transitions between numbers at age. For projection specifications, the Plan Development Team supplied an estimate of total catch for 2024, and fishing mortality was set equal to F40%SPR for 2025-2027. Annual fishery selectivity and maturity were fixed at a recent 2 year average (2022-2023 values), following analyses and decisions made at the 2021 research track. Weights at age for catch and SSB that were predicted from a Gaussian Markov Random Field (GMRF) model, rather than a recent 2 year average, were preferred by the peer

reviewers at the 2022 management track assessment, and were used in the projections summarized in this report. The GMRF projected weights for 2022 and 2023 from the previous management track were compared to observed values in those years, and were more accurate than a 2 year average. Retrospective adjustments were not applied. The Overfished threshold is 12,112 mt, and the stock is not projected to drop below this value in the next 4 years.

Table 3: Short term projections of total fishery catch and spawning stock biomass (with 95% CI) for Georges Bank haddock based on a harvest scenario of fishing at 100% F_{MSY} *proxy* between 2025 and 2027. Catch in 2024 was assumed to be 9,627 mt (estimate provided by the Groundfish Plan Development Team).

Year	Catch (mt)	SSB (mt)	$\bar{F}_{5-7}$
2024	9,627	34,180 (14,038 - 83,225)	0.316 (0.116 - 0.859)

Year	Catch (mt)	SSB (mt)	F_{5-7}
2025	8,034 (2,430 - 26,570)	34,516 (10,532 - 113,116)	0.264
2026	8,177 (1,956 - 34,188)	36,029 (8,534 - 152,117)	0.264
2027	8,439 (1,553 - 45,865)	37,263 (6,843 - 202,924)	0.264

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).

  Sources of uncertainty include dynamics in the plus group (ages 9+), future recruitment, and future assumptions about weights and selectivity at age. The 2013 year class, the largest ever observed for this stock, is in the plus group for the final year of the model (2023) and is no longer the main contributer to catch or biomass. The 2020 year class accounts for 47% of SSB in 2023.

- Does this assessment model have a retrospective pattern? If so, is the pattern minor, or major? (A major retrospective pattern occurs when the adjusted SSB or $\bar{F}_{5-7}$ lies outside of the approximate joint confidence region for SSB and $\bar{F}_{5-7}$).

  The 7-year Mohn's ρ, relative to SSB, was 0.26 in the 2022 assessment and was 0.50 in 2023. The 7-year Mohn's ρ, relative to F, was -0.27 in the 2022 assessment and was -0.37 in 2023. There was a minor retrospective pattern for this assessment because the ρ adjusted estimates of 2023 SSB (SSB_ρ=32,730) and 2023 F (F_ρ=0.17) were inside the estimated 95% confidence regions around SSB (17,749 - 60,356) and F (0.077 - 0.375). No retrospective adjustment was made for either the determination of stock status or for projections of catch in 2025.

- Based on this stock assessment, are population projections well determined or uncertain? If this stock is in a rebuilding plan, how do the projections compare to the rebuilding schedule?

  As noted in the first bullet, population projections for Georges Bank haddock are uncertain due to future values of selectivity and weights at age, dynamics of the plus group (ages 9+), and magnitude of incoming 2020 and 2021 year classes. Large estimates of process error contribute to wide confidence intervals in the projections. This stock is not in a rebuilding plan.

- 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.

  Two years of additional data were incorporated in the Georges Bank haddock assessment for this update. New options in WHAM were tested that were not available during the 2021 research track, specifically bias correction and recruitment decoupling. Decoupling the yearly random effects in recruitment from the yearly random effects in ages 2+ was suggested by reviewers during the State Space Research Track Review. This option improved the likelihood and was implemented for this 2024 management track; it had minimal impact

on model estimates. Bias correction has been the default setting in WHAM. The current guidelines are to evaluate the impact of this setting. This option was tested, and the likelihood improved without bias correction, and it was implemented for this 2024 management track. Without bias correction, reported model estimates are medians rather than means. Because of the large estimates of process error, particularly for recruitment, there is a large difference in scale, with the median much less than the mean.

- If the stock status has changed a lot since the previous assessment, explain why this occurred.
  The stock status of Georges Bank haddock has not changed. The reported scale of the population, and of the reference points, has changed due to the modeling updates described in the previous bullet.

- Provide qualitative statements describing the condition of the stock that relate to stock status.
  The Georges Bank haddock shows a broad age structure, but as the really large year classes have declined in abundance, the stock's spatial distribution has contracted and is less broadly distributed. This stock has produced several exceptionally strong year classes in the last 20 years (2003, 2010, 2013), leading to record high SSB in the last decade. As the strong year classes age out of the population, abundance has returned to levels last observed in the early 2000s. An increase in maturity at age and weights at age were observed in the most recent 2 years, likely a result of decreased density-dependent pressures on growth. Projected catch at F40% exceeds MSY and SSBMSY for several reasons: i) the stock is currently above SSB[F40%]; ii) the 2020 year class is above average and accounts for a large proportion of projected SSB and catch; and iii) short term weights at age (GMRF) are larger than the 5 year average weights at age used to calculate reference points. The NEFSC Bottom Trawl surveys have shown a steady decline from the peak in 2015. The Spring 2023 survey data were not used, and this increased uncertainty in terminal year estimates.

- Indicate what data or studies are currently lacking and which would be needed most to improve this stock assessment in the future.
  The research track assessment in 2021 for Georges Bank haddock strongly recommended studies to collect data to re-estimate gutted to whole weight conversion factors, as well as measuring individual fish weight in addition to the length and otolith sampling performed on commercially landed fish. A proposal to undertake this research was recently funded and work is currently underway.

- Are there other important issues?
  The Georges Bank haddock assessment estimates that the haddock stock has declined to levels last observed in the early 2000s. Projections at F40% using GMRF weights at age predict a very slight increase in SSB in 2024-2027. Surges in stock abundance and quotas are driven by strong year classes, creating a boom and bust cycle. The current assessment estimates that the stock has left the boom phase and is heading in the bust direction. The current estimates of the 2020 year class is near the time series average, which may slow the current decline in the near term. The assessment models for the domestic Georges Bank stock and the transboundary Eastern Georges Bank management unit do not align. Now that the Georges Bank assessment is not bias correcting, this creates another misalignment with potentially important implications for the scale of estimated population abundance and catch advice.

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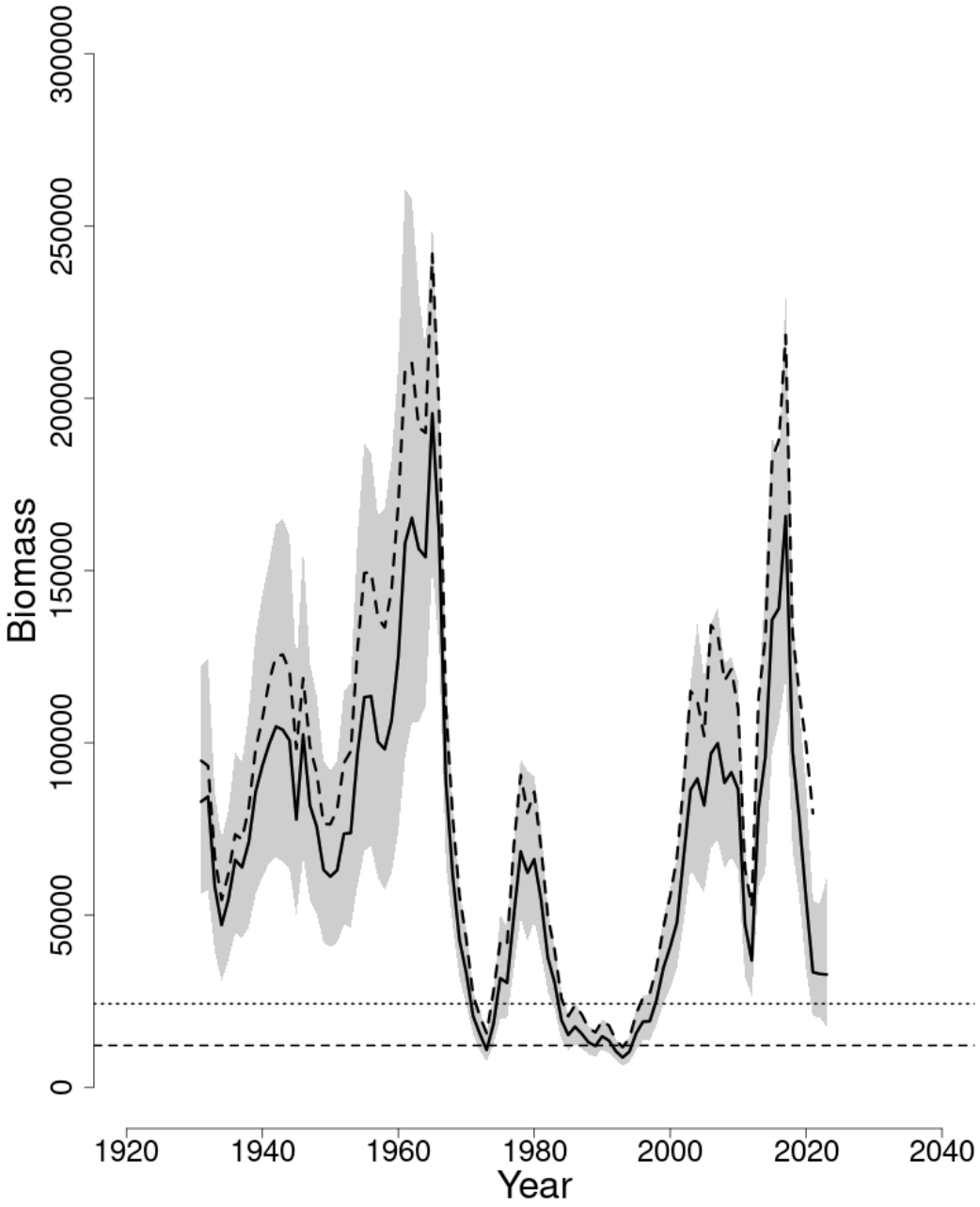

Figure 1: Trends in spawning stock biomass of Georges Bank haddock between 1931 and 2023 from the current (solid line) and previous (dashed line) 2022 assessment and the corresponding $SSB_{Threshold}$ ($\frac{1}{2}$ SSB_{MSY} *proxy*; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY} *proxy*; horizontal dotted line) based on the current 2024 assessment. The 95% confidence intervals are shown.

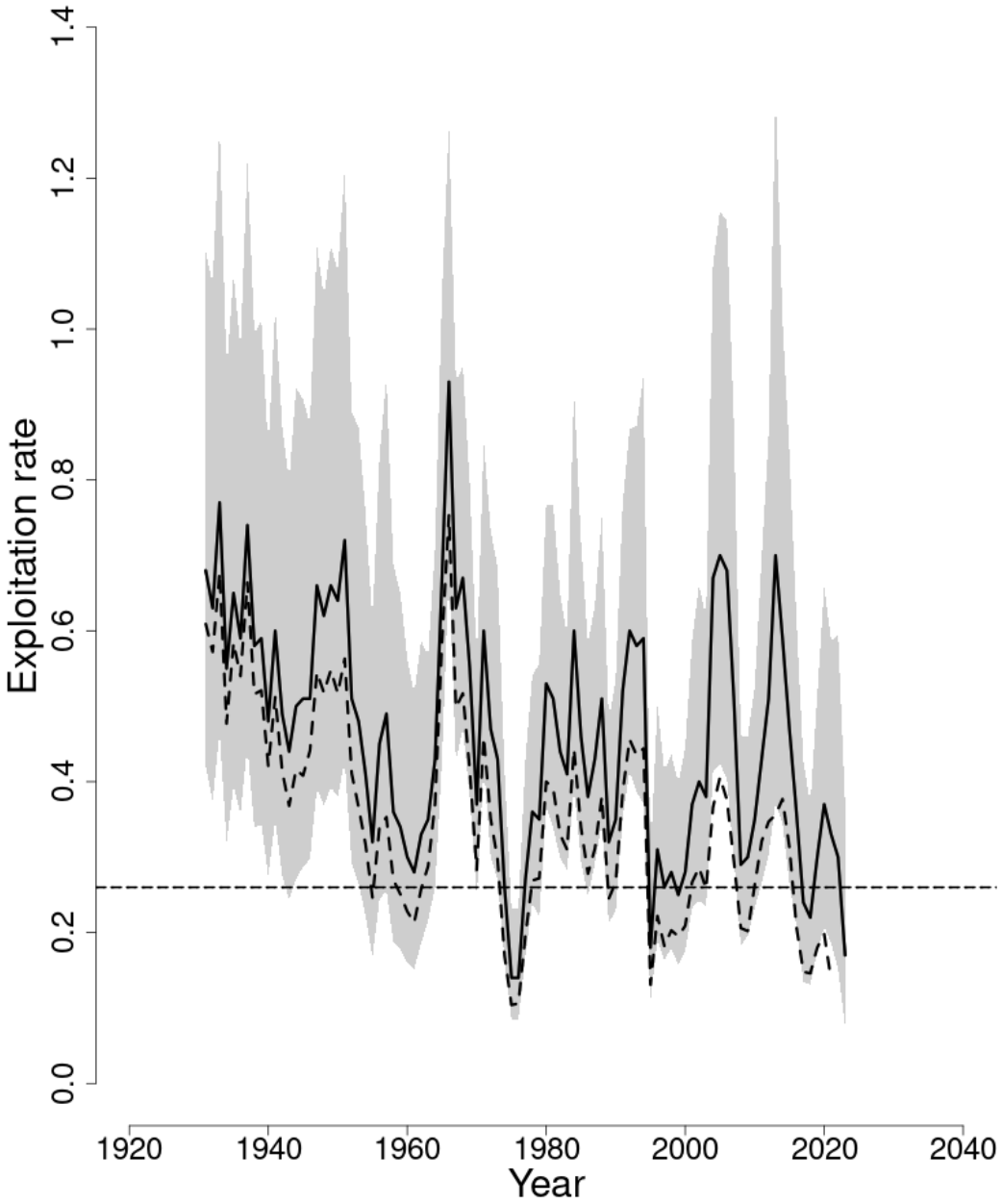

Figure 2: Trends in the average fishing mortality ($\bar{F}_{5-7}$) of Georges Bank haddock between 1931 and 2023 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (F_{MSY} *proxy*=0.26; horizontal dashed line) based on the current 2024 assessment. $\bar{F}_{5-7}$ was adjusted for a retrospective pattern and the adjustment is shown in red. The 95% confidence intervals are shown.

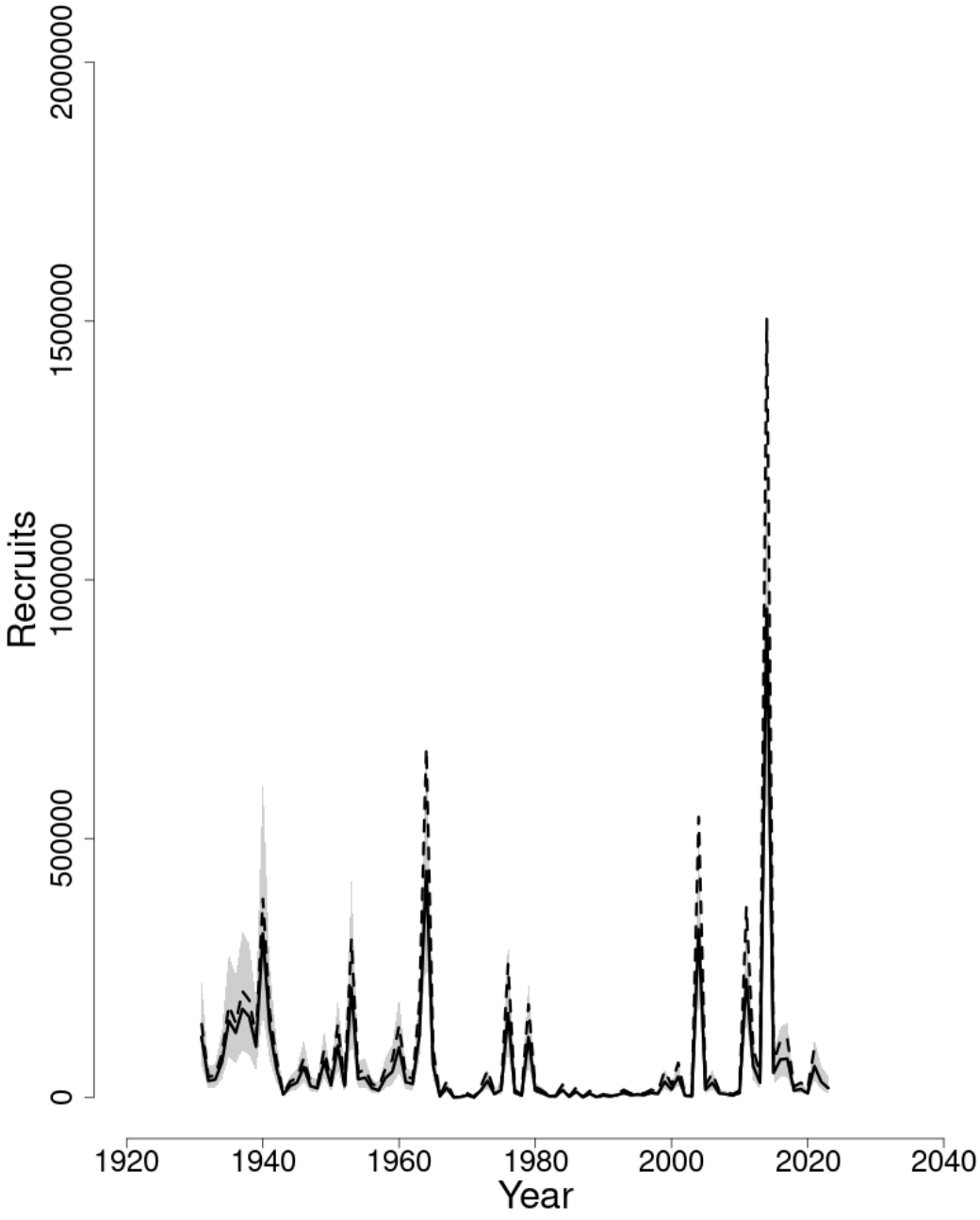

Figure 3: Trends in Recruits (age 1) (000s) of Georges Bank haddock between 1931 and 2023 from the current (solid line) and previous (dashed line) assessment. The 95% confidence intervals are shown.

