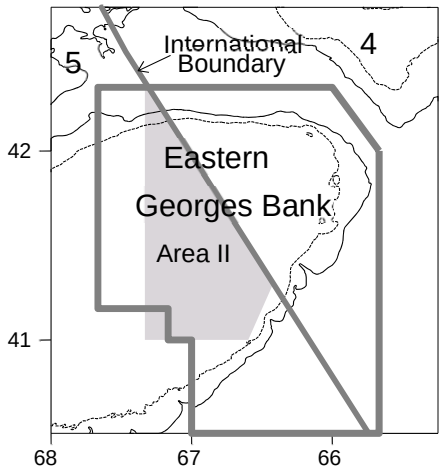
EASTERN GEORGES BANK COD

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



Summary

- Combined Canada/USA catches were 614 mt, including 128 mt of discards in the 2012 calendar year.

- The Virtual Population Analysis (VPA) "M 0.8" model from the 2013 benchmark was used to provide status determination and catch advice. Natural mortality (M) was fixed at 0.2 for all the ages in all years except for at 0.8 for ages 6+ in years after 1994.

- Since 1995, adult population biomass (ages 3+) has fluctuated between 5,800 mt and 19,600 mt. The estimated adult population biomass at the beginning of 2013 from the VPA "M 0.8" model was 11,160 mt.

- Recruitment at age 1 has been low in recent years. The 2003 year class is estimated to be the highest recruitment since 2000 (excluding 2010). The initial estimate of the 2010 year class is stronger than the 2003 year class based on the 2013 assessment.

- Fishing mortality was high prior to 1994 and declined in 1995 to F=0.11 due to restrictive management measures. F in 2012 was estimated to be 0.07.

- Average weight at length, used to reflect condition, has been stable in the past, but has started to decline in recent years. Lower weights at age in the population in recent years and poor recruitment have contributed to the lack of rebuilding.

- A 50% probability of not exceeding F=0.11 implies catches less than 1,225 mt. However, given the extremely low Spawning Stock Biomass (SSB), TRAC advises that management should try to realize the growth potential from the 2010 year class to rebuild the spawning

stock biomass. In order to not exceed F=0.11, and to achieve a 10% increase in biomass, catches must not exceed 600 mt.

- A consequence analysis to understand the risks associated with assumptions of the VPA "M 0.8" and ASAP "M 0.2" models (reviewed at the 2013 benchmark) was examined.

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

		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Avg[1]	Min[1]	Max[1]
Canada[9]	Quota	1	0.7	1.3	1.4	1.6	1.2	1	0.9	0.5	0.5			
	Catch	1.3	0.9	1.4	1.2	1.5	1.2	0.8	0.7	0.5		5.8	0.7	17.9
	Landed	1.1	0.6	1.1	1.1	1.4	1	0.7	0.7	0.4		5.8	0.6	17.8
	Discard	0.1	0.2	0.3	0.1	0.1	0.2	0.1	<0.1	<0.1		0.1	<0.1	0.5
USA[9]	Quota[2]	0.3	0.3	0.4	0.5	0.7	0.5	0.3	0.2	0.2	0.1			
	Catch[2]	0.2	0.2	0.3	0.3	0.5	0.5	0.3	0.2	<0.1				
	Landed	1	0.2	0.1	0.2	0.2	0.4	0.4	0.3	0.1		3.5	0.1	10.6
	Discard	0.1	0.3	0.1	0.4	<0.1	0.2	0.1	<0.1	<0.1		<0.1	<0.1	0.3
Total[9]	Quota	1.3	1	1.7	1.9	2.3	1.7	1.3	1.1	0.7	0.6			
	Catch	2.3	1.3	1.7	1.8	1.8	1.9	1.3	1	0.6		9.5	1	26
	Catch[3,4]	1.5	1.1	1.7	1.5	2	1.7	1.1	0.9	0.5				
From "M 0.8" model														
	Adult Biomass[5]	10	5.83	7.19	7.48	8.31	10	9.12	7.55	7.7	11.2	26.5	6	59.7
	Age 1 Recruits	4.1	1.3	2.7	2.2	1.4	1.2	2.0	6.4	1.7		6.0	0.6	24.1
	Fishing mortality[6]	0.37	0.23	0.36	0.28	0.22	0.18	0.16	0.14	0.07		0.36	0.07	0.66
	Exploitation Rate[7]	30%	18%	27%	22%	15%	10%	14%	16%	7%		26%	7%	44%
	Exploitation Rate[8]	23%	18%	21%	22%	21%	23%	15%	6%	3%		24%	3%	43%

[1]1978 – 2012
[2]for fishing year from May 1 – April 30
[3]for Canadian calendar year and USA fishing year May 1-April 30
[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
[8]ages 6-9
[9] unless otherwise noted, all values reported are for calendar year

Fishery

Combined Canada/USA catches averaged 17,198 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 in 2012 were 614 mt, including 128 mt of discards (Figure 1).

