



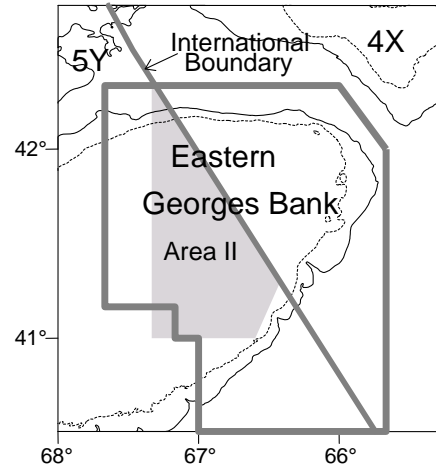
Transboundary Resources Assessment Committee

Status Report 2011/02

**EASTERN
GEORGES BANK**

COD

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



Summary

- Combined Canada/USA catches were 1,326 mt, including 221 mt of discards in the 2010 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 2011.
- Since 1995 adult population biomass (ages 3+) from the “split M 0.2” model has fluctuated between 3,100 mt and 10,100 mt. Biomass was 3,288 mt at the beginning of 2011. Since 1995 adult population biomass from the “split M 0.5” model has fluctuated between 4,200 mt and 12,600 mt. Biomass was 5,088 mt at the beginning of 2011. Biomass in 2011 is the second lowest in the time series from both models.
- Fishing mortality (F) in 2010 was estimated to be 0.41 from the “split M 0.2” model and 0.25 from the “split M 0.5” model. F has been consistently above $F_{ref} = 0.18$.
- Since 2000, the 2003 year class was the highest recruitment observed by either model, but was less than half of the average (about 10 million) during 1978-1990, when productivity was considered to be higher. The 2002 and 2004 year classes were the lowest on record in both models. Initial indications were that the 2007, 2008, and 2009 year classes were less than 2 million. Recruitment indices from the bottom trawl surveys for the 2010 year class were higher than those for recent year classes although they were not estimated in the VPA.
- Resource productivity is currently very poor due to low recent recruitment and low weights-at-age.

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- For the “split M 0.2” model, assuming a 2011 catch equal to the 1,050 mt total quota a combined Canada/USA catch of 600 mt corresponds to a neutral (50%) probability that F will exceed $F_{ref} = 0.18$. Catches of 1,350 mt will result in a neutral risk (50%) that the 2013¹ adult biomass (4+) will be lower than the 2012 adult biomass, a catch of 1,000 mt will result in a neutral risk (50%) that 2013¹ adult biomass will not increase by 10% and a catch of 650 mt will result in a neutral risk (50%) that 2013¹ adult biomass will not increase by 20%.
- For the “split M 0.5” model, assuming a 2011 catch equal to the 1,050 mt total quota a combined Canada/USA catch of 925 mt corresponds to a neutral (50%) probability that F will exceed $F_{ref} = 0.18$. Catches of 900 mt will result in a neutral risk (50%) that the 2013¹ adult biomass (4+) will be lower than the 2012 adult biomass and a catch of about 300 mt will result in a neutral risk (50%) that the 2013¹ adult biomass will not increase by 10%. Even at 0 catch, there is a more than 50% probability that 4+ biomass will not increase by 20% in 2013¹.