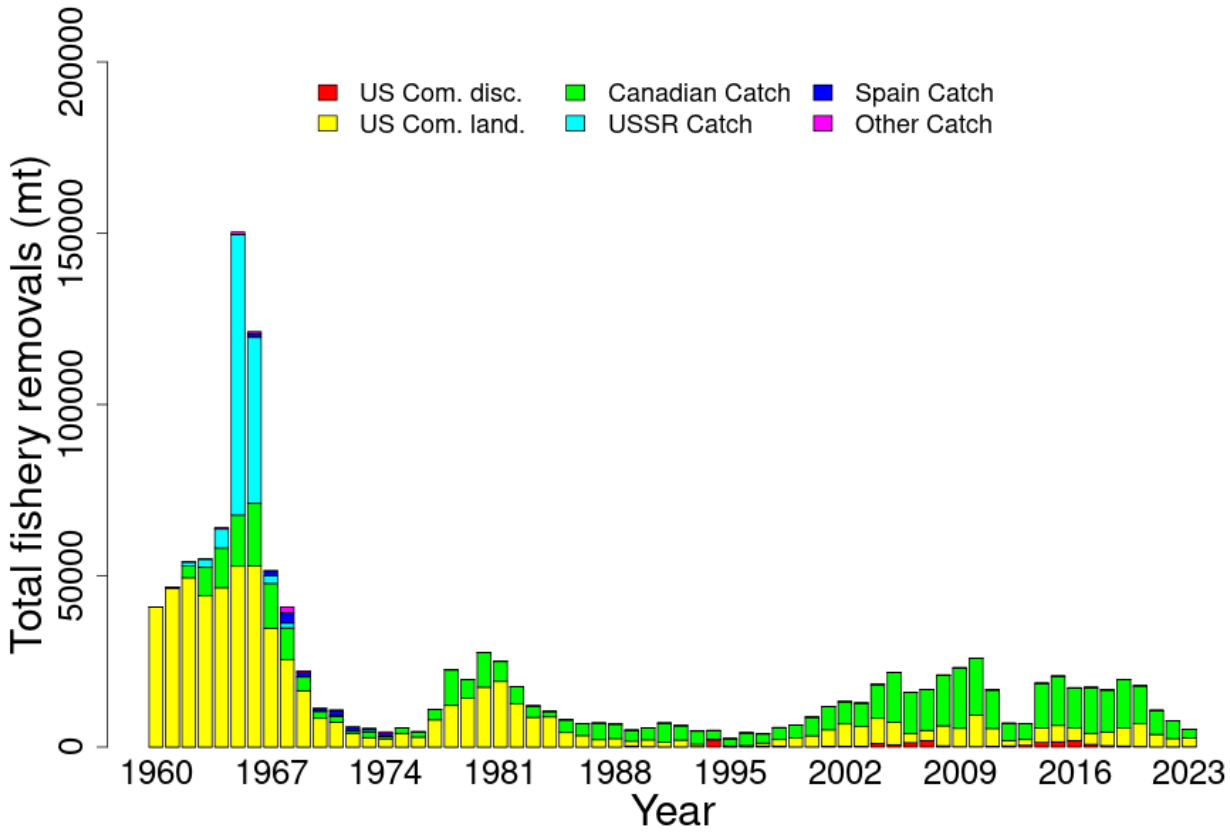

Figure 4: Total catch of Georges Bank haddock between 1931 and 2023 by fleet (US Commercial, Canadian, or foreign fleet) and disposition (landings and discards).

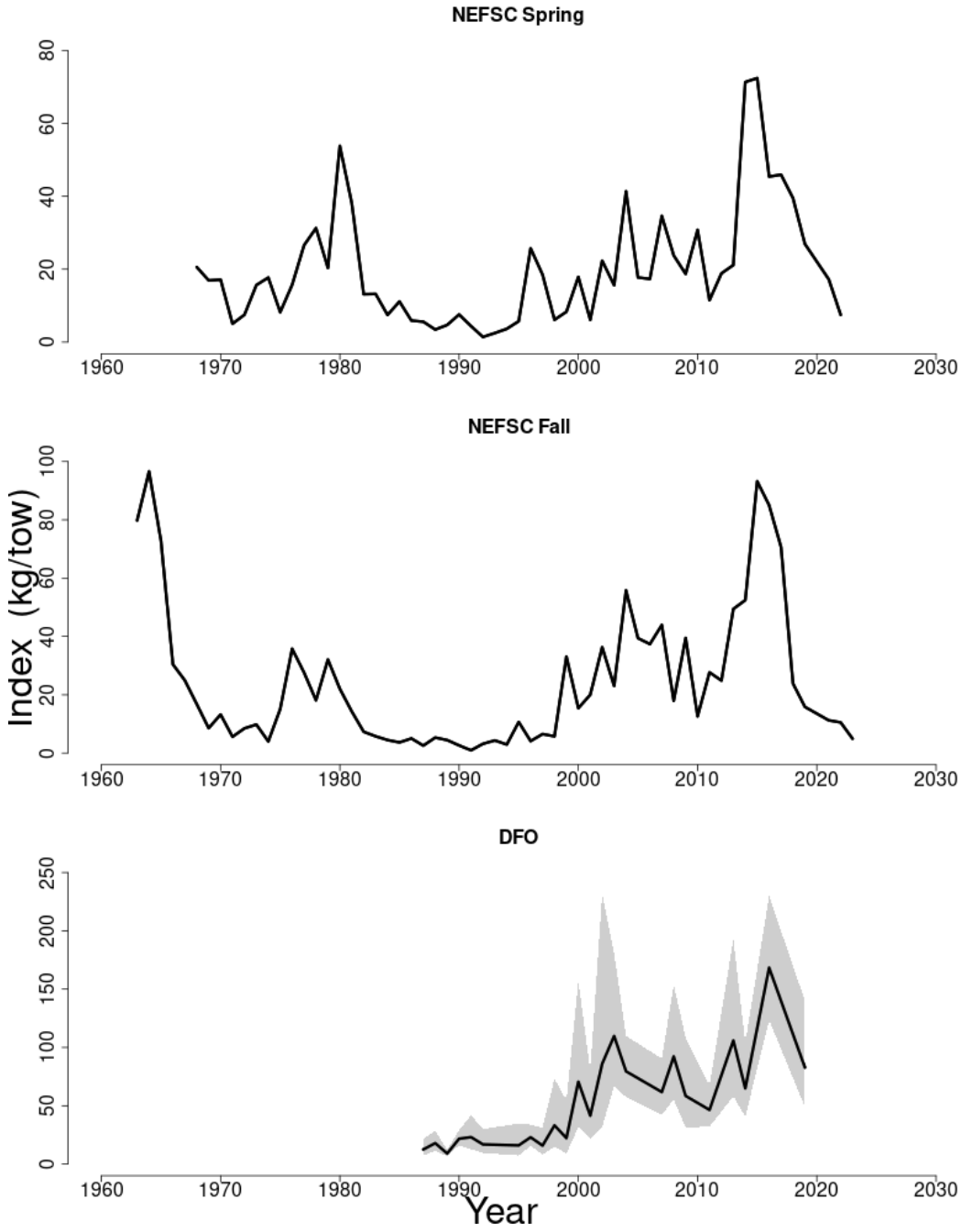

Figure 5: Indices of biomass (Mean kg/tow) for the Georges Bank haddock stock between 1963 and 2023 for the Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl surveys and the DFO winter bottom trawl survey. The approximate 95% lognormal confidence intervals are shown for DFO only. Confidence bounds for the new length-based biomass calibration are not yet available.

Apportionment results for Georges Bank Haddock and Atlantic Cod 2025

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Abstract

Historically, there was agreement between the spatial footprint of stock assessments used by the Transboundary Management Guidance Committee (TMGC) and the corresponding management unit for Atlantic cod, haddock, and yellowtail flounder on Georges Bank. Beginning in 2024, the TMGC began using domestic Canadian and US stock assessments to inform management so an apportionment method was developed to reconcile different spatial footprints between the TMGC management unit and the US Total Georges Bank (TGB) assessments for haddock and Atlantic cod. This report uses US and Canadian survey data updated through 2024 to update the 2025 management cycle apportionment calculations for TGB haddock (75% EGB, 25% WGB) and TGB Atlantic cod (100% EGB, 0% WGB).

In the 2025 management cycle, a revision was made to TGB haddock apportionment methods to fully align apportionment calculations with the survey footprint used in the US domestic assessment for this stock. Research recommendations to re-examine survey averaging methods and evaluate the frequency of sampling gaps due to survey post-stratification were also addressed, but methods were not revised in response to this research.

Introduction

The Transboundary Management Guidance Committee (TMGC) supports the management of Atlantic cod, haddock and yellowtail flounder on Georges Bank (GB). The TMGC management unit for haddock and Atlantic cod is restricted only to Eastern Georges Bank (EGB)

while the management unit for yellowtail flounder covers the Total Georges Bank (TGB) footprint. Historically, the TMGC relied on stock assessments developed by the Transboundary Resources Assessment Committee (TRAC) to provide advice on the same spatial footprint as the management unit for each stock. Beginning in 2024 the TMGC instead started to utilize domestic Canadian and US assessments to support transboundary management. The US domestic TGB yellowtail flounder assessment provides advice on the same spatial footprint as the TMGC management unit, but US domestic assessments for TGB Atlantic cod and TGB haddock both cover different TGB footprints so this change necessitated the development of a new method to apportion TGB advice from these assessments between the EGB management unit and Western Georges Bank (WGB). The apportioned advice is then subject to a further country allocation process established by the TMGC to allocate advice within the EGB management unit between Canada and the US (Andrushchenko 2023).

This document outlines the apportionment methods for US domestic TGB haddock and Atlantic cod (Section 1), provides apportionment results for the 2025 management cycle (Section 2), and documents research recommendations that have been addressed since the last management cycle (Section 3).

1 Methods

Apportionment methods developed and peer reviewed during the 2024 management cycle were closely aligned with methods developed by the TRAC to allocate catch between the US and Canada within the EGB management unit. TGB cod apportionment uses two US surveys (Northeast Fishery Science Center, NEFSC, spring and fall bottom trawl surveys, Figure 1) and one Canadian survey (Department of Fisheries and Oceans, DFO, spring survey, Figure 2). TGB haddock apportionment is calculated using only the two US surveys, as the DFO spring survey does not consistently cover the full TGB area for haddock (i.e. more limited sampling coverage in WGB for this stock). The following steps were implemented to calculate the apportionments between the EGB management unit and WGB.

Steps 1-4 were applied only to the two US surveys (NEFSC spring, NEFSC fall) to the proportion of TGB swept area biomass in EGB and WGB over time for each survey. Canada calculated similar proportions for the DFO spring survey.

1. Surveys were post-stratified to EGB and WGB for each stock (Figure 3 - Figure 4). Strata and sub-strata assignments to EGB and WGB largely aligned with those used for TMGC country allocation calculations (Andrushchenko 2023), but several new (i.e. strata not historically used for TMGC country allocation calculations) were incorporated to post-stratify survey data for the TGB haddock footprint (Table 1).

2. A mean biomass per tow was calculated for each stratum or sub-stratum. Stratum or sub-stratum with no tows were assumed to have a mean biomass per tow of zero, adopting the same assumption used in TMGC country allocations.

3. The swept area biomass for each stratum or sub-stratum was calculated by expanding the mean biomass per tow to the number of towable units within each stratum or sub-stratum, assuming a standard tow size.

4. The proportion of TGB swept area biomass in each region was calculated by first summing the swept area biomass across strata and sub-strata in each region (EGB or WGB) and then comparing regional totals to the TGB swept area biomass. This provides a time series of biomass proportions in EGB and WGB for each survey.

5. Canada used a similar approach to calculate the proportion of TGB swept area biomass in EGB and WGB for the DFO spring survey, using available data from strata 5Z1-5Z8 (Figure 2). More recent (2010+) sampling in stratum 5Z9 was excluded from these calculations as this strata was not part of the negotiated strata established for EGB allocation methods.

Steps 6-8 were applied to generate final apportionments using the relevant survey proportions of TGB swept area in the EGB management unit and WGB (DFO spring, NMFS spring and fall surveys for cod, NMFS spring and fall surveys for haddock).

6. Survey biomass proportions in EGB and WGB were combined by averaging annual (i.e. calendar year) proportions across surveys to provide a single unsmoothed biomass distribution time series.

    - TGB cod averaged three surveys, giving equal weight to each: US NEFSC spring, US NEFSC fall, DFO spring
    - TGB haddock averaged two surveys, giving equal weight to each: US NEFSC spring, US NEFSC fall
    - If a survey biomass proportion could not be calculated in a given year (e.g. due to insufficient spatial coverage or survey disruption), then an average was calculated over the remaining surveys. If there were fewer than two surveys available to characterize apportionment in a given year and species, then a recent two year average of the survey biomass proportions was used to fill the gap.
        - In 2020, NEFSC spring and fall sampling did not occur so a 2 year recent average (2018-2019) for each survey biomass proportion was used in this year to avoid using a single survey (DFO spring) to characterize resource distribution in this year.
    - The 2023 NEFSC spring survey did not have sufficient day and night sampling coverage for inclusion in the US domestic assessments, but spatial coverage on GB was generally sufficient to calculate the relative proportion of survey biomass in WGB and EGB. All survey strata were sampled within the TGB cod footprint, but two strata (29 and 30) were not sampled within the TGB haddock footprint. Consequently, apportionment calculations assumed no haddock biomass was located

in these unsampled strata, which could lead to underprediction of WGB haddock biomass. However, the proportion of WGB haddock biomass was still higher than the prior two years despite the sampling gap so the index was used (i.e. NEFSC spring 2023 survey data was not treated as missing so a recent 2 year average was not used instead) in haddock apportionment calculations.

- The 2022 DFO spring survey does not have a calibration coefficient yet and was excluded from the US domestic assessment, but this year of data was used in these calculations for TGB cod because there was sufficient spatial coverage on GB to calculate the relative proportion of survey biomass in WGB and EGB.

7. A LOESS smooth algorithm was applied to the most recent 33 years of combined survey biomass porportions to calculate the final resource apportionment percentage. Settings for this smoothing were unchanged from those used in the TMGC country allocation calculations (Andrushchenko 2023).

    - Smoothed values greater than 100 percent were capped at 100 and negative percentages were capped at zero percent.

8. The smoothed survey biomass distribution for the terminal year of data (here 2024) represents the 2025 management cycle apportionment result for the EGB management unit and WGB. This result is used to apportion TGB advice to the EGB management unit which is then subject to a further country allocation process established by the TMGC.

2 Apportionment results

The above apportionment methodology (Section 1) was applied to TGB haddock and cod data for 1991 - 2024 to generate 2025 management cycle apportionment results (Table 2). The TGB haddock apportionment incorporates a revision made in 2025 to fully align apportionment calculations with the survey footprint used in the US domestic assessment for this stock (see Section 3 for specifics). Apportionment results reflect the terminal year LOESS smoothed survey biomass for TGB haddock (Figure 5) and cod (Figure 6). Figure 7 and Figure 8 show the distribution of terminal year NEFSC survey tows (2024) for TGB haddock and cod respectively.

3 Research updates

Three research recommendations have been addressed since the 2024 management cycle, with specifics provided below.

3.1 TGB Haddock apportionment footprint

In response to industry's reported haddock catches on WGB, we reevaluated our apportionment methodology for TGB haddock to ensure that the most appropriate survey strata were included. As a result of this work, a revision was implemented beginning in the 2025 management cycle to incorporate additional WGB strata (strata 23, 24, 25, 29, 30) into apportionment calculations for TGB haddock (Figure 3). This revision improved upon the strata used in the 2024 management cycle (strata 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, Figure 9), which were historically used for TMGC country allocation calculations, and fully aligned TGB haddock apportionment with the survey footprint used in the US domestic assessment for this stock.

3.2 TGB Cod survey averaging method

The 2024 management cycle apportionment methods for TGB cod combined survey biomass proportions by averaging across surveys, giving equal weight to each to align with Canadian apportionment calculations. We addressed a research recommendation to revisit seasonal survey weighting for TGB cod (i.e. average the two spring surveys first and then average across seasons). No revisions to methods were made in response to these conclusions so the 2024 peer-reviewed method to combine survey biomass proportions with equal weighting was used for the 2025 management cycle TGB cod apportionment calculations.

The method used to combine survey proportions for TGB Atlantic cod had little impact on the magnitude or trend of the combined survey time series (Figure 10). The small differences between methods pointed to slightly higher EGB apportionment when seasonal averaging was implemented because that method weights the NEFSC fall survey more heavily and this survey tends to observe a larger portion of the stock biomass on EGB than either spring survey. There was less than a 7 percent difference between the combined survey time series calculated using equal weighting (the default) compared to seasonal weighting and in most years the difference was between 0-3% (Figure 11).