Canadian catches decreased from 743 mt in 2011 to 468 mt in 2012. Since 1995, cod quotas have been reduced, leading to less directed fishing for cod and changes in fishing gear and practices. Discards were estimated at 31 mt from the mobile gear fleet and at 0 mt from the fixed gear fleet. Since 1996, the Canadian scallop fishery has not been permitted to land cod. Estimated discards of cod by the Canadian scallop fishery were 42 mt in 2012.

USA catches decreased from 287 mt in 2011 to 146 mt in 2012. Since December 1994, a year-round closure of Area II has been in effect, with the exception of groundfish Special Access Programs in 2004 and since 2010. With the implementation of a catch share system in 2010, all

groundfish fleets are now managed by quotas. Estimated discards of cod for 2012 were 55 mt, almost entirely from the otter trawl groundfish fishery.

The combined Canada/USA 2012 **fishery age composition** (landings + discards) was dominated by the 2009 year class at age 3, followed by the 2010 year class at age 2 and the 2008 year class at age 5. The 2003 year class, one of the largest in recent years, made less contribution than expected at age 9 to the 2012 catch (0.3% by number, 0.7% by weight). The contribution to the catch of fish older than age 7 continued to be small in recent years: 3% by number and 6% by weight in 2012. 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 limit reference. At the 2013 benchmark meeting, it was agreed that the current F_{ref}=0.18 is not consistent with the Virtual Population Analysis (VPA) "M 0.8" model, and a lower value for F_{ref} would be more appropriate. When stock conditions are poor, fishing mortality rates should be further reduced to promote rebuilding.

State of Resource

Evaluation of the state of the resource was based on results from an age structured analytical assessment ((VPA), which used fishery catch statistics and sampling for size and age composition of the catch for 1978 to 2012 (including discards). The VPA was calibrated to trends in abundance from three bottom trawl survey series: NMFS spring, NMFS fall, and DFO.

The consensus during the benchmark assessment review in 2013 was to provide advice based on a VPA "M 0.8" model (Claytor and O'Brien, 2013). Natural mortality (M) was fixed at 0.2 for all the ages in all years except for at 0.8 for ages 6+ in years after 1994. In the assessment with catch data through 2012, the 2003 year class was estimated to be substantially smaller than the estimate from the 2013 benchmark model formulation with one less year of data. In the benchmark model with catch data through 2011, there was no retrospective pattern in terms of SSB, F and recruitment. The prevalence of age 9 fish in the commercial catch in 2012 was expected to be high based on the abundance of the 2003 cohort in each of the previous age categories. However, a proportionately low value of age 9 catch [2003 year class] in 2012 led to a much lower estimate of this cohort, causing a retrospective bias.

There is a strong retrospective bias in SSB and F from the 2013 assessment (VPA "M 0.8") which is caused by the substantial reduction in the estimated size of the 2003 year class. Sensitivity analyses suggest that this low estimate of the 2003 year class may be an outlier. However, the estimation of the 2003 year class had little impact on the estimation of other year classes in the terminal year. The adult biomass, recruitment, and fishing mortality estimates presented below were from the VPA "M 0.8" model.

Since 1995, **adult population biomass** (ages 3+) has fluctuated between 5,800 mt and 19,600 mt (Figure 2). The estimated adult population biomass at the beginning of 2013 from the VPA

"M 0.8" model was 11,160 mt, which was about 20% of the adult biomass in 1978 (Figure 2). The increase since 2005 was largely due to recruitment and growth of the 2003 year class.

Recruitment at age 1 has been low in recent years (Figure 2). The 2003 year class is estimated to be the highest recruitment since 2000 (excluding 2010). The initial estimate of the 2010 year class is stronger than the 2003 year class based on the 2013 assessment. The bottom trawl surveys caught no fish from the 2012 year class.

Fishing mortality (population weighted average of ages 4-9) was high prior to 1994 and declined in 1995 to F=0.11 due to restrictive management measures. F in 2012 was estimated to be 0.07 from the VPA "M 0.8" model (Figure 1).

