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 the TMGC's guidance to both countries for the 2018 fishing year (calendar year for Canada; May 1, 2018, through April 30, 2019, for the United States). Pertinent reference documents and consultations used in the TMGC deliberations are listed at the end of this document.

Since inception, the 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. The benefits of this approach are worth noting: fishing mortality rates for the three management units considered by the TMGC have been reduced and Eastern Georges Bank haddock is at record high abundance.

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.

In 2017, the Transboundary Resource 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 proposed process is available at https://www.nefsc.noaa.gov/saw/trac/trac-process-overview-2017.pdf. The process in 2017 diverged slightly from the proposed process and is described in the TRAC Status Reports. The TMGC and TRAC both felt it was an improvement and will continue to refine the process.

September 2017

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

Guidance

The TMGC concluded that the most appropriate combined Canada/U.S. Total Allowable Catch (TAC) for Eastern Georges Bank cod for the 2018 fishing year is 951 mt. The status of the stock remains poor, however there has been recent improvement in survey indices. Accordingly, the TMGC sought to balance the utilization of other species while continuing to promote biomass growth. This catch reflects a reduction from the VPA low-risk (25%) of exceeding F_{ref}, recognizing that VPA projected catches are likely to be optimistically high based on recent years model performance, and a desire to allow the 2013 year class to have future spawning opportunities. Due to model performance issues in recent years, the 2017 TRAC updated the empirical approach developed in the 2016 TRAC to provide additional guidance on TAC setting. A 2018 TAC of 951 mt is less than the lower bound of the confidence intervals for the empirical approach and results in projected biomass growth in the VPA model formulation, while the consequence analysis ASAP model formulation resulted in a projected decline in biomass for 2019. With respect to the TMGC harvest strategy, a 2018 TAC of 951 mt is expected to result in a fishing mortality rate (F) below the fishing mortality reference point (0.11) based on the benchmark model, and is lower than the results of the empirical approach to address potential instability in the terminal year estimate. The annual allocation shares between countries for 2018 are based on a combination of historical catches (10% weighting) and resource distribution based on trawl surveys (90% weighting). Combining these factors entitles the United States to 27% and Canada to 73% of the TAC, resulting in a national quota of 257 mt for the United States and 694 mt for Canada.
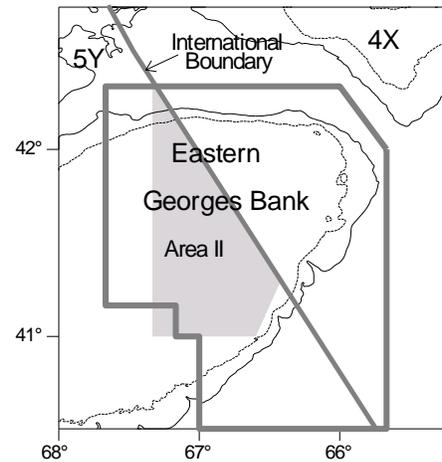
Harvest Strategy & Reference Points

The strategy is to maintain a low to neutral risk of exceeding the fishing mortality limit reference, $F_{ref} = 0.18$. When stock conditions are poor, fishing mortality rates should be further reduced to promote rebuilding.

At the 2013 cod benchmark assessment, the TRAC agreed that the current $F_{ref} = 0.18$ is not consistent with the VPA "M 0.8" model given that it was derived with an assumption of natural mortality (M) = 0.2 in the assessment. Based on analyses presented at the 2014 TRAC, the TMGC agreed that F = 0.11 is an appropriate fishing reference point to use for providing catch advice based on the VPA "M 0.8" model.

Fishery Exploitation

Combined Canada/U.S. catches in 2016 were 537 mt, which included 17 mt of discards, with a quota of 625 mt. 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.

