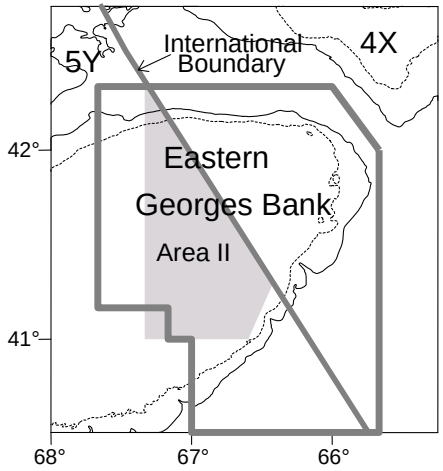
EASTERN GEORGES BANK COD

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



Summary

- Combined Canada/USA catches were 1,858 mt, including 425 mt of discards in the 2009 calendar year.

- Two alternative model formulations were used. Both assumed a split in the survey indices in 1994 but one assumed M=0.2, whilst the other assumed M=0.2 for all ages and years, except for ages 6+ where M=0.5 from 1994 to 2010.

- Since 1995 adult population biomass (ages 3+) from the "split M 0.2" model has fluctuated between 3,200 mt and 10,100 mt. Biomass was 6,334 mt in 2009 and 6,394 mt at the beginning of 2010. Since 1995 adult population biomass from the "split M 0.5" model has fluctuated between 5,084 mt and 10,824 mt. Biomass was 9,856 mt in 2009 and 9,260 mt at the beginning of 2010.

- Fishing mortality (F) in 2009 was estimated to be 0.33 from the "split M 0.2" model and 0.20 from the "split M 0.5" model. Both models show recent reductions in F; however, F has been consistently above the F_{ref}=0.18.

- Recruitment at age 1 of 3.6 million for the 2003 year-class from the "split M 0.2" model was similar to the 1996 year-class at age 1. Recruitment at age 1 of 5.0 million for the 2003 year-class from the "split M 0.5" model was the highest since the 1990 year-class but was still lower than the pre-1990 average level (10 million). The 2002 and 2004 year-classes were the lowest on record.

- Resource productivity is currently poor due to low recent recruitment and low weights-at-age.

- Assuming a 2010 catch equal to the 1,350 mt total quota, a combined Canada/USA catch of about 1,000 mt ("split M 0.2" model) and 1,400 mt ("split M 0.5" model) in 2011 will result in a neutral risk (50%) that the fishing mortality rate in 2011 will exceed F_{ref}. A catch of 1,850 mt ("split M 0.2" model) and 1,350 mt ("split M 0.5" model) will result in a neutral risk (50%) that the 2011 adult biomass (ages 4+) will be lower than 2010. A catch of about 1,100 mt ("split M 0.2" model) and 450 mt ("split M 0.5" model) will result in a neutral risk (50%) that 2012 adult biomass will not increase by 10% from 2011.

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

		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Avg[1]	Min[1]	Max[1]
Canada	Quota	2.1	1.2	1.3	1.0	0.7	1.3	1.4	1.6	1.2	1.0			
	Landed	2.1	1.3	1.3	1.1	0.6	1.1	1.1	1.4	1.0		6.1	0.6	17.8
	Discard	0.1	0.1	0.2	0.1	0.2	0.3	0.1	0.1	0.2		0.1	0.0	0.5
USA	Quota[2]				0.3	0.3	0.4	0.5	0.7	0.5	0.3			
	Catch[2]				0.2	0.2	0.3	0.3	0.7	0.5				
	Landed	1.5	1.7	1.9	1.0	0.2	0.1	0.2	0.2	0.4		3.8	0.1	10.6
	Discard	0.2	0.0	0.1	0.1	0.2	0.1	0.3	0.0	0.2		0.1	0.0	0.3
Total	Quota				1.3	1.0	1.7	1.9	2.3	1.7	1.3			
	Catch	4.0	3.1	3.5	2.3	1.3	1.7	1.8	1.8	1.9		10.0	1.3	26.5
From "split M 0.2" Model														
	Adult Biomass[3]	10.1	7.9	6.0	5.3	3.2	5.0	5.0	5.2	6.3	6.4	24.1[4]	3. 2[4]	60.4[4]
	Age 1 Recruits	1.0	1.7	0.5	3.6	0.6	1.4	2.0	1.3	1.2		5.6	0.5	23.6
	Fishing mortality[5]	0.65	0.47	0.79	0.84	0.40	0.63	0.35	0.35	0.33		0.57	0.32	1.29
	Exploitation Rate[5]	44%	34%	50%	52%	30%	43%	27%	27%	26%		38%	25%	67%
From "split M 0.5" Model														
	Adult Biomass[3]	12.8	10.4	7.8	7.7	5.1	7.8	8.3	8.4	9.9	9.2	25.5[4]	5.1[4]	60.4[4]
	Age 1 Recruits	1.2	2.5	0.7	5.0	0.8	1.7	2.4	1.5	1.5		5.8	0.7	23.7
	Fishing mortality[5]	0.46	0.35	0.55	0.52	0.23	0.32	0.21	0.20	0.20		0.47	0.20	1.06
	Exploitation Rate[6]	32%	25%	37%	37%	19%	23%	15%	17%	18%		33%	15%	60%
	Exploitation Rate[7]	34%	27%	36%	37%	26%	26%	20%	15%	13%		30%	13%	53%

