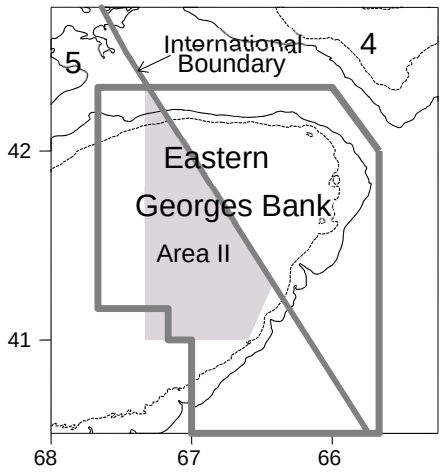
EASTERN GEORGES BANK COD

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



Summary

- Combined Canada/USA catches were 463 mt, including 54 mt of discards in the 2013 calendar year.

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

- Based on analyses presented, TRAC agreed that F = 0.11 was an appropriate fishing reference point for the VPA "M 0.8" model.

- Since 1995, adult population biomass (ages 3+) has fluctuated between 5,900 mt and 18,800 mt. The estimated adult population biomass at the beginning of 2014 from the VPA "M 0.8" model was 11,179 mt.

- Recruitment at age 1 has been low in recent years. The 2003 year class is estimated to be the largest cohort since the 1998 cohort (excluding 2010). The estimate of the 2010 year class is stronger than the 2003 year class based on the 2013 assessment. The 2012 year class is the lowest on record.

- Fishing mortality was high prior to 1994 and declined in 1995 to F = 0.11 due to restrictive management measures. F in 2013 was estimated to be 0.04.

- 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 1,150 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. Even an F = 0 in 2015 implies a greater than 50% risk of a decrease in adult biomass from 2015 to 2016, and a catch of 225 mt would result in at least a 75% risk that 2016 adult biomass would decrease.

- A consequence analysis to understand the risks associated with assumptions of the VPA "M 0.8" and Age Structured Assessment Program (ASAP) "M 0.2" models was examined.

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

		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Avg[1]	Min[1]	Max[1]
Canada[2]	Quota	0.7	1.3	1.4	1.6	1.2	1	0.9	0.5	0.5	0.5			
	Catch	0.9	1.4	1.2	1.5	1.2	0.8	0.7	0.5	0.4		5.6	0.4	17.9
	Landed	0.6	1.1	1.1	1.4	1	0.7	0.7	0.4	0.4		5.5	0.4	17.8
	Discard	0.2	0.3	0.1	0.1	0.2	0.1	<0.1	<0.1	<0.1		0.1	<0.1	0.5
USA[2]	Quota[3]	0.3	0.4	0.5	0.7	0.5	0.3	0.2	0.2	0.1	0.2			
	Catch[3]	0.2	0.3	0.3	0.5	0.5	0.3	0.2	<0.1	<0.1[4]				
	Landed	0.2	0.1	0.2	0.2	0.4	0.4	0.3	0.1	<0.1		3.3	<0.1	10.6
	Discard	0.3	0.1	0.4	<0.1	0.2	0.1	<0.1	<0.1	<0.1		<0.1	<0.1	0.3
Total[2]	Quota	1	1.7	1.9	2.3	1.7	1.3	1.1	0.7	0.6	0.7			
	Catch[5,6]	1.3	1.7	1.8	1.8	1.9	1.3	1	0.6	0.5		9	0.5	26
	Catch	1.2	1.7	1.7	1.8	1.8	1.3	1.0	0.6	0.5				
From "M 0.8" model														
	Adult Biomass[7]	5.9	7.5	7.5	8.9	11.2	10.1	8.5	8.2	10.4	11.7	26.2	6	59.7
	Age 1 Recruits	0.8	3.5	2.5	1.4	1.0	1.8	5.4	1.6	0.4		6.0	0.4	24.1
	Fishing mortality[8]	0.22	0.35	0.26	0.23	0.16	0.14	0.12	0.07	0.04		0.34	0.04	0.66
	Exploitation Rate(%)[9]	18%	27%	22%	18%	14%	12%	14%	8%	4%		26%	4%	44%
	Exploitation Rate (%)[10]	17%	21%	21%	21%	23%	19%	10%	4%	1%		24%	1%	46%

[1]1978 – 2013
[2] unless otherwise noted, all values reported are for calendar year
[3]for fishing year from 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 discards, and USA catch (includes discards)
[7]January 1 ages 3+
[8]ages 4-9
[9]ages 4-5; M = 0.2
[10]ages 6-9; M = 0.8

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 2013 were 463 mt, including 54 mt of discards (Figure 1).