Catches and Biomass (thousands mt); Recruits (millions)

		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Avg[1]	Min[1]	Max[1]
Canada[9]	Quota	1.6	1.2	1.0	0.9	0.5	0.5	0.5	0.5	0.5	0.6			
	Catch	1.5	1.2	0.8	0.7	0.5	0.4	0.5	0.5	0.4		5.2	0.4	17.9
	Landed	1.4	1.0	0.7	0.7	0.4	0.4	0.4	0.5	0.4		5.1	0.4	17.8
	Discard	0.1	0.2	0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1	0.4
USA[9]	Quota[2]	0.7	0.5	0.3	0.2	0.2	0.1	0.2	0.1	0.1	0.1			
	Catch[2]	0.5	0.5	0.3	0.2	<0.1	<0.1	0.1	0.1	<0.1				
	Landed	0.2	0.4	0.4	0.3	0.1	<0.1	<0.1	<0.1	<0.1		3.2	<0.1	10.6
	Discard	<0.1	0.2	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1	0.3
Total[9]	Quota	2.3	1.7	1.3	1.1	0.7	0.6	0.7	0.7	0.6	0.7			
	Catch[3,4]	2.0	1.7	1.1	0.9	0.5	0.4	0.5	0.6	0.5				
	Catch	1.7	1.8	1.3	1.0	0.6	0.4	0.6	0.6	0.5		8.5	0.5	26.5
From "M 0.8" model														
Adult Biomass[5]		8.3	9.4	7.4	6.0	5.0	6.0	7.6	8.1	12.5	13.9	25.2	5.9	59.7
Age 1 Recruits		0.5	1.1	1.2	3.2	1.7	0.8	6.0	2.6	0.3		5.6	0.5	24.1
Fishing mortality[6]		0.26	0.17	0.21	0.26	0.14	0.08	0.06	0.06	0.05		0.33	0.05	0.66
Exploitation Rate[7]		21%	18%	23%	51%	44%	6%	6%	6%	7%		26%	6%	44%
Exploitation Rate[8]		22%	24%	23%	17%	11%	32%	11%	5%	1%		23%	1%	46%

[1]1978-2016
[2]for fishing year from May 1st - April 30th
[3]for Canadian calendar year and USA fishing year May 1st - April 30th
[4]sum of Canadian landed, Canadian discard, and USA catch (includes discards)
[5]Jan 1 ages 3+
[6]ages 4-9
[7]ages 4-5; M=0.2
[8]ages 6-8; M=0.8
[9] unless otherwise noted, all values reported are for calendar year

State of Resource

Survey biomass indices increased for all three surveys, while recruitment has been poor for the last 25 years. Relative fishing mortality (F) has declined since 1995, although total mortality from all sources (Z) has remained high.

Evaluation of the state of the resource was based on results from an age structured analytical assessment (i.e., VPA "M 0.8" model), which used fishery catch statistics and sampling for size and age composition of the catch for 1978 to 2016 (including discards). The VPA was calibrated to trends in abundance from three research bottom trawl survey series: DFO, NMFS spring, and NMFS fall. A statistical catch at age model (ASAP), which uses the same data as the VPA, was also examined. In addition, a suite of indicators derived solely from survey and fishery data were updated.

At the 2013 benchmark review, there was no consensus on an assessment model; however, it was agreed that the VPA "M 0.8" model would be used to provide catch advice (Claytor and O'Brien, 2013). Natural mortality (M) was fixed at 0.2 for all the ages in all years, except for ages 6 and older in years after 1994, where M=0.8. The scale of the values were much lower for the ASAP results, although the trend was comparable.

The estimated adult population biomass at the beginning of 2017 from the VPA "M 0.8" model was 13,944 mt, which was about 25% of the adult biomass at the start of the time series in 1978.

Recruitment at age 1 has been low in recent years, but the 2013 year class estimated from the VPA "0.8" model at 6 million fish shows the highest estimated recruitment since 1990. The current estimate of the 2015 year class from the VPA "M 0.8" model is 0.3 million fish at age 1 which is the lowest recruitment estimate on record, although survey and model estimates are highly uncertain.

