



## Transboundary Management Guidance Committee

**Guidance Document 2022/01**

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The Transboundary Management Guidance Committee (TMGC), established in 2000, is a government-industry committee composed of representatives from Canada and the United States. The TMGC's purpose is to develop guidance in the form of harvest strategies, resource sharing, and management processes for Canadian and U.S. management authorities for the cod, haddock and yellowtail flounder transboundary resources on Georges Bank. This document is a summary of the basis of TMGC's guidance to both countries for the 2023 fishing year (calendar year for Canada; May 1, 2023 through April 30, 2024, for the United States). For the first time since 2019, the TMGC met in person, in Boston on September 12 and 13, 2022. Remote access remained available for participants that desired to join in that manner. Pertinent reference documents and consultations used in the TMGC deliberations are listed at the end of this document.

Since inception, TMGC has successfully coordinated management of three trans-boundary groundfish resources. Annual harvest levels have been established consistent with the legal and policy requirements of both countries. Fishing mortality rates for the three management units considered by TMGC have been reduced, this a notable benefit of this approach.

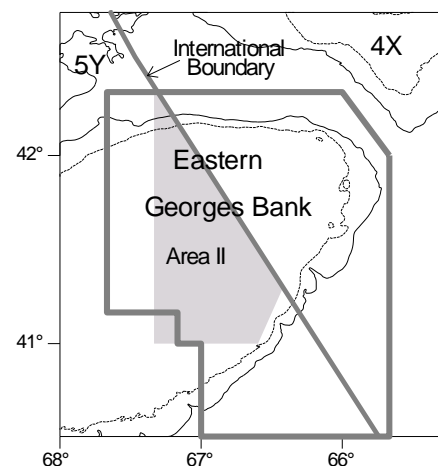
In January of 2011, the International Fisheries Clarification Act was signed into law in the United States. This Act recognizes the U.S./Canada Transboundary Resources Sharing Understanding, and provides the United States with flexibility in the rebuilding period and catch level requirements for Georges Bank yellowtail flounder under the Magnuson-Stevens Fishery Conservation and Management Act.

The annual allocation shares between countries for 2023 are based on a combination of historical catches (10% weighting), and resource distribution based on trawl surveys (90% weighting).

## Eastern Georges Bank Cod [5Zjm; 551, 552, 561, 562]

### *Guidance*

TMGC concluded that the most appropriate combined Canada/U.S. Total Allowable Catch (TAC) for Eastern Georges Bank Cod for the 2023 fishing year is 520 mt, a 8% percent reduction relative to 2022. The TRAC applied the Data Limited Methods Tool (DLMtool) to identify a simple, simulation tested method of providing advice. Based on the TMGC approved Management Procedure, the catch advice provided by TRAC for 2023 was 520 mt. TMGC sought to reduce the quota in 2023, while continuing to balance the utilization of other species, and consideration of risks to the stock. The status of the stock remains poor.



Only aggregate landings and discards were available from the USA commercial fishery. The length and age composition information was not available for the 2020 or 2021 USA fishery. Full data from the 2022 DFO spring survey are not yet available pending the availability of a new vessel conversion factor.

Applying the allocation shares for 2023 entitles the U.S. to 26% and Canada to 74% of the TAC, resulting in a national quota of 135 mt for the U.S. and 385 mt for Canada.

### *Harvest Strategy & Reference Points*

The TMGC has adopted a strategy to maintain a low to neutral risk of exceeding the fishing mortality limit reference,  $F_{ref}=0.18$  (TMGC 2003). When stock conditions are poor, fishing mortality rates should be further reduced to promote rebuilding. With the rejection of the 2013 Benchmark models and the implementation of the Data Limited Methods tool (DLMtool) simulation framework, an estimate of fishing mortality can no longer be calculated.

### *Fishery Exploitation*

Combined Canada/U.S. catches in 2021 were 487 mt, including 11 mt of discards, with a quota of 635 mt (77% of the quota). Historically, catches averaged 17,200 mt between 1978 and 1993, peaking at 26,463 mt in 1982. Catches declined to 1,683 mt in 1995, then fluctuated at about 3,000 mt until 2004, and have subsequently declined.

Table 1. Catches of Eastern Georges Bank Cod.

	Canada					USA				Combined	
Year	Landings	Discards Scallop	Discards Groundfish	Total Catch	TAC	Landings	Discards	Total Catch	TAC	Catch	TAC
2017	474	7	7	488	584	34	4	38	146	526	730
2018	510	5	2	517	694	47	2	48	257	565	951
2019	388	5	3	396	461	30	1	31	189	428	650
2020	362	11	4	377	461	64	3	67	189	444	650
2021	420	5	6	431	444.5	55	1	56	190.5	487	635
Min	362	5	0	377		377	24	0		428	
Max	17,827	200	428	17,898		17,898	10,558	279		26,463	
Ave	4,541	66	72	4,647		4,647	2,747	54		7,796	

### State of Resource

Without an assessment model, the state of the resource is described by summarizing relevant survey trends.