3.3 Sampling gaps due to post stratification

TMGC methods to calculate country resource allocations post-stratify several Northeast Fishery Science Center (NEFSC) bottom trawl survey strata to the US and Canadian portions of the EGB management unit and similar methods were applied to post-stratify between EGB and WGB for haddock and cod apportionment calculations. Because survey stations are assigned based on a stratified random sampling design, it is possible that by random chance no survey stations are assigned to a sub-stratum. When no survey stations were assigned, allocation calculations assumed that the mean biomass (kg) per tow within the substratum was zero and this assumption was applied to the 2024 haddock and cod apportionment calculations. We addressed a reviewer recommendation to evaluate the frequency of substrata with

no assigned tows due to post-stratification or lack of sampling. Methods for the 2025 management cycle apportionment were not revised in response to this research in order to maintain consistent post-stratification methods with the country allocation calculations and the 2024 peer reviewed apportionment implementation. However, these results may help identify years with higher uncertainty in apportionment results.

There were 134 instances between 1963-2024 where there were no NEFSC bottom trawl tows in a strata or substrata to calculate the mean biomass per tow used in apportionment calculations (Figure 12). More gaps occurred in the spring (117) than the fall (17) and there were more gaps in WGB strata (80) than EGB strata (54). 24 of these gaps occurred over the range of years used during the 2024 management cycle calculations (1991-2023, Figure 13) and of these, 3 gaps occurred in strata only used in the haddock assessment (stratum 30 in fall 2018 and strata 29 and 30 in 2023). No gaps occurred in 2024 for TGB cod or haddock.

Gaps due to a lack of sampling or post-stratification methods are most likely to introduce large biases into apportionment calculations when they occur in larger substrata as the mean biomass per tow is assumed to be zero over a larger area when gaps occur. For this reason, sampling gaps in stratum 29 (WGB) and either region of strata 19 and 20 are expected to introduce larger biases than gaps in either region of strata 21, 22, and 30, especially when these gaps occur near the end of the time series (e.g. gap in stratum 29 in spring of 2023 due to lack of sampling).

4 Figures and tables

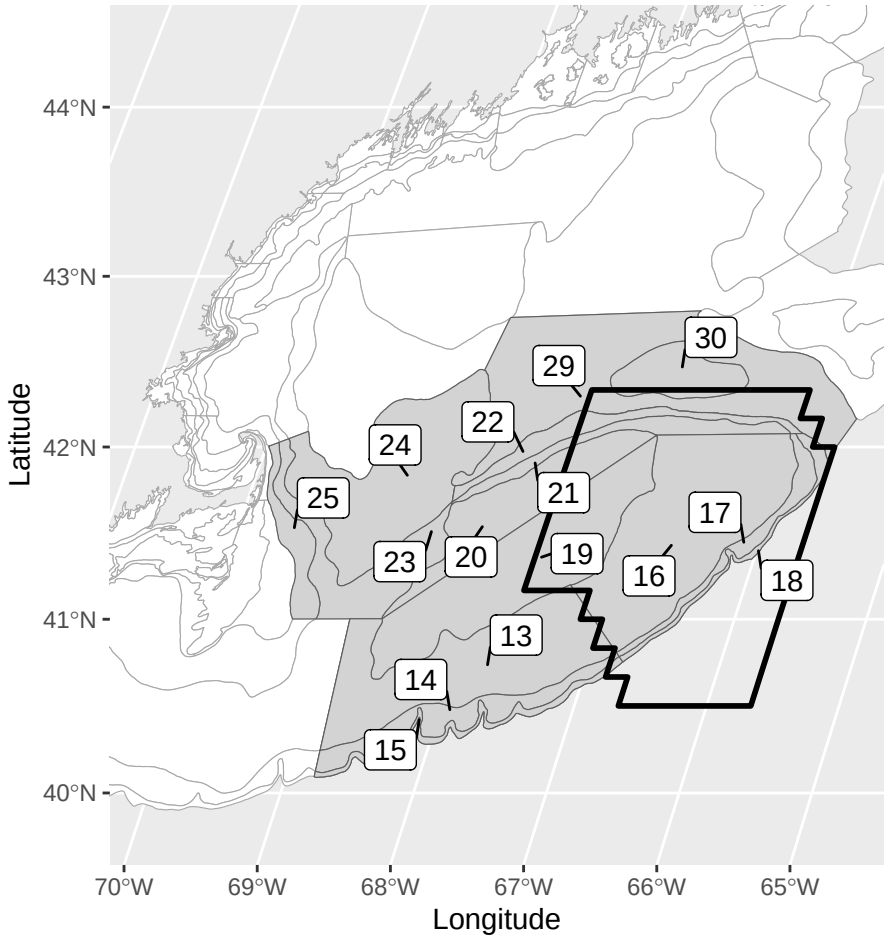

Figure 1: Northeast Fishery Science Center bottom trawl survey strata (gray) used in apportionment calculations for Total Georges Bank (TGB) cod or haddock with the footprint of the TMGC Eastern Georges Bank management unit (thick black line).

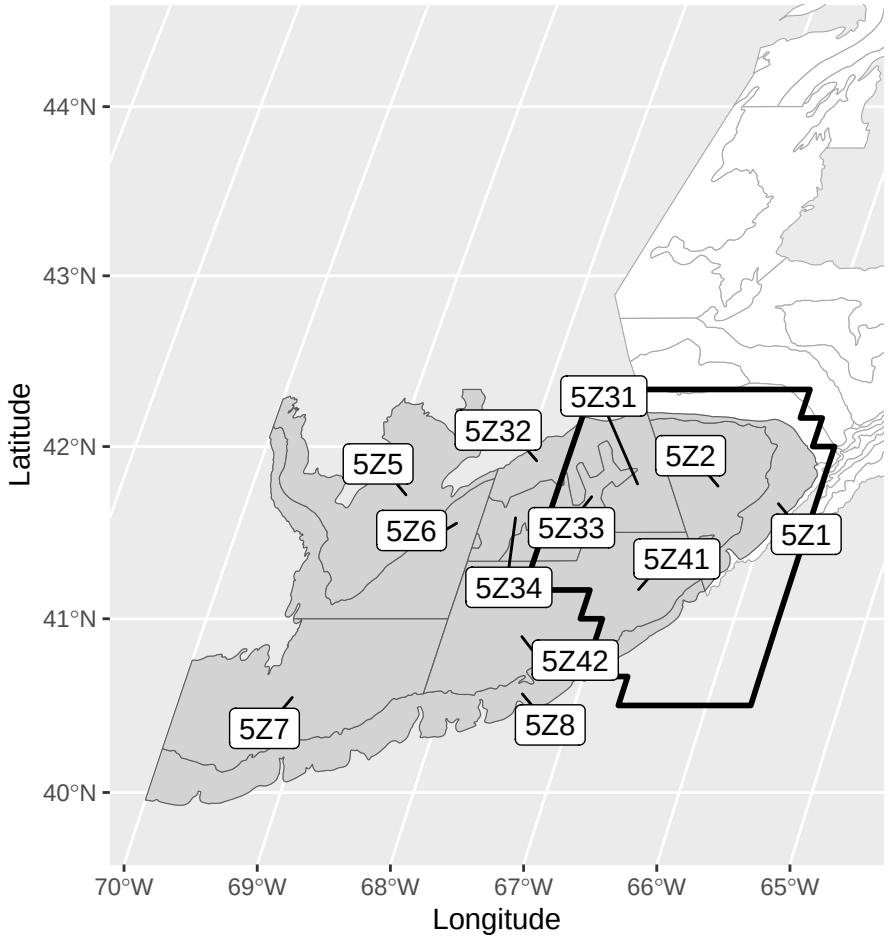

Figure 2: Department of Fisheries and Oceans bottom trawl survey strata (gray) used in apportionment calculations for Total Georges Bank (TGB) cod or haddock with the footprint of the TMGC Eastern Georges Bank management unit (thick black line).

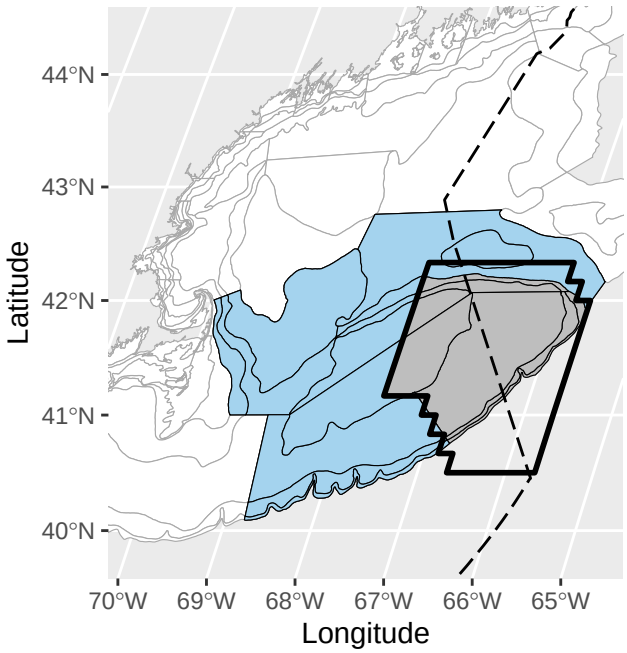

Figure 3: Northeast Fishery Science Center bottom trawl survey footprint used in domestic US Georges Bank haddock assessment, spatially apportioned between Western Georges Bank strata (blue) and Eastern Georges Bank strata (gray) that fall within the EGB management unit (thick black line). The EEZ is denoted by the dotted black line.

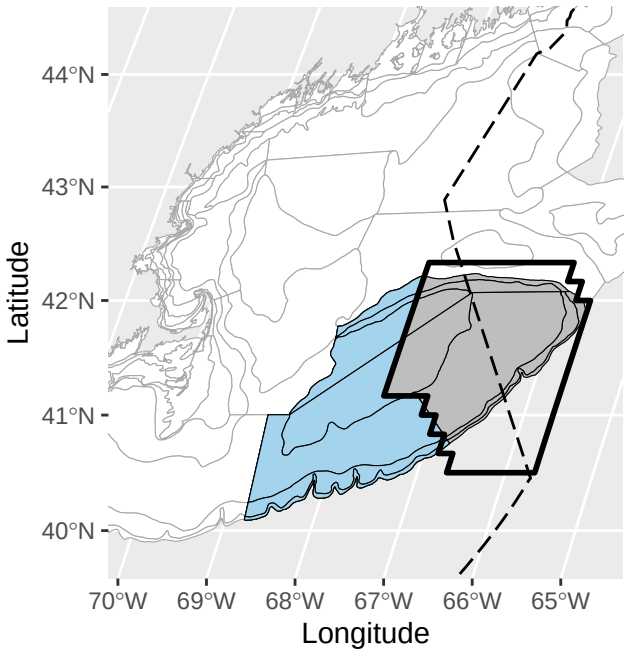

Figure 4: Northeast Fishery Science Center bottom trawl survey footprint used in domestic US Georges Bank Atlantic cod assessment, spatially apportioned between Western Georges Bank strata (blue) and Eastern Georges Bank strata (gray) that fall within the EGB management unit (thick black line). The EEZ is denoted by the dotted black line.

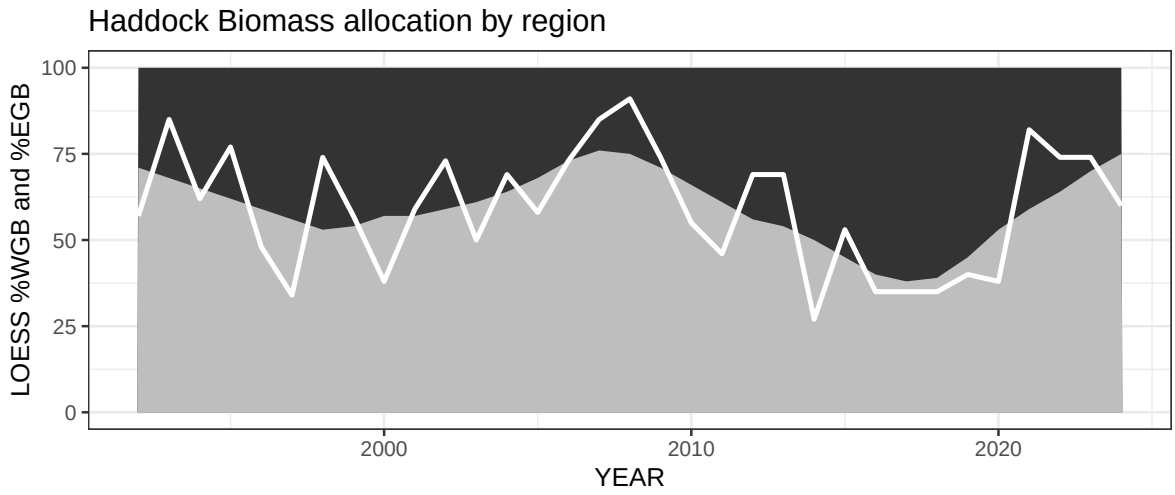

Figure 5: LOESS smoothed survey biomass distribution for Georges Bank haddock, terminal smoothed value is the 2025 management cycle apportionment. Final apportionment values were constrained between 0-100% and were be rounded to 0% or 100% if the terminal smoothed value fell outside of this range.

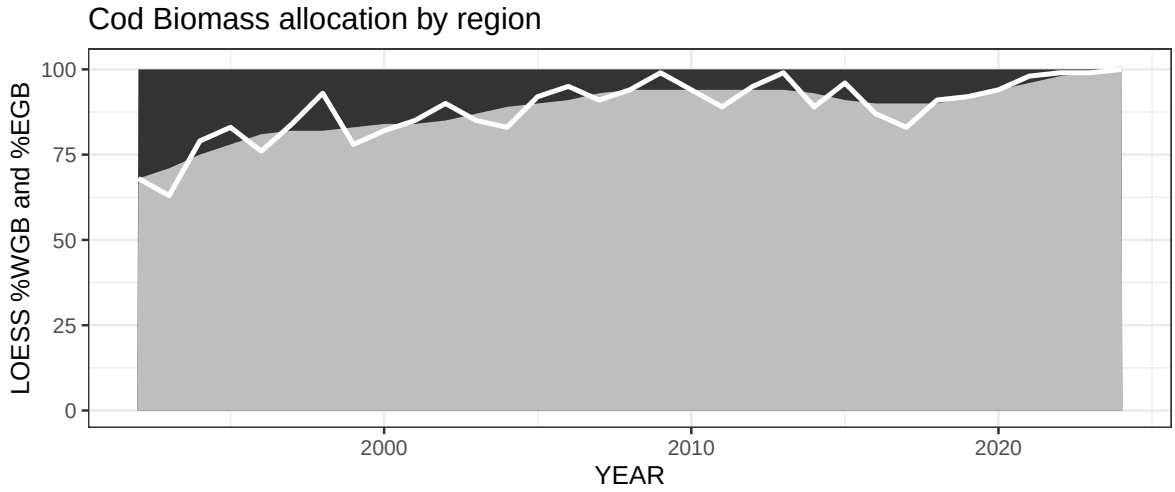

Figure 6: LOESS smoothed survey biomass distribution for Georges Bank cod, terminal smoothed value is the 2025 management cycle apportionment. Final apportionment values were constrained between 0-100% and were be rounded to 0% or 100% if the terminal smoothed value fell outside of this range.

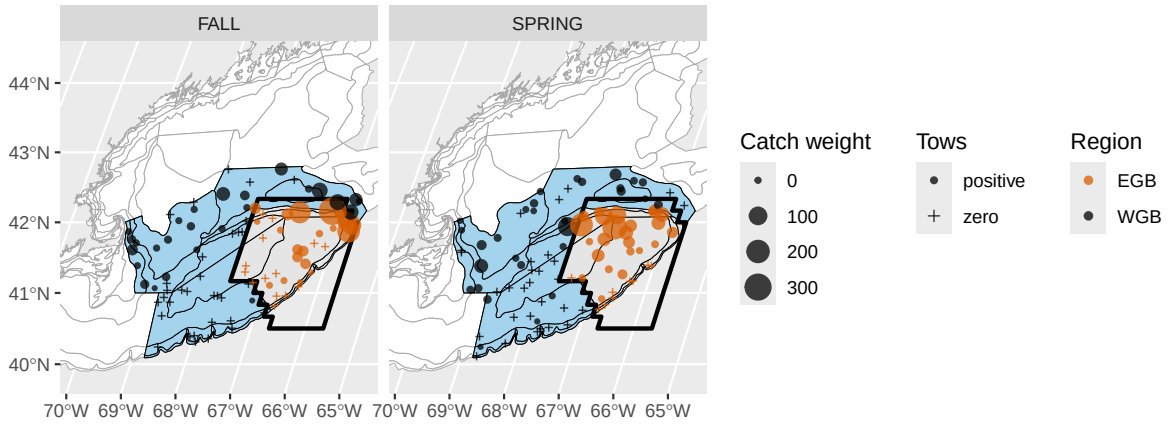

Figure 7: Distribution of 2024 Northeast Fishery Science Center (NEFSC) bottom trawl survey tows for Georges Bank haddock within Western Georges Bank (blue strata, black points) and Eastern Georges Bank (gray strata, orange points). The Eastern Georges Bank management unit is defined by the thick black line.

