New England Fishery Management Council
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MEMORANDUM

DATE: January 12, 2012

TO: Science and Statistical Committee (SSC)

FROM: Groundfish Plan Development Team (PDT)

SUBJECT: **Gulf of Maine Cod – Projected Catches**

1. For the SSC's January 25, 2012 meeting, the PDT calculated GOM cod catches for the scenarios listed. These scenarios may not meet legal or policy objectives.

1) F=0
2) 75% of F_{MSY}
3) F_{MSY}
4) Constant catch that ends overfishing in 2, 3 or 4 years
5) Catch that allows the current stock (2012 January 1 biomass) to grow ~10 pct annually from 2012 – 2014. This differs slightly from the TORs because the PDT found it impossible to increase stock size by 10 percent from 2011 to 2012, even at F=0.
6) Catch that maintains current stock size (2012 January 1 biomass) through 2013.

Projection Assumptions

2. The projections are based on the SARC 53 Gulf of Maine cod assessment. The PDT is aware that there may be changes to this assessment as a result of revised recreational catch estimates but until those changes are known the PDT cannot be certain what the impacts will be. Informal information suggests the MRIP recreational catches may be lower than that used in the assessment that was based on MRFSS data. Revised recreational catch estimates based on the MRIP program are expected to be release prior to the January Council meeting. These could affect the assessment by changing the catch and weights-at-age, but it is not clear when the analyses with the new catches will be available. The new recreational estimates could also change the catch estimated for 2011. Neither of these changes is likely to be large enough that projected ABCs will approach recent values. The catches provided in this memorandum are

based on the data currently available to the PDT and do not take into account the possible changes to recreational catch estimates.

3. All projection inputs for selectivity, weights-at-age, maturity, initial numbers at age, etc. are those specified by the assessment and the SARC review panel. The recruitment assumption samples from a cumulative distribution function (c.d.f.) based on all recruitments. Since the smallest observed stock size was 7,300 mt, the c.d.f. declines linearly from this point to zero as the stock approaches zero. This approach was specified by the review panel. The PDT ran a sensitivity analysis on one scenario where a different recruitment was used to specify the c.d.f. (details are provided below). The main projection assumption changed by the PDT was the assumption for catch in 2011 and 2012.

4. 2011 Catch Assumption: The projections run for the SARC assumed that the 2011 catch was the same as the 2010 catch – 11,392 mt. There is evidence, however, that the 2011 catch was not the same as the 2010 catch used in the assessment.

Commercial catch estimates provided by NERO, based on ACL monitoring, estimated the CY 2011 catch (landings and discards) as 4,349 mt, common pool and sector vessels combined. This is less than the 5,598 mt caught in CY 2010.

The GOM cod assessment calculated recreational catches in 2010 as 5,794 mt. This was much higher than the 2,923 mt caught in 2009. Further investigation shows that the increase is primarily due to an unusually high estimate of catch in Wave 2 (March/April), a period when landing GOM cod is only legal for two weeks. While new estimates will eventually be available through the MRIP system they are not yet public.

The MRFSS cod numbers for 2011 are more similar to 2008 and 2009 than they are 2010 (see Table 1). Note that these are not stock specific – while stock-specific values are available for 2008 – 2010 they are not yet available for 2011. In 2008 the recreational catch of GOM cod was 2,858 mt; in 2009 it was 2,923 mt. Since the cod numbers caught in waves 2-5 are similar for the years 2008, 2009, and 2010, the PDT assumed 2011 GOM cod catches were 3,000 mt in 2011 – similar to the 2008 and 2009 values.

Table 1 – MRFSS cod catches (numbers of fish; not stock specific)

TOTAL CATCH (TYPE A + B1 + B2)	Year – Running Totals in Each Wave			
Wave	2008	2009	2010	2011
2	298,346	175,282	1,530,940	269,632
3	1,214,897	972,392	2,405,049	1,009,454
4	1,531,034	1,187,942	2,753,711	1,281,229
5	1,757,199	1,368,384	3,046,994	1,440,103
6	1,767,454	1,622,055	3,067,049	1,440,103

In FY 2010, approximately 250 mt (247.8 mt) was caught by other fisheries. There does not appear to be a reason to expect this to change dramatically in 2011.