Biomass and abundance indices for the 2022 DFO spring survey will not be available until comparative fishing is complete. The survey **swept area biomass** was 1,114 mt for the 2021 NMFS fall survey, and 3,686 mt for the 2022 NMFS spring survey. The 2021 NMFS fall survey swept area biomass value represents a decrease from 2019, while the NMFS spring value represents an increase from 2021. The **swept area abundance** from the NMFS fall survey increased slightly from 638,000 in 2019 to 653,000 in 2021, but remains below the recent series mean (1994–2019, 1.1 million fish); for the NMFS spring survey, it increased from 1.5 million fish in 2020 to 1.8 million fish in 2021, but also remains below the recent series mean (2.8 million fish, 1994–2021). The DFO spring survey data are not ready for analysis, as a new vessel conversion factor has not yet been calculated.

**Total mortality (Z)** is calculated by two age groups (ages 4–5 and ages 6–8) using the NMFS spring survey abundance indices only. Total mortality trends from the NMFS spring survey based on catch curves began to break down over the past decade. The increasing occurrence of year and age combinations with no Cod observed in the surveys, particularly for the older ages, is problematic for these simple calculations of survey Z. For recent years where the calculation is functioning, total mortality on older fish is higher than on younger fish. Two additional years of data continue to show intermittent presence of older fish. In combination with missing surveys, this creates numerous gaps in the time series. Although the time series only provides intermittent glimpses into the level of total mortality, the absence of older fish from the survey catch confirms that high mortality on older fish continues. The total mortality calculation using the Sinclair (2001) approach also appears to have broken down for the NMFS spring survey, but the exact cause was not investigated due to time limitations.

### ***Productivity***

The **spatial distributions** of Cod in the 2021 NMFS fall surveys and 2022 DFO and NMFS spring surveys remained comparable to the previous years. The DFO data were considered without conversion only to illustrate the location of catches and not catch size. For the NMFS spring and fall surveys, large survey sets recorded along the northeastern edge of Georges Bank in the previous ten years were absent in the most recent year. The catches from the DFO spring survey were distributed across the Canadian portion of the bank, while the NMFS spring catches were broadly distributed across the American portion of eastern Georges Bank, particularly near the Hague Line. The NMFS fall catches were confined to the northeast edge of the Canadian portion of the bank. Given the comparable magnitude of catches for the USA spring survey in the past two years, the accompanying coefficients of variation were relatively low.

The **length frequency** of the survey catch in the 2022 NMFS spring survey peaked at 58 cm (23in), while the 2021 NMFS fall survey catch is characterized by an unusually large peak at 43 cm (17 in), representing one-year old fish.

Fulton's **condition factor** (K) was updated for all three surveys. The surveys showed a downward trend throughout the series until 2009, when K either stabilized or began to increase for all three surveys. With the most recent data, Cod condition remains below the long-term mean for the DFO spring survey and above the long-term mean for both the NMFS fall and spring surveys.

The most recent data update indicated an improvement in **growth** of young Cod on eastern Georges Bank, while older fish continue to grow slowly. The effect is most pronounced on fish aged 1 through 5, is evident across various data sources (Canadian fishery and surveys) and ageing labs (NMFS and DFO), and persists when time of year is taken into account. In general, it appears as though young fish sampled in 2021 and 2022 all grow as well as the faster growing fish sampled in previous years, comparable to the level of growth seen prior to 1994. An initial examination of growth by cohort indicated that the growth rate of the 2019, 2020 and 2021 cohorts is among the highest in the recent time period. Further examination of growth rates and investigation into likely causes should take place as resources permit, particularly in preparation for a benchmark.

### ***Outlook***

Available survey and fishery indicators generally remained consistent with previous years, indicating that productivity of the stock remains low and there is no notable change in the state of the stock.

### ***DLMtool***

The TRAC applied the Data Limited Methods Tool (DLMtool), which is a simulation platform that mimics stock dynamics across a range of uncertainties, against which simple index-based management procedures for provision of interim advice can be tested.

On April 22<sup>nd</sup>, 2021, the outputs of the simulation were presented at a TMGC Intersessional, with the TMGC selecting two Management Procedures (MP) to provide interim advice: status quo (650 mt) and status quo minus 20% (520 mt). In 2022 after discussion at an intersessional, the TMGC revised their decision to only select the status quo minus 20% (520 mt) MP. Given the simulated low productivity state for this stock, none of the MPs considered are expected to substantially change the current state of the EGB Cod stock, as long as conditions of low productivity persist.

Given the parameterization of the DLMtool application, and the existence of six operating models, the reference points coming out of the simulation testing were not deemed appropriate for use in evaluation of the Management Procedures. Consequently, a TMGC sub-working group developed and refined three short to medium term Management Objectives with five evaluation criteria and one performance metric to help evaluate the performance of the Management Procedures.

The application of DLMtool to EGB cod required several assumptions about the current biological metrics of the stock, namely weight, growth and maturity. The outputs of the simulation testing remain valid as long as these biological assumptions hold. The DLMtool uses empirical data up to 2018 as the basis for these assumptions, which leaves room to test whether these assumptions hold as additional years of information become available. This year, the weight-at-age, growth, and maturity assumptions were compared to empirical survey data from the available National Marine Fisheries Service (NMFS) and Fisheries and Oceans Canada (DFO) surveys since 2019. Note that the 2020 NMFS spring and fall surveys were cancelled due to COVID-19 restrictions and are therefore absent from the analysis. In addition, the 2021 NMFS spring ages were not available in time for the 2021 TRAC assessment, so the current document includes updated information for the 2021 NMFS spring survey and newly presented 2022 data.

