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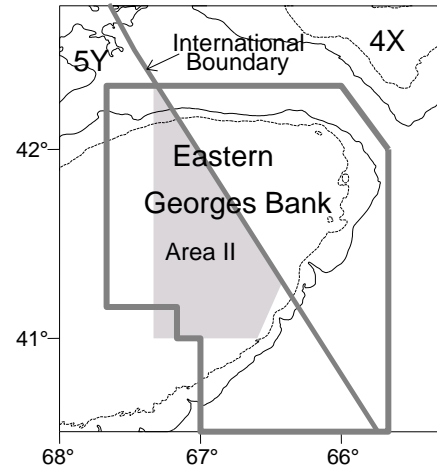NATIONAL MARINE FISHERIES SERVICE

Transboundary Resources Assessment Committee

Status Report 2019/##

EASTERN

GEORGES BANK

HADDOCK

[5Zjm; 551,552,561,562]

Summary

- **Combined Canada and USA catches** for Eastern Georges Bank (EGB) Haddock were 12,495 mt in 2018
- The 2018 and 2019 survey indices were above their respective means for the time series. In the most recent year, Fisheries and Oceans, Canada (DFO) and National Marine Fisheries Service (NMFS) fall indices decreased, while the NMFS spring index increased.
- The **population age structure** displays a broad representation of age groups, reflecting improving recruitment since 1995. The **spatial distribution** patterns observed during the most recent bottom trawl surveys were similar to the average patterns over the previous ten years.
- There are no indications of exceptional year classes coming into the population. There are preliminary indications of above average **recruitment** for 2016, although that observation is uncertain.
- There has been a general decline in **weights at age** since the late 1990s. As biomass has increased, growth rates and asymptotic length have declined. This decline in size at age is exacerbated for the 2013 year class.
- The assessment model was rejected, so there are no analytical projections to characterize risk for catches in 2020 and 2021. Survey and relative F trends, comparisons with the 2003 year class in 2009 (which is akin to the 2013 year class in 2019), and results from the 2012 virtual population analysis (VPA) are summarized in an attempt to relate current relative measures to analytical estimates from the last VPA with acceptable performance.
- Relative F tended to be above the mean during the earlier years of the time series until 1997 and has remained low since 2012.

Canada

July 2017

- The population is expected to decline from 2019 to 2020 and 2021 even if no catches are taken in 2020. This is primarily due to the decline in numbers of the 2013 year class, which is expected to have very little gains in weight from age 6 to 8.
- Although the population is still abundant, and well above the time series average survey biomass, maintaining a constant quota on a declining population (where catch is primarily coming from a single year class) would lead to an increasing trend in relative F. The uncertain availability, combined with weights at age being the lowest observed for the 2013 year class, argue against the status quo quota.
- The Transboundary Resources Assessment Committee (TRAC) recommends no increase in quota in 2020 above the 2019 quota of 30,000 mt, but recommends a decrease in quota in 2021. There is no consensus on whether to decrease quota in 2020.
- For guidance on a potentially reasonable range of quota advice, the Transboundary Management Guidance Committee (TMGC) could consider the quota advice for the 2003 year class in 2009-2011, as a starting point.

TRAC Review Process

In the interest of transparency and in order to avoid any perceived conflict of interest, in 2017 the Transboundary Resources Assessment Committee (TRAC) introduced a new process of review for Eastern Georges Bank Cod and Haddock and Georges Bank Yellowtail Flounder. An overview of the entire process is available at https://www.nefsc.noaa.gov/saw/trac/trac-process-overview-2017.pdf.

Table 1. Catches, Survey Biomass Index (thousands mt) and relative fishing mortality of haddock.