Fishing mortality (population weighted average of ages 4-9) in 2016 was estimated from the VPA "M 0.8" model to be 0.05. In recent years, ages 6+ are not fully selected to the fishery. As a result, this average F_{4-9} does not reflect exploitation on fully recruited ages. In 2016, ages 3 and 4 were fully recruited, with F values of 0.03 and 0.11, respectively. Consequently, the average F on ages 4-9 cannot be directly compared to the model reference F=0.11, so it is difficult to conclude whether a low risk of exceeding F=0.11 is being achieved.

Productivity
Recruitment, age structure, fish growth (as measured by length and weight at age), and spatial distribution typically reflect changes in productive potential. The current biomass is well below the threshold where higher recruitment is observed. The population age structure displays a low proportion of ages 7+ compared to the 1980s. However, the 2013 year class at 6 million fish is the highest recruitment estimate since 1990 and is expected to be the predominant year class in the catch until 2020. Average weight at length, used to reflect condition, declined throughout the time series, but has started to show improvement since 2009. The survey weight at age has been declining since the 1990s. Lower weights at age in the population in recent years, a truncated age structure, poor recruitment, and high total mortality have contributed to the lack of rebuilding. The research survey spatial distribution patterns of adult (3+) cod have not changed over the past decade.

Outlook
This outlook is provided in terms of consequences with respect to the harvest reference points for alternative catch quotas in 2018. Three assessment methodologies were used to generate 2018 catch advice.

Benchmark Formulation (VPA "M 0.8" model)
In 2018, a 50% risk of not exceeding F=0.11 corresponds to catches less than 1,558 mt, and a lower (25%) risk of not exceeding F=0.11 corresponds to catches less than 1,288 mt.

Probability of exceeding F = 0.11	**25%**	**50%**	**75%**
2018 Catch	1,288 mt	1,558 mt	1,854 mt

Consequence Analysis

A consequence analysis was examined to understand the risks associated with assumptions of the VPA "M 0.8" and ASAP "M 0.2" models (reviewed at the 2013 cod benchmark assessment). Natural mortality is assumed to be higher for age 6+ in the VPA (M=0.8) since 1994 compared to M=0.2 for all ages in the ASAP model. Comparison of the 2017 assessment results of the two models indicates that biomass (ages 3+) is estimated to be higher in the VPA, in contrast to the ASAP model that estimated lower biomass. The consequence analysis estimated the projected catch at F_{ref} (0.18) and F = 0.11 as if each model represented the true state of the resource and examined the consequences to expected biomass under alternative model assumptions.

		VPA "M 0.8"	ASAP "M 0.2"
Catch 2016		537 mt	537 mt
Quota 2017		730 mt	730 mt
2017 Biomass (3+)		12,433 mt	2,433 mt
2018 Biomass (3+)		13,944 mt	2,285 mt
2018 Catch/Model Assumption			
1,270 mt	2018 F	0.11	0.68
(VPA F = 0.11)	2019 Biomass (mt)	14,169	1,369
	% change in biomass from 2018	2%	-40%
412 mt	2018 F	0.04	0.18
(ASAP F = 0.18)	2019 Biomass (mt)	14,964	2,140
	% change in biomass from 2018	7%	-6%

Empirical Approach

The empirical approach method was developed to provide quota advice independently of the two models. The method adjusts recent quotas by recent population biomass trends derived from fitting the average of the three surveys (DFO spring, NMFS spring, NMFS fall) to a *loess* smoother. This method is essentially a constant exploitation approach, which relies on recent quotas (2014-2016).

Quota advice (mt) resulting from application of the empirical approach method, where recent average quota (658 mt) is multiplied by the most recent 3-year average biomass trend, is shown below. The percentiles (50% = median) reflect the probability that the true average 3-year trend is within a given bound, rather than risk. For example, between 5% and 95%, the true average 3-year trend will fall within these bounds 90% of the time.

