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New England Fishery Management Council

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C. M. "Rip" Cunningham, Jr., *Chairman* | Paul J. Howard, *Executive Director*

MEMORANDUM

DATE: January 30, 2012 *(Corrected Jan 31, 2013)*

TO: Groundfish Oversight Committee

FROM: Groundfish Plan Development Team (PDT)

SUBJECT: **GOM Cod – Example Catch Levels**

1. At the January 25, 2012 Science and Statistical Committee (SSC) meeting, the SSC concurred with the methods used by the PDT to calculate future catch levels for GOM cod based on the SARC 53 assessment, and to estimate the revenue impacts. This memo extends those analyses for several different possible catch scenarios and documents the information for the Committee.

Projected Catches

2. The catch levels shown in this memo include the scenarios prepared for the SSC as well as several additional scenarios. Future catch levels may be affected by an issue that has not yet been resolved*: if the rebuilding plan for this stock is modified, what is the ending date*? Most of the scenarios prepared for the SSC assume that F_{MSY} is the mortality target after a few years, which generally achieves the rebuilding target after 2030. This is both higher than the default ABC control rule and may not meet rebuilding requirements. The catch levels reviewed by the SSC are shown in Table 1 and Table 2; the probability stock size will be above 7,300 mt is shown in Table 3.

3. When the catch levels were prepared for the SSC the legal and policy framework was unclear. Most of the SSC scenarios were not based on achieving F_{MSY} in FY 2013. Based on a letter received from NOAA Fisheries on January 30, 2012, the legal and policy guidance is that any emergency or interim action taken by the Secretary for FY 2012 must meet two criteria:

- It must make a substantial reduction in overfishing. (It is not clear to the PDT what the starting point is for determining if a reduction overfishing is expected.)
- It must not deteriorate the condition of the stock. (Presumably this means that stock size must not decrease.)

4. The PDT prepared additional scenarios in light of this guidance that the Council may want to consider as a recommendation for an interim catch level in FY 2012. These scenarios used F_{MSY} as the fishing mortality rate in FY 2013 and beyond. The catch streams for the additional scenarios are shown in Table 4; the probability the SSB is greater than 7,300 mt is shown in Table 5. Catches, fishing mortality, and SSB are plotted in Figure 1 through Figure 3. Figure 4 plots the catch in 2012 vs. the catch in 2013 and the probability that the stock will exceed 7,300 mt. This figure includes catches sat 75 pct. of F_{MSY} in FY 2013; generally, these catches are about 600 mt less than the catches at F_{MSY}. ***It should be recognized that catch levels will be lower if the rebuilding plan ends before 2030.*** This can be seen by comparing the 2013 catches at F_{MSY} to the 2013 catches at 75 pct. of F_{MSY} in Figure 4 .

5. The catches from these scenarios are compared to various interpretations of the policy guidance in Table 12.

6. Large catches in the early years have a higher probability that the SSB will decline below the lowest levels observed (7,300 mt). The impact of these differences are difficult to portray, but the SSC notes that since these stock levels have not been observed there is uncertainty in how the stock might react. One preliminary PDT analysis suggested that if the stock declines below 7,300 mt in 2012 then the 2013 catches should be on the order of 800 mt. Fishing mortality increases from the estimate for 2011 at the GARM III ACL and the catch that maintains January 1 biomass.

7. The difference between the fishing year and the assessment/calendar year is problematic when the ABC changes dramatically from one year to the next. It is not yet clear if this is an issue the Council will need to take into account when setting fishing year catch levels.

8. There are a number of caveats worth repeating when considering these catch levels:

- Projections do not capture all sources of uncertainty. Extensive work by the PDT last summer indicated that groundfish stock projections are often biased high - that is, future stock growth is projected to be faster than realized, resulting in catches that are set too high.

- These projections do not account for the retrospective pattern that remains in the assessment.

- As the SSC noted, unresolved questions related to the assessment could affect the projections in either direction.

Economic Impacts

9. Using the analytic approach reviewed by the SSC the PDT prepared the impacts on groundfish revenues for several example catch scenarios. The results for these scenarios are summarized in Table 5 through Table 10. Note that these scenarios are not identical to the catch levels prepared

for the SSC as all assume that the limiting fishing mortality rate in 2013 is F_{MSY}. This is because it appears the Council will be required to end overfishing in FY 2013 – at a minimum. Rebuilding requirements could result in a lower mortality rate and lower catch levels.