Canadian catches decreased from 468 mt in 2012 to 424 mt in 2013. 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 21 mt from the mobile gear and fixed gear fleets in 2013.

Since 1996, the Canadian scallop fishery has not been permitted to land cod. Estimated discards of cod by the Canadian scallop fishery were 18 mt in 2013.

USA catches decreased from 287 mt in 2012 to 39 mt in 2013. 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. Estimated discards of cod for 2013 were 15 mt, almost entirely from the otter trawl groundfish fishery.

The combined Canada/USA 2013 **fishery age composition** (landings + discards) was dominated by the 2010 year class at age 3, followed by the 2009 year class at age 4 and the 2011 year class at age 2. The contribution to the catch of fish older than age 7 (including the 2003 year class) continued to be small in recent years: 1% by number and 3% by weight in 2013. 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 eastern Georges Bank (EGB) cod 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 (see Outlook section). 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 model (VPA), which used fishery catch statistics and sampling for size and age composition of the catch for 1978 to 2013 (including discards). The VPA was calibrated to trends in abundance from three bottom trawl survey series: NMFS spring, NMFS fall, and DFO winter.

The agreement at the benchmark assessment review in 2013 was to provide catch 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 ages 6+ in years after 1994, which were set at M = 0.8.

Since 1995, **adult population biomass** (ages 3+) has fluctuated between 5,900 mt and 18,800 mt (Figure 2). The estimated adult population biomass at the beginning of 2014 from the VPA "M 0.8" model was 11,719 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 largest cohort since the 1998 cohort (excluding 2010). The current estimate of the 2010 year class is stronger than the 2003 year class based on the 2013 assessment. The 2012 year class is the lowest on record.

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 2013 was estimated to be 0.04 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 fewer fish at 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 2013 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 2015. 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. At the 2014 TRAC, it was agreed that F = 0.11 was an appropriate fishing reference point for the VPA "M 0.8" model based on the analyses presented. A projection analysis was also run at the current F_{ref} = 0.18, which was derived with an assumption of M = 0.2 in the assessment.

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 2015 to 2016. 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 2015 and 2016. The 2014 and 2015 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 2014-2016 projections. The projection could be optimistic if the 2013 year class size is lower than estimated. Catch in 2014 was assumed to be equal to the 700 mt quota, and F = 0.18 or F = 0.11 in 2015.

Probability of exceeding Fref in 2015	0.25	0.5	0.75
"M 0.8"(F =0.11)	1,000 mt	1,150 mt	1,350mt
"M 0.8"(F_{ref}=0.18)	1,625 mt	1,850 mt	2,150 mt

Risk (75%) that biomass will not increase by:	**0%**
"M 0.8"	225 mt

Considering that 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 = 0.11.

A 50% probability of not exceeding F = 0.11 implies catches less than 1,150 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. A catch of 225 mt would result in a greater than 75% risk that 2016 adult biomass would decrease (see text tables above). Even an F = 0 in 2015 implies a greater than 50% risk of a decrease in adult biomass from 2015 to 2016 (Figure 4).

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 estimate of the 2010 year class is higher than adjacent year classes, but it is still well below the average during 1978-1990, when the productivity is considered to have been higher. Rebuilding will not occur without improved recruitment.

Consequence Analysis

Two models were examined at the benchmark, each providing a stark contrast to the other relative to stock status. Natural mortality is assumed to be higher for ages 6+, after 1994, in the VPA (M = 0.8) compared to M = 0.2 for all ages in the ASAP model. Comparison of the 2014 assessment results of the two models indicates that biomass is estimated to be higher in the VPA, in contrast to the ASAP model that estimated substantially lower biomass. A consequence analysis to understand the risks associated with assumptions of the VPA "M 0.8" and ASAP "M 0.2" models was examined. This consequence analysis shows 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.

A catch of 1,150 mt at F = 0.11, would result in a decrease in biomass of 10% in the VPA and 5% in the ASAP. A catch of 489 mt at F_{ref} = 0.18 would result in at least a minimum 10% increase in the 2016 biomass based on the ASAP 0.2 model; however, the biomass in 2016 would decrease by 5% based on the VPA M 0.8 model.