5%	25%	50%	75%	95%
1002	1133	1156	1164	1168

TRAC Advice

The TRAC recommends catch advice in the range of 730 mt to 900 mt for 2018. In order to provide a range of catch advice, the TRAC considered all three model results, risk projections, retrospective patterns and projection performance, as well as biological signals.

Due to the presence of the stronger 2013 year class and the increase in biomass for all three surveys in the most recent year, the TRAC reached consensus that there was no reason to recommend reducing catch advice below the 2017 quota; therefore, it was agreed that 730 mt was an appropriate lower bound for the 2018 catch advice.

The TRAC recommends an upper bound of 900 mt (23% increase). This reflects a reduction from the VPA F_{ref}, which is consistent with the TMGC Harvest Strategy, and recognizes the potential that 2018 VPA projected catches are likely to be optimistically high.

Special Considerations

The consequence analysis reflects the uncertainties in the assessment model assumptions. Despite these uncertainties, all assessment results, and all biological and fishery indicators, suggest that low catches are needed to promote rebuilding.

Performance of the VPA and ASAP for EGB Cod was poor and seemed to be getting worse with time with regard to model diagnostics. Some of the diagnostic issues were poor fits to the survey data and significant retrospective patterns in biomass, fishing mortality, and recruitment, indicating an undiagnosed misspecification in the model. The VPA and ASAP modeling approaches are becoming increasingly unreliable for providing management advice.

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

Guidance

The TMGC concluded that the most appropriate combined Canada/U.S. TAC for Eastern Georges Bank haddock for the 2018 fishing year is 40,000 mt, representing a value below the low risk (25%) of exceeding F_{ref} using the VPA and below the neutral risk (50%) of exceeding F_{ref} in the sensitivity analysis accounting for past model overestimation of biomass. Although model projections show a decrease in biomass in upcoming years, biomass is expected to remain high. Analyses provided by TRAC suggest that while there have been changes in growth and selectivity since the last benchmark, the F_{ref} is more conservative than when originally negotiated and remains relevant. This quota represents a 10,000 mt reduction compared to the 2017 TAC and addresses concerns around the growth of the 2013 year class and the request from industry for stability in inter-annual TACs. The TMGC also agreed that since the TRAC provided two-year catch advice, and given uncertainties surrounding model performance and the request for stability, the TMGC recommends that 40,000 mt be used as an upper bound when determining 2019 catch advice. The annual allocation shares between countries for 2018 are based on a combination of historical catches (10% weighting) and resource distribution based on trawl surveys (90% weighting). Combining these factors entitles the U.S. to 39% and Canada to 61% of the TAC, resulting in a national quota of 15,600 mt for the U.S. and 24,400 mt for Canada.
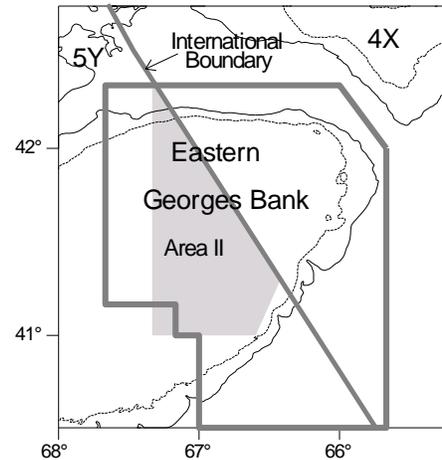
Harvest Strategy & Reference Points

The strategy is to maintain a low to neutral risk of exceeding the fishing mortality limit reference, $F_{ref} = 0.26$. When stock conditions are poor, fishing mortality rates should be further reduced to promote rebuilding. In recent years, substantial fish growth changes and changes in fishery management measures led to concerns whether the F_{ref} is still reflective of the current fishery, and analyses provided by TRAC suggest that the F_{ref} is more conservative than when originally negotiated and remains relevant.

Fishery Exploitation

Combined Canada and USA catches 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. 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 2016 and a total catch of 12,409 mt in 2016.