		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Avg[1]	Min[1]	Max[1]
Canada[2]	**Quota**	15	18.9	17.6	12.5	9.1	6.4	16.5	19.2	21.8	20.5	24.0				
	Landed	14.8	17.6	16.6	11.2	5	4.6	13	14.6	11.9	13.4	12.2		6.4	0.5	17.6
	Discard	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		0.1	<0.1	0.2
USA[2]	**Quota[3]**	8.1	11.1	12	9.5	6.9	4	10.5	17.8	15.2	29.5	16.0				
	Catch[3]	1.6	1.6	1.8	1.1	0.4	0.64	1.3	1.9	0.5	0.4	0.6				
	Landed	1.1	2.2	2.2	1.3	0.4	0.3	1.2	1.5	0.3	0.2	0.3		1.9	<0.1	9.1
	Discard	0.1	0.1	<0.1	0.1	0.1	0.1	0.1	0.4	0.1	<0.1	<0.1		0.5	0.0	7.6
Total[2]	**Quota[3]**	23	30	29.6	22	16	10.4	27	37	37	50.0	40.0	30.0			
	Catch[5,6]	16.5	19.2	18.4	12.3	5.5	5.2	14.3	16.5	12.4	13.9	12.5				
	Catch	16	19.9	18.8	12.7	5.6	5.1	14.2	16.1	12.4	13.7	12.9		8.7	2.1	23.3
Avg Survey Biomass Index[6]		74.4	54.3	50.8	33.4	59.7	90.7	76.1	138.0	176.3	104.8	65.7	62.0	34.8[8]	3.3[8]	176.3[8]
Relative F[7]		0.6	0.9	1.0	1.2	0.3	0.2	0.6	0.3	0.2	0.4	0.5		1.0	0.2	3.8

[1] 1969-2018

[2] unless otherwise noted, all values are reported for the calendar year

[3] for fishing year from May 1st – April 30th

[4] for Canadian calendar year and USA fishing year May 1st-April 30th

[5] sum of Canadian landed, Canadian Discards, and USA catch (including discards)

[6] Average survey biomass index for NMFS Spring, DFO and the NMFS fall from the previous year (not adjusted for catchability)

[7] Relative fishing mortality; The standardized average (1987-2018) of the annual catch divided by the biomass index for each of the three survey indices (DFO, NMFS spring and fall).

[8] 1969-2019

Fishery

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 about 3,000 mt and 4,000 mt until 1999, and increased to 15,257 mt in 2005 (Figure 1). Combined catches then decreased to 12,510 mt in 2007, increased to 19,855 mt in 2009, decreased from 2010 to 2013 with higher catches from 2014 to 2018 and a total catch of 12,495 mt in 2018 (Table 1).

The **Canadian catch** decreased from 13,384 mt in 2017 to 12,222 mt in 2018. Discards in the groundfish fishery are considered to be negligible. Discards of haddock by the Canadian sea scallop fishery were 5 mt in 2018 but ranged between 5 mt and 186 mt over the time series.

USA catches decreased from 295 mt in 2017 to 274 mt in 2018. Landings in 2018 were 253 mt and discards were estimated to be 21 mt, primarily from the otter trawl fishery with a small amount from the scallop dredge fishery (0.1 mt).

The combined Canada and USA **fishery age composition** (landings + discards) in 2018 was dominated by the 2013 (age 5) year class by numbers and weight. Both the Canadian and the USA fisheries were adequately sampled to determine length composition of the catch.

Harvest Strategy and Reference Points

The Transboundary Management Guidance Committee (TMGC) has adopted a strategy to maintain a low to neutral risk of exceeding the fishing mortality reference, $F_{ref} = 0.26$ (established in 2002 by the TMGC). When stock conditions are poor, fishing mortality rates should be further reduced to promote rebuilding. Due to the lack of an assessment model, an estimate of fishing mortality rate can no longer be calculated. Status determination relative to reference points is not possible because reference points have not been defined. Relative F (Catch/Average survey biomass) is shown instead of fishing mortality rates, but it is noted that the two measures are not comparable.

State of Resource

The 2018 and 2019 survey indices were above their respective means for the time series. In the most recent year, Fisheries and Oceans, Canada (DFO) and National Marine Fisheries Service (NMFS) fall indices decreased (16% from 2018 to 2019 for the DFO survey and 27% from 2017 to 2018 for the NMFS fall survey), while the NMFS spring index increased by 35% from 2018 to 2019 (Figure 2).