Productivity

Recruitment, age structure, fish growth, and spatial distribution typically reflect changes in the productive potential. The current biomass is well below 25,000 mt; when biomass is above this threshold, there is a better chance for higher recruitment (Figure 3). In absolute numbers, the **population age structure** displays a low proportion of ages 7+ compared to the 1980s. Average weight at length, used to reflect condition, has been stable in the past, but has started to decline in recent years. Lower weights at age in the population in recent years and poor recruitment have contributed to the lack of rebuilding. **Size at age** in the 2012 fishery remained at low levels. 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 2014. At the 2013 cod benchmark meeting, it was agreed that the current F_{ref}=0.18 was inconsistent with the VPA "M 0.8" model given that it was derived based on models with an M=0.2. Although no consensus was reached as to what an appropriate F_{ref} would be for the VPA "M 0.8" model, it was agreed that it should be lower. The TRAC agreed that projections would be run at the current F_{ref} of 0.18 and at a value less than the F_{ref}. The sensitivity value of F=0.11 was used for the second projection analysis.

Uncertainty about current biomass generates uncertainty in forecast results, which is expressed here as the probability of exceeding F_{ref} = 0.18 or F = 0.11 and change in adult biomass from 2014 to 2015. The risk calculations assist in evaluating the consequences of alternative catch quotas by providing a general measure of the uncertainties. However, risk calculations are dependent on the data and model assumptions and do not include uncertainty due to variations in weight at age, partial recruitment to the fishery, natural mortality, systematic errors in data reporting, the possibility that the model may not reflect stock dynamics closely enough, and retrospective bias.

For **projections**, the average of the most recent three years of fishery and survey weight data were used for fishery and beginning year population weights for 2014 and 2015. The 2013 and 2014 partial recruitment pattern was based on the most recent five years of estimated partial recruitment. The 2008-2012 geometric mean of recruitment at age 1 was used for 2013-2015 projections. The initial indication of the 2012 year class is very weak; the projection could be

optimistic. Catch in 2013 was assumed to be equal to the 600 mt quota, and F=0.18 or F=0.11 in 2014.

Although the VPA "M 0.8" model results are not reliable for population trends, comparison with the sensitivity analyses that adjusted for the 2003 year class indicates similar catch advice.

2014 Catch (mt)

Probability of exceeding target F in 2014	**0.25**	**0.5**	**0.75**
"M 0.8"(F =0.11)	1,075 mt	1,225 mt	1,425mt
"M 0.8"(Fref=0.18)	1,800 mt	2,100 mt	2,400 mt

Neutral risk (50%) that biomass will not increase by:	**0%**	**10%**
"M 0.8"	2,075 mt	600 mt

Considering F_{ref}=0.18 is not consistent with the assessment VPA "M 0.8" model, it is inappropriate for the catch advice (shown in grey font in the text table above). TRAC recommends basing catch advice on F lower than F_{ref}.

A 50% probability of not exceeding F=0.11 implies catches less than 1,225 mt (Figure 4). However, given the extremely low SSB, TRAC advises that management should try to realize the growth potential from the 2010 year class to rebuild the spawning stock biomass. In order to not exceed F=0.11, and to achieve a 10% increase in biomass, catches must not exceed 600 mt (see text tables above and Table 1). No fishing in 2014 implies an increase in adult biomass from 2014 to 2015 of about 15%.

While management measures have resulted in a decreased exploitation rate since 1995, total mortality has remained high and adult biomass has fluctuated at a low level. The continuing poor recruitment since the early 1990s and the assumed high natural mortality on ages 6+ since 1995 are important factors for this lower productivity. The initial estimate of the 2010 year class is higher than adjacent year classes, but is still well below the average of 1978-1990, when the productivity is considered to have been higher. Rebuilding will not occur without improved recruitment.

A consequence analysis to understand the risks associated with assumptions of the VPA "M 0.8" and ASAP "M 0.2" models (reviewed at the 2013 benchmark) was examined. This consequence analysis estimated the projected catch at F_{ref} 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. It showed that under both sets of model assumptions, a projected catch of about 600 mt in 2014 would not exceed F_{ref}=0.18 while achieving a 10% increase in SSB between 2014 and 2015.

Considering F_{ref}=0.18 is not consistent with the assessment VPA "M 0.8" model, it is inappropriate for the catch advice (shown in top left dark grey shaded box font in the consequence table below).