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

		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Avg ¹	Min ¹	Max ¹
Canada	Quota	1.2	1.3	1.0	0.7	1.3	1.4	1.6	1.2	1.0	0.9			
	Catch	1.4	1.5	1.3	0.9	1.4	1.2	1.5	1.2	0.8				
	Landed	1.3	1.3	1.1	0.6	1.1	1.1	1.4	1.0	0.7		5.9	0.6	17.8
	Discard	0.1	0.2	0.1	0.2	0.3	0.1	0.1	0.2	0.1	0.1	0.1	<0.1	0.5
USA	Quota ²			0.3	0.3	0.4	0.5	0.7	0.5	0.3	0.2			
	Catch ²			0.2	0.2	0.3	0.3	0.5	0.5	0.3				
	Landed	1.7	1.9	1.0	0.2	0.1	0.2	0.2	0.4	0.4		3.8	0.1	10.6
	Discard	<0.1	0.1	0.1	0.3	0.1	0.4	<0.1	0.2	0.1		0.1	<0.1	0.4
Total	Quota			1.3	1.0	1.7	1.9	2.3	1.7	1.3	1.1			
	Catch ^{3,4}			1.5	1.1	1.7	1.5	2.0	1.7	1.1				
	Catch	3.1	3.5	2.3	1.3	1.7	1.8	1.8	1.8	1.3		10.0	1.3	26.5
From "split M 0.2" model														
	Adult Biomass ⁵	7.9	5.9	5.1	3.1	4.2	3.9	3.6	4.2	3.9	3.3	22.1	3.1	59.2
	Age 1 Recruits	1.6	0.5	2.8	0.5	1.0	1.6	1.0	0.9	0.8		5.4	0.5	23.6
	Fishing mortality ⁶	0.48	0.80	0.85	0.43	0.69	0.49	0.53	0.54	0.41		0.6	0.3	1.3
	Exploitation Rate ⁶	35%	50%	53%	32%	45%	36%	38%	38%	31%		39%	26%	67%
From "split M 0.5" model														
	Adult Biomass ⁵	10.1	7.4	6.7	4.2	6.2	6.3	6.0	7.0	6.1	5.1	24.1	4.2	59.2
	Age 1 Recruits	1.9	0.7	4.1	0.6	1.3	1.9	1.2	1.1	1.0		5.6	0.6	23.8
	Fishing mortality ⁶	0.37	0.59	0.58	0.31	0.43	0.28	0.26	0.27	0.25		0.5	0.2	1.1
	Exploitation Rate ⁷	27%	40%	41%	23%	28%	18%	21%	25%	24%		33%	18%	60%
	Exploitation Rate ⁸	32%	43%	46%	35%	37%	34%	27%	20%	11%		35%	11%	60%

¹1978 – 2010

²for fishing year from May 1 – April 30

³for Canadian calendar year and USA fishing year May 1-April 30

⁴sum of Canadian landed, Canadian Discard, and USA Catch (includes discards)

⁵Jan 1 ages 3+

⁶ages 4-9

⁷ages 4-5

⁸ages 6-9

¹ Revised July 27, 2011 – 2012 corrected to 2013.

Fishery

Combined Canada/USA catches averaged 17,208 mt between 1978 and 1992, peaking at 26,464 mt in 1982. Catches declined to 1,683 mt in 1995, then fluctuated at about 3,000 mt until 2004, subsequently declining. Catches in 2010 were 1,326 mt, including 211 mt of discards (Figure 1).

Canadian catches decreased to 840 mt in 2010 from 1,209 mt in 2009. Since 1995, with reduction in cod quotas, the fishery has reduced targeting for cod through changes in fishing practices. All 2010 landings were subject to dockside monitoring, and at sea observers monitored close to 18% by weight of the mobile gear fleet landings, 6% by weight of the fixed gear landings and 10% by weight of the gillnet fleet landings. Discards were estimated at 48 mt from the mobile 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 44 mt in 2010.

USA catches decreased to 486 mt in 2010 from 628 mt in 2009. Since December 1994, a year-round closure of Area II has been in effect, with the exception of Special Access Programs in 2004 and 2010. With the implementation of a catch share system in 2010 most of the fleets are now managed by quotas. Estimated discards of cod for 2010 were 129 mt, almost entirely from the otter trawl groundfish fishery.

The combined Canada/USA 2010 **fishery age composition** (landings + discards) was dominated by the 2006 year class at age 4 (44% by number, 41% by weight), followed by the 2007 at age 3 (23% by number, 17% by weight) and the 2005 year class at age 5 (15% by number, 19% by weight). The contribution to the catch of fish older than age 7 continued to be small in recent years: 8% by number and 17% by weight in 2010, although the stronger 2003 year class turned to age 7 in this year.