Catches and Biomass (thousands mt); Recruits (millions)

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Avg[1]	Min[1]	Max[1]
Canada[2]	**Quota**	14.5	12.7	15.0	18.9	17.6	12.5	9.1	6.4	16.5	19.2	21.8	20.5			
	Landed	12.0	11.9	14.8	17.6	16.6	11.2	5.0	4.6	13.0	14.6	11.9		6.1	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]	7.5	6.3	8.1	11.1	12.0	9.5	6.9	4.0	10.5	17.8	15.2	29.5			
	Catch[3]	0.7	0.3	1.6	1.6	1.8	1.1	0.4	0.6[4]	1.3	1.9	0.5				
	Landed	0.3	0.3	1.1	2.2	2.2	1.3	0.4	0.3	1.2	1.5	0.3		1.9	<0.1	9.1
	Discard	0.3	0.3	0.1	0.1	<0.1	0.1	0.1	0.1	0.1	0.4	0.1		0.5	0.0	7.6
Total[2]	**Quota**[3]	22.0	19.0	23.0	30.0	29.6	22.0	16.0	10.4	27.0	37.0	37.0	50.0			
	Catch[5,6]	12.7	12.3	16.5	19.2	18.4	12.3	5.5	5.2	14.3	16.5	12.4				
	Catch	12.6	12.5	16.0	19.9	18.8	12.7	5.6	5.1	14.2	16.1	12.4		8.7	2.1	23.3
Adult Biomass[7]		83.3	96.8	93.0	92.8	66.2	40.4	23.9	85.0	105.0	95.6	293.3	274.5	45.8[8]	4.9[8]	293.3[8]
Age 1 Recruits		9.0	3.1	4.5	1.8	4.0	243.5	20.8	9.9	884.9	10.6	45.9	111.6	39.6[8]	0.2[8]	884.9[8]
Fishing mortality[9]		0.37	0.21	0.15	0.25	0.36	0.41	0.47	0.36	0.41	0.12	0.10		0.32	0.10	0.57
Exploitation Rate[9]		28%	17%	12%	20%	28%	30%	34%	28%	31%	10%	9%		24%	9%	40%

[1] 1969 – 2016
[2] unless otherwise noted, all values reported are for calendar year
[3] for fishing year from May 1st – April 30th
[4] preliminary estimate
[5] for Canadian calendar year and USA fishing year May 1st – April 30th
[6] sum of Canadian landed, Canadian discard, and USA catch (includes discards)
[7] January 1st ages 3+
[8] 1969 – 2017
[9] ages 4-8 for 1969 – 2002; ages 5-8 for 2003 – 2016

State of Resource
The 2016 DFO survey index was the highest value for the time series (1986-2016), but decreased by 48% in 2017. A similar decrease occurred for the 2016 NMFS fall survey from 2015 to 2016 (53%), but index values increased by 16% from 2016 to 2017 for the NMFS spring survey.

Evaluation of the state of the resource was based on results from an age structured analytical assessment (Virtual Population Analysis, VPA) that used fishery catch statistics and sampling for size and age composition of the catch for 1969 to 2016 (including discards). The VPA was calibrated to trends in abundance from three bottom trawl survey series: DFO, NMFS spring, and NMFS fall.

Several large recruitment events since 1990 and reduced capture of small fish in the fisheries allowed the adult population biomass (ages 3+) to increase from near a historical low of 10,208 mt in 1993 to a historical high of 293,317 mt in 2016. At the beginning of 2017, adult biomass was 274,482 mt. A preliminary estimate for the 2016 year class is 111 million age 1 fish. The current estimate for the 2013 year class at age 1 is 885 million fish, which would make it the largest cohort in the assessment time series, followed by the 2010 year class at 243 million age 1 fish.

Fishing was below $F_{ref} = 0.26$ during 1995 to 2003, fluctuated around 0.35 in 2004 to 2006, then declined to 0.15 in 2008. Fishing mortality increased to levels above F_{ref} from 2010 to 2014 before dropping off again in 2015. In 2016, F was estimated at 0.10, well below F_{ref}.