10. There is less than 2 percent difference in the NPV of these scenarios over a five year time period. The net present value analysis (NPV) presented here does not capture the economic risk associated with catch scenarios that have a higher probability of reducing stock size to the lowest levels observed.

Table 1 – Calendar year catches for SSC scenarios. Catches in thousands of metric tons. Highlighted cells are constant catch years. (1) Projection assumes F_{MSY} in 2014 and beyond

Year	F=0 Adjusted for 2012 catch	75%Fmsy Adjusted for 2012 catch	Fmsy=0.2 Adjusted for 2012 catch	Catch Constant 2yr	Catch constant 3yr	Catch constant 4yr	Increase Jan 1 Biomass `10% to 2014	Maintain Jan 1 Biomass to 2014[1]
2011	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75
2012	2.2	3.223	3.541	2.7	3.55	4.3	6.339	7.779
2013	0	1.961	2.512	2.7	3.55	4.3	7.075	8.302
2014	0	2.989	3.747	3.885	3.55	4.3	2.315	1.803
2015	0	4.023	4.939	5.074	4.791	4.3	3.535	3.011
2016	0	4.967	5.988	6.111	5.854	5.468	4.774	4.289
2017	0	5.835	6.91	7.015	6.811	6.472	5.887	5.432
2018	0	6.648	7.752	7.838	7.658	7.383	6.927	6.533
2019	0	7.351	8.457	8.522	8.397	8.168	7.801	7.477
2020	0	7.898	9.004	9.045	8.942	8.774	8.511	8.266
2021	0	8.312	9.389	9.421	9.341	9.211	8.97	8.778
2022	0	8.631	9.684	9.71	9.653	9.548	9.43	9.271
2023	0	8.871	9.895	9.914	9.871	9.798	9.679	9.571
2024	0	9.04	10.045	10.06	10.029	9.97	9.855	9.783
2025	0	9.166	10.148	10.155	10.127	10.076	9.995	9.944
2026	0	9.259	10.208	10.217	10.2	10.161	10.135	10.099
2027	0	9.324	10.262	10.267	10.252	10.224	10.192	10.165
2028	0	9.368	10.3	10.304	10.297	10.28	10.255	10.234
2029	0	9.427	10.347	10.35	10.344	10.333	10.302	10.281
2030	0	9.473	10.376	10.378	10.374	10.365	10.287	10.277

Table 2 –Fishing year catches. For the three F-based scenarios, the FY 2012 catch is the projection output at the target F. For the other scenarios, the FY 2012 catch is 2,200 mt plus 70 percent of the projection output for the calendar year catch. Thousands of metric tons.

(1) The difference between the fishing year and the calendar year is problematic when there are large decreases in the ABC from one year to the next. These values for 2014 do not consider the difference between the fishing year and the calendar year.

Year	F=0 Adjusted for 2012 catch	75%Fmsy Adjusted for 2012 catch	Fmsy=0.2 Adjusted for 2012 catch	Catch Constant 2yr	Catch constant 3yr	Catch constant 4yr	Increase Jan 1 Biomass 10% to 2014	Maintain Jan 1 Biomass to 2014
2011	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75
2012	0	1.462	1.915	0.714	1.93	3.0	5.9	7.97
2013	0	1.961	2.512	2.7	3.55	4.3	7.075	8.302
2014	0	2.989	3.747	3.885	3.55	4.3	2.315[1]	1.803[1]
2015	0	4.023	4.939	5.074	4.791	4.3	3.535	3.011
2016	0	4.967	5.988	6.111	5.854	5.468	4.774	4.289
2017	0	5.835	6.91	7.015	6.811	6.472	5.887	5.432
2018	0	6.648	7.752	7.838	7.658	7.383	6.927	6.533
2019	0	7.351	8.457	8.522	8.397	8.168	7.801	7.477
2020	0	7.898	9.004	9.045	8.942	8.774	8.511	8.266
2021	0	8.312	9.389	9.421	9.341	9.211	8.97	8.778
2022	0	8.631	9.684	9.71	9.653	9.548	9.43	9.271
2023	0	8.871	9.895	9.914	9.871	9.798	9.679	9.571
2024	0	9.04	10.045	10.06	10.029	9.97	9.855	9.783
2025	0	9.166	10.148	10.155	10.127	10.076	9.995	9.944
2026	0	9.259	10.208	10.217	10.2	10.161	10.135	10.099
2027	0	9.324	10.262	10.267	10.252	10.224	10.192	10.165
2028	0	9.368	10.3	10.304	10.297	10.28	10.255	10.234
2029	0	9.427	10.347	10.35	10.344	10.333	10.302	10.281
2030	0	9.473	10.376	10.378	10.374	10.365	10.287	10.277