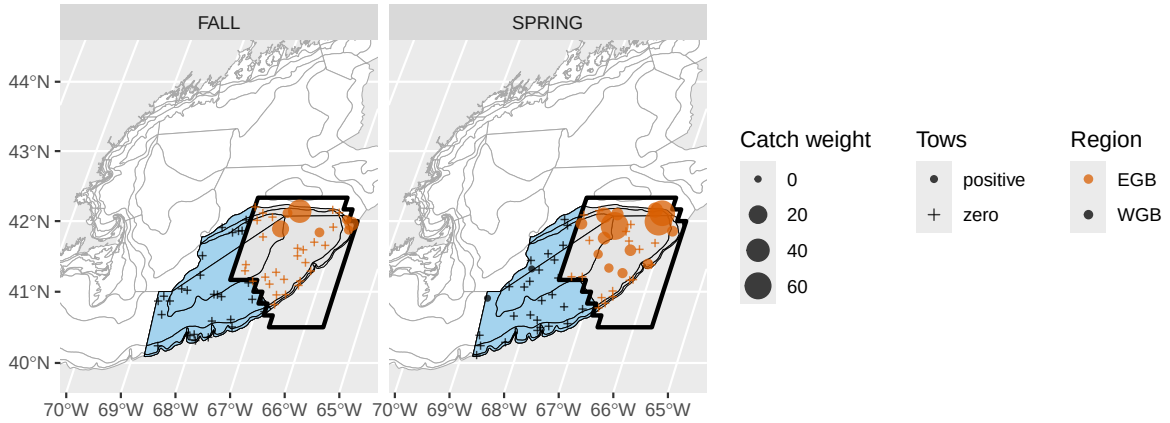

Figure 8: Distribution of 2024 Northeast Fishery Science Center (NEFSC) bottom trawl survey tows for Georges Bank Atlantic cod within Western Georges Bank (blue strata, black points) and Eastern Georges Bank (gray strata, orange points). The Eastern Georges Bank management unit is defined by the thick black line.

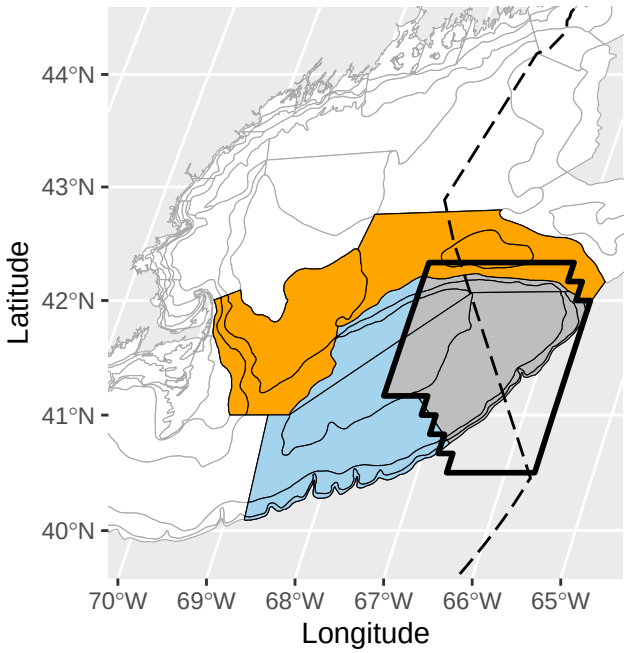

Figure 9: Northeast Fishery Science Center bottom trawl survey strata that were assigned towable units for Georges Bank (GB) haddock apportionment calculations in the 2024 and 2025 management cycles: Western GB in 2024 (blue), in 2025 (blue and orange) and Eastern Georges Bank in both years (gray). The Eastern GB management unit is denoted by the thick black line and EEZ by the dotted black line.

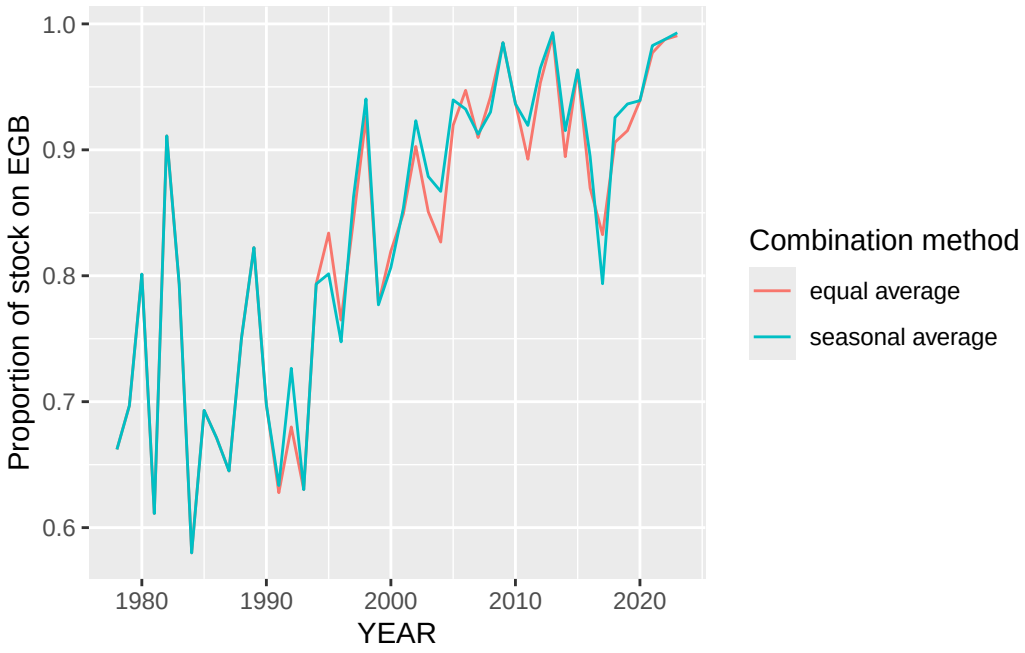

Figure 10: Proportion of TGB cod stock on Eastern Georges Bank (1978-2023) by survey combination method.

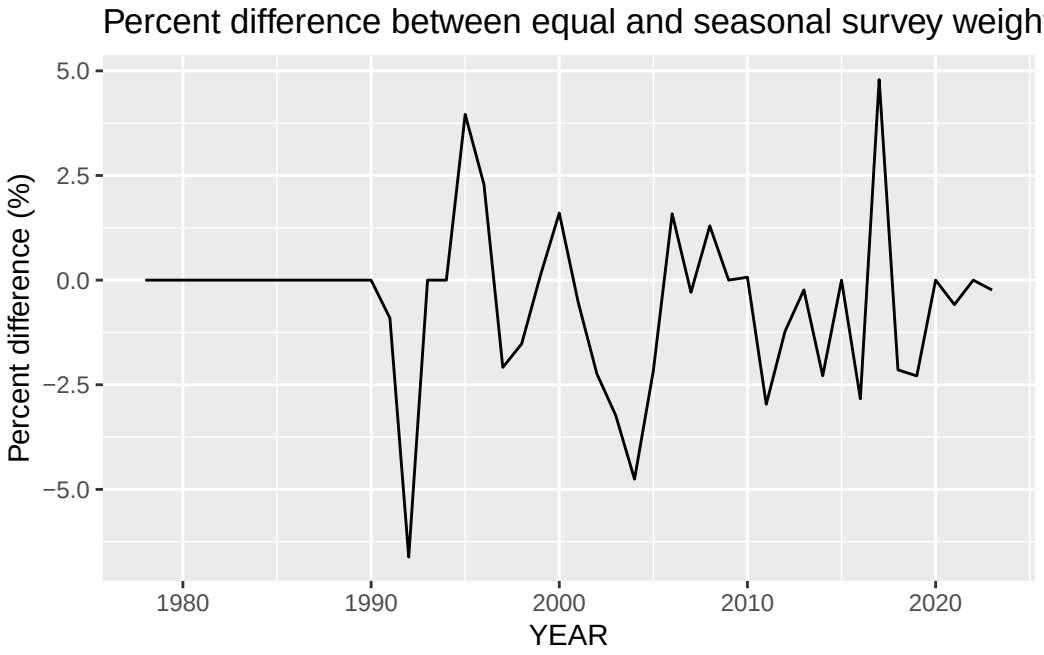

Figure 11: Percent difference between equally weighted (default) and seasonally-weighted survey combination method to calculate the distribution of cod on Eastern Georges Bank.

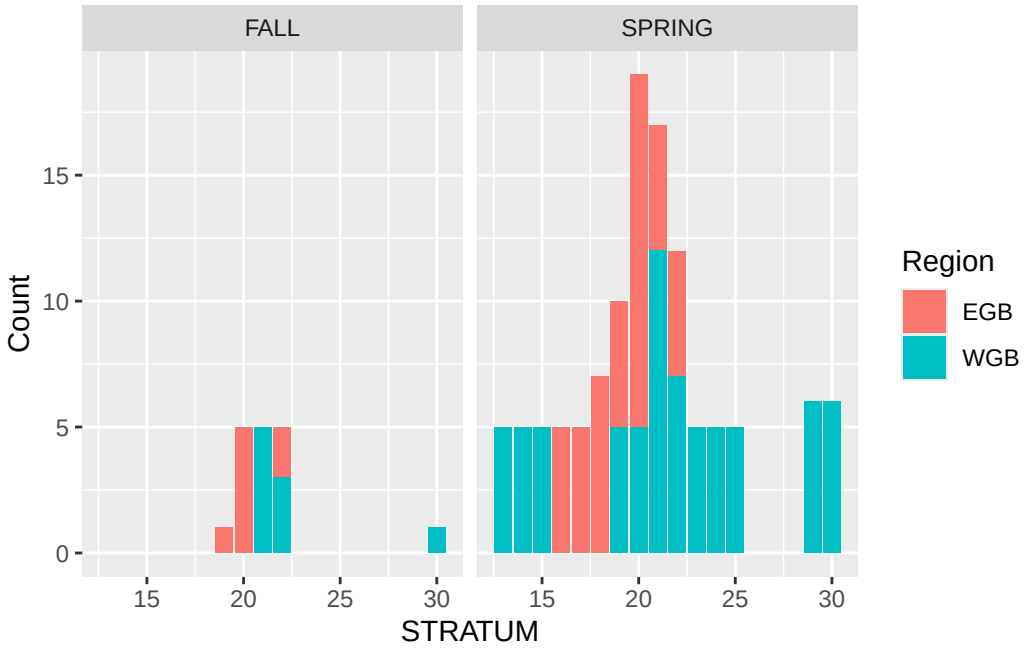

Figure 12: Frequency of years where no NEFSC bottom trawl tows were available within a stratum or substratum used in TGB cod and/or haddock apportionment calculations due to sampling gaps or post-stratification methods between 1963-2024.

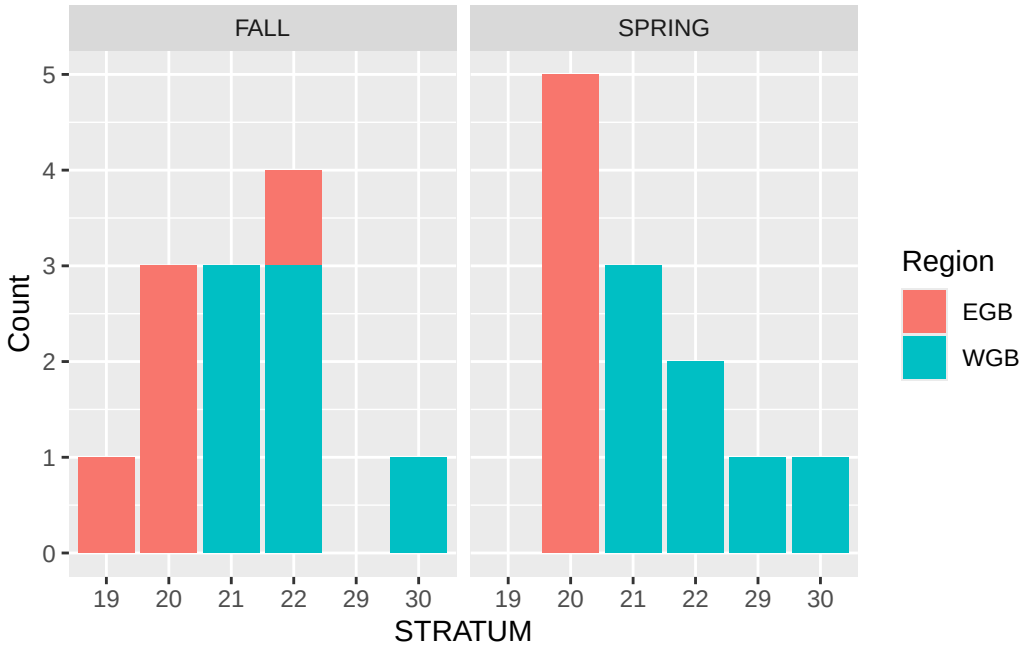

Figure 13: Frequency of years where no NEFSC bottom trawl tows were available within a stratum or substratum used in TGB cod and/or haddock apportionment calculations due to sampling gaps or post-stratification methods for years used in 2024 and 2025 management cycle calculations (1991-2024).

Table 1: Area of NEFSC bottom trawl survey strata in Canada EGB, US EGB, and US WGB. Haddock strata that were first incorporated into apportionment calculations during the 2025 management cycle (i.e. were not historically considered in country allocation calculations) are shown in bold.

STRATUM	Survey	Country	Region	Area_nm
13	NMFS	Canada	EGB	0
13	NMFS	US	EGB	0
13	NMFS	US	WGB	2374
14	NMFS	Canada	EGB	0
14	NMFS	US	EGB	0
14	NMFS	US	WGB	656
15	NMFS	Canada	EGB	0
15	NMFS	US	EGB	0
15	NMFS	US	WGB	230
16	NMFS	Canada	EGB	1553

16	NMFS	US	EGB	1427
16	NMFS	US	WGB	0
17	NMFS	Canada	EGB	284
17	NMFS	US	EGB	76
17	NMFS	US	WGB	0
18	NMFS	Canada	EGB	127
18	NMFS	US	EGB	45
18	NMFS	US	WGB	0
19	NMFS	Canada	EGB	0
19	NMFS	US	EGB	1059
19	NMFS	US	WGB	1395
20	NMFS	Canada	EGB	0
20	NMFS	US	EGB	335
20	NMFS	US	WGB	886
21	NMFS	Canada	EGB	210
21	NMFS	US	EGB	78
21	NMFS	US	WGB	136
22	NMFS	Canada	EGB	125
22	NMFS	US	EGB	106
22	NMFS	US	WGB	223
23	**NMFS**	**US**	**EGB**	**0**
23	**NMFS**	**Canada**	**EGB**	**0**
23	**NMFS**	**US**	**WGB**	**1016**
24	**NMFS**	**US**	**EGB**	**0**
24	**NMFS**	**Canada**	**EGB**	**0**
24	**NMFS**	**US**	**WGB**	**2569**
25	**NMFS**	**US**	**EGB**	**0**
25	**NMFS**	**Canada**	**EGB**	**0**
25	**NMFS**	**US**	**WGB**	**390**
29	**NMFS**	**US**	**EGB**	**0**
29	**NMFS**	**Canada**	**EGB**	**0**
29	**NMFS**	**US**	**WGB**	**3245**
30	**NMFS**	**US**	**EGB**	**0**
30	**NMFS**	**Canada**	**EGB**	**0**
30	**NMFS**	**US**	**WGB**	**619**

Table 2: Apportionment results for Georges Bank haddock and Atlantic cod stocks for the 2025 management cycle.

Stock	Region	Apportionment	Terminal Year
TGB Cod	EGB	100	2024
TGB Cod	WGB	0	2024
TGB Haddock	EGB	75	2024
TGB Haddock	WGB	25	2024

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Allocation Shares for Canada and the USA of the Transboundary Resources of Atlantic Cod, Haddock, and Yellowtail Flounder on Georges Bank Through Fishing Year 2026

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TABLE OF CONTENTS

ABSTRACT

The development of consistent management by Canada and the United States of America (USA) for the transboundary resources of Atlantic Cod, Haddock, and Yellowtail Flounder on Georges Bank led to a sharing allocation agreement by the Transboundary Management Guidance Committee (TMGC). For Atlantic Cod and Haddock, the agreement is limited to the Eastern Georges Bank management unit (Fisheries and Oceans Canada (DFO) Statistical Unit Areas 5Zj and 5Zm; USA Statistical Areas 551, 552, 561, and 562). The management unit for Yellowtail Flounder encompasses the entire Georges Bank east of the Great South Channel (DFO Statistical Unit Areas 5Zh, 5Zj, 5Zm, and 5Zn; USA Statistical Areas 522, 525, 551, 552, 561, and 562). Two principles are incorporated in the sharing formulae: 1) historical utilization based on reported landings during 1967 through 1994; 2) spatial-temporal changes in resource distributions determined from the DFO and USA National Marine Fisheries Service (NMFS) survey results that are updated annually. From 2010 onward, utilization will account for 10% and distribution for 90% of the allocation. This report uses the 2024 DFO and NMFS survey results to update the calculation for the 2026 fishing year allocations.

The resource distributions in 2024 were: 18% USA, 82% Canada, for Atlantic Cod; 40% USA, 60% Canada, for Haddock; and 62% USA, 38% Canada, for Yellowtail Flounder. The 2026 fishing year allocations (calendar year for Canada; May 1, 2026 to April 30, 2027 for the USA), updated with the 2024 resource distributions, resulted in shares for Atlantic Cod of 32% USA, 68% Canada, for Haddock of 21% USA, 79% Canada, and for Yellowtail Flounder of 54% USA, 46% Canada.