Based on this information, a revised catch estimate for 2011 seems appropriate. The catch weights for 2011 used in the projection are shown below.

Commercial sector and common pool:	4,500 mt
Recreational:	3,000 mt
Other:	250 mt
Total	**7,750 mt**

5. 2012 catch assumption: The SARC projections assumed that the 2012 ABC is caught in 2012. As discussed in attachment A, this assumption ignores the difference between the assessment calendar year and the groundfish fishing year. The assessment uses data from a calendar year and the catch output is also for the calendar year. The groundfish fishing year is from May 1 through April 30 and ABCs are specified for this year. As explored in Attachment A, this difference may be important for determining catches and stock size when there are large changes in the authorized catch levels from year to year. It is very possible that catches before May 1, 2012 (the earliest new specifications are likely to be adopted) will exceed the desired calendar year catch at 75% of MFSY or F_{MSY}.

Unfortunately, there is only one year of catch data under sectors to use to develop an estimate of how much catch will be caught from January – April 2012. In FY 2010, 58 percent of the commercial catch was harvested between May – December 2010, and only 84 percent total was caught for the entire year. In FY 2011, however, about 70 percent (3,356 mt) of the commercial ACL was caught during May – December 24. It appears that FY 2011 commercial catches will approach the total ACL (5,169 mt), which would mean that the fishery is on track to catch about 1,800 mt between January and April 2012.

The recreational fishery is more uncertain. In terms of numbers of fish, in CY 2008 about 17 percent of the cod caught were harvested in March/April 2008. In CY 2009 about 11 percent of the cod caught was harvested in March/April 2009. If the weight of GOM cod caught is proportional to the numbers of cod (no stock ID) caught, then in March/April 2008 GOM cod catches were about 485 mt and in 2009 it was about 323 mt. The average of these two numbers is 404 mt. The 2010 values are not shown here because they appear unusually high.

Based on this analysis, an estimate of catches in the first four months of CY 2012 is about 2,200 mt (1,800 mt commercial; 400 mt recreational). Note that this is higher than the SARC projection for 2012 catches at F_{MSY}.

It is not clear what measures will be adopted to control catches in FY 2012, beginning May 2012. So if the assumption is that necessary measures will be adopted to restrict catches to the ABC/ACL for the fishing year and the distribution of catches will remain unchanged, then the catches from May – December 2012 would be about 70 percent of the FY 2012 ABC.

The end result is that in order to calculate catches and projected stock size, an iterative process needs to be followed to account for CY 2012 catches because of the large change in ABCs/ACLs from FY 2011 to FY 2012. The process is as follows:

1) Calculate ABC for calendar year 2012 using the desired mortality targets or management objective.

2) Rerun the projection using the desired mortality target for 2013 and beyond. For 2012, input catch, calculated as:

Catch Jan – Apr 2012 (2,200 mt) plus 70 percent of 2012 ABC

This iterative process could be repeated for later years as well. It was not because previous work by the PDT has demonstrated that catch advice is not very sensitive to short term catches unless there are large changes in catches or mortality targets.

6. Recruitment: The SARC projections use a two-stage recruitment stream. When stock size is above 7,300 mt SSB, the projection uses a cumulative distribution function of observed recruitments. When stock size is below 7,300 mt SSB recruitment declines linearly to 0.

The recruitment stream for the entire time series has a median value of 7.4 million. The median for the last five years is 6.75 million, 91.4 pct of the long-term median. The median for the last ten years is 6.9 million, 93 pct of the long-term median. The median for the last 20 years is 6.3 million, 85 pct of the long-term median. Perhaps more importantly, over the entire series the 90^{th} percentile is 14.4 million while over the last twenty years it is 9.1 million. In recent years there have been fewer high recruitment events.