Table 3 – Probability SSB is more than 7,300 mt for SSC scenarios

Year	F=0 Adjusted for 2012 catch	75%Fmsy Adjusted for 2012 catch	Fmsy=0.2 Adjusted for 2012 catch	Catch Constant 2yr	Catch constant 3yr	Catch constant 4yr	Increase Jan 1 Biomass 10% to 2014	Maintain Jan 1 Biomass to 2014
2011	0.811	0.811	0.811	0.811	0.811	0.811	0.811	0.811
2012	0.776	0.758	0.755	0.766	0.755	0.736	0.71	0.66
2013	0.974	0.947	0.935	0.952	0.921	0.881	0.869	0.617
2014	1	0.99	0.998	0.996	0.981	0.96	0.989	0.897
2015	1	1	1	0.99	0.992	0.974	1	0.998
2016	1	1	1	1	0.998	0.981	1	1
2017	1	1	1	1	1	0.993	1	1
2018	1	1	1	1	1	0.997	1	1
2019	1	1	1	1	1	0.998	1	1
2020	1	1	1	1	1	0.999	1	1
2021	1	1	1	1	1	0.999	1	1
2022	1	1	1	1	1	1	1	1
2023	1	1	1	1	1	1	1	1
2024	1	1	1	1	1	1	1	1
2025	1	1	1	1	1	1	1	1
2026	1	1	1	1	1	1	1	1
2027	1	1	1	1	1	1	1	1
2028	1	1	1	1	1	1	1	1
2029	1	1	1	1	1	1	1	1
2030	1	1	1	1	1	1	1	1

Table 4 – Example calendar year catch levels assuming F$_{MSY}$ in 2013. Catch in '000's of metric tons.

Year	GARM 3 ACL	Maintain Biomass 2012 - 2013	CY 2012 6000	CY 2012 5000	CY 2012 4000	CY 2012 3000	Fmsy in 2012
2011	7.75	7.75	7.75	7.75	7.75	7.75	7.75
2012	8.551	7.8	6	5	4	3	1.915
2013	1.674	1.774	2.082	2.256	2.431	2.607	2.796
2014	2.92	3.034	3.336	3.504	3.672	3.837	4.009
2015	4.155	4.27	4.56	4.717	4.869	5.02	5.167
2016	5.227	5.339	5.62	5.772	5.92	6.061	6.2
2017	6.209	6.327	6.584	6.725	6.856	6.972	7.101
2018	7.178	7.273	7.488	7.601	7.707	7.806	7.91
2019	7.991	8.075	8.26	8.35	8.422	8.497	8.581
2020	8.613	8.683	8.836	8.91	8.977	9.034	9.094
2021	9.079	9.126	9.24	9.314	9.368	9.413	9.468
2022	9.451	9.494	9.588	9.632	9.669	9.702	9.736
2023	9.727	9.761	9.83	9.857	9.882	9.907	9.929
2024	9.928	9.949	9.997	10.018	10.036	10.05	10.073
2025	10.056	10.07	10.105	10.125	10.141	10.15	10.163
2026	10.148	10.156	10.182	10.194	10.204	10.21	10.223
2027	10.215	10.224	10.241	10.251	10.26	10.27	10.272
2028	10.273	10.277	10.29	10.294	10.298	10.3	10.305
2029	10.331	10.332	10.339	10.342	10.345	10.35	10.351
2030	10.36	10.363	10.371	10.373	10.375	10.38	10.38

Table 5 – Probability SSB is greater than 7,300 mt for different catch scenarios

Year	GARM 3 ACL	Maintain Biomass 2012 - 2013	CY 2012 6000	CY 2012 5000	CY 2012 4000	CY 2012 3000	Fmsy in 2012
2011	0.811	0.811	0.811	0.811	0.811	0.811	0.811
2012	0.609	0.634	0.686	0.718	0.745	0.76	0.794
2013	0.665	0.719	0.823	0.879	0.922	0.951	0.99
2014	0.956	0.965	0.982	0.992	0.997	0.999	1
2015	0.994	0.995	0.998	1	1	1	1
2016	0.999	0.999	1	1	1	1	1
2017	1	1	1	1	1	1	1
2018	1	1	1	1	1	1	1
2019	1	1	1	1	1	1	1
2020	1	1	1	1	1	1	1
2021	1	1	1	1	1	1	1
2022	1	1	1	1	1	1	1
2023	1	1	1	1	1	1	1
2024	1	1	1	1	1	1	1
2025	1	1	1	1	1	1	1
2026	1	1	1	1	1	1	1
2027	1	1	1	1	1	1	1
2028	1	1	1	1	1	1	1
2029	1	1	1	1	1	1	1
2030	1	1	1	1	1	1	1