In the past the evaluation of the state of the resource was based on results from an age structured analytical assessment (Virtual Population Analysis, VPA). In 2019, the TRAC agreed that the assessment model is not able to provide reliable advice on current abundance nor is it able to provide reliable advice for catch due. The retrospective pattern, which first emerged in 2014, increased each year and became extreme in 2019, implying abundance had to be scaled down to about 1/3 of the initial estimated value. In addition, fits to the indices were poor, displaying consecutive years where nearly all ages were overestimated or underestimated. Furthermore, there was increased uncertainty in the data at age going in to the model. The increased uncertainty is due to the less abundant year classes on either side of the 2013 year class having complete overlap in length distributions, which results in "smearing" of the 2013 age class into adjacent ages when an age length key is applied to those lengths. Due to the VPA's poor performance, and increased

uncertainty in the age-specific data, survey biomass and total catch are summarized to describe the state of the resource, rather than results from the rejected model.

Average survey biomass is well above (30-40% higher in 2018-2019) the time series mean. The 2013 year class remains the largest observed in the entire survey time series, but two out of 3 surveys declined in the most recent year, and further decline is expected in the immediate future as the large 2013 year class declines in number.

Relative fishing mortality (F) (catch/survey biomass not adjusted for catchability) was calculated individually for each of the surveys and then an annual average relative fishing mortality was calculated using the DFO and NMFS Spring surveys and the NMFS Fall survey in the previous year, 1987-2018 (Figure 5). Relative F tended to be above the mean during the earlier years of the time series until 1997 and has remained low since 2012.

Productivity

Recruitment, as well as age structure, spatial distribution, and fish growth reflect changes in the productive potential. Recruitment, while highly variable, has generally been higher when adult biomass has been above 40,000 mt, and the stock has produced several exceptionally strong year classes in the last 16 years. There are no indications of exceptional year classes coming into the population (2000-2018 numbers at age from NMFS Fall survey in Figure 3). There are preliminary indications of above average recruitment for 2016 (Figure 3), although that observation is uncertain. The **population age structure** displays a broad representation of age groups, reflecting improving recruitment since 1995. The **spatial distribution** patterns observed during the most recent bottom trawl surveys were similar to the average patterns over the previous ten years.

There has been a general decline in weights at age since the late 1990s. As biomass has increased, growth rates and asymptotic length have declined. This decline in size at age is exacerbated for the 2013 year class (Figure 4). Fish condition, as measured by Fulton's K, has generally been below the time series average since 2004 for DFO and NMFS spring surveys. In 2018 (NMFS Fall) and 2019 (NMFS Spring) the condition increased above the time series mean; in 2019, condition in the DFO survey increased but remained below the time series average.

Outlook and TRAC Advice

The assessment model was rejected, so there are no analytical projections to characterize risk for catches in 2020 and 2021. Instead, survey and relative F trends, and comparisons with the 2003 year class in 2009 (which is akin to the 2013 year class in 2019) are provided (Table 2). In addition to these model-free summaries, results from the 2012 VPA are summarized in an attempt to relate current relative measures to analytical estimates from the last VPA with acceptable performance (Table 2). Model-free observations about the population status and reasons to adjust future quotas are summarized in Table 3.

The population is expected to decline from 2019 to 2020 and 2021 even if no catches are taken in 2020. This is primarily due to the decline in numbers of the 2013 year class, which is expected to have very little gains in weight from age 6 to 8. Providing quota advice for 2020 and 2021 is challenging with no analytical model. With a quota of 30,000 mt for 2019, the TRAC agreed that quota in 2020 and 2021 should not be increased. Two alternatives for catch advice are to maintain

status quo, or to decrease quota. Although the population is still abundant, and well above the time series average survey biomass (30-40% higher in 2018 and 2019), maintaining a constant quota on a declining population (where catch is primarily coming from a single year class) would lead to an increasing trend in relative F. Furthermore, the availability of the 2013 year class to the fishery at those older ages is uncertain, due to indications of low availability to the fishery beyond age 8 (observations from VPAs over the last decade). The uncertain availability, combined with weights at age being the lowest observed for the 2013 year class, argue against a status quo quota.