The updated data showed no major departure from the range used for the assumptions of weight-at-age, growth, and maturity, although the growth parameters are progressively moving towards the outer limits of the assumed range. If the young cohorts (2019+) continue to exhibit better growth as their contribution to the population increases, the growth parameters assumed in the projections of DLMtool may move outside of the bounds in the upcoming years.

### ***TRAC Advice***

Given that the biological assumptions going into DLMtool are maintained, the simulated operating models remain appropriate. Based on the approved Management Procedure selected by the TMGC, the TRAC catch advice for EGB Cod for 2023 is 520 mt and remains appropriate. There is a need to continue annual evaluation of whether the assumptions made in the projections of the DLMtool remain realistic, particularly if further evidence of higher than assumed growth emerges. The current application of the DLMtool is only intended as a short-term solution and should be replaced or supplemented with at least one functioning population model as soon as possible. The TRAC strongly recommends a benchmark for this stock.

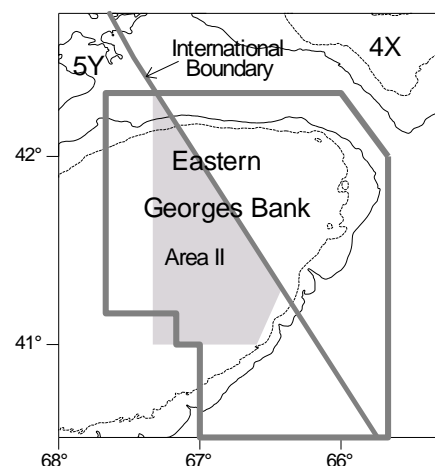
*Special Considerations*

- Estimated removals in recent years in USA EGB Cod catches are a source of uncertainty. Further investigation is needed into the ecological role of Cod and the potential implications of these changes on the recent productivity trends of Cod. In addition, investigation into the recent levels of natural mortality on eastern Georges Bank is recommended.
- The USA commercial fishery data processing system is undergoing a change and will transition to the Catch Accounting and Monitoring System (CAMS).
- Apparent improvement in growth of young fish and their relatively high abundance compared to the recent years in 2021 NMFS fall survey must be monitored to see if the signal persists as the fish age and increase their contribution to the population.
- The USA is conducting a research track assessment on Atlantic Cod and an update was provided at this meeting. The TRAC anticipates another update next year. The current application of the DLMtool was only intended as a short-term solution and should be replaced with at least one functioning population model as soon as possible, particularly in light of apparent changes in growth of incoming year classes and the need by both Canada and the USA for science advice on stock status, reference points, etc.

## Eastern Georges Bank Haddock [5Zjm; 551, 552, 561, 562]

### Guidance

TMGC was unable to reach consensus on the most appropriate combined Canada/U.S. TAC for Eastern Georges Bank Haddock for 2023. The TMGC was challenged by uncertainties regarding *M* and differing interpretations of both *M* and the results of TRAC, which provided projections under two different *M* scenarios: High *M* (2,784 mt) and the range of projected catch bounded by the High *M* and Low *M* scenarios (2,784 mt – 4,601 mt). TRAC did not come to consensus on the scenario of *M* to use to provide catch advice. The only consensus advice available to the TMGC was that a decrease in catch advice was necessary and that the Low *M* scenario should not be used for EGB haddock in the short term. Application of the allocation shares for 2023 result in a U.S. of 42% and a Canadian share of 58%.



The Canadian delegation's opening position for a shared TAC for EGB haddock was 4,200 mt and were willing to agree to a shared TAC as low as 4,000 mt. Canada considers a TAC of 4,000 mt for 2023 Eastern Georges Bank (EGB) Haddock appropriate for the following reasons: The amount follows the advice from TRAC for a large reduction and is within the range of advice provided by the TRAC taking into account both the low *M* and high *M* projections provided, both 4,200 mt and 4,000 mt incorporate the uncertainty around the current and future levels of *M*, while also acknowledging the importance of the continued harvest of this species to Canada. Natural mortality, due to factors related to density dependence since the emergence of the historically strong 2013 year class, will decline as the population declines from historic highs which is expected to result in increased future survival of EGB haddock. There are positive signs that new year classes will be entering the fishery, however it was acknowledged that it will take a few years for these potentially larger year classes to contribute to the fishery and SSB. Using a shared TAC of 4,000 mt and applying allocation shares, Canada proposes domestic TAC of 2,320 mt.

The U.S. delegation's opening position was 2,784 mt, in recognition of the sharp decline in biomass for the stock and the risk evaluation under the High *M* Scenario. The U.S. was willing to agree to a shared TAC as high as 3,619 mt, understanding the difficulty that these quotas pose to Canadian industry, but could not support a quota of 4,000 mt. The U.S. does not support the logic for optimism with the EGB haddock stock, and is concerned about its observed decline through 2021. Until projected improvements are realized, the U.S. believes fishing mortality rates should be reduced consistent with the TMGC harvest strategy to promote rebuilding.