Table 6 – FY 2012 catch that maintains Jan 1 biomass from 2012 to 2013

	ACL (mt)		F		Probability stock falls below lowest level ever	SSB (Jan 1, mt)	Recreational sub-ACL (lbs.)	Commercial sub-ACL (lbs.)	Commercial gross groundfish revenue	Inshore GOM small vsl share
	FY	CY	FY	CY			FY	FY		
2012	7,782	7,757	**1.10**	**> 1.1**	28%	8,265	**5,376,192**	**9,183,706**	**$89,032,765**	8.6%
2013	1,761	3,567	0.20	**> 0.20**	5%	9,219	**1,216,586**	**2,078,194**	**$72,306,647**	3.2%
2014	2,965	2,604	0.20	< 0.20	< 1%	14,873	**2,048,369**	**3,499,061**	**$78,146,358**	4.6%
2015	4,184	3,818	0.20	< 0.20	< 1%	20,905	**2,890,515**	**4,937,629**	**$83,672,439**	5.6%
2016	5,329	4,986	0.20	< 0.20	< 1%	26,788	**3,681,538**	**6,288,868**	**$87,092,367**	6.5%

Rebuild year: ➤ 2030

Net Present Value: *$378,172,222*

Net Present Value Inshore GOM Small: *$22,144,632*

ABC	= Allowable Biological Catch
FY	= Fishing year, May 1 - April 30 (allocation year)
CY	= Calendar year, Jan 1 - Dec 30 (assessment year)
ACL	= Annual Catch Level = ABC * ???
F	= Fishing mortality rate
Overfishing	= YES when F > 0.2, NO when F < 0.2
Collapse risk	= Probability that stock size will decline below 7,200mt SSB
Recreational sub-ACL	= Recreational fishery allocation, lbs
Commercial sub-ACL	= Commercial fishery allocation (Sector + Common Pool), lbs
Commercial gross revenue	= One-year model of estimated gross revenues for commercial sector vessels, estimates are gross approximations after 2012
Net Present Value	= Net present value, assuming 3% discount rate
Inshore GOM small vsl share	= Proportion of total estimated gross groundfish revenues accruing to vessels under 50ft sailing from ports in New Hampshire plus Gloucester, Scituate, Plymouth and Provincetown MA.

Note: NPV corrected January 31, 2012

Table 7 – FY 2012 catch of 6,000 mt

	ACL (mt)		F		Probability stock falls below lowest level ever	SSB (Jan 1, mt)	Recreational sub-ACL (lbs.)	Commercial sub-ACL (lbs.)	Commercial gross groundfish revenue	Inshore GOM small vsl share
	FY	CY	FY	CY			FY	FY		
2012	6,000	6,510	**0.76**	**> 0.76**	12%	8,815	**4,145,098**	**7,080,730**	**$90,042,479**	**7.0%**
2013	2,082	3,257	0.20	**> 0.20**	5%	10,829	**1,438,349**	**2,457,013**	**$73,995,815**	**3.6%**
2014	3,336	2,960	0.20	< 0.20	< 1%	16,788	**2,304,674**	**3,936,886**	**$80,009,240**	**5.0%**
2015	4,560	4,193	0.20	< 0.20	< 1%	22,925	**3,150,274**	**5,381,355**	**$84,743,318**	**5.8%**
2016	5,620	5,302	0.20	< 0.20	< 1%	28,615	**3,882,575**	**6,632,283**	**$88,823,341**	**6.7%**

Rebuild year: ➤ 2030

Net Present Value: $384,923,555

Net Present Value Inshore GOM Small: $22,038,344

Note: NPV corrected January 31, 2012

Table 8 – FY 2012 catch of 5,000 mt

	ACL (mt)		F		Probability stock falls below lowest level ever	SSB (Jan 1, mt)	Recreational sub-ACL (lbs.)	Commercial sub-ACL (lbs.)	Commercial gross groundfish revenue	Inshore GOM small vsl share
	FY	CY	FY	CY			FY	FY		
2012	5,000	5,810	**0.60**	**> 0.60**	18%	9,070	**3,454,248**	**5,900,608**	**$86,095,951**	6.3%
2013	2,256	3,079	0.20	**> 0.20**	5%	11,681	**1,558,557**	**2,662,354**	**$74,034,809**	3.9%
2014	3,504	3,130	0.20	< 0.20	< 1%	17,650	**2,420,737**	**4,135,146**	**$81,232,275**	5.2%
2015	4,717	4,353	0.20	< 0.20	< 1%	23,773	**3,258,738**	**5,566,634**	**$84,985,285**	6.0%
2016	5,772	5,456	0.20	< 0.20	< 1%	29,458	**3,987,584**	**6,811,662**	**$89,635,505**	6.8%