7. As a sensitivity analysis to evaluate the impact of the recruitment assumption on short-term catch advice, projections were also run using a c.d.f. based on the most recent twenty years of recruitment. This was only performed for the FMSY scenario. This sensitivity analysis on recruitment levels demonstrated that using the last 20 years of observed recruitment results in lower catch and SSB starting in 2015 when compared to using the long-term recruitment stream.

Outputs

8. The results from each projection scenario are provided in Attachment B. The following information is provided:

- Median catch for years 2011 – 2030
- Median F for years 2011 - 2030
- Median SSB for years 2011 – 2030
- Probability of stock size being less than 7,300 mt SSB in each year. This is provided as a rough metric of the risk of stock collapse, if stock collapse is defined as a decline in stock size below the lowest observed value in the time series.

9. All catches shown are calendar year catches. The practice has been to “slide” these catches forward to the fishing year. This may be problematic for the constant catch scenarios in FY 2012 given the large change between the FY 2011 ABC and these projected catches. Table 11 adjusts the FY 2012 ABCs so that the 2012 calendar year catch would be expected to equal the projection input. It may also be a problem for the constant catch scenarios in the years when the target is reduced to F_{MSY}; the PDT will bring additional material to the SSC meeting to address this point.

Based on the projections in all cases there is a 20-34 percent probability that SSB in 2012 would be lower than the lowest value in the time series (see Table 6 and Table 10).

Comments/Discussion

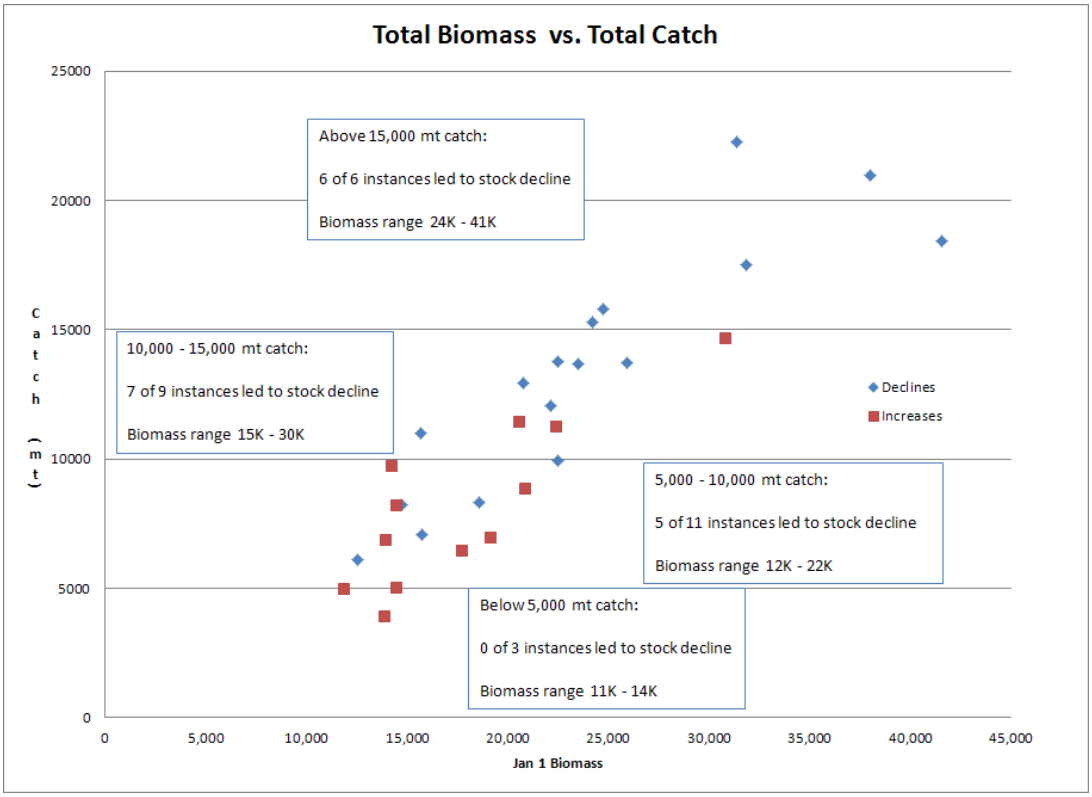
10. Stochastic projections for groundfish stocks are often biased high, as demonstrated by analyses presented to the SSC last year. The probabilities of being overfished, of overfishing, and of stock size less than 7,300 mt that are reported here do not capture all uncertainties associated with the assessments.