Only aggregate landings and discards were available from the USA commercial fishery. The length and age composition information was not available for the 2020 or 2021 USA fishery. Full data from the 2022 DFO spring survey are not yet available pending the availability of a new vessel conversion factor.

Both delegations look forward to an updated assessment of the stock in 2023 and emphasize continued efforts to come to agreement as often as possible regarding TACs for shared stocks.

### ***Harvest Strategy & Reference Points***

The strategy is to maintain a low to neutral risk of exceeding the fishing mortality limit reference, which in the past has been  $F_{ref} = 0.26$ . When stock conditions are poor, fishing mortality rates should be further reduced to promote rebuilding.

A new assessment model for Eastern Georges Bank Haddock passed peer review at the Haddock Research Track assessment (RTA) meeting held in March 2022. The results of this new model suggest that the  $F_{ref}=0.26$ , derived from the 2002 Virtual Population Analysis (VPA) model output and adopted by TMGC (TMGC Meeting Summary, Oct. 2, 2003), is no longer appropriate. The new candidate  $F_{ref}$  was calculated using  $F_{40\%spr}$  (spawner per recruit) as a proxy for  $F_{MSY}$  (maximum sustainable yield). The  $F_{40\%spr}$ , associated with the higher level of natural mortality ( $M$ ) in the 2010–2019 period was extremely high ( $>3$ ); therefore, a lower  $M$  of 0.2 was proposed for the  $F_{40\%spr}$  calculation for 2023 advice.

The proposed reference point is  $F_{40\%spr}=0.367$ , with the suggestion to update every 3 years and calculated with the data from the last 5 years. The 3-year update reflects perceptions of the resolution of fishery changes, and it does not require updating on a regular basis (one or two year update). The TRAC suggested this value for TMGC discussion, the TMGC is using this as an interim reference point, further work by the TRAC and TMGC to make a final decision is needed.

### ***Fishery Exploitation***

**Combined Canada and USA catches** for Eastern Georges Bank (EGB) Haddock declined from 6,504 mt in 1991 to a low of 2,150 mt in 1995, varied between 2,865 mt and 4,094 mt until 1999, and increased to 15,248 mt in 2005 (Figure 1). From 2006 to 2020, catches varied between 11,735 mt and 19,856 mt apart from a decrease to just above 5,000 mt in 2012 and 2013. In 2021, the total catch decreased to 7,526 mt and represented 53% of the combined 14,100 mt quota.

*Table 2. Catches (mt) of Eastern Georges Bank Haddock.*

		2018	2019	2020	2021	2022	Avg <sup>1</sup>	Min <sup>1</sup>	Max <sup>1</sup>
Canada <sup>2</sup>	Quota	24,000	15,000	13,800	7,614	7,473			
	Landed	12,216	14,156	11,045	6,997		6,603	462	17,595



		2018	2019	2020	2021	2022	Avg <sup>1</sup>	Min <sup>1</sup>	Max <sup>1</sup>
USA <sup>2</sup>	<b>Discard</b>	5	4	7	5		87	4	186
	<b>Quota<sup>3</sup></b>	16,000	15,000	16,200	6,486	6,627			
	<b>Catch<sup>3</sup></b>	623	715	563	417				
	<b>Landed</b>	253	544	633	518		1,796	15	9,081
	<b>Discard</b>	20	50	50	6		450	0	7,561
Total <sup>2</sup>	<b>Quota<sup>4</sup></b>	40,000	30,000	30,000	14,100	14,100			
	<b>Catch<sup>4</sup></b>	12,844	14,875	11,615	7,418				
	<b>Catch<sup>5</sup></b>	12,495	14,754	11,735	7,526		8,864	2,150	23,344

<sup>1</sup> 1969-2021

<sup>2</sup> unless otherwise notes, all values are reported for the calendar year

<sup>3</sup> for fishing year from May 1<sup>st</sup>–April 30<sup>th</sup>

<sup>4</sup> for Canadian calendar year and USA fishing year May 1<sup>st</sup>–April 30<sup>th</sup>

<sup>5</sup> sum of Canadian landed, Canadian Discards, and USA catch (including discards)

### ***State of the Resource***

The state of the resource is based on the EGB Haddock model developed in the Haddock Research Track and approved by the peer review panel to be used by the TRAC for catch advice for EGB Haddock.

Significant changes in the resource have been a function of large year classes, with the 2013 year class sustaining the fishery since it recruited. Since then, subsequent year classes have been poor at contributing to the fishery. Density-dependent changes in growth have occurred and, presently, the contribution of the large 2013 year class to the stock is greatly diminished. As a consequence, overall stock size has been reduced. There is some evidence of a better than average 2020 year class, which is expected to recruit to the fishery in 2023.

Improved recruitment since 1990, lower exploitation, and reduced capture of small fish in the fisheries all contributed to the **SSB** increasing to 52,000 mt in 2003. A subsequent increase to 87,000 mt in 2009 was largely due to the strong 2003 year class estimated at 208 million age-1 fish. The biomass sharply decreased after the 2009 high and, in 2012, the SSB was 26,000 mt. When the strong 2010 and 2013 year classes joined the SSB group, SSB increased to 82,000 mt in 2016, followed by a sharp and continued decline in the subsequent years. The current SSB estimate for 2021 is 15,351 mt, which is below the median SSB of 25,235 mt for the time series (1969–2021).