INTRODUCTION

The designation of units for management entails a compromise between the biological realities of stock structure and the practical convenience of analysis and policy making (Gulland 1980). For Yellowtail Flounder, Canada and the United States of America (USA) use a common management unit (for Canada the Fisheries and Oceans Canada (DFO) Statistical Unit Areas 5Zh, 5Zj, 5Zm, and 5Zn; for the USA the USA Statistical Areas 522, 525, 551, 552, 561, and 562) encompassing the entire bank east of the Great South Channel (Figure 1), referred to hereafter as Georges Bank. For Atlantic Cod and Haddock, Canada uses only the eastern portion of Georges Bank, while the USA employs a management unit comprising all of Georges Bank and extending south and west of Cape Cod. The Transboundary Management Guidance Committee (TMGC) agreed that, for the purpose of developing a sharing formula for Atlantic Cod and Haddock, the management unit would be limited to the eastern portion of Georges Bank (Figure 1; DFO Statistical Unit Areas 5Zj and 5Zm; USA Statistical Areas 551, 552, 561, and 562), referred to as Eastern Georges Bank.

Consistent fisheries management advice utilizing an allocation sharing arrangement for Eastern Georges Bank was provided for the first time in the 2003 TMGC Guidance Document (TMGC 2003) for application to the 2004 fishing year quotas, and subsequently in the 2005 to 2022 TMGC Guidance Documents for application to the 2006 to 2023 fishing year quotas, respectively (TMGC 2020). The analyses are based on calendar year data. The fishing year for Canadian fisheries starts on January 1st and ends on December 31st, whereas the fishing year for USA fisheries starts on May 1st and ends on April 30th the following year.

Principles of resource sharing for transboundary stocks include consideration of access to resources occurring or produced within national boundaries and historical participation in exploitation of the resources (Gavaris and Murawski 2004). The former has emerged from the effective property rights associated with Exclusive Economic Zones, as well as, the distribution of stocks occurring in areas under national jurisdiction (UN 1995). The latter recognizes traditional involvement and investment in the development of a fishery. Both principles were incorporated in the TMGC sharing proposal, but historical participation gradually was down-weighted so that after an eight year phase-in period the annual allocation would be based primarily on resource distribution (90%).

Details for calculating the national allocations for Canada and the USA were described by Murawski and Gavaris (2004). The approach incorporates both resource utilization and resource distributions relative to the Canada/USA east coast maritime boundary. Results for fishing years 2005 to 2023 have been reported annually, most recently by Andrushchenko et al. (2021).

DATA AND METHODS

DATA

The allocation for this analysis used data for years 1992-2024. The NMFS survey did not sample in calendar year 2020 due to COVID-19; imputed values were used in the allocation analysis to deal with these missing data points in 2020 (see Andrushchenko et al. 2021). In 2022, the DFO spring survey was carried out using a new vessel (CCGS Jacques Cartier) and net (NEST; three-bridle, four-seam), but conversion factors for this transition are not calculated yet. As the allocation algorhithm considers the proportion of biomass on either side of the Hague Line, and not the absolute biomass values, the unconverted data from the 2022 DFO Spring survey were used in the calculation.

FORMULA

The TMGC agreed approach for calculating the respective country shares (TMGC 2002), that takes into historical utilization and adapts to shifts in resource distribution, is as follows:

$\%share_{year,country} = (\alpha_{year} \times \%utilization_{year,country}) + (\beta_{year} \times \%resource\ distribution_{year,country})$

where α_{year} = percentage weighting for utilization in year
β_{year} = percentage weighting for resource distribution in year
$\alpha_{year} + \beta_{year} = 100\%$

The initial sharing formula was based on the weighting of country utilization by 40% and resource distribution from surveys by 60%. Thereafter, the percentage weighting was changed in 5% annual increments until the weightings reached 10% country utilization from landings and 90% resource distribution from surveys. This sharing agreement was implemented in 2003, with the end of the transition to a 90:10 resource distribution-to-utilization weighting in the 2010 fishing year.

RESOURCE UTILIZATION

Historical participation in exploitation of these resources was assessed for the three species using landings records (Table 1). The TMGC agreed to use the percentage of the total landings by country from 1967 to 1994 (inclusive), as the measure of country utilization.

RESOURCE DISTRIBUTION

Resource distribution patterns are determined based on two NMFS (spring and fall) and one DFO (winter/spring) survey. Surveys of Georges Bank have been conducted by DFO since 1986 (February/March), and by NMFS each fall (October) since 1963 and each spring (April/May) since 1968. Each of the three surveys cover Canadian and USA waters on both sides of the Hague line (Figure 2). Further details about DFO and USA Northeast Fisheries Science Center (NEFSC) vessels and calibrations can be found in Gross et al. (2014) and Andrushchenko et al. (2018).

Swept area biomass, considered a relative index of abundance, was computed for each species in each stratum (Table 2, Figure 2) and apportioned to USA and Canadian sectors in each year. DFO survey sampling strata were revised in 1987 to incorporate the international boundary. Thus, only results since 1987 have been used from this survey. Since both the DFO and NMFS survey designs are based on randomization within strata, the data were post-stratified to Canadian and USA zones within the existing survey strata.

Estimates of biomass indices were calculated for each stratum or stratum section, unless no observations occurred within a stratum (Tables 3 to 11). Prior to 2005, on the few occasions where no observations were available in a stratum section, density and distribution patterns from adjacent areas and years were used as substitute values. The magnitude of these derived values was generally small and did not influence results. When such values are combined over surveys, they have only a minor effect on the annual aggregate biomass index estimates within the transboundary management units. In recent years, missing observations have been assumed to be zero, as derived values did not influence results when adjusted prior to 2005 (Tables 3 to 11). The swept area biomasses for each groundfish species were summed individually to derive the biomass index on the Canadian and USA side for each management unit. Age- and size-specific distribution patterns were not considered while developing the biomass indices.

The biomass index estimate derived from each survey represents a synoptic snapshot of resource distribution at a specific time during a year. Combining the results of multiple surveys

requires an understanding of seasonal movement patterns and how much of the biological year each survey represents. For Atlantic Cod, the DFO and the NMFS spring surveys in each year were averaged to characterize the distribution during the winter-spring period. This result was averaged with the NMFS fall survey distribution percentage, thereby giving equal weight to the winter-spring and summer-fall periods. Prior to initiation of the DFO survey in 1987, the NMFS spring survey was used alone to characterize the winter-spring period. For Haddock and Yellowtail Flounder, the results from all three surveys in each year were averaged to represent the annual distribution pattern. Prior to 1987, only the NMFS spring and fall surveys were averaged for these two species.

A robust locally-weighted regression algorithm (Cleveland 1979), referred to as LOESS, was adopted for removing both unpredictable fluctuations and sampling variation from survey observations. A 30% smoothing parameter was chosen as it reflected current trends, was responsive to changes, and provided the most appropriate results for contemporary resource sharing. The recommended default of two robustness iterations also was adopted (Cleveland 1979). Resource distributions are updated annually by incorporating data from the latest survey (i.e. 2024) and dropping data from the earliest survey used in the previous year (i.e. 1991) so that a 33-year window is maintained. After the surveys were combined, the LOESS smoother was applied to the 1992 to 2024 survey data. The fixed resource utilization (10% weighting) and the 2024 resource distributions (90% weighting) were applied to the agreed sharing formula to determine national allocation shares of each of the three transboundary groundfish species for the upcoming fishing year (i.e. 2026), two years ahead of the survey data that is used (i.e. 2024).

RESULTS AND CONCLUSIONS

The country utilization aspect of the sharing formula, based on each country's landings during the period of 1967 to 1994 (Table 1), resulted in the following percentage weightings for utilization: Atlantic Cod 60% Canada, 40% USA; Haddock 55% Canada, 45% USA; and Yellowtail Flounder 2% Canada, 98% USA. The 2010 fishing year marked the end of transition to a 90/10 weighting of resource distribution and country utilization. Historical utilization now accounts for only 10% of the sharing formula.

The biomass indices were updated with the 2024 survey values for each species (Tables 3 to 11; Figures 3 to 5). The proportion resource distribution by country, for each survey and for the combined surveys summarized in Tables 12 to 14, include the proxy data for the missing 2020 NMFS spring and fall surveys. The results from the smoothing algorithm for the most recent 33-year time period were determined for Atlantic Cod, Haddock, and Yellowtail Flounder (Tables 12 to 14, respectively; Figure 6). The smoothed percentages for the time series differ from those previously calculated, due to dropping the earliest year of survey data (1991) and the incorporation of the next recent year of survey data (2024) in the smoothing algorithm. The resulting smoothed resource distributions for Eastern Georges Bank in 2024 were, for Atlantic Cod: 69% Canada, 31% USA; for Haddock: 81% Canada, 19% USA; and for Yellowtail Flounder: 51% Canada, 49% USA (Table 15b, Figure 6).

The 2024 smoothed resource distributions and the fixed resource utilization (Table 15a) were applied to the agreed sharing formula and result in shares for the 2026 fishing year (calendar year for Canada; May 1, 2026 to April 30, 2027 for the USA) presented below and in Table 15b:

Allocation Shares for 2026		
Stock	Canada	USA
Eastern Georges Bank Atlantic Cod	68%	32%
Eastern Georges Bank Haddock	79%	21%
Georges Bank Yellowtail Flounder	46%	54%

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TABLES

Table 1. Annual landings (mt) of Atlantic Cod, Haddock, and Yellowtail Flounder from the transboundary management units on Georges Bank from 1967 to 1994. The TMGC agreed to use the percentage of total landings by country from this time period as the measure of country utilization.

Year	Atlantic Cod			Haddock			Yellowtail Flounder		
	Canada	USA	Total	Canada	USA	Total	Canada	USA	Total
1967	8188	3115	11303	12999	11999	24998	133	8407	8540
1968	9055	3244	12299	9195	7646	16841	122	12799	12921
1969	5876	3676	9552	3941	6621	10562	327	15944	16271
1970	2580	3211	5791	1970	3154	5124	70	15505	15575
1971	2950	4389	7339	1610	3533	5143	102	11878	11980
1972	2535	2708	5243	609	1551	2160	8	14157	14165
1973	3222	3064	6286	1565	1396	2961	12	15899	15911
1974	1370	3792	5162	462	955	1417	5	14607	14612
1975	1833	3108	4941	1353	1705	3058	8	13205	13213
1976	2320	2037	4357	1362	974	2336	11	11336	11347
1977	6156	4256	10412	2871	2428	5299	38	9444	9482
1978	8777	5502	14279	9968	4724	14692	56	4519	4575
1979	5979	6408	12387	5080	5212	10292	17	5475	5492
1980	8065	6418	14483	10017	5615	15632	81	6481	6562
1981	8498	8092	16590	5658	9075	14733	12	6182	6194
1982	17825	8565	26390	4872	6280	11152	18	10634	10652
1983	12131	8573	20704	3208	4453	7661	43	11350	11393
1984	5761	10551	16312	1463	5120	6583	4	5764	5768
1985	10442	6641	17083	3484	1684	5168	3	2477	2480
1986	8411	5697	14108	3415	2201	5616	27	3041	3068
1987	11844	4793	16637	4703	1418	6121	56	2743	2799
1988	12740	7645	20385	5941	1694	7635	47	1866	1913
1989	7895	6182	14077	3060	785	3845	32	1134	1166
1990	14364	6414	20778	3340	1188	4528	13	2751	2764
1991	13459	6353	19812	5423	931	6354	25	1784	1809
1992	11673	5080	16753	4090	1629	5719	15	2859	2874
1993	8524	4027	12551	3725	424	4149	675	2089	2764
1994	5278	1229	6507	2412	32	2444	2139	1589	3728
Total mt 1967–94	217751	144770	362521	117796	94427	212223	4099	215919	220018
Percentage 1967–94	**60%**	**40%**	**100%**	**55%**	**45%**	**100%**	**2%**	**98%**	**100%**

Table 2. Fisheries and Oceans (DFO) and National Marine Fisheries Service (NMFS) strata (or strata section) areas (in square nautical miles) used in the calculation of biomass indices. The designation 'eGB' denotes the Eastern Georges Bank management unit used for Cod and Haddock. The designation '~eGB' denotes the portion of the stratum not in the Eastern Georges Bank management unit.

DFO/NMFS Strata	Canada	USA(eGB)	USA(~eGB)
DFO 5Z1	795	0	0
5Z2	1252	0	0
5Z3	0	1504	791
5Z4	0	1350	1729
NMFS 13	0	0	2374
14	0	0	656
15	0	0	230
16	1553	1427	0
17	284	76	0
18	127	45	0
19	0	1059	1395
20	0	335	886
21	210	78	136
22	125	106	223

Table 3. Atlantic Cod biomass (mt) index by strata sections of Eastern Georges Bank (see Figure 2) from the National Marine Fisheries Service (NMFS) spring survey. Light shaded cells represent missing values calculated from adjacent strata sections. Cells with "-" represent missing values assumed to be zero while "0" represents observed zeros. Only the 33 year moving average data are shown. The 2020 NMFS spring survey was cancelled due to COVID-19 restrictions.

Year	USA 16	CAN 16	USA 17	CAN 17	USA 18	CAN 18	USA 19	USA 20	USA 21	CAN 21	USA 22	CAN 22	USA total	CAN total
1992	0	2116	-	293	-	9	491	316	55	639	-	1240	862	4296
1993	749	695	-	1322	-	0	2229	472	-	134	-	229	3451	2380
1994	143	0	0	21	0	-	96	43	36	658	-	73	318	752
1995	350	7548	-	63	0	-	302	503	-	265	-	150	1154	8026
1996	1161	1545	-	221	-	0	1211	74	358	1653	0	0	2803	3419
1997	756	1561	11	107	0	28	471	0	116	176	-	343	1355	2214
1998	235	6238	0	187	-	72	0	-	110	5408	186	263	531	12168
1999	1053	2482	0	13	-	0	337	667	0	338	495	25	2552	2858
2000	1458	3281	0	11	0	-	967	1513	27	302	-	96	3965	3691
2001	191	1795	-	59	-	0	275	166	207	155	-	340	839	2349
2002	1341	2243	0	23	-	46	318	-	0	477	0	64	1659	2851
2003	478	3194	25	50	-	0	387	61	242	318	149	131	1342	3694
2004	309	2252	-	12	-	119	252	2462	119	11393	-	0	3142	13776
2005	1235	1599	0	266	0	-	0	64	-	697	121	151	1420	2713
2006	3162	511	0	457	-	0	524	277	509	1011	-	0	4472	1979
2007	2287	1759	15	128	0	0	398	237	452	260	-	82	3388	2229
2008	1488	1669	0	18	0	0	368	300	6	788	0	345	2162	2820
2009	1024	2673	7	0	0	100	535	47	256	3045	37	0	1906	5817
2010	541	1070	0	410	0	125	667	461	941	1010	94	198	2704	2813
2011	474	1573	0	133	0	74	56	0	0	460	0	196	530	2436
2012	1075	3504	6	182	0	0	646	1412	-	695	-	146	3139	4528
2013	40	1158	0	54	0	77	740	1312	-	7808	61	239	2153	9335
2014	0	1304	0	93	0	0	1214	1773	40	202	-	45	3027	1644
2015	411	394	0	284	0	422	106	462	-	411	-	113	979	1624
2016	24	2867	0	0	0	13	83	146	0	935	0	20	253	3835
2017	81	6929	0	30	0	115	4260	350	57	80	89	467	4837	7620
2018	220	508	0	73	0	68	1938	-	0	300	-	0	2158	948
2019	185	8204	0	0	0	49	192	58	20	333	451	22	905	8609
2020	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	1191	969	0	22	0	0	139	1881	60	197	0	54	3271	1242
2022	417	559	0	2	0	0	2383	2272	0	51	0	0	5072	613
2023	36	3745	0	51	0	0	902	2061	45	855	0	125	3043	4776
2024	1564	1691	0	116	0	0	265	319	0	759	0	91	2147	2658

Table 4. Atlantic Cod biomass (mt) index by strata sections of Eastern Georges Bank (see Figure 2) from the National Marine Fisheries Service (NMFS) fall survey. Shaded cells represent missing values calculated from adjacent strata sections. Cells with "-" represent missing values assumed to be zero while "0" represents observed zeros. Only the 33 year moving average data are shown. The 2020 NMFS fall survey was cancelled due to COVID-19 restrictions.

Year	USA 16	CAN 16	USA 17	CAN 17	USA 18	CAN 18	USA 19	USA 20	USA 21	CAN 21	USA 22	CAN 22	USA total	CAN total
1992	57	643	0	704	-	0	0	35	13	380	-	57	105	1784
1993	0	92	-	188	-	0	0	0	-	54	-	26	0	361
1994	0	56	-	157	-	201	0	0	7	1583	-	0	7	1997
1995	0	23	-	127	-	71	0	67	28	1171	0	-	95	1392
1996	0	652	-	311	-	48	0	-	66	181	-	93	66	1284
1997	0	0	-	57	-	0	0	0	-	1285	-	0	0	1342
1998	0	1031	-	31	-	170	0	0	-	769	-	-	0	2001
1999	0	58	-	154	-	56	0	0	-	465	22	15	22	748
2000	0	269	-	226	-	48	0	0	0	234	0	0	0	778
2001	40	423	-	431	-	0	0	0	0	288	-	9	40	1151
2002	0	2955	0	366	-	34	207	0	0	7312	61	16	268	10684
2003	0	133	-	0	-	0	135	0	0	405	-	23	135	561
2004	0	5982	0	485	0	50	0	0	41	731	61	0	102	7247
2005	0	486	0	445	0	40	0	77	32	366	0	102	109	1440
2006	59	1781	0	0	0	0	0	-	-	190	-	0	59	1972
2007	0	149	0	34	-	0	47	47	4	214	-	21	98	418
2008	0	368	0	131	0	73	0	0	0	108	0	23	0	704
2009	0	834	0	16	0	0	0	332	0	724	24	31	356	1605
2010	0	457	0	0	0	47	0	0	0	480	45	0	45	984
2011	0	3317	0	77	0	160	0	0	112	93	0	0	112	3647
2012	0	120	0	0	0	158	0	0	0	622	171	0	171	900
2013	0	2745	0	110	0	12	25	98	-	551	-	0	123	3419
2014	0	631	0	0	0	0	0	122	-	972	-	36	122	1639
2015	0	3751	0	665	0	41	0	515	0	897	-	74	515	5427
2016	0	0	0	52	0	47	214	2951	0	2287	-	0	3165	2387
2017	0	376	0	250	0	30	0	-	0	70	0	0	0	727
2018	0	2203	0	0	0	41	0	58	0	151	0	0	58	2395
2019	0	0	0	0	0	78	0	805	0	798	0	0	805	875
2020	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	0	1288	0	409	0	306	0	32	0	16	0	9	32	2028
2022	0	1820	0	0	0	0	65	0	0	0	30	0	95	1820
2023	0	1102	0	344	0	0	0	0	0	11	0	0	0	1457
2024	0	45	0	30	0	90	514	0	0	465	0	0	514	630

Table 5. Atlantic Cod biomass (mt) index by strata and strata sections of Eastern Georges Bank (see Figure 2) from the Fisheries and Oceans Canada (DFO) survey.