Rebuild year: ➤ 2030

Net Present Value: $383,048,597

Net Present Value Inshore GOM Small: $21,696,467

Note: NPV corrected January 31, 2012

Table 9 – FY 2012 catch of 4,000 mt

	ACL (mt)		F		Probability stock falls below lowest level ever	SSB (Jan 1, mt)	Recreational sub-ACL (lbs.)	Commercial sub-ACL (lbs.)	Commercial gross groundfish revenue	Inshore GOM small vsl share
	FY	CY	FY	CY			FY	FY		
2012	4,000	5,110	0.46	> 0.46	8%	9,309	2,763,399	4,720,486	$84,356,272	5.4%
2013	2,431	2,902	0.20	> 0.20	3%	12,541	1,679,456	2,868,876	$74,493,931	4.0%
2014	3,672	3,300	0.20	< 0.20	< 1%	18,513	2,536,800	4,333,407	$82,565,677	5.3%
2015	4,869	4,510	0.20	< 0.20	< 1%	24,610	3,363,747	5,746,012	$86,042,899	6.1%
2016	5,920	5,605	0.20	< 0.20	< 1%	30,297	4,089,830	6,986,320	$90,222,191	6.9%

Rebuild year: >2030

Net Present Value: $382,766,680

Net Present Value Inshore GOM Small: $21,476,491

Note: NPV corrected January 31, 2012

Table 10 – FY 212 catch of 3,000 mt

	ACL (mt)		F		Probability stock falls below lowest level ever	SSB (Jan 1, mt)	Recreational sub-ACL (lbs.)	Commercial sub-ACL (lbs.)	Commercial gross groundfish revenue	Inshore GOM small vsl share
	FY	CY	FY	CY			FY	FY		
2012	3,000	4,410	**0.33**	**> 0.33**	5%	9,530	**2,072,549**	**3,540,365**	**$78,146,358**	4.6%
2013	2,607	2,725	0.20	**> 0.20**	< 1%	13,411	**1,801,045**	**3,076,577**	**$76,572,224**	4.2%
2014	3,837	3,468	0.20	< 0.20	< 1%	19,370	**2,650,790**	**4,528,127**	**$82,865,677**	5.2%
2015	5,020	4,665	0.20	< 0.20	< 1%	25,448	**3,468,065**	**5,924,210**	**$86,095,951**	6.3%
2016	6,061	5,749	0.20	< 0.20	< 1%	31,136	**4,187,240**	**7,152,717**	**$90,042,479**	7.0%

Rebuild year: ➤ 2030

Net Present Value: $380,323,428

Net Present Value Inshore GOM Small: $20,773,934

Note: NPV corrected January 31, 2012

Table 11 – FY 2012 catch at F_{MSY}

	ACL (mt)		F		Probability stock falls below lowest level ever	SSB (Jan 1, mt)	Recreational sub-ACL (lbs.)	Commercial sub-ACL (lbs.)	Commercial gross groundfish revenue	Inshore GOM small vsl share
	FY	CY	FY	CY			FY	FY		
2012	1,915	3,666	0.2	**> 0.2**	< 1%	9,478	**1,322,977**	**2,259,933**	**$73,412,576**	**3.4%**
2013	2,796	2,532	0.2	< 0.2	< 1%	9,754	**1,931,616**	**3,299,620**	**$77,072,224**	**4.4%**
2014	4,009	3,645	0.2	< 0.2	< 1%	14,357	**2,769,616**	**4,731,108**	**$82,847,502**	**5.5%**
2015	5,167	4,820	0.2	< 0.2	< 1%	20,292	**3,569,620**	**6,097,688**	**$86,966,944**	**6.4%**
2016	6,200	5,890	0.2	< 0.2	< 1%	26,242	**4,283,268**	**7,316,754**	**$90,666,142**	**7.1%**

Rebuild year: ➢ 2030

Net Present Value: **$377,356,154**

Net Present Value Inshore GOM Small: **$20,288,646**

Note: NPV corrected January 31, 2012

Table 12 – Evaluation of possible catch levels for changes in SSB and fishing mortality from various starting points. A "yes" answer indicates an increase in SSB or a decrease in fishing mortality.