11. Revisions to the recreational catches may prove important for this assessment and may have an effect on short-term catch advice. There is a strong possibility that the 2010 recreational catch will be closer to the 2009 and 2011 catches (about 2,000 mt) than the value used in the assessment (5,800 mt). Because there is widespread speculation about how important such a change might be, the PDT crudely estimates that if this were the only recreational catch change it would likely increase the 2012 and 2013 catch advice by about 400 mt. While this is a large relative change it would not result in catches similar to recent years.

12. The projection results suggest that in the short term catches well above FMSY levels will still allow for substantial increases in stock size. This is surprising even though the assessment results show that this stock has withstood high fishing pressure for over two decades. This projection result may be largely due to the lack of a defined stock-recruit relationship. While the projection does reduce recruitment at low stock sizes this does not occur until Fs are above 1.0 which are needed to drive the SSB below 7,300 mt, the lowest observed value in the time series. Projections assume that recruitment will continue as it has during the assessment time series with Fs well above Fmsy.

13. A simple plot of observed catches against SSB shows that the stock size has never been observed to decline when catch was less than 5,000 mt, and declined about 35% of the time when catches were less than 10,000 mt (Figure 1).

Figure 1 – Plot of total biomass vs. total catch. Red symbols indicate increases in stock size from the year of the catch to the following year; blue symbols indicate a decline in total biomass from the year of the catch to the following year.



Attachment A

Influence of 2012 Catch Assumption on Future Catches

Stock assessments use data and determine stock status based on a calendar year. Catches from projections based on those assessments are also calculated for a calendar year. The Northeast Multispecies fishing year is from May 1 – April 30. There is a difference of four months between the assessment year and the fishing year. There is considerable commercial fishing for these four months; recreational activity is also extensive in April (subject to regulatory restrictions).

It has long been the practice to use the projected calendar year catch from the assessment for the fishing year catch without any adjustment. Prior to Amendment 16, these were target TACs and were not true "hard" quotas; after Amendment 16, these became ABCs/ACLs and for most of the fishery are quotas. In any given year, the difference between the calendar year and the fishing year means the TTAC/ABC/ACL is slightly mis-specified. A more accurate fishing year ABC/ACL would be based on part of the first calendar year ABC for May – December and part of the second-year ABC/ACL for January – April. Without such an adjustment, if stocks are increasing, the fishing year catch would be slightly under-estimated; if stocks are decreasing, they would be over-estimated. Such an adjustment has not been routinely made and is not recommended here.

With the normal changes in stock size from year-to-year, this issue is not a major concern as such differences tend to smooth themselves out over a multi-year period. When there is a major change in stock perception, however, this difference becomes an issue because of the delay between receiving an assessment and implementing new catch advice. This is a biological concern when ABCs/ACLs must have a large decline due to a new assessment. Because a new quota will not be adopted until May 1, fishing activity under the old ABC from January through April can result in calendar year catches that are higher than the new ABC. As a result, mortality targets may not be achieved as soon as expected. This must be taken into account when setting multi-year specifications, at least during the first year, or there is a risk that ABCS/ACLs will be set too high in years two and three.

GOM Cod Example

The SARC 53 assessment prepared sample projections for GOM cod. These projections assumed a catch for CY 2011 and then input a fishing mortality for CY 2012 through 2014 to get the catch associated with the input fishing mortality for those years. This approach ignores that the FY 2011 ABCs/ACLs apply to the fishery through April 2012 and the amount of cod that can be caught during this period may exceed the desired calendar year catch.