CONSEQUENCE ANALYSIS

		VPA 0.8	ASAP
Catch 2013		463 mt	463 mt
Quota 2014		700 mt	700 mt
2013 biomass (3+)		10,410 mt	2,285 mt
2014 biomass (3+)		11,719 mt	NA
Projected 2015 Catch (mt)			
1,850	2015 F	0.18	0.89
(VPA F=0.18)	2016 Biomass(mt)	10,802	2,169
	% inc B from 2015	-15%	-28%
1,150	2015 F	0.11	0.48
(VPA F=0.11)	2016 Biomass(mt)	11,484	2,843
	% inc B from 2015	-10%	-5%
489	2015 F	0.04	0.18
(ASAP F=0.18)	2016 Biomass(mt)	12,129	3,481
	% inc B from 2015	-5%	16%
308	2015 F	0.03	0.11
(ASAP F=0.11)	2016 Biomass(mt)	12,307	3,660
	% inc B from 2015	-4%	22%

F<=Fref and 10% biomass increase in 2016
F< =Fref and biomass increase < 10% in 2016
F>Fref and biomass increase < 10% in 2016

not a 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 the ASAP model, the retrospective bias was not adjusted for 2014 and projected catches would be lower if the adjustments were done.

In July 2013, there was a reduction in the minimum size of Atlantic cod from 22 inches to 19 inches in the USA fishery. This is expected to result in reduced discards and a possible change in partial recruitment for the youngest ages.

Source Documents

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.

O'Brien L., and T. Worcester, editors. 2014. Proceedings of the Transboundary Resources Assessment Committee (TRAC): Eastern Georges Bank Cod and Haddock, and Georges Bank Yellowtail Flounder. Report of Meeting held 23-26 June 2014. TRAC Proceedings 2014/02.

Wang, Y., and L. O'Brien. 2014. Assessment of Eastern Georges Bank Atlantic Cod for 2014. TRAC Reference Document 2014/03.

Correct Citation

TRAC. 2014. Eastern Georges Bank Cod. TRAC Status Report 2014/01.

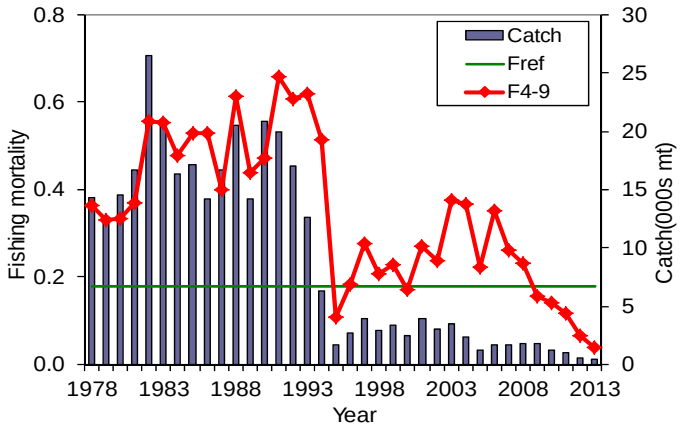


Figure 1. Catches and fishing mortality (F) for EGB cod.

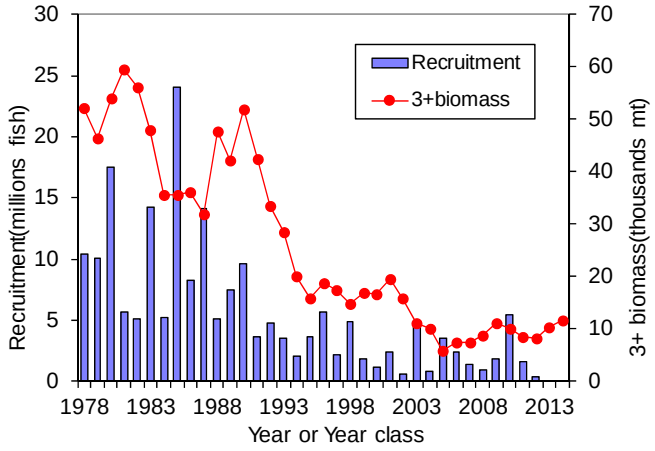


Figure 2. Biomass and recruitment for EGB cod.

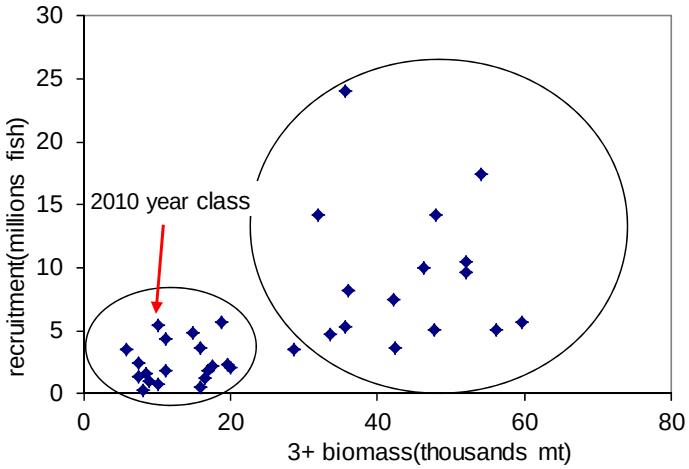


Figure 3. Stock recruitment patterns for EGB cod. Red arrow indicates 2010 year class at age 1.