The remaining alternative is to decrease 2020 and 2021 quota advice from the 2019 quota of 30,000 mt. The TRAC recommends no increase in quota in 2020 above the 2019 quota of 30,000 mt, but recommends a decrease in quota in 2021. There is no consensus on whether to decrease quota in 2020. For guidance on a potentially reasonable range of quota advice, the TMGC could consider the quota advice for the 2003 year class in 2009-2011, as a starting point. Average survey biomass in 2009 (54,254 mt, Table 2) is of similar magnitude to the 2019 average survey biomass (62,041 mt), and it might be expected to see a similar biomass trend as the 2013 year class declines with age and moves towards the plus group (ages 9 and older). The quotas set in 2010-2011 pre-date the appearance of the VPA retrospective pattern, suggesting that the scale of those quotas was probably appropriate. The catches removed in 2009-2011 are estimated to have been below F_{ref} (0.26), and even if the full quota had been removed then the F would have ranged from 0.19 to 0.27.

While Table 2 reports 2010-2011 quotas, which could inform 2020-2021 quotas, the TRAC agrees that second year quota advice (2021) should be revisited in the 2020 TRAC. Weights at age and survey trends, as well as relative F from 2019, could provide information on the appropriateness of the second year quota. As a point of comparison, the relative F in 2009-2011 ranged from 0.94-1.20, and may be useful context when relative F for 2019 catch is calculated at the next TRAC meeting.

Table 2. Information from the 2012 VPA (yellow highlighted cells in years 2009-2011) and the 2019 average survey biomass. The 2012 VPA is the last model iteration that had no retrospective pattern, and provides a measure of scale between average survey biomass (AvgSurvB) and VPA estimated 3+ biomass (B), and between VPA estimates of F on ages 5 though 8 (F5-8) corresponding to catch removed from the average survey biomass (Rel.F). In the final column, F5-8 is scaled by the ratio of quota/catch (Q/C) to estimate what F might have been if the full quota had been caught. *Indicates values that will be filled in at TRAC2020 and ** will be filled in after TMGC 2019.

Year	F5-8	Rel. F	B	AvgSurvB	Catch	Quota	Quota/Catch	F*Q/C
2009	0.12	0.94	132,500	54,250	19,855	30,000	1.51	0.19
2010	0.15	0.99	102,000	50,800	18,794	29,600	1.57	0.24
2011	0.15	1.20	75,000	33,400	12,656	22,000	1.74	0.27
2019		*		62,000	*	30,000		
2020				*		**		
2021						**		

Table 3. Summary of positive and negative considerations of the haddock population that may inform quota advice for 2020-2021.

Positive considerations	Negative considerations
The 2013 year class is still the largest ever observed in the time series	The very large 2010 year class is in the 9+ group in 2019. Availability to the fishery of the 2010 year class is likely to be low, and it is therefore not expected to contribute much to future catch.
The average survey biomass is well above the time series average	Even if no catch were taken in 2020, biomass is projected to decline
Preliminary indication of above average recruitment for 2016 (length frequency and fishery and survey catch at age), although that observation is uncertain; it also would not contribute to very much to catch in 2020 at age 4 as that age is not fully selected to the fishery.	Weights at age are the lowest observed for the 2013 year class, and slow growth is expected to continue for the projection years.
	Availability to the fishery is very uncertain for the 2013 year class at age 7 in 2020 or age 8 in 2021; reduced availability at older ages has been indicated in many of the recent VPAs

Special Considerations
- The VPA assessment was rejected for provision of advice this year. This limited the TRAC's ability to provide analytically based quota advice and risk characterization.
- In the absence of an analytical model, uncertainty about the quota and the absolute scale of the population is very high.
- TMGC has set haddock quota since 2004, but the full quota has never been taken in any year. From 2009-2011, 66%, 63%, and 58% of the quota was caught. Since then, the fraction of quota caught has ranged from 31% (2018) to 53% (2014).
- If TMGC recommends 2 year advice, the TRAC recommends evaluating the appropriateness of 2021 quota by comparing relative F values, weights at age, and survey trends at TRAC 2020.
- A presentation at the TRAC (Clark and Trinko-Lake, 2019) investigated growth in haddock and found strong indications of density dependent growth.

Source Documents

L. Van Eeckhaute, E. N. Brooks and S. Christine Hansen. 2012. Assessment of Eastern Georges Bank Haddock for 2012. TRAC Reference Document 2012/06.