		VPA 0.8	ASAP
Catch 2012		613 mt	613 mt
quota 2013		600 mt	600 mt
2012 biomass (3+)		7700 mt	2091 mt
2013 biomass (3+)		11160 mt	
Projected Catch			
2028 mt	2014 F	0.18	0.75
(VPA F=0.18)	2015 Biomass	13314	3328
	% inc B from 2014	0.4%	-20.2%
1225 mt	2014 F	0.11	0.40
(VPA F=0.11)	2015 Biomass	14018	4153
	% inc B from 2014	6%	-0.42%
601 mt	2014 F	0.05	0.18
(ASAP F=0.18)	2015 Biomass	14646	4794
	% inc B from 2014	10.0%	15.0%
378 mt	2014 F	0.03	0.11
(ASAP F=0.11)	2015 Biomass	14858	5029
	% inc B from 2014	12%	20.6%
	F<=Fref and a 10% biomass increase in 2015		
	F< =Fref and biomass increase less than 10% in 2015		
	F>Fref and biomass increase less than 10% in 2015		
	not feasible projection		

Special Considerations

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

In July 2013, there will be a reduction in the minimum size for the USA fishery from 22 inches to 19 inches. This is expected to result in reduced discards and a possible change in PR for the youngest ages.

The TRAC agreed that projections would be run at the current F_{ref} of 0.18 and at a value less than 0.18. A value of F=0.11 was used to provide catch advice for 2014. A consequence analysis was used to determine risks under alternative model assumptions. Further investigation will be required to determine an appropriate recommendation for an exploitation rate for the benchmark model.

Source Documents

Clark, K.J., and L. O'Brien, editors. 2013. Proceedings of the Transboundary Resources Assessment Committee (TRAC): Eastern Georges Bank Cod and Haddock, and Georges Bank Yellowtail Flounder. Report of Meeting held 25-27 June 2013. TRAC Proceedings 2013/02.

Claytor R., and L. O'Brien, editors. 2013. Proceedings of the Transboundary Resources Assessment Committee (TRAC): Transboundary Resources Assessment Committee Eastern Georges Bank Cod Benchmark Assessment. TRAC Proceedings 2013/01.

Wang, Y., and L. O'Brien. 2013. Assessment of Eastern Georges Bank Atlantic Cod for 2013. TRAC Reference Document 2013/02.

Correct Citation

TRAC. 2013. Eastern Georges Bank Cod. TRAC Status Report 2013/02.

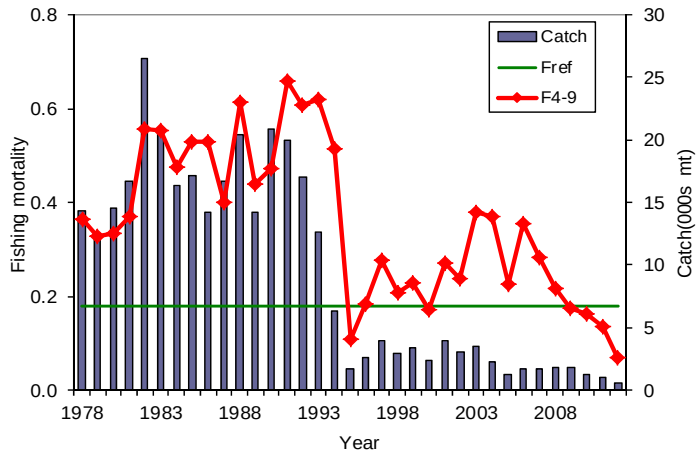


Figure 1. Catches and fishing mortality (F).

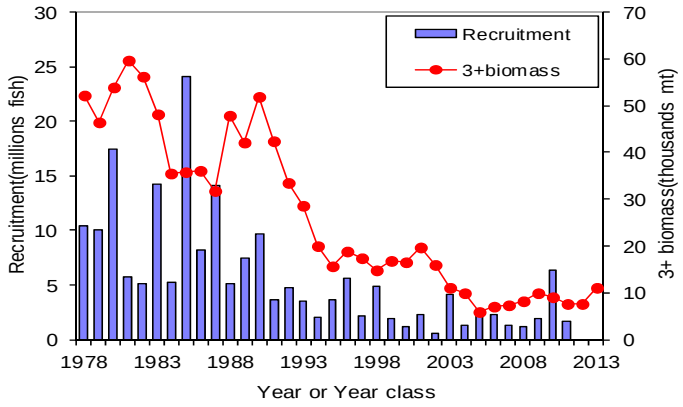


Figure 2. Biomass and recruitment.