A retrospective bias was first noted in the 2014 assessment. In 2017, retrospective analyses were conducted to detect any tendency to consistently overestimate or underestimate fishing mortality, biomass, and recruitment relative to the terminal year estimates. The current assessment continues to exhibit a retrospective bias in adult (3+) biomass, recruitment and age 5-8 F, which results in decreased estimates of biomass and recruitment, and increased estimates of F when current estimates are compared to the results of previous assessments. A retrospective adjustment (denoted rho adjustment) based on the observed retrospective bias was applied to the terminal year estimates for comparisons of status determination following the methodology in Legault et al. (2010). The adjusted 2016 recruitment is 57.36 million which is about half of the unadjusted estimate. The adjusted 2016 5-8 F is 0.19, which is below F_{ref}. The adjusted 2017 3+ biomass is 154,877 mt, which is above the threshold of 40,000 mt where recruitment has generally been higher.

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. 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 appears to be exacerbated for the 2013 year class. Fish condition, as measured by Fulton's K, has generally been below the time series average since 2004 for all three surveys and was the lowest in the time series for both the DFO and NMFS spring surveys in 2017.

Outlook
Assuming a 2017 catch equal to the 50,000 mt total quota, a combined Canada/USA catch of 86,000 mt in 2018 results in a neutral risk (50%) that the 2018 fishing mortality rate would exceed $F_{ref} = 0.26$. The 2018 catch advice at both low and neutral risk associated with not exceeding F_{ref} in 2018 will produce a decline in biomass due to the 2013 year class decrease in numbers and assumed weight at age.

A combined Canada/USA catch of 53,000 mt in 2019 results in a neutral risk (50%) that the 2019 fishing mortality rate would exceed $F_{ref} = 0.26$. Even if no catch were taken in 2019, biomass is projected to continue to decline.

The catch advice at F_{ref} from the sensitivity projections produces catches that are considerably lower than from standard projections.

Probability of exceeding F_{ref}	25%	50%	75%
2018 catch	71,000 mt	86,000 mt	102,000 mt
2018 catch (rho adjusted)	35,000 mt	44,000 mt	53,000 mt
2019 catch	44,500 mt	53,000 mt	63,000 mt
2019 catch (rho adjusted)	23,000 mt	27,500 mt	33,000 mt

There was consensus among all TRAC participants that catch should be lower than the standard projections due to the poor model performance and uncertainty about growth patterns and abundance for the 2013 year class. A sensitivity projection using rho adjustment was proposed as a method to reduce catch advice from the standard projection. However, there was no consensus on the appropriate magnitude for reducing catch advice, or how it should be derived. The external reviewers were in favour of applying the rho adjustment and following the sensitivity catch advice.

All TRAC participants agreed to provide both the standard and sensitivity (rho adjusted) projections for TMGC's consideration. There are several positive indicators for the stock, including the survey biomass being near historic highs, recent recruitment (2010 and 2013) estimated to be the highest in the time series, and expanded age structure. However, performance of the VPA model has degraded, as evidenced by the overestimation of SSB and underestimation of F in the last four assessments, the observation that terminal year biomass is lower than projected even though only about half of the quota was caught, and previous experience with assessments of other fish stocks of not accounting for retrospective bias leading to overfishing and further changes in perception of the stock status.

Special Considerations
Performance of the VPA for EGB Haddock was poor and seems to be getting worse with time. Some of the diagnostic issues were poor fits to the survey data and significant retrospective patterns in biomass, fishing mortality, and recruitment, indicating an undiagnosed misspecification in the model. The VPA modeling approach is becoming increasingly unreliable for providing management advice.

If the 2017 quota is caught, the 2017 F will be above F_{ref} due to the revision of the size of the 2013 year class in the 2017 assessment.