(1) Projections were not started from the MRIP adjusted sensitivity run and as a result these evaluations are tentative.

Catch in 2012 '000's of mt	At catch is SSB in 2013 higher than:				At catch is fishing mortality in 2012 lower than:			
	2010	2010 MRIP Adjusted Sensitivity[1]	2011 Estimate	2012	2010	2010 MRIP Adjusted Sensitivity[1]	2011 Estimate	2012 FW 44 ABC
8.551	No	*No*	No	Yes	No	*No*	No	No
7.8	No	*No*	No	Yes	Yes	*No*	No	Yes
6.0	No	*No*	Yes	Yes	Yes	*Yes*	Yes	Yes
5.0	No	*Yes*	Yes	Yes	Yes	*Yes*	Yes	Yes
4.0	Yes	*Yes*	Yes	Yes	Yes	*Yes*	Yes	Yes
3.0	Yes	*Yes*	Yes	Yes	Yes	*Yes*	Yes	Yes
1.92	Yes	*Yes*	Yes	Yes	Yes	*Yes*	Yes	Yes

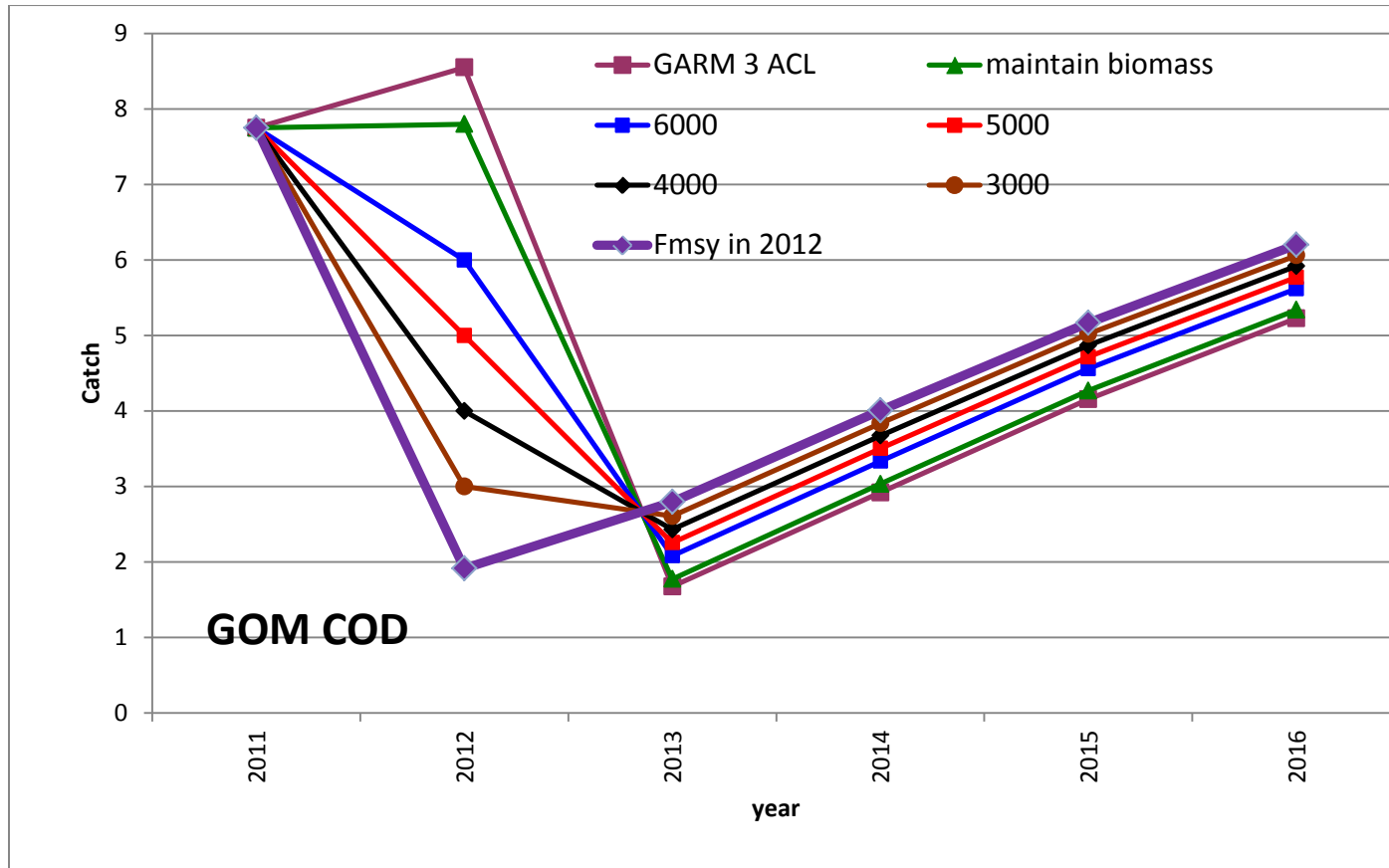**Figure 1 – Median catch streams through 2016 for seven scenarios**