Year	CAN 5Z1	CAN 5Z2	USA 5Z3	USA 5Z4	USA total	CAN total
1992	2087	7602	4005	887	4892	9689
1993	719	9427	3875	2524	6399	10146
1994	817	11821	455	47	502	12638
1995	919	3277	3368	553	3921	4197
1996	1090	22489	3927	4667	8594	23579
1997	377	7336	2095	1196	3290	7714
1998	332	4091	551	32	583	4423
1999	211	6880	1206	880	2086	7092
2000	228	21947	9281	842	10123	22174
2001	1499	15563	257	718	975	17062
2002	2298	17043	309	683	992	19341
2003	720	3571	1130	797	1927	4291
2004	685	4248	699	29	728	4933
2005	1597	7306	192	17105	17298	8903
2006	127	8469	2652	1299	3951	8595
2007	836	8930	911	552	1462	9766
2008	5880	6603	327	848	1175	12483
2009	2195	20917	0	54	54	23113
2010	218	8694	16963	477	17440	8913
2011	3702	4031	543	161	704	7733
2012	444	1311	504	203	708	1755
2013	7079	1538	1819	677	2496	8617
2014	586	1483	122	218	340	2069
2015	482	2785	225	102	327	3267
2016	693	2342	600	20	620	3036
2017	937	4343	9260	25	9285	5281
2018	2100	3111	1976	293	2269	5211
2019	103	3619	278	59	337	3722
2020	474	3507	233	0	233	3981
2021	411	1054	311	44	355	1465
2022	392	2156	741	116	857	2548
2023	403	1082	406	0	406	1485
2024	389	654	329	34	363	1043

Table 6. Haddock biomass (mt) index by strata sections of Eastern Georges Bank (see Figure 2) from the National Marine Fisheries Service (NMFS) spring survey. Light shaded cells represent missing values calculated from adjacent strata sections. Cells with "-" represent missing values assumed to be zero while "0" represents observed zeros. Only the 33 year moving average data are shown. The 2020 NMFS spring survey was cancelled due to COVID-19 restrictions.

Year	USA 16	CAN 16	USA 17	CAN 17	USA 18	CAN 18	USA 19	USA 20	USA 21	CAN 21	USA 22	CAN 22	USA total	CAN total
1992	442	1530	-	80	-	0	93	0	-	376	-	0	536	1986
1993	266	3234	-	439	-	0	0	0	-	387	-	154	266	4214
1994	2	801	11	1	0	-	0	-	6	5644	-	0	19	6446
1995	2297	578	42	60	0	-	778	0	2	3356	-	888	3119	4881
1996	3720	1021	23	32	-	0	8581	0	8	972	31	0	12362	2026
1997	218	1884	10	28	0	11	0	0	45	1239	-	74	273	3237
1998	574	6600	3	84	-	5	0	-	282	227	0	108	859	7024
1999	6267	3485	0	1598	-	0	0	74	42	366	37	38	6420	5487
2000	4238	3712	0	220	0	-	198	668	522	151	-	55	5626	4138
2001	297	1537	-	446	-	0	71	0	1215	4339	-	15	1583	6337
2002	13973	9781	0	332	-	15	8094	-	0	897	93	78	22161	11103
2003	2149	14472	2	77	-	0	699	291	1123	1438	19	46	4282	16034
2004	25198	27752	-	978	-	75	3503	28736	715	669	-	3	58152	29477
2005	1575	3031	680	948	0	-	4991	144	-	3945	132	484	7522	8408
2006	11166	8302	5	323	-	97	758	3059	143	4140	-	40	15131	12901
2007	9617	23430	7	64	0	90	19906	12979	295	795	-	124	42804	24502
2008	40456	5465	2	135	0	164	87	1869	484	151	0	204	42898	6120
2009	22760	4635	88	245	0	37	1061	1502	6546	6224	0	19	31957	11159
2010	11191	11361	92	85	0	147	12458	2895	1364	2968	36	109	28037	14670
2011	5332	6871	17	859	0	157	515	0	364	2642	0	740	6228	11270
2012	28213	15155	15	2039	1	315	3285	2483	-	3635	-	101	33997	21245
2013	5291	13149	0	557	0	294	5952	5047	-	18415	123	326	16413	32741
2014	3228	7953	133	2523	0	496	14247	21918	701	2405	-	1230	40227	14607
2015	13773	6688	367	941	59	753	54810	13065	-	5685	-	699	82074	14766
2016	24635	29393	9	326	0	1106	4735	11066	1009	6696	936	178	42390	37699
2017	6122	23207	0	765	0	220	48725	9304	418	1230	134	588	64704	26009
2018	9248	5329	540	1090	0	592	26772	-	445	3626	-	471	37006	11109
2019	7205	23707	0	2720	0	181	14820	7897	3108	715	862	2095	33892	29418
2020	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	21318	4593	0	1041	0	68	3532	24742	1531	1335	2184	46	53308	7083
2022	1114	13459	0	1006	0	27	4861	4897	1155	2163	134	140	12161	16795
2023	0	39242	0	1704	0	0	9593	23803	294	5821	149	35	33840	46802
2024	6291	3783	0	344	0	0	1639	5255	103	1880	178	386	13465	6393

Table 7. Haddock biomass (mt) index by strata sections of Eastern Georges Bank (see Figure 2) from the National Marine Fisheries Service (NMFS) fall survey. Light shaded cells represent missing values calculated from adjacent strata sections. Cells with "-" represent missing values assumed to be zero while "0" represents observed zeros. Only the 33 year moving average data are shown. The 2020 NMFS fall survey was cancelled due to COVID-19 restrictions.

Year	USA 16	CAN 16	USA 17	CAN 17	USA 18	CAN 18	USA 19	USA 20	USA 21	CAN 21	USA 22	CAN 22	USA total	CAN total
1992	171	292	0	585	-	173	0	8	0	6	-	21	179	1077
1993	0	443	-	217	-	0	0	0	-	4103	-	83	0	4846
1994	0	0	-	284	-	347	0	0	0	1162	-	0	0	1793
1995	4	5214	-	843	-	1373	0	0	0	6575	0	-	4	14005
1996	10	2057	-	1138	-	639	0	-	1	179	-	0	10	4012
1997	0	4	-	133	-	0	2	5	8	6012	-	0	15	6149
1998	7	3409	-	285	-	471	0	37	7	2241	-	-	51	6406
1999	0	151	-	113	-	2021	0	0	-	13900	0	0	0	16184
2000	100	1646	-	365	-	1351	0	0	0	9432	0	0	100	12795
2001	1013	1471	-	2264	-	395	0	0	0	21540	-	491	1013	26161
2002	314	21420	8	591	-	201	0	144	0	19620	206	223	671	42054
2003	2736	3312	-	331	-	95	342	219	123	6453	-	0	3420	10191
2004	3275	24845	746	1115	0	693	0	5	1766	8248	223	1181	6014	36083
2005	5647	13381	2	1071	0	98	3	120	585	5617	2650	11761	9009	31927
2006	2088	20548	0	837	0	571	0	-	-	4502	-	7275	2088	33732
2007	203	2560	6	788	-	39	0	0	11208	2860	-	15315	11417	21561
2008	89	2578	2	4246	0	775	0	0	0	8005	0	7470	91	23074
2009	11958	14743	0	2070	0	0	12254	304	240	3999	188	36	24944	20848
2010	2936	14967	50	1554	1	1087	0	0	2677	2604	697	707	6361	20919
2011	9122	29552	1606	2549	1	2355	166	0	1178	1096	0	443	12073	35995
2012	564	21501	0	798	0	680	0	0	784	29443	736	7528	2084	59950
2013	61804	27768	676	1060	89	447	22938	6321	-	3769	-	7276	91828	40320
2014	28032	24214	5450	7395	75	2543	16	4393	-	5710	-	6441	37966	46303
2015	15406	63954	4	10087	0	1252	186527	14234	12602	6342	-	257	228773	81892
2016	4249	75958	0	5347	0	1871	2751	3418	5738	20514	-	519	16156	104209
2017	421	10170	7	3645	0	456	52	-	7339	4838	2446	47	10266	19156
2018	248	14094	0	179	0	1186	27	1546	3249	973	599	13	5668	16446
2019	73	1344	0	44	0	807	0	1160	15	964	1708	750	2954	3906
2020	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	68	43959	0	8321	0	3027	0	14	408	1284	2	426	491	57015
2022	46	26156	0	14	0	0	0	0	1	2008	218	13	265	28192
2023	5	2889	0	10317	0	174	0	0	7	638	12	3	24	14021
2024	58	1382	1	3514	0	1947	35	5	0	2078	264	2653	363	11575

Table 8. Haddock biomass (mt) index by strata and strata sections of Eastern Georges Bank (see Figure 2) from the Fisheries and Oceans Canada (DFO) survey.

Year	CAN 5Z1	CAN 5Z2	USA 5Z3	USA 5Z4	USA total	CAN total
1992	3544	10403	5953	576	6530	13946
1993	2064	2367	110	2411	2521	4432
1994	8871	9968	19	90	108	18839
1995	2244	18041	336	0	336	20285
1996	4947	16985	440	839	1279	21933
1997	1853	11022	1298	179	1476	12875
1998	15844	29323	89	11	99	45167
1999	14775	15221	506	319	825	29996
2000	4682	41522	11048	158	11206	46205
2001	9471	43754	2022	513	2535	53225
2002	5695	28569	3391	11863	15254	34264
2003	1583	89462	4334	27407	31741	91045
2004	21198	71574	5479	1796	7274	92772
2005	9638	39589	1931	5209	7140	49226
2006	5445	53525	35052	6285	41337	58970
2007	9705	43079	3811	5009	8820	52784
2008	35446	47657	34798	6063	40861	83102
2009	29750	41728	0[1]	82	82	71478
2010	1137	44993	5148	19991	25139	46130
2011	12095	32436	4114	10518	14632	44530
2012	4365	29550	25010	18497	43508	33915
2013	21809	50425	60218	31062	91281	72235
2014	26210	40788	1423	909	2332	66997
2015	5630	28722	150689	47854	198542	34352
2016	6344	160556	66166	4793	70959	166900
2017	4493	41845	67797	9119	76915	46338
2018	2032	40680	59654	9492	69146	42712
2019	5011	80610	8671	2612	11283	85621
2020	1939	15882	14404	540	14944	17821
2021	7512	12205	7479	534	8013	19717
2022	8417	8820	5169	257	5426	17237
2023	50789	5180	940	14	954	55969
2024	8291	7742	2111	53	2164	16034

[1] No Haddock were caught in 7 tows in this stratum.

Table 9. Yellowtail Flounder biomass (mt) index by strata and strata sections of Georges Bank (see Figure 2) from the National Marine Fisheries Service (NMFS) spring survey. Cells with "-" represent missing values assumed to be zero while "0" represents observed zeros. Only the 33 year moving average data is shown. The 2020 NMFS spring survey was cancelled due to COVID-19 restrictions.

Year	USA 13	USA 14	USA 15	USA 16	CAN 16	USA 17	CAN 17	USA 18	CAN 18	USA 19	USA 20	USA 21	CAN 21	USA total	CAN total
1992	295	0	0	178	1200	-	9	-	0	169	45	0	25	688	1233
1993	84	0	0	83	349	-	8	-	0	49	0	0	6	217	363
1994	103	0	0	127	383	0	0	0	-	70	0	55	37	356	419
1995	298	0	0	439	1854	-	0	0	-	41	12	4	44	794	1898
1996	103	0	0	1020	1724	-	9	-	0	229	120	13	23	1485	1756
1997	95	0	0	432	3631	0	0	3	0	35	59	2	0	626	3631
1998	704	0	0	910	676	0	0	-	0	38	65	19	302	1737	978
1999	768	0	0	2571	6830	0	0	-	0	5	67	36	3	3448	6833
2000	681	0	0	2003	4927	0	6	0	-	180	33	61	0	2956	4933
2001	61	0	0	2486	2389	-	8	-	0	101	20	240	17	2908	2413
2002	66	0	0	3656	3876	0	0	-	0	663	8	4	3150	4397	7026
2003	173	0	0	895	6384	0	28	-	0	21	0	14	-	1103	6412
2004	261	0	-	535	1219	-	0	-	0	74	16	0	62	886	1281
2005	216	0	0	2094	1025	0	0	0	-	44	0	0	33	2354	1058
2006	93	5	0	1258	1051	0	0	-	0	87	58	2	2	1504	1053
2007	372	382	3	733	3271	0	6	0	0	38	81	89	0	1699	3277
2008	234	0	0	968	1241	44	969	0	0	92	22	28	29	1388	2238
2009	1338	0	0	4298	5566	61	116	0	0	380	24	69	104	6171	5786
2010	573	974	0	4059	6352	0	6	1	0	2491	80	3	39	8182	6397
2011	3238	110	0	1821	251	7	0	0	0	368	89	6	0	5640	251
2012	1637	0	0	4763	817	0	7	0	1	1098	424	14	111	7936	936
2013	133	0	0	665	1151	6	28	0	0	138	54	6	175	1002	1354
2014	360	0	0	498	299	0	0	0	0	563	0	102	0	1523	299
2015	395	0	0	295	166	0	40	0	0	128	187	11	37	1016	243
2016	68	0	0	89	92	0	0	0	0	60	25	0	6	242	98
2017	48	0	0	118	43	0	0	0	0	55	0	0	0	221	43
2018	7	0	0	0	5	0	0	0	0	0	0	0	0	7	5
2019	73	0	0	182	80	0	3	0	0	0	6	0	3	261	86
2020	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	25	0	0	787	334	0	0	0	0	0	0	9	57	822	391
2022	39	0	0	29	173	0	0	0	0	0	0	9	0	76	173
2023	6	0	0	74	21	0	0	0	0	0	0	0	0	80	21
2024	0	0	0	109	253	0	0	0	0	0	0	0	0	109	253

Table 10. Yellowtail Flounder biomass (mt) index by strata and strata sections of Georges Bank (see Figure 2) from the National Marine Fisheries Service (NMFS) fall survey. Cells with "-" represent missing values assumed to be zero while "0" represents observed zeros. Only the 33 year moving average data are shown. The 2020 NMFS fall survey was cancelled due to COVID-19 restrictions.

Year	USA 13	USA 14	USA 15	USA 16	CAN 16	USA 17	CAN 17	USA 18	CAN 18	USA 19	USA 20	USA 21	CAN 21	USA total	CAN total
1992	177	0	0	9	419	0	0	-	0	16	22	0	0	224	419
1993	47	0	0	24	327	-	12	-	0	0	7	18	0	96	339
1994	113	0	0	105	755	-	18	-	0	11	0	118	19	347	792
1995	47	0	0	80	214	-	0	-	0	3	10	71	0	211	214
1996	90	0	0	1494	284	-	0	-	0	0	0	10	0	1593	284
1997	232	0	0	1808	1999	-	0	-	0	38	0	37	3	2115	2003
1998	818	0	0	592	2364	-	3	-	0	0	20	5	0	1435	2367
1999	770	0	0	2935	3962	-	191	-	0	224	114	157	0	4200	4154
2000	171	0	0	5580	1097	-	4	-	0	60	22	144	20	5978	1121
2001	641	0	0	7877	2139	-	13	-	0	177	47	111	0	8853	2153
2002	161	0	0	1784	1861	0	7	-	0	5	10	214	75	2174	1943
2003	92	0	0	2825	1613	-	0	-	0	158	0	43	3	3119	1616
2004	161	0	0	5915	78	0	0	0	0	172	12	67	121	6327	198
2005	145	0	0	1133	1260	0	7	0	0	41	29	56	9	1404	1276
2006	1475	0	-	2909	294	0	45	1	0	25	3	16	37	4429	376
2007	274	0	0	5739	753	3	0	0	0	52	6	114	115	6188	868
2008	852	0	0	3090	3654	0	0	0	0	0	0	31	58	3973	3712
2009	4209	0	0	10518	785	0	45	0	0	1180	151	161	136	16219	966
2010	1497	4	0	2371	1579	18	74	4	0	61	0	20	39	3975	1692
2011	2139	0	3	2511	880	14	0	0	0	63	0	13	841	4742	1721
2012	49	0	0	4888	400	0	0	0	0	29	0	617	49	5583	449
2013	164	0	0	1255	542	0	0	0	0	260	114	0	28	1793	570
2014	392	0	0	1478	762	0	0	0	0	0	5	0	3	1875	765
2015	0	0	0	180	1016	0	0	0	0	28	0	0	34	208	1050
2016	68	0	0	211	57	0	0	0	0	3	3	4	139	289	196
2017	1	0	0	118	29	0	0	0	0	61	0	0	0	180	29
2018	0	0	0	392	126	0	0	0	0	0	0	0	0	392	126
2019	26	0	0	88	214	0	0	0	0	2	3	0	4	118	217
2020	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	0	0	0	295	232	0	0	0	0	0	0	4	0	299	232
2022	4	0	0	35	249	0	0	0	0	0	0	0	0	39	249
2023	4	0	0	240	342	0	0	0	0	0	0	0	0	244	342
2024	0	0	0	390	205	0	0	0	0	0	0	0	0	390	205

Table 11. Yellowtail Flounder biomass (mt) index by strata of Georges Bank (see Figure 2) from the Fisheries and Oceans Canada (DFO) survey.