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, $F_{ref} = 0.18$ (established in 2002 by the TMGC). 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 2010 (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 provides information on natural mortality at older ages.

Since 1995 **adult population biomass** (ages 3+) from the “split M 0.2” model has fluctuated between 3,100 mt and 10,100 mt. Biomass was 3,288 mt (80% confidence interval: 2,769 mt – 4,217 mt) at the beginning of 2011 (Figure 2). Since 1995 adult population biomass from the “split M 0.5” model has fluctuated between 4,200 mt and 12,600 mt. Biomass was 5,088 mt (80% confidence interval: 4,274 mt – 6,291 mt) at the beginning of 2011 (Figure 2). In both models, the increase since 2005 was largely due to recruitment and 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. Survey biomass indices have been lower since the mid-1990s. In 2011, the survey biomass for all the 3 surveys was lower than 2010, and the NMFS spring survey index was the second lowest in the time series. The estimated biomass at the beginning of 2011 from VPA was only 6.4% (“split M 0.2” model) and 10% (“split M 0.5” model) of the 1978 biomass. The 2011 estimates are the second lowest in the time series according to both models (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 88% for the “split M 0.2” model and approximately 62% for the “split M 0.5” model.

Recruitment at age 1 has been low in recent years. Since 2000, the 2003 year class (2.8 million fish – “split M 0.2” model and 4.1 million fish - “split M 0.5” model) was the highest recruitment observed by either model, but was less than half of the average (about 10 million) during 1978-1990, when the productivity was considered to be higher. The 2002 and 2004 year classes were the lowest on record in both models. The 2006 year class at age 1 at 1.6 million from the “split M 0.2” model and at 1.9 million from the “split M 0.5” model was closer to half the strength of the 2003 year class. Initial indications were that the 2007, 2008, and 2009 year classes were similar in strength to the 2000 year class, which was only about 10% of the 1978-1990 average recruitment in both models. The current biomass is well below 30,000 mt where recruitment has historically been poor (Figure 4). Recruitment indices from the bottom trawl surveys for the 2010 year class were higher than those for recent year classes although they were not estimated in the VPA.

Fishing mortality (population weighted average of ages 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 2010 was estimated to be 0.41 (80% confidence interval: 0.34-0.58) from the “split M 0.2” model and 0.25 (80% confidence interval: 0.21-0.34) from the “split M 0.5” model. F has been consistently above $F_{ref} = 0.18$ (Figure 1).

Both assessment models exhibit a retrospective pattern in which perceptions of fishing mortality were revised upward. If the retrospective pattern persists, the F in 2010 will be 39% higher than estimated above.

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 in the past, but has started to decline in recent years. The declines in length and weight at age from the early 1990s have hampered biomass rebuilding. **Size at age** in the 2010 fishery continued to decline for all the ages except for age 3. The research survey **spatial distribution** patterns of adult (3+) cod have not changed over the past decade. Resource productivity is currently very 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 2012. Uncertainty about current biomass generates uncertainty in forecast results, which is expressed here as the probability 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, the possibility that the model may not reflect stock dynamics closely enough and/or retrospective patterns.

For **projections**, the 2008-2010 average values were assumed for the fishery weight at age. The 2009-2011 survey average values were assumed for beginning of year population weights at age in 2012-2013. However, for the slower grow 2003 year class, fishery weights at age 8 in 2011 and age 9 in 2012 and beginning of year weights at age 9 in 2012 and at age 10 in 2013 were based on cohort regressed values. The 2006-2010 average values were assumed for the partial recruitment pattern in 2011-2012. Catch in 2011 was assumed to be equal to the 1,050 mt quota. Projections are provided from each of the model results.