Clark, K.J, and E.N. Brooks, editors. 2017. Proceedings of the Transboundary Resources Assessment Committee (TRAC): Eastern Georges Bank Cod and Haddock, and Georges Bank Yellowtail Flounder: Report of Meeting held 11-14 July 2017. TRAC Proceedings 2017/01.

Clark, K.J, and T. Trinko-Lake, editors. 2019. Proceedings of the Transboundary Resources Assessment Committee (TRAC): Eastern Georges Bank Cod and Haddock, and Georges Bank Yellowtail Flounder: Report of Meeting held 9-11 July 2019. TRAC Proceedings 2019/01.

Legault, C.M., L. Alade and H.H. Stone. 2010. Stock Assessment of Georges Bank (5Zjmnh) Yellowtail Flounder for 2010. TRAC Reference Document 2010/06.

Barrett, M.A., E.N. Brooks,. and Y. Wang. 2017. Assessment of Haddock on Eastern Georges Bank for 2017. TRAC Reference Document 2017/02.

Correct Citation

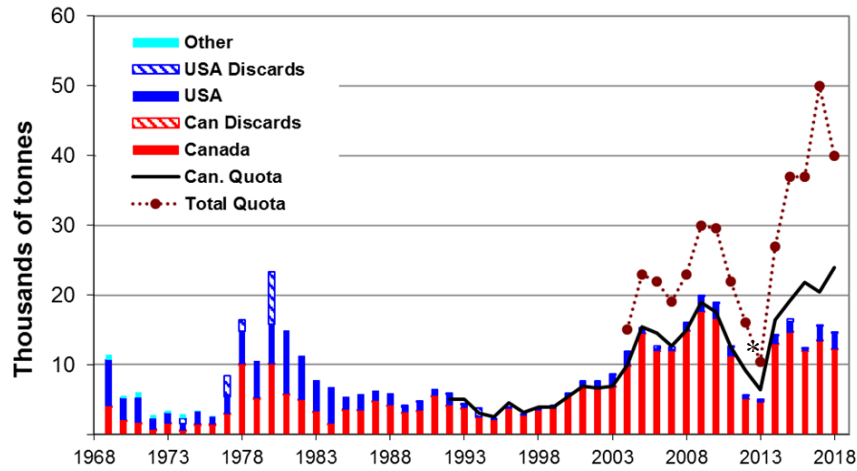TRAC. 2019. Eastern Georges Bank Haddock. TRAC Status Report 2019/##.

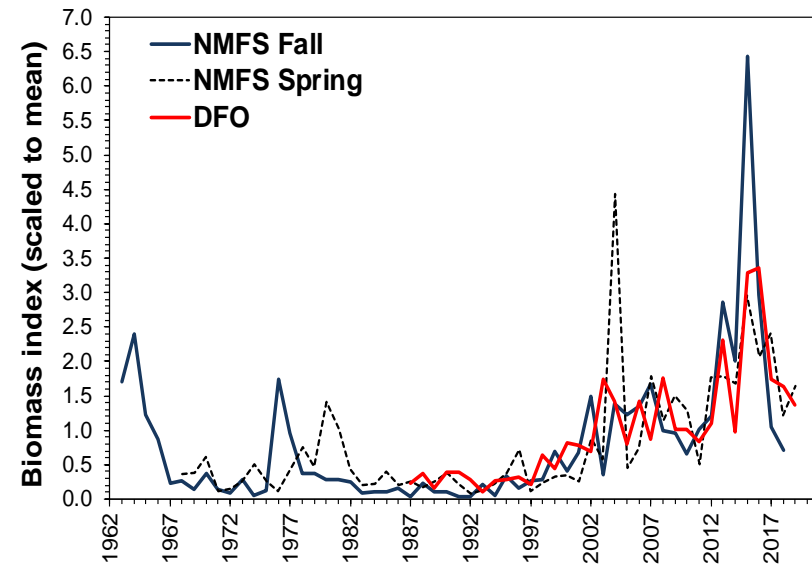*Figure 1. Catches and quota for Eastern Georges Bank (EGB) haddock.*