Year	CAN 5Z1	CAN 5Z2	USA 5Z3	USA 5Z4	USA total	CAN total
1992	119	432	327	1599	1925	550
1993	59	1634	178	771	949	1693
1994	91	501	745	1417	2162	591
1995	35	785	487	719	1206	820
1996	35	2799	1229	1241	2470	2833
1997	868	2464	2431	7529	9960	3332
1998	93	2484	613	1102	1715	2577
1999	190	6616	408	10452	10860	6806
2000	2019	5526	6430	5974	12404	7545
2001	443	4995	963	15757	16720	5438
2002	66	5052	5854	9727	15581	5118
2003	48	5739	75	10387	10462	5786
2004	84	5637	63	3271	3334	5720
2005	51	1028	392	11886	12278	1079
2006	35	776	962	4805	5767	812
2007	196	2959	102	10088	10189	3155
2008	64491	1656	262	910	1172	66147
2009	70851	1077	45	72	117	71927
2010	5332	3226	178	402	580	8558
2011	1	477	800	2552	3351	479
2012	89	1121	385	4055	4440	1210
2013	212	252	77	157	234	464
2014	79	98	79	257	336	177
2015	40	108	80	595	675	147
2016	20	235	31	1441	1473	255
2017	20	90	15	217	232	110
2018	22	68	24	138	162	90
2019	20	19	0	18	18	38
2020	10	47	0	68	68	57
2021	46	76	0	17	17	122
2022	23	133	14	143	156	156
2023	50	26	20	61	81	76
2024	22	13	0	51	51	35

Table 12. Resource distribution for Eastern Georges Bank Atlantic Cod on the Canadian and USA sides of the international boundary for the National Marine Fisheries Service (NMFS) and Fisheries and Oceans Canada (DFO) surveys, the distribution resulting from combining the surveys, and the smoothed resource distribution. The combined distribution was obtained by averaging the NMFS spring and DFO surveys to represent winter-spring and subsequently averaging with NMFS fall which represented summer-fall. All values of the smoothed resource distribution in the final two columns were updated to reflect the results of the most recent LOESS application. Open box highlights current year results. Only the 33 year moving average data are shown. Due to the cancellation of the NMFS spring and fall surveys in 2020, the % values for NMFS fall and spring in 2020 are an average of the previous two years (2018–2019).

Year	NMFS fall		NMFS spring		DFO		Combined surveys		Smoothed	
	%CAN	%USA	%CAN	%USA	%CAN	%USA	%CAN	%USA	%CAN	%USA
1992	94	6	83	17	66	34	85	15	85	15
1993	100	0	41	59	61	39	76	24	84	16
1994	100	0	70	30	96	4	91	9	83	17
1995	94	6	87	13	52	48	82	18	83	17
1996	95	5	55	45	73	27	80	20	84	16
1997	100	0	62	38	70	30	83	17	84	16
1998	100	0	96	4	88	12	96	4	84	16
1999	97	3	53	47	77	23	81	19	85	15
2000	100	0	48	52	69	31	79	21	85	15
2001	97	3	74	26	95	5	90	10	84	16
2002	98	2	63	37	95	5	88	12	84	16
2003	81	19	73	27	69	31	76	24	82	18
2004	99	1	81	19	87	13	91	9	80	20
2005	93	7	66	34	34	66	71	29	77	23
2006	97	3	31	69	69	31	73	27	77	23
2007	81	19	40	60	87	13	72	28	78	22
2008	100	0	57	43	91	9	87	13	79	21
2009	82	18	75	25	100	0	85	15	81	19
2010	96	4	51	49	34	66	69	31	82	18
2011	97	3	82	18	92	8	92	8	82	18
2012	84	16	59	41	71	29	75	25	81	19
2013	97	3	81	19	78	22	88	12	81	19
2014	93	7	35	65	86	14	77	23	79	21
2015	91	9	62	38	91	9	84	16	77	23
2016	43	57	94	6	83	17	66	34	76	24
2017	100	0	61	39	36	64	74	26	74	26
2018	98	2	31	69	70	30	74	26	74	26
2019	52	48	90	10	92	8	72	28	74	26
2020	75	25	61	39	94	6	76	24	75	25
2021	98	2	28	72	80	20	76	24	75	25
2022	95	5	11	89	75	25	69	31	73	27
2023	100	0	61	39	79	21	85	15	79	21
2024	55	45	55	45	74	26	60	40	69	31

Table 13. Resource distribution for Eastern Georges Bank Haddock on the Canadian and USA sides of the international boundary for the National Marine Fisheries Service (NMFS) and Fisheries and Oceans Canada (DFO) surveys, the distribution resulting from combining the surveys, and the smoothed resource distribution. The combined distribution was obtained by averaging over all surveys. All values of the smoothed resource distribution in the final two columns were updated to reflect the results of the most recent LOESS application. Open box highlights current year results. Only the 33 year moving average data are shown. Due to the cancellation of the NMFS spring and fall surveys in 2020, the % values for NMFS fall and spring in 2020 are an average of the previous two years (2018–2019).

Year	NMFS fall		NMFS spring		DFO		Combined surveys		Smoothed	
	%CAN	%USA	%CAN	%USA	%CAN	%USA	%CAN	%USA	%CAN	%USA
1992	86	14	79	21	68	32	78	22	84	16
1993	100	0	94	6	64	36	86	14	85	15
1994	100	0	100	0	99	1	100	0	86	14
1995	100	0	61	39	98	2	86	14	88	12
1996	100	0	14	86	94	6	69	31	89	11
1997	100	0	92	8	90	10	94	6	88	12
1998	99	1	89	11	100	0	96	4	86	14
1999	100	0	46	54	97	3	81	19	85	15
2000	99	1	42	58	80	20	74	26	81	19
2001	96	4	80	20	95	5	91	9	78	22
2002	98	2	33	67	69	31	67	33	76	24
2003	75	25	79	21	74	26	76	24	74	26
2004	86	14	34	66	93	7	71	29	72	28
2005	78	22	53	47	87	13	73	27	69	31
2006	94	6	46	54	59	41	66	34	66	34
2007	65	35	36	64	86	14	62	38	64	36
2008	100	0	12	88	67	33	60	40	61	39
2009	46	54	26	74	100	0	57	43	61	39
2010	77	23	34	66	65	35	59	41	61	39
2011	75	25	64	36	75	25	72	28	59	41
2012	97	3	38	62	44	56	60	40	59	41
2013	31	69	67	33	44	56	47	53	58	42
2014	55	45	27	73	97	3	59	41	57	43
2015	26	74	15	85	15	85	19	81	54	46
2016	87	13	47	53	70	30	68	32	53	47
2017	64	36	29	71	38	62	43	57	53	47
2018	74	26	23	77	38	62	45	55	53	47
2019	57	43	46	54	88	12	64	36	54	46
2020	66	34	35	65	54	46	52	48	56	44
2021	99	1	12	88	71	29	61	39	58	42
2022	99	1	58	42	76	24	78	22	70	30
2023	100	0	58	42	98	2	85	15	82	18
2024	97	3	32	68	88	12	72	28	81	19

Table 14. Resource distribution for Georges Bank Yellowtail Flounder on the Canadian and USA sides of the international boundary for the National Marine Fisheries Service (NMFS) and Fisheries and Oceans Canada (DFO) surveys, the distribution resulting from combining the surveys, and the smoothed resource distribution. The combined distribution was obtained by averaging over all surveys. All values of the smoothed resource distribution in the final two columns were updated to reflect the results of the most recent LOESS application. Open box highlights current year results. Only the 33 year moving average data are shown. Due to the cancellation of the NMFS spring and fall surveys in 2020, the % values for NMFS fall and spring in 2020 are an average of the previous two years (2018-2019).

Year	NMFS fall		NMFS spring		DFO		Combined surveys		Smoothed	
	%CAN	%USA	%CAN	%USA	%CAN	%USA	%CAN	%USA	%CAN	%USA
1992	65	35	64	36	22	78	51	49	41	59
1993	78	22	63	37	64	36	68	32	48	52
1994	70	30	54	46	21	79	48	52	51	49
1995	50	50	71	29	40	60	54	46	51	49
1996	15	85	54	46	53	47	41	59	50	50
1997	49	51	85	15	25	75	53	47	50	50
1998	62	38	36	64	60	40	53	47	48	52
1999	50	50	66	34	39	61	52	48	46	54
2000	16	84	63	37	38	62	39	61	44	56
2001	20	80	45	55	25	75	30	70	43	57
2002	47	53	62	38	25	75	44	56	42	58
2003	34	66	85	15	36	64	52	48	40	60
2004	3	97	59	41	63	37	42	58	38	62
2005	48	52	31	69	8	92	29	71	36	64
2006	8	92	41	59	12	88	20	80	36	64
2007	12	88	66	34	24	76	34	66	39	61
2008	48	52	62	38	98	2	69	31	43	57
2009	6	94	48	52	100	0	51	49	44	56
2010	30	70	44	56	94	6	56	44	41	59
2011	27	73	4	96	13	87	14	86	38	62
2012	7	93	11	89	21	79	13	87	34	66
2013	24	76	57	43	67	33	49	51	31	69
2014	29	71	16	84	35	65	27	73	31	69
2015	83	17	19	81	18	82	40	60	32	68
2016	40	60	29	71	15	85	28	72	31	69
2017	14	86	16	84	32	68	21	79	34	66
2018	24	76	43	57	36	64	34	66	38	62
2019	65	35	25	75	68	32	52	48	42	58
2020	45	55	33	67	46	54	41	59	47	53
2021	44	56	32	68	88	12	55	45	52	48
2022	86	14	69	31	50	50	69	31	64	36
2023	58	42	21	79	48	52	42	58	57	43
2024	34	66	70	30	41	59	48	52	51	49

Table 15a. Resource utilization of Eastern Georges Bank Atlantic Cod and Haddock, and Georges Bank Yellowtail Flounder (Ytl) for USA and Canada Values are a percentage.

Country	Resource Utilization		
	Cod	Haddock	Ytl
USA	40	45	98
Canada	60	55	2

Table 15b. Smoothed distribution of Eastern Georges Bank Atlantic Cod and Haddock (Had), and Georges Bank Yellowtail Flounder (Ytl) and the weightings used in the USA/Canada allocation sharing formula. Allocation shares are updated annually based on resource distribution. Values are a percentage.

Country	Survey Year	Resource Distribution			Fishing Year	Weighting		**Allocation Shares**		
		Cod	Had	Ytl		Utilization	Distribution	**Cod**	**Had**	**Ytl**
USA	2002	12	26	62	2004	40	60	**23**	**34**	**76**
Canada	2002	88	74	38	2004	40	60	**77**	**66**	**24**
USA	2003	18	27	56	2005	35	65	**26**	**33**	**71**
Canada	2003	82	73	44	2005	35	65	**74**	**67**	**29**
USA	2004	14	29	56	2006	30	70	**22**	**34**	**69**
Canada	2004	86	71	44	2006	30	70	**78**	**66**	**31**
USA	2005	21	29	63	2007	25	75	**26**	**33**	**72**
Canada	2005	79	71	37	2007	25	75	**74**	**67**	**28**
USA	2006	26	32	73	2008	20	80	**29**	**35**	**78**
Canada	2006	74	68	27	2008	20	80	**71**	**65**	**22**
USA	2007	29	36	73	2009	15	85	**31**	**37**	**77**
Canada	2007	71	64	27	2009	15	85	**69**	**63**	**23**
USA	2008	23	40	60	2010	10	90	**25**	**40.5**	**64**
Canada	2008	77	60	40	2010	10	90	**75**	**59.5**	**36**
USA	2009	17	43	50	2011	10	90	**19**	**43**	**55**
Canada	2009	83	57	50	2011	10	90	**81**	**57**	**45**
USA	2010	22	43	44	2012	10	90	**24**	**43**	**49**
Canada	2010	78	57	56	2012	10	90	**76**	**57**	**51**
USA	2011	13	37	37	2013	10	90	**16**	**38**	**43**
Canada	2011	87	63	63	2013	10	90	**84**	**62**	**57**
USA	2012	19	37	81	2014	10	90	**21**	**38**	**83**
Canada	2012	81	63	19	2014	10	90	**79**	**62**	**17**
USA	2013	16	45	67	2015	10	90	**18**	**45**	**70**
Canada	2013	84	55	33	2015	10	90	**82**	**55**	**30**
USA	2014	19	43	72	2016	10	90	**21**	**43**	**75**
Canada	2014	81	57	28	2016	10	90	**79**	**57**	**25**
USA	2015	18	61	66	2017	10	90	**20**	**59**	**69**
Canada	2015	82	39	34	2017	10	90	**80**	**41**	**31**
USA	2016	26	38	68	2018	10	90	**27**	**39**	**71**
Canada	2016	74	62	32	2018	10	90	**73**	**61**	**29**
USA	2017	28	51	74	2019	10	90	**29**	**50**	**76**
Canada	2017	72	49	26	2019	10	90	**71**	**50**	**24**
USA	2018	28	55	71	2020	10	90	**29**	**54**	**74**
Canada	2018	72	45	29	2020	10	90	**71**	**46**	**26**
USA	2019	29	46	60	2021	10	90	**30**	**46**	**64**
Canada	2019	71	54	40	2021	10	90	**70**	**54**	**36**
USA	2020	27	47	57	2022	10	90	**28**	**47**	**61**
Canada	2020	73	53	43	2022	10	90	**72**	**53**	**39**
USA	2021	25	42	48	2023	10	90	**26**	**42**	**53**
Canada	2021	75	58	52	2023	10	90	**74**	**58**	**47**
USA	2022	27	30	36	2024	10	90	**29**	**31**	**42**
Canada	2022	73	70	64	2024	10	90	**71**	**69**	**58**
USA	2023	21	18	43	2025	10	90	**23**	**21**	**48**
Canada	2023	79	82	57	2025	10	90	**77**	**79**	**52**
USA	**2024**	**31**	**19**	**49**	**2026**	**10**	**90**	**32**	**21**	**54**
Canda	**2024**	**69**	**81**	**51**	**2026**	**10**	**90**	**68**	**79**	**46**

FIGURES

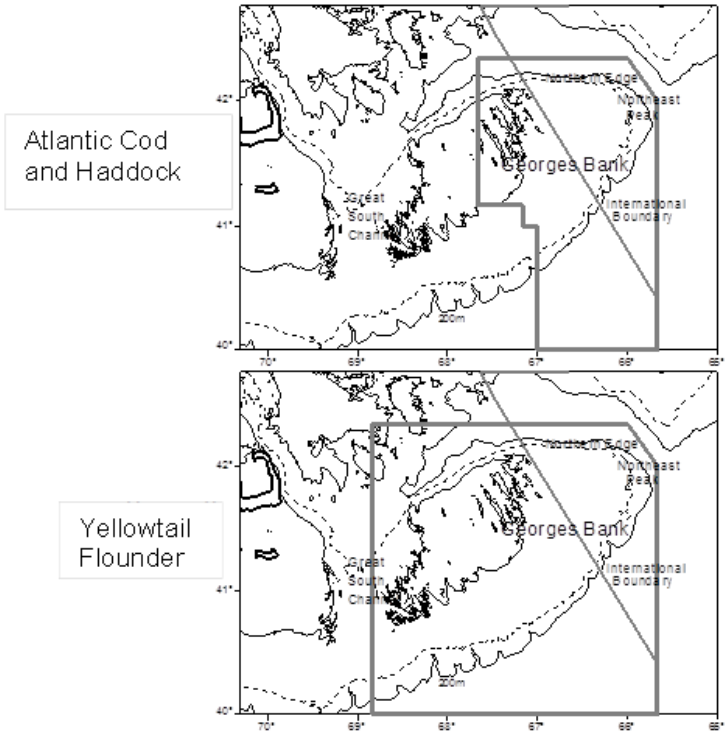

Figure 1. The management areas for Atlantic Cod, Haddock (upper panel), and Yellowtail Flounder (lower panel) on Georges Bank (thick grey line), including the Canada/USA boundary line (thin grey line) across which resource distribution was determined.