A. “split M 0.2” model

A combined Canada/USA catch of 525 mt corresponds to a low (25%) probability that F will exceed $F_{ref}=0.18$, whereas catches of 600 mt correspond to a neutral (50%) probability and catches of 700 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 2013¹ adult biomass (4+) will be lower than the 2012 adult biomass, a catch of 1,000 mt will result in a neutral risk (50%) that 2013¹ adult biomass will not increase by 10% and a catch of 650 mt will result in a neutral risk (50%) that 2013¹ adult biomass will not increase by 20% (Figure 5).

B. “split M 0.5” model

A combined Canada/USA catch of 825 mt corresponds to a low (25%) probability that F will exceed $F_{ref}=0.18$, whereas catches of 925 mt correspond to a neutral (50%) probability and catches of 1,025 mt correspond to a high (75%) probability that F will exceed F_{ref} . Catches of 900 mt will result in a neutral risk (50%) that the 2013¹ adult biomass (4+) will be lower than the 2012 adult biomass (Figure 5) and a catch of about 300 mt will result in a neutral risk (50%) that

¹ Revised July 27, 2011 – 2012 corrected to 2013.

the 2013¹ adult biomass will not increase by 10%. Even at 0 catch there is a more than 50% probability that 4+ biomass will not increase by 20%.

2012 Catch (mt)

Probability of Exceeding F_{ref}	25%	50%	75%
Split M 0.2	525 mt	600 mt	700mt
Split M 0.5	825 mt	925 mt	1,025 mt

The benchmark methods do not account for the retrospective pattern in projections. If the magnitude of the retrospective pattern was accounted for, short term projections for catch would be decreased for both models.

While management measures have resulted in decreased exploitation rate since 1995, fishing mortality has remained above F_{ref} and adult biomass has fluctuated at a low level. The 2003 year class made a substantial contribution to the fishery and population biomass. It is projected to be only a small component in the population biomass and fishery catch biomass in 2011 (10% from “split M 0.2” model and 16% from “split M 0.5” model) and to a lesser extent in 2012 (less than 10% from both models). With the passing of the 2003 year class through the population, rebuilding will not occur without improved recruitment.

Special Considerations

Although the VPA used in both models for management advice assumes a split in the survey indices, the mechanisms for the large changes in survey catchability are not easily explained. These changes in survey catchability are most appropriately thought of as aliasing an unknown mechanism that produces a better fitting model. The inability to plausibly explain these survey catchability changes causes increased uncertainty in this assessment. This additional source of uncertainty should be considered when setting the 2012 quota and indicates lower catch advice than the projections from the two VPAs that assumed a split in the survey indices.

There is no strong evidence to determine which of the two benchmark methods provides a better scientific basis for fishery management; both models should be considered when setting catch levels. The range of stock perceptions and outlooks from the two models reflect the substantial uncertainty in the assessment. Despite these uncertainties, all assessment results indicate that low catches are needed to promote rebuilding and/or prevent further decline.

Source Documents

Wang Y, O'Brien L, Clark K, Hatt B. 2011. Assessment of Eastern Georges Bank Atlantic Cod for 2011. TRAC Reference Document 2011/02.

¹ Revised July 27, 2011 – 2012 corrected to 2013.

O'Brien L, Worcester T, editors. 2009. Proceedings of the Transboundary Resources Assessment Committee (TRAC): Transboundary Resources Assessment Committee Eastern Georges Bank cod benchmark assessment. TRAC Proceedings 2009/02.

Porter JM, O'Brien L, editors. 2011. Proceedings of the Transboundary Resources Assessment Committee (TRAC): Eastern Georges Bank Cod and Haddock, and Georges Bank Yellowtail Flounder. Report of Meeting held 20-24 June 2011. TRAC Proceedings 2011/01.