The TMGC is requesting that the Steering Committee consider a benchmark review for Eastern Georges Bank haddock a priority. The last benchmark review was conducted in 1998. This, combined with declines in model performance, changes in productivity, and the TMGC's recent reliance on TRAC's two year catch advice with an interim report to form the basis for management, all suggest an increased need for a benchmark.

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

Guidance

The TMGC concluded that the most appropriate combined Canada/U.S. TAC for Georges Bank yellowtail for the 2018 fishing year is 300 mt. The change in survey catchability in this year's empirical approach resulted in an increased estimate of survey biomass, although the declining trend of the stock remains. Available information suggests that catch is not a major driver of current stock conditions, because total mortality remains high in spite of record low catches. In light of this information, the TMGC sought to balance yellowtail flounder stock conditions and the utilization of other species. A quota of 300 mt is based on an exploitation rate of 10%, which is a decrease from the 16% exploitation rate used to set the quota in 2016. The TMGC and the TRAC will continue to explore the most appropriate catch strategy to use for this stock. The annual allocation shares between countries for 2018 are based on a combination of historical catches (10% weighting) and resource distribution based on trawl surveys (90% weighting). Combining these factors entitles the United States to 71% and Canada to 29% of the TAC, resulting in a national quota of 213 mt for the United States and 87 mt for Canada.
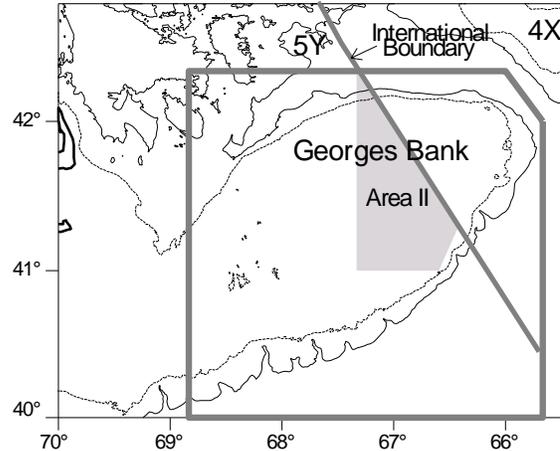
Harvest Strategy & Reference Points

The strategy is to maintain a low to neutral risk of exceeding the fishing mortality limit reference, $F_{ref} = 0.25$. 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 cannot be defined.

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 44 mt in 2016 due in part to restrictive management measures. The 2016 value was the lowest catch in the time series beginning in 1935.

Catches (thousands mt)

		2011	2012	2013	2014	2015	2016	2017	Avg[1]	Min[1]	Max[1]
Canada[2]	Quota	1,192	586	285	72	106	85	93			
	Landed	22	46	1	1	3	1		433	1	2,913
	Discard	53	48	39	14	11	10		428	10	815
USA[2]	Quota[3]	1,458	564	215	328	248	269	207			
	Catch[3]	1,074	379	93	122	68	26[4]				
	Landed	904	443	130	70	63	26		3,878	26	15,899
	Discard	192	188	49	74	41	7		530	7	3,021
Total[2]	Quota[5]	2,650	1,150	500	400	354	354	300			
	Catch[5]	1,149	473	132	136	82	36[4]				
	Catch[6]	1,171	725	218	159	118	44		5,307	44	17,211

[1] 1973 – 2016
[2] unless otherwise noted, all values reported are for calendar year
[3] for fishing year May 1 – April 30
[4] preliminary estimate
[5] for Canadian calendar year and USA fishing year May 1 – April 30
[6] 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 amounts, indicates a poor state of the resource. Recent catch is low relative to the biomass estimated from the surveys (relative F), but catch curve analyses indicate high total mortality rates. In the mid-1990s, reductions in relative F resulted in a slight decrease in total mortality rates. Stock biomass increased due to both this decrease in total mortality and increased recruitment. Following the mid-1990s, total mortality appears to have increased and remains high despite decreases in relative F, suggesting increases in mortality from sources other than estimated catches. 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, survey recruits per biomass indicate low reproductive success recently, and age structure is truncated (i.e., both fewer young fish and fewer old fish). While the proportion of older fish in the population has increased, this is a result of the lack of young fish entering the population and is not due to a broadening of the age structure. Spatial distribution patterns from the three bottom trawl surveys generally follow recent averages. Growth, as measured by length at age in the surveys, has been variable without trend, and condition (weight at length) has been poor recently. Stock biomass is low and productivity is poor.