[1]1978 – 2009
[2]for fishing year from May 1st – April 30th
[3]January 1st ages 3+
[4]1978 – 2010
[5]ages 4-9
[6]ages 4-5
[7]ages 6-9

Fishery

Combined Canada/USA catches averaged 17,508 mt between 1978 and 1992, peaked at 26,463 mt in 1982, and declined to 1,684 mt in 1995. Catches fluctuated around 3,000 mt until 2004, and subsequently declined again. Catches in 2009 were 1,858 mt, including 425 mt of discards (Figure 1).

Canadian catches decreased to 1,209 mt in 2009 from 1,529 mt in 2008. Since 1995, with reduction in cod quotas, the fishery has reduced targeting for cod through changes in fishing

practices. All 2009 landings were subject to dockside monitoring, and at sea observers monitored close to 23% by weight of the mobile gear fleet landings and 15% by weight of the fixed gear landings. Discards were estimated at 22 mt from the mobile gear fleet and 115 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 69 mt in 2009.

USA catches increased to 649 mt in 2009 from 253 mt in 2008. Since December 1994, a year-round closure of Area II has been in effect, with the exception of a Special Access Program for yellowtail flounder in 2004. Minimum mesh size limits were increased in 1994, 1999 and 2002. Limits on sea days and trip limits have also been implemented. Quotas were introduced in May 2004. Eastern Georges Bank was not open for trawl vessels until August 1st, 2009. Estimated discards of cod for 2009 were 218 mt from the groundfish fishery and 1 mt from the sea scallop fishery.

The combined Canada/USA 2009 **fishery age composition** was dominated by the 2006 year-class at age 3 (33% by number, 20% by weight) and the 2003 year-class at age 6 (25% by number, 38% by weight) followed by the 2005 year-class at age 4 (20% by number, 21% by weight). The contribution to the catch of fish older than age 7 continued to be small in recent years (4% by number, 9% by weight in 2009). Discards at age from the USA groundfish and scallop fishery (1989 to 2009), the Canadian groundfish fishery (1995 to 2009) and the Canadian scallop fishery (1978 to 2009) were included in the assessment when identified.

Harvest Strategy and Reference Points

The Transboundary Management Guidance Committee has adopted a strategy 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.

State of Resource

Evaluation of the state of the resource was based on results from an age structured analytical assessment (Virtual Population Analysis, VPA), which used fishery catch statistics and sampling for size and age composition of the catch for 1978 to 2009 (including discards). The VPA was calibrated to trends in abundance from three bottom trawl survey series: NMFS spring, NMFS fall and DFO.

Two VPA model formulations were established during the benchmark assessment meeting in 2009. These model formulations will be referred to as the "split M 0.2" and "split M 0.5" model. The survey abundance indices were split in 1993-1994 for both model formulations. Natural mortality (M) was fixed at 0.2 for all the ages in all years for the "split M 0.2" model and was fixed at 0.5 for ages 6+ in years after 1994 for the "split M 0.5" model. It was recommended at the benchmark meeting to consider both model formulations until the fate of the 2003 year-class has been documented and thus provides information on natural mortality.

Since 1995 **adult population biomass** (ages 3+) from the "split M 0.2" model has fluctuated between 3,200 mt and 10,100 mt. Biomass was 6,334 mt in 2009 and 6,394 mt (80% confidence interval: 4,857 mt- 7,508 mt) at the beginning of 2010 (Figure 2). Since 1995 adult population biomass from the "split M 0.5" model has fluctuated between 5,084 mt and 10,824 mt. Biomass

was 9,856 mt in 2009 and 9,260 mt (80% confidence interval: 7,202 mt-10,942 mt) at the beginning of 2010 (Figure 2). In both models, the increase in 2006 was largely due to recruitment of the 2003 year-class, and the increases in 2007, 2008 and 2009 were due to growth of the 2003 year-class. Lower weights-at-age in the population in recent years and generally poor recruitment have contributed to the lack of sustained rebuilding, although improvement in size at some ages has been seen in the 2009 fishery and 2010 DFO survey. Total population biomass (age 1+) has shown a slight decrease for both models since 1994, whilst survey biomass indices have fluctuated without clear trend (Figure 3).