Correct Citation

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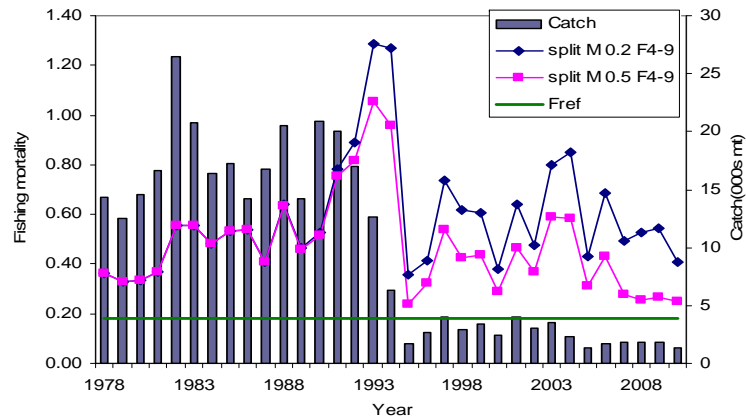


Figure 1. Catches and fishing mortality (F).

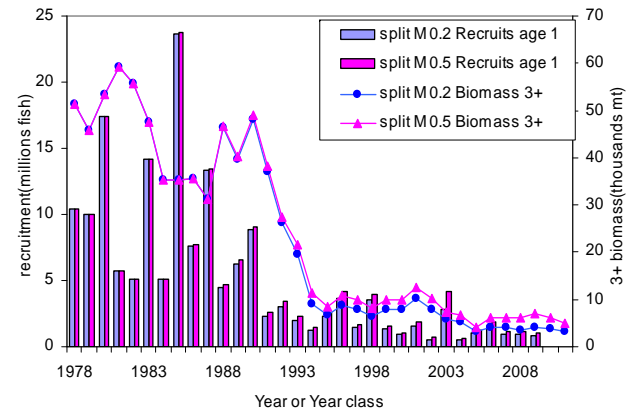


Figure 2. Biomass and recruitment.

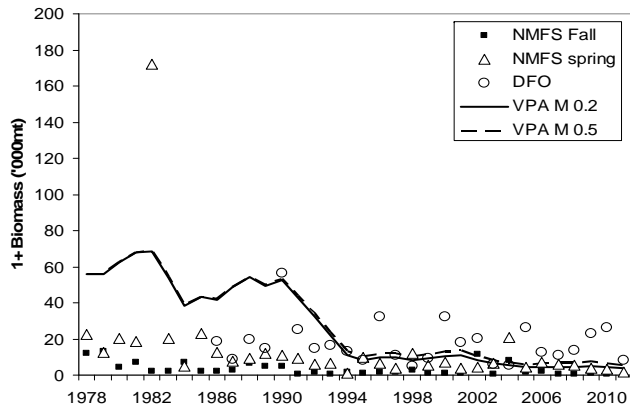


Figure 3. Age 1+ biomass from the surveys and assessments. The survey biomasses are not adjusted by survey catchability.

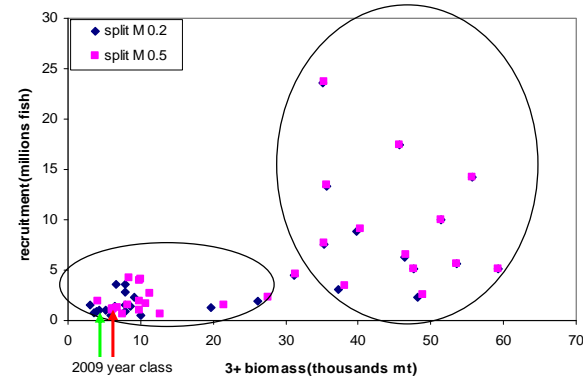


Figure 4. Stock recruitment patterns. Green and red arrows indicate 2009 year class at age 1 for from “split M 0.2” model and “split M 0.5” model, respectively.