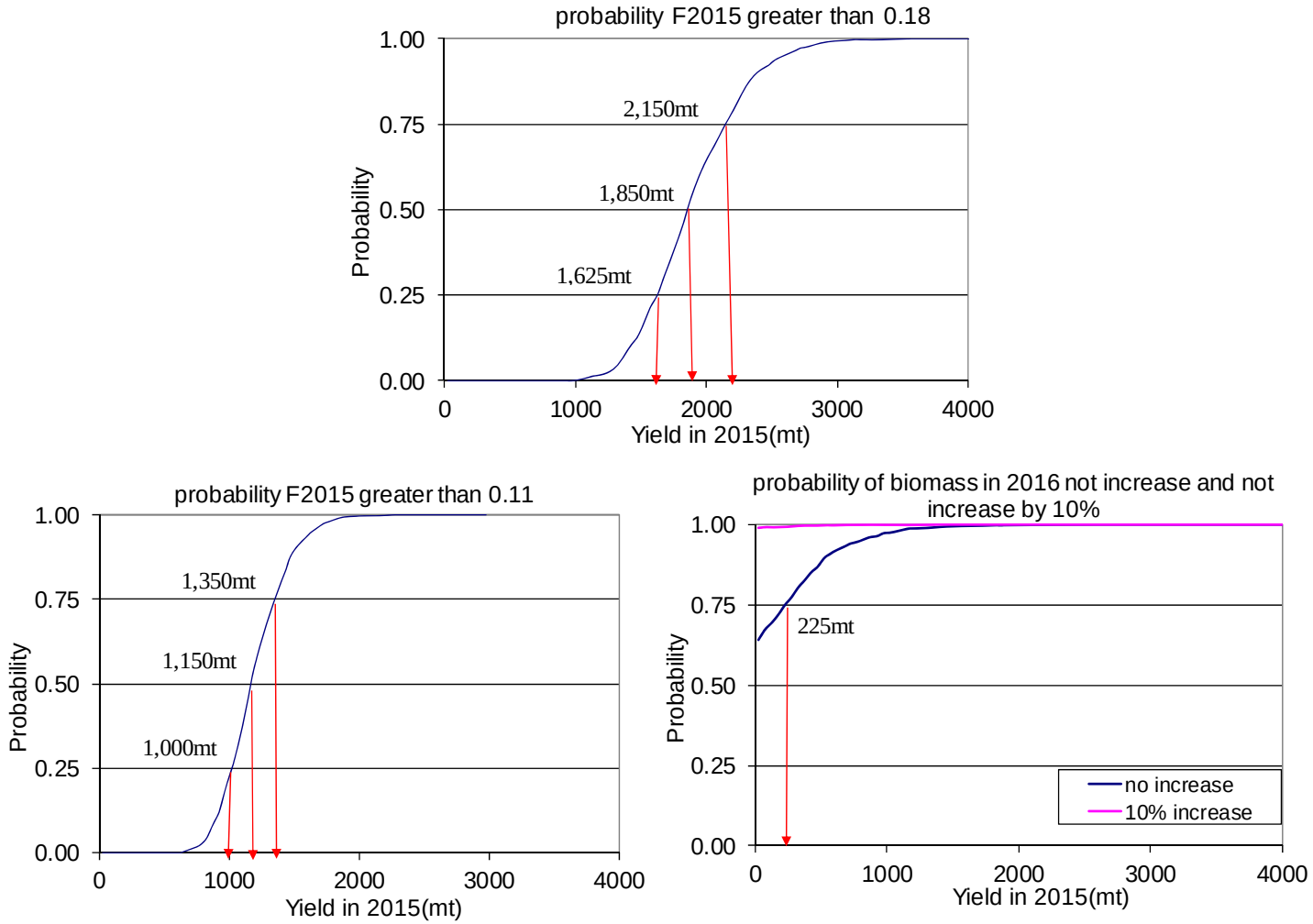


Figure 4. Projections and risks for EGB cod.