**Recruitment** at age 1 has fluctuated between 1.6 and 69 million since 1990, except for the strong year classes. The 2003, 2010, and 2013 year classes were estimated at 209, 379, and 956 million. The preliminary estimate of the 2020 year class is 111 million. The median recruitment for the time series (1968–2020 year class) is 8.8 million.

Fully recruited **fishing mortality** fluctuated between 0.27 and 0.49 during the 1980s. After reaching a high of 0.59 in 1993, it decreased to 0.29 in 1995, stayed low until 2004–2006 when it increased to around 0.8, followed by a decline to 0.19 in 2008. Fishing mortality increased to higher levels between 0.33 and 0.73 from 2010–2019, and was estimated at 0.79 and 0.76 for 2020 and 2021, respectively. These are the highest values since 2006.

### ***Productivity***

Recruitment, **natural mortality**, **growth**, **age structure** and **spatial distribution** generally reflect changes in the productive potential. Recruitment has been highly variable. Higher recruitment tends to occur when SSB is above 20,000 mt. This stock has produced three exceptional and five strong year classes in the last 21 years. However, the Base model estimates a substantial increase in natural mortality from the historical assumed level of 0.2 to 0.516 over the last 12 years. The stock is leaving a period of unprecedented high biomass where density-dependent natural mortality

rate may have been exceptionally high and would not necessarily continue given a return to biomass levels more consistent with the historical average.

Both fishery and survey average lengths- and weights-at-age have declined considerably since 2000 with an increase in biomass. With density-dependent effects, changes in growth in response to changes in stock abundance and episodes of very strong recruitments have been observed throughout the history of this stock. With the sharp decrease in biomass in the last few years, some improvements of both haddock length- and weight-at-age have been observed in fishery and survey data, although the length- and weight-at-age are within the range observed during 2010–2019 (the High M period) for most ages. Despite different trends across seasons, there have been improvements in fish condition in the last three years for all three surveys.

Due to both high natural and fishing mortality in most recent years, the contribution of the exceptionally strong 2013 year class to the SSB and the 2023 fishery is expected to be very small. The 2021 DFO spring survey and the 2022 NMFS spring survey indicate that the EGB Haddock stock is mostly composed of younger and not fully mature fish in 2022. The spatial distribution patterns observed during these bottom trawl surveys are generally similar to the average patterns over the previous ten years. The 2021 NMFS fall survey was an exception to this, as age-0 and age-1 Haddock were mostly observed on the northern part of eastern Georges Bank.

The full quota for EGB Haddock has never been utilized in any year since 2004, when the TMGC began setting the Total Allowable Catch (TAC). In the past 10 years, between 27–53% of the TAC was realized. This is largely driven by lower USA catches (TRAC 2021) and the Canadian fleet-share arrangements. Considering the impact of the assumed 2022 EGB Haddock catch on 2023 catch advice at the proposed  $F_{ref}=0.367$ , the TRAC agreed to use 7,526 mt as the assumed 2022 catch in the projection. This 7,526 mt is the same as the 2021 catch and 53% of 2022 TAC.

Two scenarios of projection and risk evaluation with different assumptions on future M were reviewed at the 2022 TRAC meeting, Low M and High M. The Low M scenario assumes a return to  $M=0.2$  in 2022–2023. The High M ( $M=0.516$ ) scenario assumes that M in 2022–2023 M will stay the same as 2010–2021.

### ***Low M scenario***

Assuming a resumption to historical Low  $M=0.2$  in 2022–2024, Table 2 shows the median estimates of biomass, SSB, and F in 2022 based on 2,000 realizations of terminal year population sizes and an assumed catch of 7,526 mt. For 2023, the median biomass, SSB, and catch estimates are obtained by applying an  $F=0.367$  to each realization conditional on an assumed catch of 7,526 mt in 2022. The risk analysis in Figure 7 applies a similar logic to estimate the probability of exceeding  $F=0.367$  in 2023 given various catch levels ranging from 0 mt to 16,000 mt in steps of 1,000 mt. The levels of catch associated with 25%, 50%, and 75% of risk are estimated by linear

interpolation such that the catch associated with the 50% probability of overfishing differs slightly (0.5%) from the equivalent median catch for 2023 (4,601 mt) reported in Table 3.

The median SSB will increase from approximately 16,000 mt in 2022 to 29,000 mt in 2023, and to approximately 38,000 mt in 2024. In 2022,  $F=1.019$  from a catch of 7,526 mt (Table 3). The median catch at the proposed  $F_{ref}=0.367$  in 2023 is 4,601 mt. Population biomass is projected to increase in both 2023 and 2024 based on the Base model estimates when  $M$  is reduced to 0.2. The assumed higher survival of recruits in the projections (from 0.516 in model years to 0.2 in projection years) is largely responsible for the increase. The 2020 year class is projected to make the dominant contribution to fishery catch in 2023 due to the lack of older fish in the population and small partial recruitment of younger age groups.