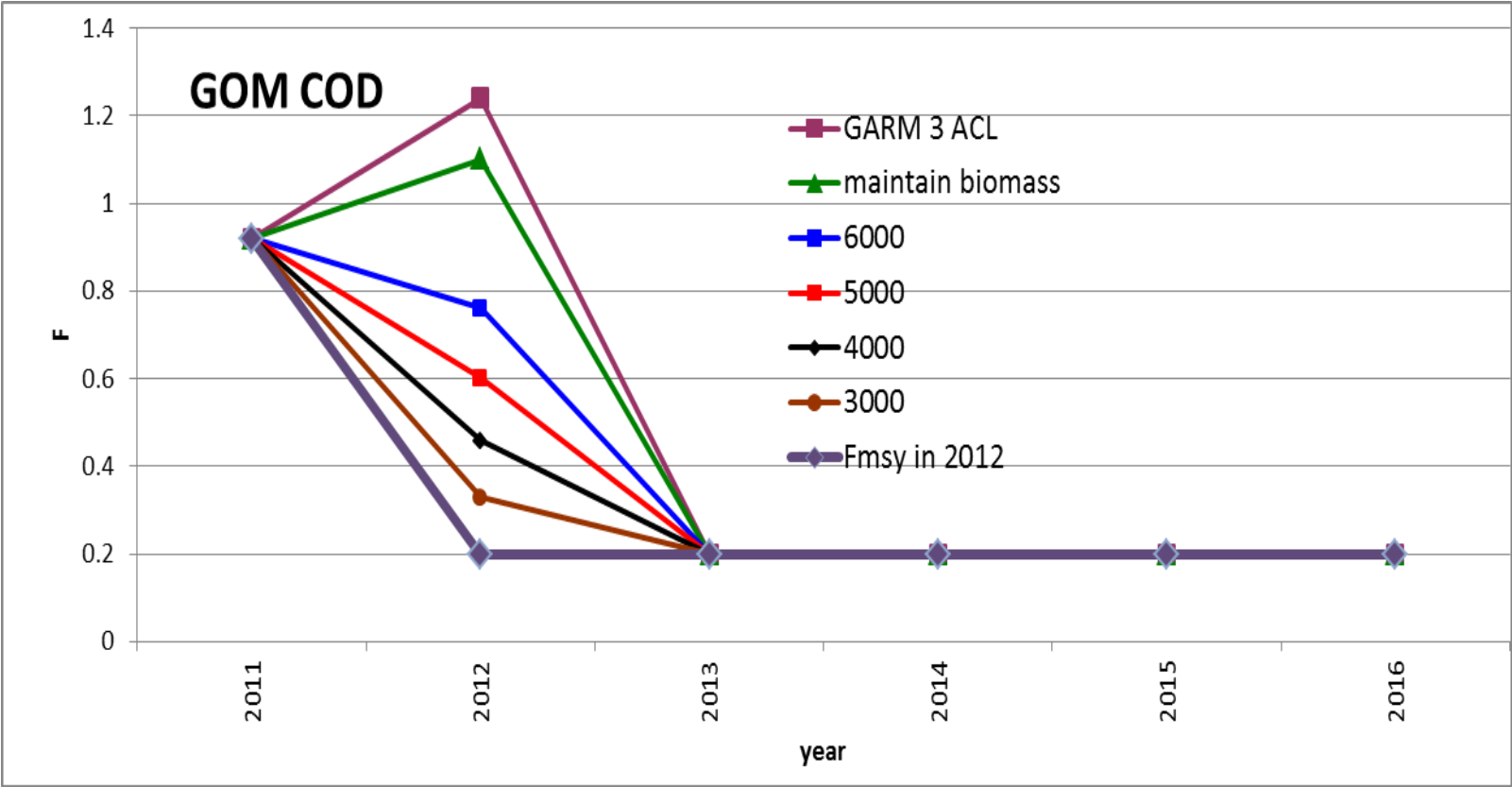**Figure 2 – Fishing mortality for seven scenarios**