Both assessment models exhibit a retrospective pattern in which perceptions of stock size were revised downward. The retrospective inconsistency in the 3+ biomass was approximately 50% for the "split M 0.2" model and approximately 30% for the "split M 0.5" model.

Recruitment at age 1 of 3.6 million for the 2003 year-class from the "split M 0.2" model was similar to the 1996 year-class at age 1. Recruitment at age 1 of 5.0 million for the 2003 year-class from the "split M 0.5" model was the highest since the 1990 year-class but was still lower than the pre-1990 average level (10 million). The 2002 and 2004 year-classes were the lowest on record. The 2006 year-class at age 1 was about half the strength of the 2003 year-class for both models (2 million for "split M 0.2", 2.4 million for "split M 0.5). Initial indications are that the 2008 year-class is similar in strength to the 2007 and 2005 year-classes, which were between 66% and 75% of the post 1990 average values from both models for recruitment at age 1. The current biomass is less than 30,000 mt where recruitment has historically been poor (Figure 4).

Fishing mortality (population weighted average of age groups 4-9) was high prior to 1994. F declined in 1995 to 0.36 for the "split M 0.2" model and to 0.24 for the "split M 0.5" model due to restrictive management measures. F in 2009 was estimated to be 0.33 (80% confidence interval: 0.27-0.50) from the "split M 0.2" model and 0.20 (80% confidence interval: 0.16-0.26) from the "split M 0.5" model. Both models show recent reductions in F; however, F has been consistently above the F_{ref}=0.18 (Figure 1).

Both assessment models exhibit a retrospective pattern in which perceptions of fishing mortality were revised upward. The retrospective inconsistency in the fishing mortality was approximately 20% for the split M 0.2 model and approximately 10% for the split M 0.5 model.

Productivity

Recruitment, age structure, fish growth and spatial distribution typically reflect changes in the productive potential. Although there is high **recruitment** variability at any given biomass, the recruit per spawner has not increased when the biomass has been low. This hampers stock rebuilding. 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, but declines in length and weight at age have hampered biomass rebuilding. **Size at age** in the 2009 fishery continued to decline for ages 4 to 8. The **spatial distribution** patterns observed during the most recent bottom trawl surveys showed that adult cod were distributed throughout the area in a similar manner to the average over the past decade. Resource productivity is currently poor due to low recent recruitment and low weights at age compared to the 1980s.

Outlook

This outlook is provided in terms of consequences with respect to the harvest reference points for alternative catch quotas in 2010. Uncertainty about current biomass generates uncertainty in forecast results, which is expressed here as the risk of exceeding F_{ref} =0.18. The risk calculations assist in evaluating the consequences of alternative catch quotas by providing a general measure of the uncertainties. However, they 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 or the possibility that the model may not reflect stock dynamics closely enough.

For **projections**, the 2007-2009 average values were assumed for the fishery weight at age. However the weights of the slower growing 2003 year-class were calculated by a regression. The 2008-2010 survey average values were assumed for beginning of year population weight at age in 2011-2012 for ages 1 to 6. Beginning of year weights for ages 7 to 9 were based on cohort regressed values. The 2005-2009 average values were assumed for the partial recruitment pattern in 2010-2011. Catch in 2010 was assumed to be equal to the 1,350 mt quota. Projections are provided from each of the model results.

A. "split M 0.2" Model

A combined Canada/USA catch of 850 mt correspond to a low (25%) probability that F will exceed F_{ref}=0.18, whereas catches of 1,000 mt correspond to a neutral (50%) probability and catches of 1,150 mt correspond to a high (75%) probability that F will exceed F_{ref}.

Catches of 1,850 mt will result in a neutral risk (50%) that the 2012 adult biomass (4+) will be lower than the 2010 adult biomass (Figure 5). A catch of about 1,100 mt will result in a neutral risk (50%) that 2012 adult biomass will not increase by 10% and a catch of about 750 mt will result in a neutral risk (50%) that the 2012 adult biomass will not increase by 20%.