2017 Catch Risk Assessment
The lack of an assessment model makes it difficult to evaluate risk associated with various quotas.

The TRAC external reviewers and science members recommend application of the 2014 Diagnostic and Empirical Benchmark formulation of the empirical approach as modified by the 2017 intersessional for catch advice. The continued declines in the surveys to the lowest values in their time series (DFO and NMFS spring surveys) or third lowest in its time series (NMFS fall survey), along with truncated age structure, low recruits per biomass estimated in the surveys, and a high total mortality rate estimated from the surveys all indicate that the catch advice should not increase from the 2017 quota of 300 mt. There are no indications in the data that support increasing the quota. While the changes to survey catchability and wing width affect the magnitude of the average survey biomass, they do not impact the downward trends. The TRAC external reviewers and science members recommend low exploitation to allow for the possibility of rebuilding. The average exploitation rate associated with the quota during the past eight years has been 6% using the new biomass estimates. The TRAC external reviewers and science members feel this is an appropriate upper bound for the exploitation rate given the declines continuing in the surveys so recommend using a range of 2% to 6% for setting the 2018 catch advice, resulting in 62 mt to 187 mt.

The broader TRAC considered the full range of exploitation rates from the 2014 Diagnostic and Empirical Benchmark, 2% to 16%, to still be informative. The broader TRAC agreed there were no indications in the data that support increasing the catch advice for 2018 from the 300 mt quota for 2017, but feel the possibility of low catch advice for yellowtail flounder limiting the catch of other species such as sea scallops and groundfish should be considered as well.

Special Considerations
The 2% to 16% range of exploitation rates used previously was based on a number of per-recruit calculations that considered trade-offs in spawning potential and yield over a range of possible natural and fishing mortality conditions. The strong decline of the stock since 2010, despite both quotas and catches being well below the upper end of this exploitation range (16%) under the new value of survey catchability (0.31) and use of wing width, is the reason for the reconsideration of the exploitation rate range this year.

The TRAC notes that the catch has been below the quota since 2004 and, on average, catch has been 42% of the quota since 2010. This can be attributed in part to management regulations in both countries; for example, yellowtail is not allocated to the directed fishery in Canada, gear restrictions in both countries, bycatch avoidance programs in the USA, and Total Allowable Catch (TAC) management of a multispecies fisheries in the USA. The US scallop fishery uses rotational management between the Mid-Atlantic and Georges Bank. In years when the scallop fishery is on Georges Bank, higher US catches of yellowtail flounder are expected.

Due to the implementation of the new TRAC process in 2017, the catch advice from the TRAC scientists and external reviewers was provided along with the perspective from the broader TRAC comprised of other participants attending TRAC.

Source Documents

Noble, V., Q. McCurdy, and E.N. Brooks. 2017. Update of allocation shares for Canada and the USA of the Transboundary Resources of Atlantic Cod, Haddock and Yellowtail Flounder on Georges Bank through Fishing Year 2017. TRAC Reference Document 2017/04.

TRAC. 2017. Eastern Georges Bank cod. TRAC Status Report 2017/01.

TRAC. 2017. Eastern Georges Bank haddock. TRAC Status Report 2017/02.

TRAC. 2017. Georges Bank yellowtail flounder. TRAC Status Report 2017/03.

Consultations

2017 TRAC meeting, St. Andrews, New Brunswick, 11-14 July 2017.

TMGC public consultation in Canada, Yarmouth, Nova Scotia, 17 August 2017.

TMGC public consultation in U.S., Gloucester, Massachusetts, 16 August 2017.