Figure 2. Scaled total biomass indices from research surveys for EGB haddock. Indices are not adjusted by catchability.
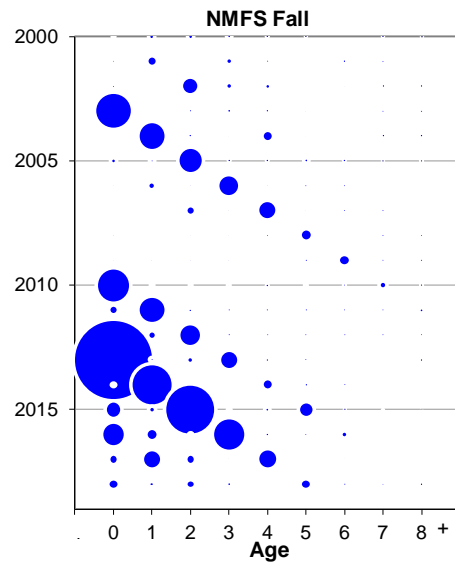
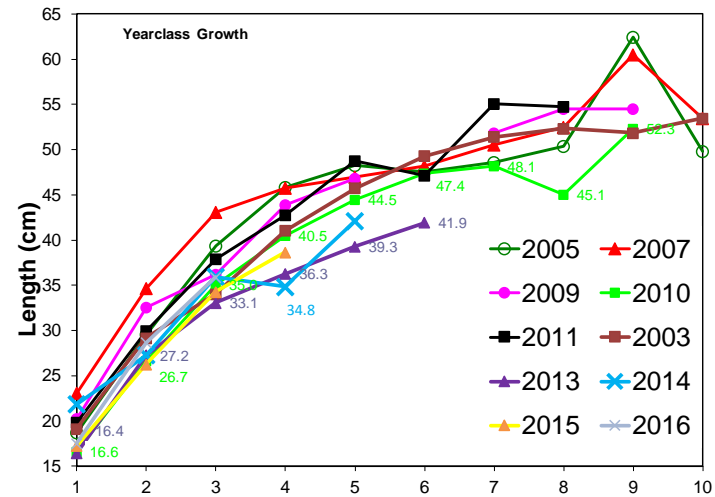*Figure 3. Fall survey catch at age in numbers for EGB haddock, 2000-2018.*

Figure 4. Mean length at age for selected year classes of EGB haddock sampled from the DFO survey.
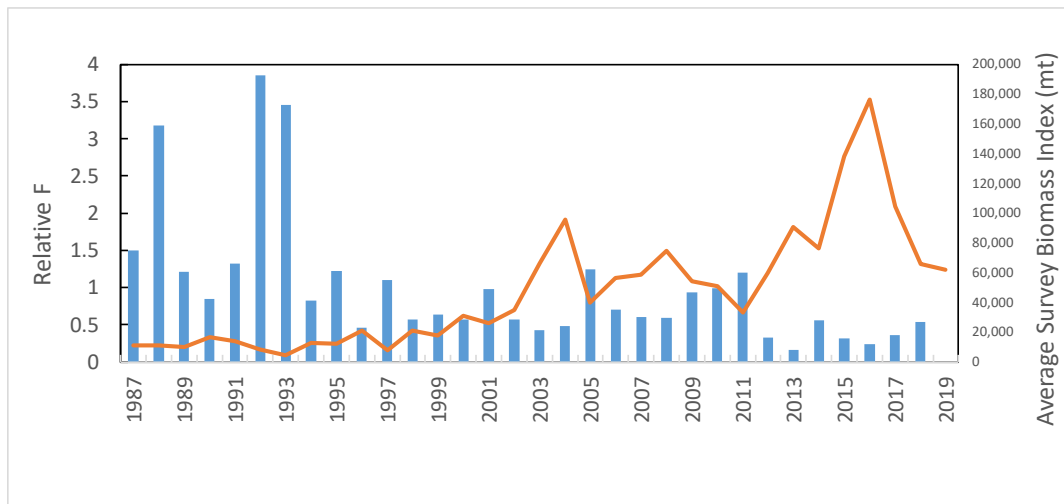

Figure 5. Relative fishing mortality (bars) and average survey biomass (solid line).