*Table 3. Projection under Low M scenario with an assumption of 2022 fishery catch of 7,526 mt of Eastern Georges Bank Haddock (median value of 2000 simulations). The 0.5 mt difference of the 2022 median catch with the input Total Allowable Catch (TAC) of 7,526 mt is caused by the tolerance in openMSE to determine when the catch equals the TAC when solving for  $F$  in the simulations. This difference does not impact 2023 catch advice.*

Year	Recruitment	Biomass(mt)	SSB (mt)	Catch (mt)	F
2022	29,674	32,321	16,603	7,525.5	1.019
2023	20,334	43,997	28,840	4,601	0.367
2024		53,306	38,334		

A Low  $M$  scenario is used to provide a lower bound on  $M$ .

### **High $M$ scenario**

Assuming the  $M$  continues to be 0.516 in 2022–2024, Table 4 shows the median estimates of biomass, SSB and  $F$  in 2022 based on 2,000 realizations of terminal year population sizes and an assumed catch of 7,526 mt. For 2023, the median biomass, SSB, and catch estimates are obtained by applying an  $F=0.367$  to each realization conditional on an assumed catch of 7,526 mt in 2022. The risk analysis in Figure 8 applies a similar logic to estimate the probability of exceeding  $F=0.367$  in 2023 given various catch levels ranging from 0 mt to 16,000 mt in steps of 1,000 mt. The levels of catch associated with 25%, 50%, and 75% of risk are estimated by linear interpolation such that the catch associated with the 50% probability of overfishing (approximate value of 2,820 mt) differs slightly (1.2%) from the equivalent median catch for 2023 (2,784 mt) reported in Table 3.

The median SSB will increase from approximately 15,000 mt in 2022 to 19,000 mt in 2023 and remain at approximately 19,000 mt in 2024. The median catch at the proposed  $F_{ref}=0.367$  in 2023 is 2,784 mt. Fishing mortality in 2022 would be 1.213 from a catch of 7,526 mt (Table 3). Similar to the Low  $M$  scenario, the 2020 year class is projected to make the dominant contribution to fishery catch in 2023 due to the lack of older fish in the population and small partial recruitment of younger age groups (Figure 6).

*Table 4. Projection under High M scenario with an assumption of 2022 fishery catch of 7,526 mt of Eastern Georges Bank Haddock. The 0.5 mt difference of the 2022 median catch with the input Total Allowable Catch (TAC) of 7,526 mt is caused by the tolerance in openMSE to determine when the catch equals the TAC when solving for F in the simulations. This difference does not impact 2023 catch advice.*

Year	Recruitment	Biomass(mt)	SSB (mt)	Catch (mt)	F
2022	29,674	32,321	15,097	7,525.5	1.213
2023	20,334	32,440	19,048	2,784	0.367
2024		31,318	19,297		

The High M scenario is based on consistency with the Base model.

### ***Outlook and TRAC Advice***

Given the uncertainties of M in the near future, TRAC provided projections that were conducted under two different M scenarios: High M (2,784 mt) and the range of projected catch bounded by the High M and Low M scenarios (2,784 mt – 4,601 mt). The TRAC did not reach consensus on which scenario is more likely; however, the TRAC came to consensus that a decrease in catch advice is necessary, and that the Low M scenario only should not be used to provide catch advice in the short term. In the TSR for EGB haddock, TRAC presented two sets of rationale for catch advice based on projections using the High M only scenario (2,784 mt) and those using a range using the High M and Low M as bounds.

The stock abundance is expected to decrease from historical high in the next few years due to the exit of the strong 2013 year class from the stock and fishery. Density-dependent factors influencing EGB Haddock maturity, growth, and associated changes in fishery selectivity will be reduced. The 2021 NMFS fall survey and the 2022 DFO and NMFS spring surveys all suggest that the 2021 year class is the largest since 2013; however, the linear-model-predicted cohort strength predicts the 2021 class to be about a third of the 2013 year class.

### ***Special Considerations***

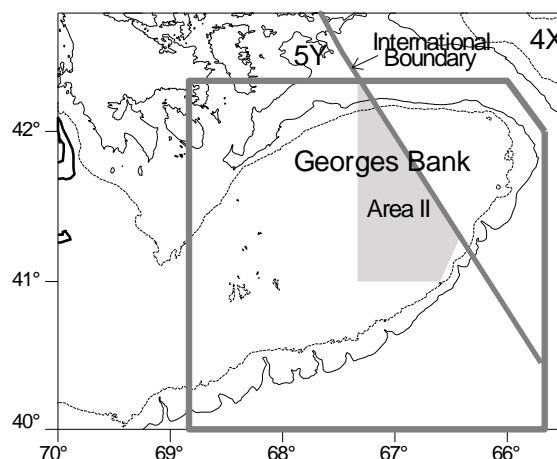
- As the Base model has its time period of M increase hard-wired into the model, a number of models with alternative M configurations were examined for the updated years (2020–2021). Despite the uncertainties of M in recent years, SSB estimated from all models shows a consistent trend over time with low values in 2021.
- The Base model used by TRAC was not supported by all members of the Haddock Research Track working group; see the Haddock Research Track Working Group report (*in prep*), or the Haddock Research Track Update by Brian Linton during TRAC 2022 (ten Brink and McIntyre 2022), for more details on points of non-consensus.