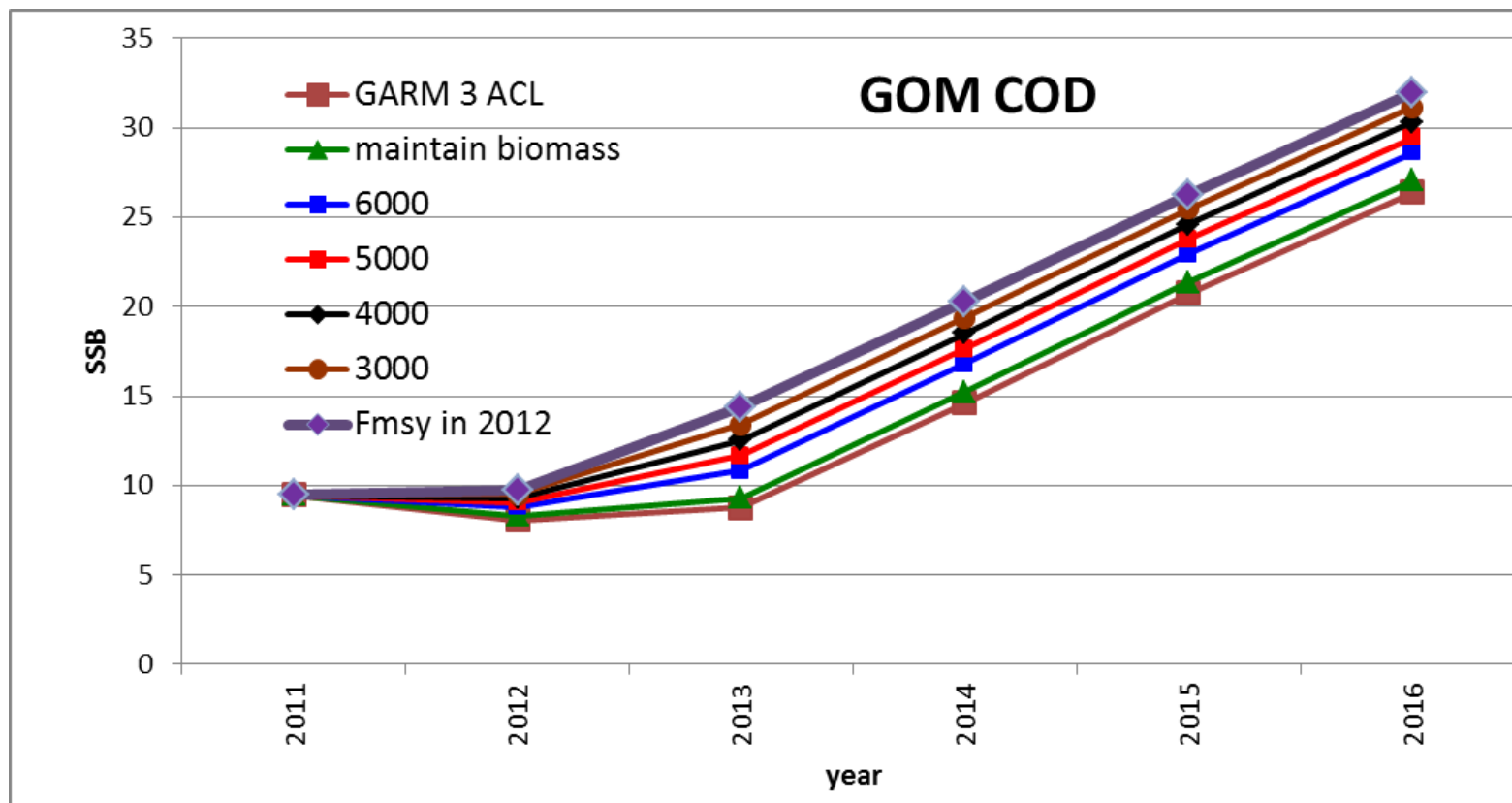**Figure 3 – Median SSB trajectories for seven scenarios**

Figure 4 – Plot of catch in 2012 vs. .catch in 2013 (left axis), combined with plot of catch in 2012 vs. probability SSB will be less than 7,300 mt at the start of 2013. Probabilities assume F_{MSY} in 2013.