B. "split M 0.5" Model

A combined Canada/USA catch of 1,250 mt correspond to a low (25%) probability that F will exceed F_{ref}=0.18, whereas catches of 1,400 mt correspond to a neutral (50%) probability and catches of 1,600 mt correspond to a high (75%) probability that F will exceed F_{ref}.

Catches of 1,350 mt will result in a neutral risk (50%) that the 2012 adult biomass (4+) will be lower than the 2010 adult biomass (Figure 5). A catch of about 450 mt will result in a neutral risk (50%) that the 2012 adult biomass will not increase by 10%. Even with no catch, there is a less than a 50% chance that adult biomass will increase by 20% in 2012.

Probability of Exceeding F_{ref} in 2011	**25%**	**50%**	**75%**
Split M 0.2	850 mt	1,000 mt	1,150 mt
Split M 0.5	1,250 mt	1,400 mt	1,600 mt

The benchmark methods do not account for retrospective inconsistencies in projections. If the magnitude of retrospective inconsistencies were accounted for, short term projections of stock biomass and catch would be decreased by approximately 50% for the "split M 0.2" and approximately 30% for the "split M 0.5" model.

While management measures have resulted in decreased exploitation rate since 1995, fishing mortality has remained above F_{ref} and adult biomass has fluctuated without any appreciable rebuilding. The continuing poor recruitment since the early 1990s is an important factor for this lower productivity. The 2003 year-class made the largest contribution by weight to the 2009 fishery and population biomass, and it is projected to continue to be an important component in the fishery catch biomass in 2010 (above one quarter of the catch) and to a lesser extent in 2011 (between 16 and 18% of the catch). With the passing of the 2003 year-class through the population, rebuilding will not occur without improved recruitment.

Special Considerations

Cod and haddock are often caught together in groundfish fisheries, although they are not necessarily caught in proportion to their relative abundance because their catchabilities to the fisheries differ. Due to the higher haddock quota, discarding of cod may be high and should be monitored. Modifications to fishing gear and practices, with enhanced monitoring, may mitigate these concerns.

Changes in survey catchability and/or natural mortality could be aliasing 'missing' catch, particularly during the regulatory and reporting changes of the mid 1990s. They could also be aliasing emigration or imperfect designation of the boundaries for this component, though an excess of larger/older fish is not apparent in adjacent cod components. Mechanisms that explain these changes could not be established.

There is no strong evidence to determine which of the two benchmark methods provides a better scientific basis for fishery management. The range of stock perceptions and outlooks from the two models reflect the substantial uncertainty in the assessment. Despite these uncertainties, all perceptions of historical and recent fishing mortalities are greater than F_{ref}.

Surveys conducted by the FSV Henry B. Bigelow in the spring and fall of 2009 and spring of 2010, calibrated to the RV Albatross IV units, were included in this assessment.

Source Documents

Clark K, Emery P, O'Brien L, Wang Y, Hatt B. 2010. Assessment of Eastern Georges Bank Atlantic Cod for 2010. TRAC Reference Document 2010/04.

O'Brien L, Worcester T, editors. 2010. Proceedings of the Transboundary Resources Assessment Committee (TRAC): Eastern Georges Bank Cod and Haddock, and Georges Bank Yellowtail Flounder: Report of Meeting held 20-23 July 2010. TRAC Proceedings 2010/02.

Correct Citation

TRAC. 2010. Eastern Georges Bank Cod. TRAC Status Report 2010/03.

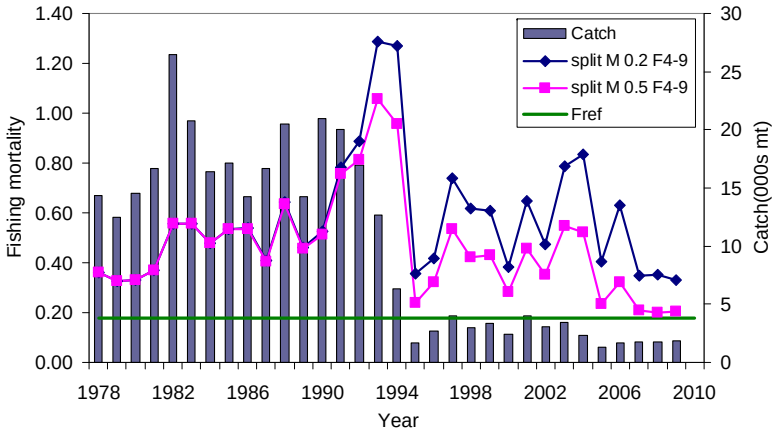


Figure 1. Catches and fishing mortality.