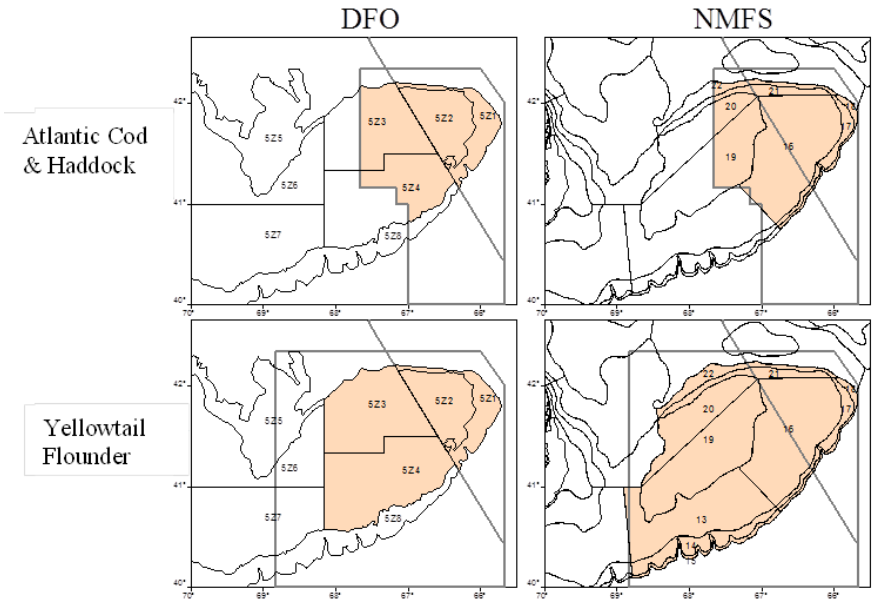

Figure 2. National Marine Fisheries Service (NMFS) and Fisheries and Oceans Canada (DFO) survey strata used to develop biomass indices on either side of the Canada/USA boundary for eastern Georges Bank Atlantic Cod and Haddock (upper panels) and Georges Bank Yellowtail Flounder (lower panels) in relation to the management unit borders. Strata boundaries (thin black lines) with strata labels are shown. The shaded area represents the strata and strata sections that were used to approximate the respective management units (thick grey lines).

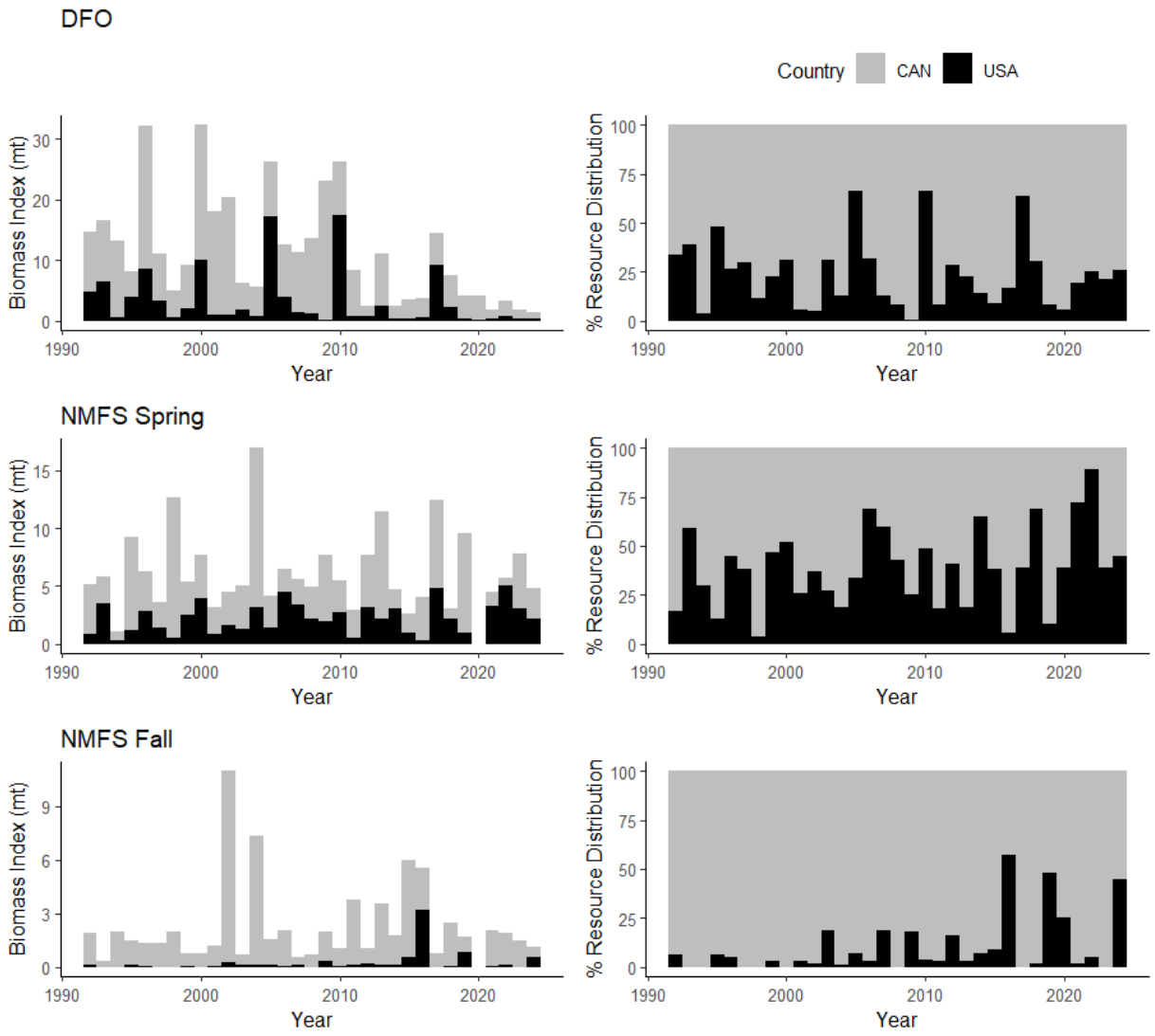

Figure 3. Relative indices of biomass (left) and percentage resource distribution (right) in relation to the international boundary for Atlantic Cod on Eastern Georges Bank for the 33 year running average. The 2020 NMFS Fall and Spring surveys were cancelled due to COVID-19, so no biomass estimates are available. The percentage resource distribution for the missing years are filled using the values calculated in Andrushchenko et al. 2021.

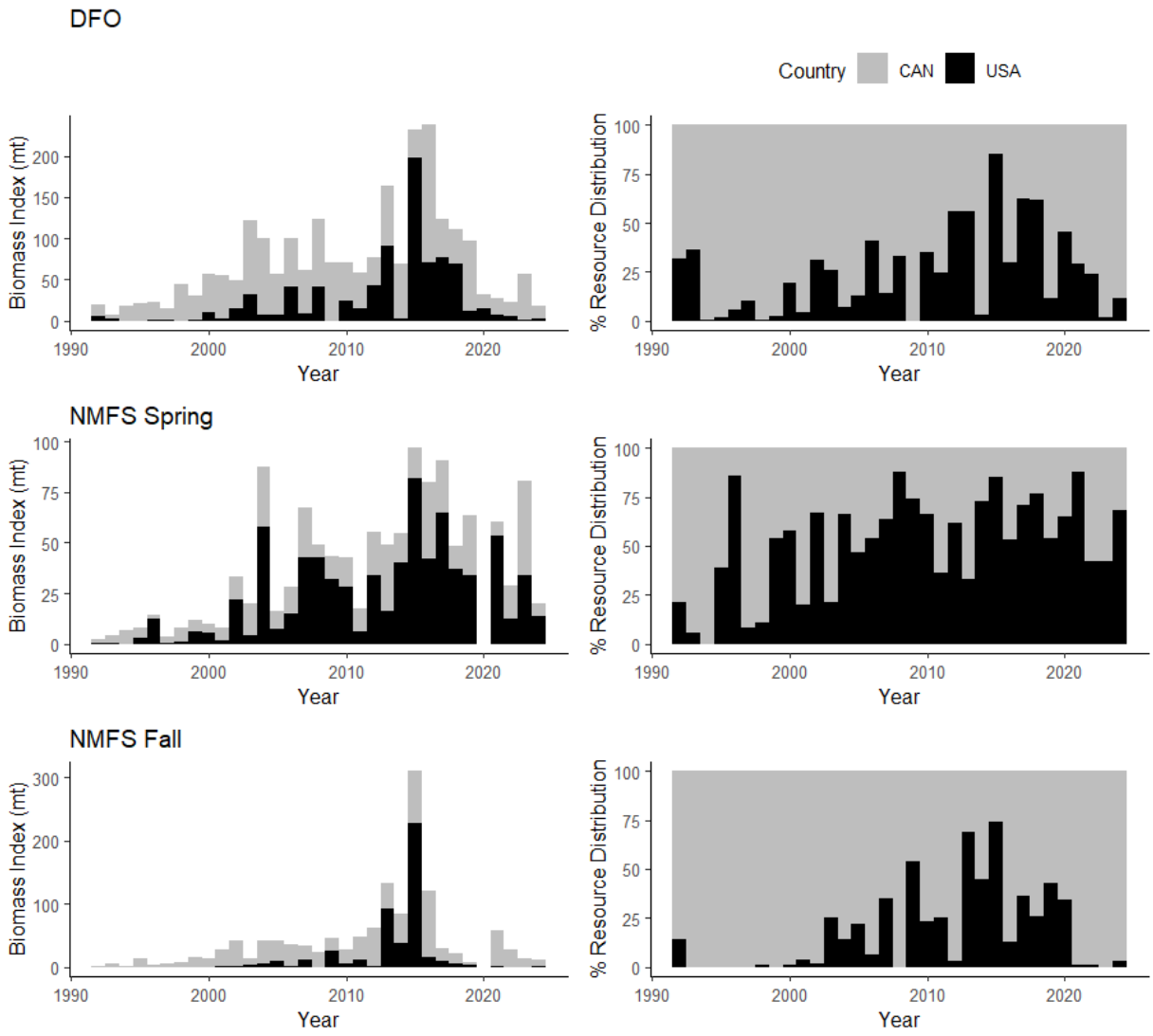

Figure 4. Relative indices of biomass and percentage resource distribution in relation to the international boundary for Haddock on Eastern Georges Bank for the 33 year running average. The 2020 NMFS Fall and Spring surveys were cancelled due to COVID-19, so no biomass estimates are available. The percentage resource distribution for the missing years are filled using the values calculated in Andrushchenko et al. 2021.

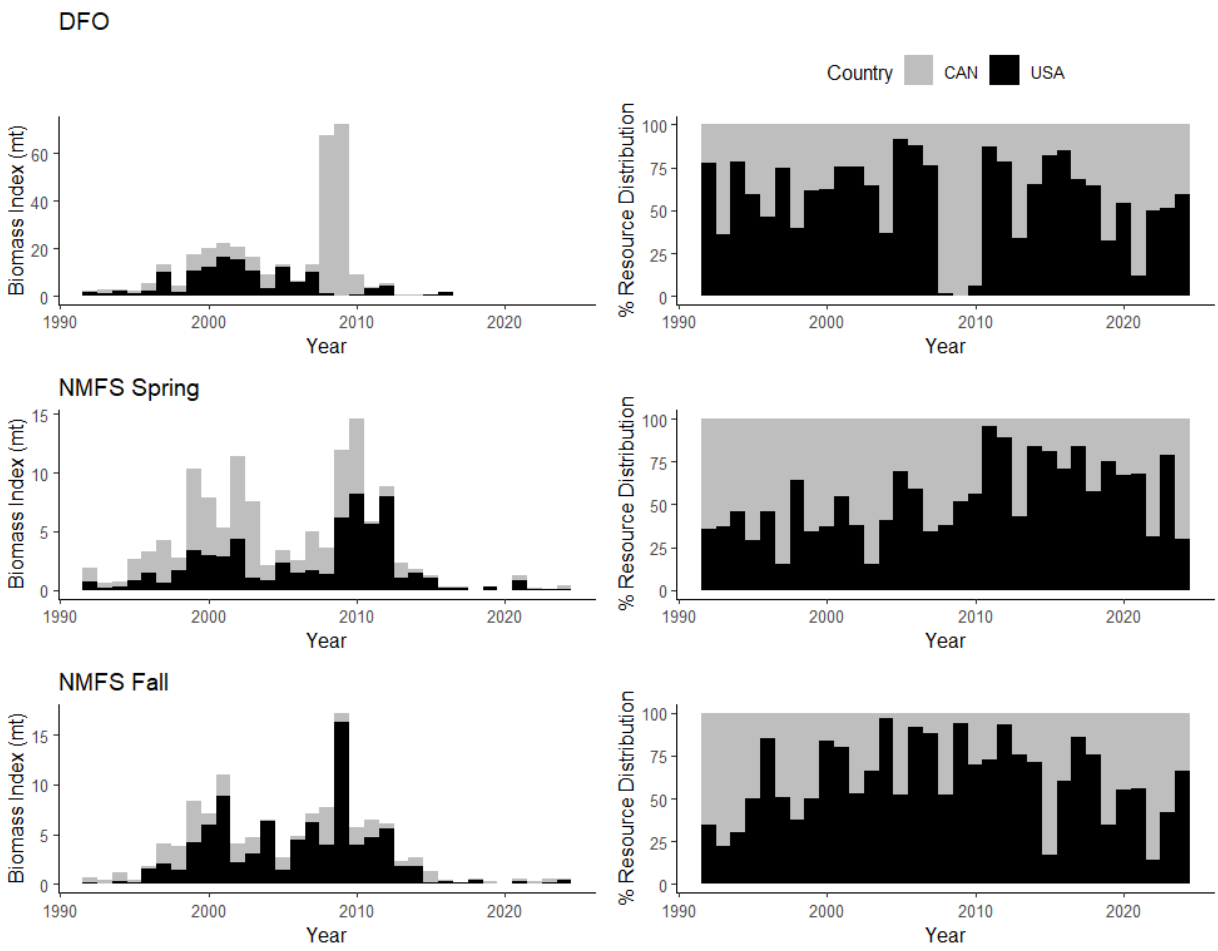

Figure 5. Relative indices of biomass and percentage resource distribution in relation to the international boundary for Yellowtail Flounder on Georges Bank for the 33 year running average. The 2020 NMFS Fall and Spring surveys were cancelled due to COVID-19, so no biomass estimates are available. The percentage resource distribution for the missing years are filled using the values calculated in Andrushchenko et al. 2021.

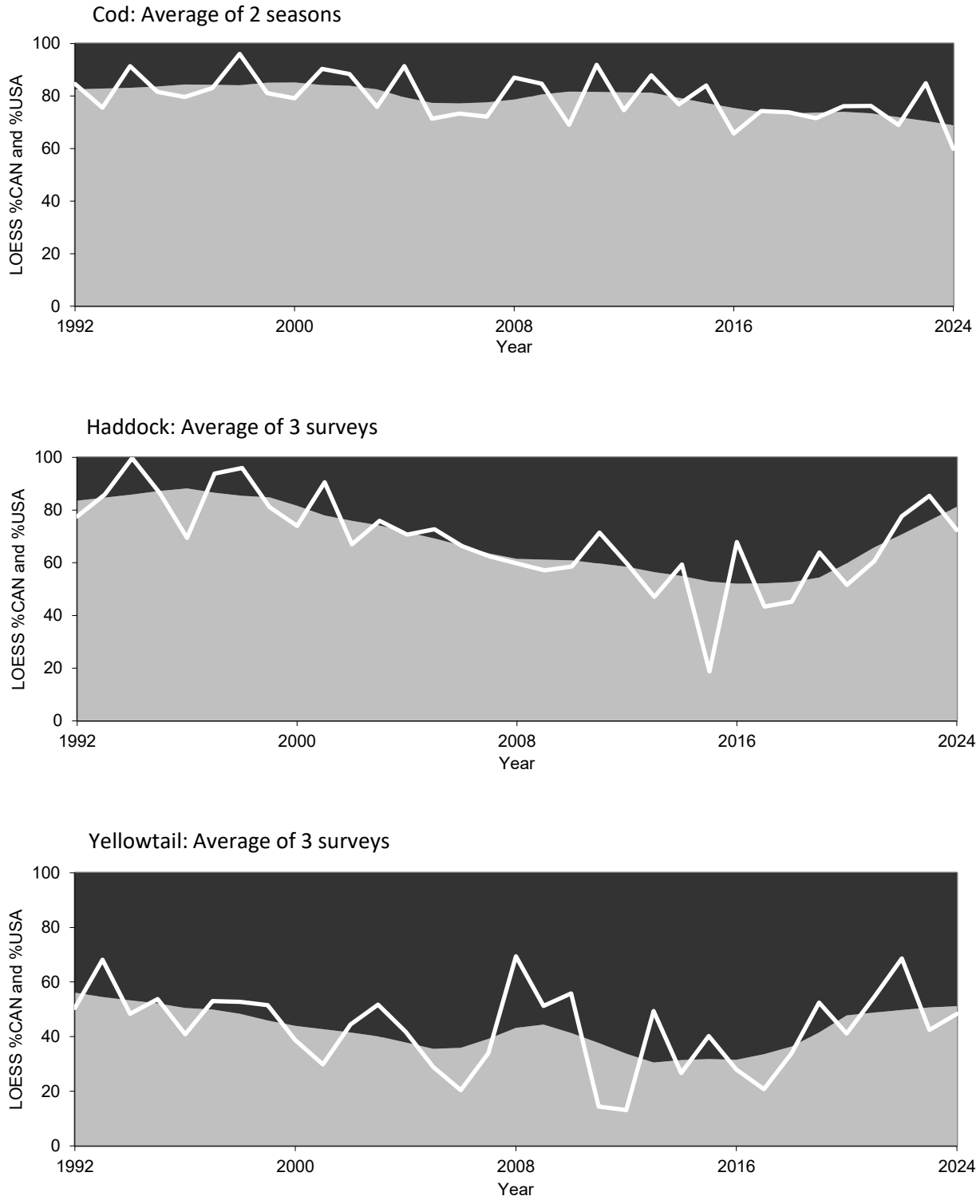

Figure 6. Observed annual percentage (white line) and smoothed trends of proportion of Eastern Georges Bank Atlantic Cod (upper panel), Eastern Georges Bank Haddock (middle panel), and Georges Bank Yellowtail Flounder (bottom panel) on the Canadian (grey) and US (black) side of the international boundary.