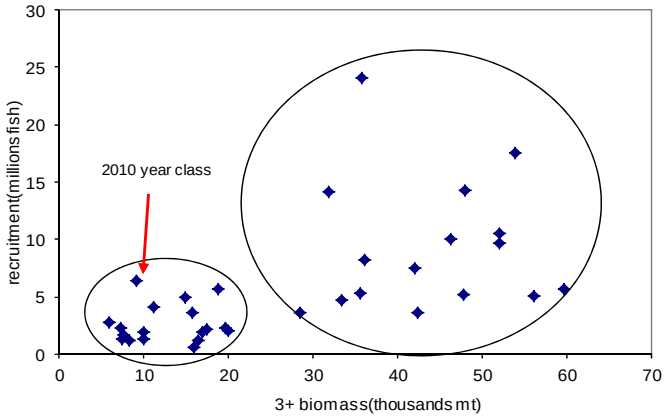


Figure 3. Stock recruitment patterns. Red arrow indicates 2010 year class at age 1.

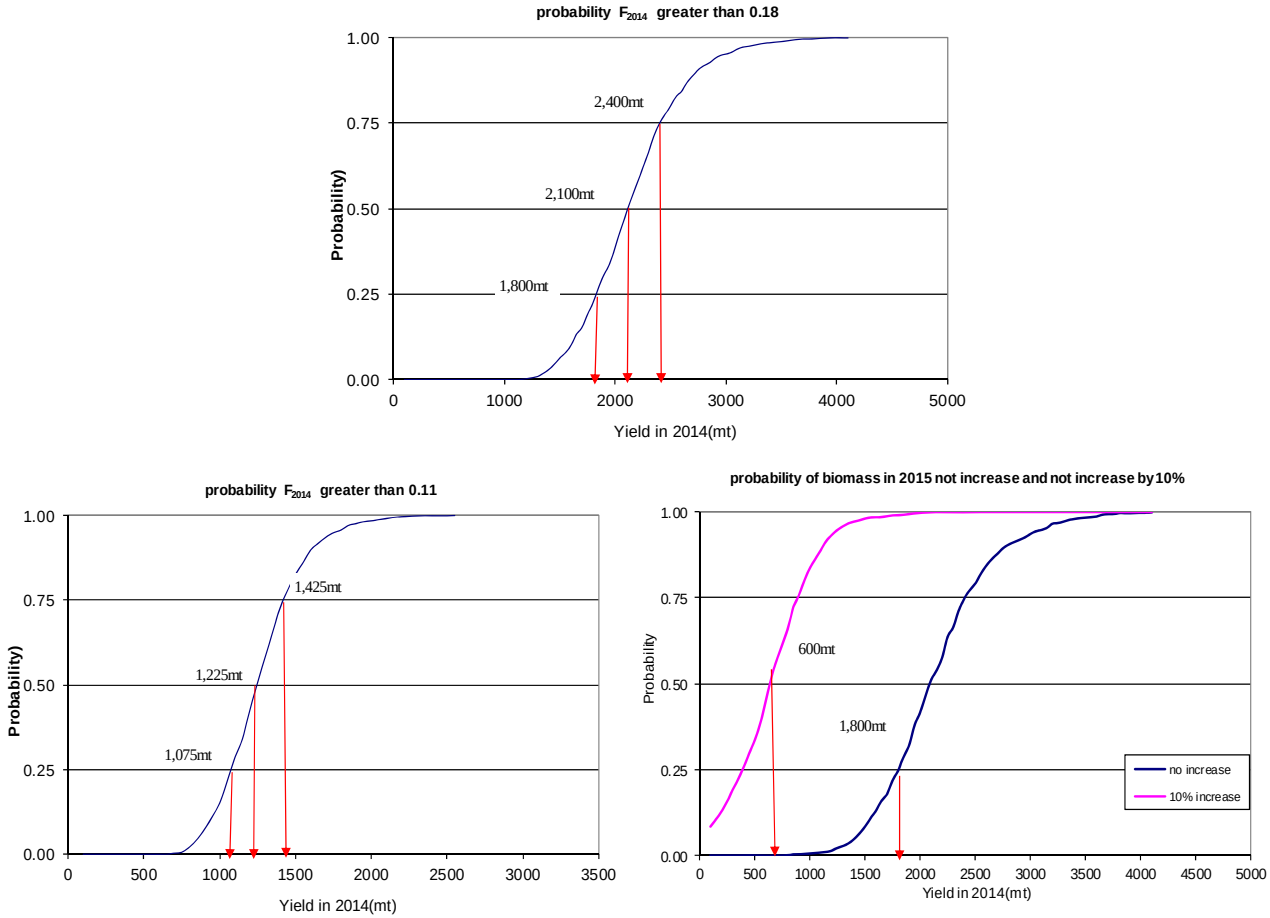


Figure 4. Projections and risks.