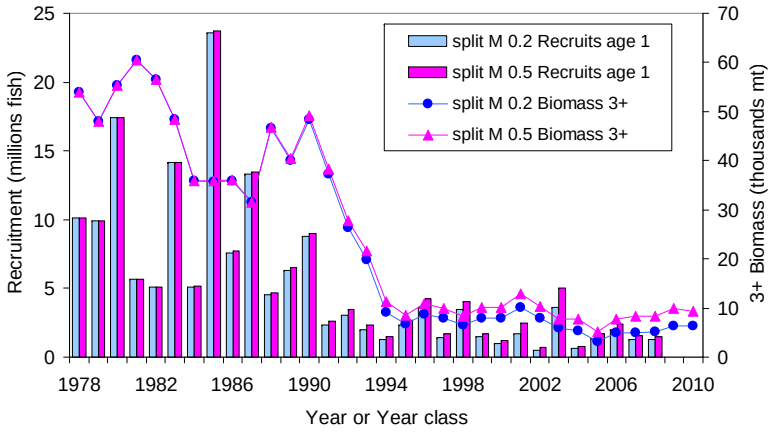


Figure 2. Biomass and recruitment.

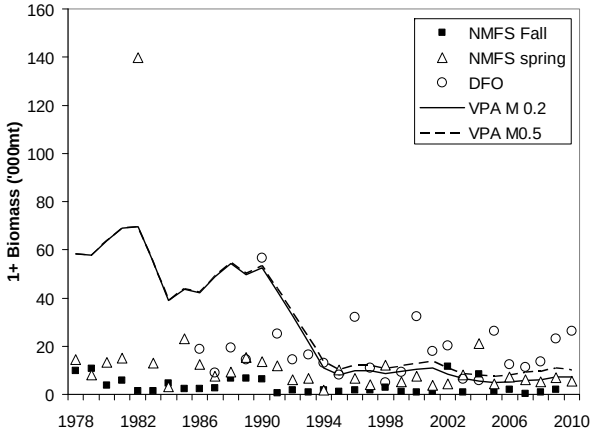


Figure 3. Age 1+ biomass from the surveys, "split M 0.2" and "split M 0.5" models.

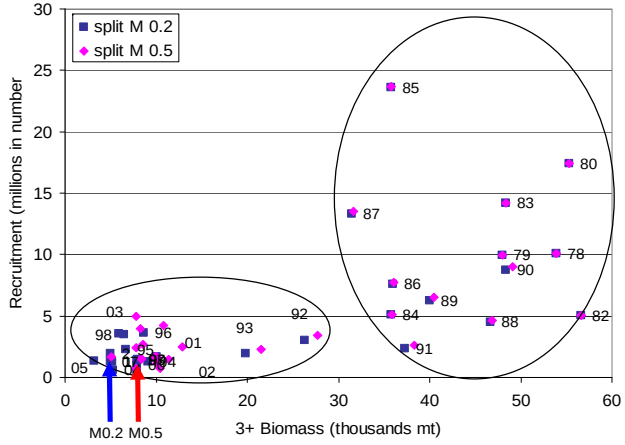


Figure 4. Stock recruitment patterns. Arrows indicate 2008 year-class at age 1.

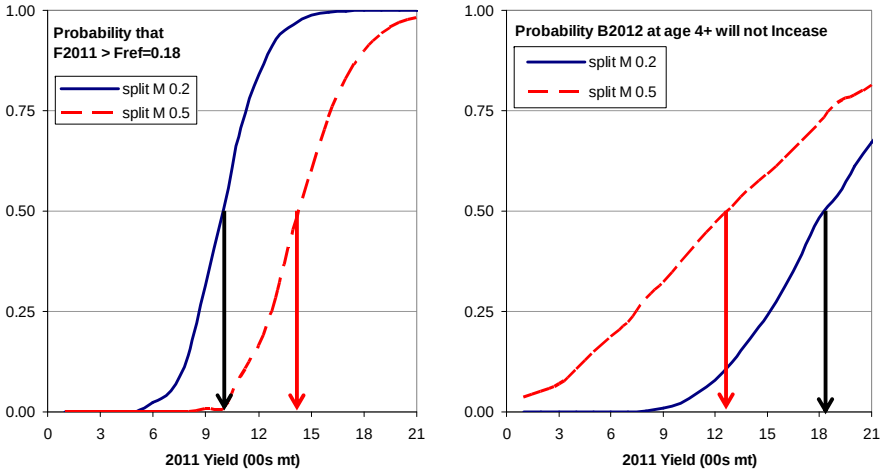


Figure 5. Projection and Risks.