- The EGB and Georges Bank Haddock models developed in the Haddock Research Track are not consistent with each other and, as recommended by the Haddock Research Track peer review panel, future work to harmonize the models would be useful.

## Georges Bank Yellowtail Flounder [5Zhjmn; 522,525, 551, 552, 561, 562]

### Guidance

TMGC concluded that the most appropriate combined Canada/U.S. TAC for Georges Bank yellowtail for the 2023 fishing year is 200 mt. This TAC is a status quo TAC in relation to 2022. The TMGC agreed with the TRAC recommendation of 200 mt developed using the Limiter Tool. The declining trend in survey biomass to low levels, despite reductions in catch to historical low levels indicates a poor state of the resource. Available information suggests that current levels of catch are not the primary factor impacting stock rebuilding



Only aggregate landings and discards were available from the USA commercial fishery. The length and age composition information was not available for the 2020 or 2021 USA fishery. Full data from the 2022 DFO spring survey are not yet available pending the availability of a new vessel conversion factor.

Applying the allocation shares for 2023 entitles the U.S. to 53% and Canada to 47% of the TAC, resulting in a national quota of 106 mt for the U.S. and 94 mt for Canada.

### Harvest Strategy & Reference Points

The Transboundary Management Guidance Committee (TMGC) has adopted a strategy to maintain a low to neutral risk of exceeding the fishing mortality limit reference,  $F_{ref} = 0.25$  (established in 2002 by the TMGC). When stock conditions are poor, fishing mortality rates should be further reduced to promote rebuilding. However, due to the lack of an assessment model, an estimate of fishing mortality rate cannot be calculated. Status determination relative to reference points is not possible because reference points have not been defined for the Empirical or Limiter approaches.

### Fishery Exploitation

**Total catches** of Georges Bank Yellowtail Flounder peaked at about 21,000 mt in both 1969 and 1970. The combined Canada/USA catch increased from 1995 through 2001, averaged 6,300 mt during 2002–2004, but declined to 51 mt in 2021 due in part to restrictive management measures. The 2021 **Canadian catch** of 4 mt was 9% of the 45 mt quota, with landings of less than 1 mt and estimated discards of 4 mt from the sea scallop dredge fishery.



**USA catches** in calendar year 2021 were 47 mt, with landings of 1 mt and discards of 46 mt. The USA landings in calendar year 2021 were predominantly from the trawl fishery, while discards were predominantly from the scallop dredge fishery. Preliminary estimates of the USA catches (landings plus discards) for fishing year 2021 were 38% of the 80 mt quota.

*Table 5. Yellowtail Catches (mt)*

		2016	2017	2018	2019	2020	2021	2022	Avg <sup>1</sup>	Min <sup>1</sup>	Max <sup>1</sup>
<b>Canada<sup>2</sup></b>	<b>Quota</b>	85	93	87	34	42	45	78			
	<b>Landed</b>	1	<1	<1	<1	<1	<1		395	<1	2,913
	<b>Discard</b>	10	2	3	4	6	4		385	2	815
<b>USA<sup>2</sup></b>	<b>Quota<sup>3</sup></b>	269	207	213	106	120	80	122			
	<b>Catch<sup>3</sup></b>	26	84	40	5	8	48 <sup>4</sup>				
	<b>Landed</b>	26	35	32	3	5	<1 <sup>4</sup>		3,484	3	15,899
	<b>Discard</b>	7	57	11	2	56	47 <sup>4</sup>		479	2	3,021
<b>Total<sup>2</sup></b>	<b>Quota<sup>5</sup></b>	354	300	300	140	162	125	200			
	<b>Catch<sup>5</sup></b>	36	87	42	9	14	30 <sup>4</sup>				
	<b>Catch<sup>6</sup></b>	44	95	45	8	68	51 <sup>4</sup>		5,877	8	17,211

<sup>1</sup>1973 – 2021

<sup>2</sup> unless otherwise noted, all values reported are for calendar year

<sup>3</sup> for fishing year May 1 – April 30

<sup>4</sup> preliminary estimate

<sup>5</sup> for Canadian calendar year and USA fishing year May 1 – April 30

<sup>6</sup> sum of Canadian landed, Canadian discard, and USA catch (includes discards)

### ***State of Resource***

The declining trend in survey biomass to low levels, despite reductions in catch to historical low levels, indicates a poor state of the resource. Recent catch is low relative to the biomass estimated from the surveys, but catch curve analyses (Sinclair Z) indicate conflicting information between USA and Canadian surveys (Figure 3). However, the low catches in the survey in recent years make interpretation of the current relative F and survey Z difficult. Fishing does not appear to be a major driver of stock status currently.

### ***Productivity***

Recruitment, spatial distribution, and fish growth typically reflect changes in the productive potential. Recent recruitment has generally been below average and age structure is truncated (i.e., both fewer young fish and fewer old fish). Recent spatial distribution patterns from the bottom trawl surveys generally follow the ten-year average, although low survey catches make these comparisons difficult. Growth, as measured by length-at-age in the surveys, has been variable without trend, and condition (weight at length) has been average or poor recently, although low

survey catches makes interpreting these trends difficult. Stock biomass is low and productivity is poor.