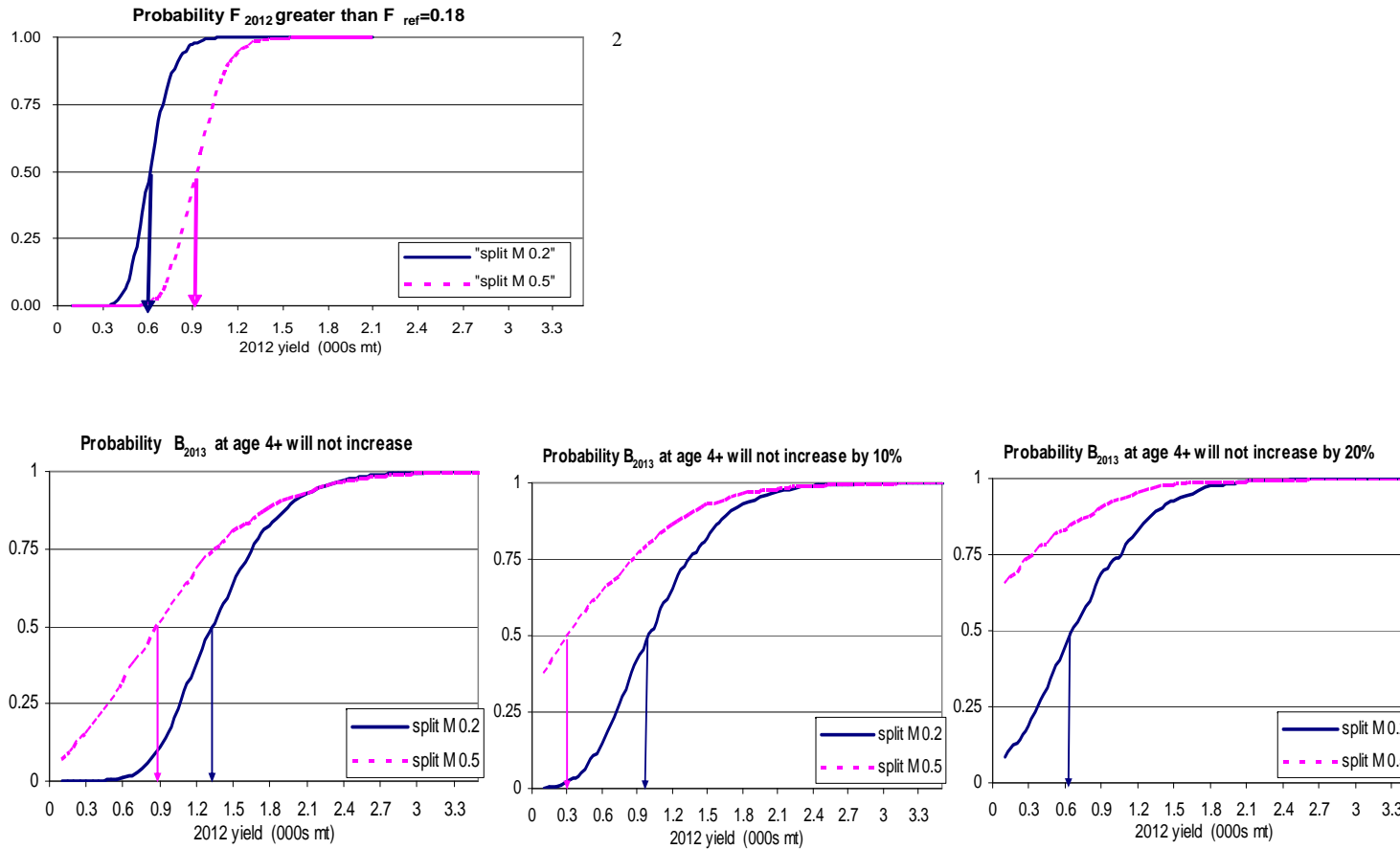


Figure 5. Projection and Risks.

² Revised July 27, 2011 – Figure added.