### ***Outlook***

This outlook is provided in terms of agreements reached through a series of meetings of the TRAC and TMGC regarding the Empirical Approach and a Limiter Approach. Both the Empirical and Limiter approaches rely on average estimates of biomass from the Fisheries and Oceans Canada (DFO) survey, National Marine Fisheries Service (NMFS) spring, and NMFS fall surveys. The Empirical Approach applies an exploitation rate to this average to generate catch advice. The Limiter Approach sets constant catch advice as long as the average survey biomass remains within predetermined limits.

Findings this year show both positive and negative signals. The following is a positive signal: the relative  $F$  continues to be low. The negative signals are: biomass detected in both available surveys decreased; biomasses in the two available surveys (NMFS fall and NMFS spring) were the second lowest surveys in their respective time series; recent recruitment continues to be below average; and the abundance of age 6+ fish in both available surveys decreased.

USA landings estimates for 2020 and 2021 are from the newly implemented Catch Accounting and Monitoring System (CAMS). In addition, USA discard estimates for 2020 have been revised since the 2021 TRAC meeting. Observed trips in 2020 were processed and an updated discard estimate was calculated. As a result, scallop dredge fleet discard estimates for 2020 were higher than prior estimates reported in the 2021 TRAC meeting.

During 2011 to 2021, the catch has averaged 32% of the quota, ranging from 6% to 63%. The TRAC recognizes that catch has been well below the quota in recent years and expects this to continue in the future if current management measures continue and there is not a significant change in stock abundance or distribution. The TRAC recommends continued low exploitation to allow for the possibility of rebuilding.

At the 2020 TRAC meeting, the missing 2020 NMFS spring survey was shown to have little impact on the average survey biomass by examining previous years with and without the NMFS spring survey. At the 2021 TRAC meeting, the missing 2020 NMFS fall survey was shown to have a larger impact. Adjusting for the mean relative difference between the ten years with and without the NMFS fall survey leads to a 24% increase in average survey biomass and catch advice. At the same meeting and using the same methods, it was estimated that if the DFO survey was missing, average survey biomass and catch advice would decrease by 24%. The TRAC presents both the adjusted and non-adjusted values for comparison purposes to account for the missing 2022 DFO survey.

Prior to the application of the Limiter Approach, the Empirical Approach was used to provide catch advice. Application of the Empirical Approach, with the Miller et al. (2021) adjustment that incorporates tow-specific area swept, and an exploitation rate of 7%, results in catch of 105 mt for 2023. Adjusting for the missing DFO survey results in a reduced catch of 85 mt for 2023. This adjustment is based on a comparison between the average survey biomass estimated with all three surveys compared to estimates using only the DFO and NMFS spring survey, which showed an average relative difference of 24%. The adjustment factor is 0.807, which is derived from  $1/(1 + 0.24)$ .

Low catches and poor condition of the stock, along with a desire to stop chasing survey noise, led to the development of the Limiter Approach, a tool to help make the decisions regarding the constant catch advice and average survey biomass limits. This tool is an R Shiny app available at <https://github.com/cmlegault/limiter>.

The catch advice for 2023 was based on the Limiter Approach. The average survey biomass for 2022 was 1,500 mt, which is between the limits (lower limit: 1,000 mt; upper limit 7,300–8,500 mt). The average survey biomass for 2022 adjusted for the missing DFO survey was 1,211 mt, which is between the limits. Thus, TRAC recommends the constant catch advice of 200 mt.

### ***Special Considerations***

- Results from the most recent surveys are considered valid for use in the Empirical Approach despite the lack of a DFO 2022 survey (due to an absence of a catchability conversion factor to account for changes in survey vessel).
- Updated USA catch-at-age data were not available this year due to the transition to CAMS. These estimates are expected to be available for next year.
- Discard estimates in 2020 are uncertain due to lower observer coverage in semester two for the USA scallop dredge fleet.
- In 2022, the average survey biomass is near the lower bound of the Limiter Approach.
- While the NMFS surveys were adjusted for catchability based on Miller et al. (2021), the DFO survey was not adjusted since it uses a different gear configuration. It is possible that the DFO survey catchability estimate could be adjusted with further analysis.

### **Source Documents**

I.A. Andrushchenko, E.N. Brooks, and C.M. Legault. 2022. Update of Allocation Shares for Canada and the USA of the Transboundary Resource of Atlantic Cod, Haddock, and Yellowtail Flounder on Georges Bank Through Fishing Year 2023.

TRAC. 2022. Eastern Georges Bank Cod. TRAC Status Report 2022.

TRAC. 2022. Eastern Georges Bank Haddock. TRAC Status Report 2022.

TRAC. 2022. Georges Bank yellowtail flounder. TRAC Status Report 2022.

### **Consultations**

2022 TRAC meeting, Virtual Meeting, 12 - 14 July 2022.

TMGC public consultation in Canada, Hybrid from Yarmouth, Nova Scotia, 03 August 2022.

TMGC public consultation in the United States, Hybrid from Gloucester, MA , 29 August 2022.