The PDT prepared preliminary projections to assess the impacts of ignoring this difference on future catch estimates. The projections were performed for two different scenarios. All projections are based on the preliminary assessment results available in mid-December, 2012.

A. No change in CY 2011 catch assumption

For this set of projections, the calendar year 2011 catch was assumed to be 11,392 mt, the same value used in the projections performed at the SARC.

Calendar year 2012 catch was estimated. For commercial catches, the catch was assumed to be 1,030 mt from January through April, the same amount caught in January through April 2011. For the rest of the year, the commercial fishery was assumed to catch 58% of the FY 2012 groundfish sub-ACL, the same percentage as the FY 2011 sub-ACL caught between May and December 2011. Recreational catches were assumed to be the same as CY 2009, or 2,923 mt, since the 2010 recreational catch seems unusually high. The recreational catch assumption in this projection may seem high since it assumes that nothing changes for recreational fishermen as a result of the assessment, but there are at present no measures in place that would restrict recreational catch in CY (or FY) 2012. Note that this example was calculated prior to the PDT discussion of the 2012 catch assumption, which resulted in a different catch for 2012 that is used in the projections provided to the SSC.

Projections were run at 75% of FMSY and at FMSY. Results are shown in Table 2.

Generally, failure to accurately account for CY 2012 catches results in setting the ABC/ACL for FY 2013 and FY 2014 about 400 – 500 mt too high. This is generally about 30 percent higher than the more accurate ABC and, if caught, would result in overfishing continuing through FY 2014.

B. Change in CY 2011 catch assumption

The example SARC 53 projections assumed that CY 2011 catch was the same as CY 2010 catch. This is not likely, since it is known that commercial catches were about 1,000 mt less and the recreational catch in CY 2010 seems unusually high. The catch results shown in Table 3 show that ignoring the fishing year issue results in 2013 catches that are about 200 mt too high.

Table 2 – Example projections, SARC 53 assumption for CY 2011 catch (scenario A)

	SARC 53 – 75% of FMSY			SARC 53 - FMSY			A1 – 75% of FMSY			A2 - FMSY		
	F	Catch	SSB	F	Catch	SSB	F	Catch	SSB	F	Catch	SSB
2011	1.684	11392	8178	0.2	11392	8178	1.684	11392	8178	1.684	11392	8178
2012	0.15	1001	6894	0.2	1313	6834	0.757	4192	6217	0.782	4300	6191
2013	0.15	1745	11838	0.2	2232	11463	0.15	1320	9095	0.2	1714	8930
2014	0.15	2780	18310	0.2	3482	17363	0.15	2344	15397	0.2	2973	14784

Attachment B: GOM Cod Catch Projection Output
Mortality-Based Projections

Table 3 – Calendar year catch for F based projection scenarios

Year	F=0	75%Fmsy	Fmsy=0.2	F=0 Adjusted for 2012 catch	75%Fmsy Adjusted for 2012 catch	Fmsy=0.2 Adjusted for 2012 catch	F_{MSY} using 20-year rec. stream
2011	7.75	7.75	7.75	7.75	7.75	7.75	7.8
2012	0	1.462	1.915	2.2	3.223	3.541	3.5
2013	0	2.197	2.796	0	1.961	2.512	2.5
2014	0	3.218	4.009	0	2.989	3.747	3.6
2015	0	4.233	5.167	0	4.023	4.939	4.5
2016	0	5.17	6.2	0	4.967	5.988	5.1
2017	0	6.016	7.101	0	5.835	6.91	5.8
2018	0	6.796	7.91	0	6.648	7.752	6.3
2019	0	7.471	8.581	0	7.351	8.457	6.7
2020	0	7.995	9.094	0	7.898	9.004	7
2021	0	8.386	9.468	0	8.312	9.389	7.2
2022	0	8.695	9.736	0	8.631	9.684	7.4
2023	0	8.908	9.929	0	8.871	9.895	7.5
2024	0	9.081	10.073	0	9.04	10.045	7.6
2025	0	9.188	10.163	0	9.166	10.148	7.6
2026	0	9.278	10.223	0	9.259	10.208	7.7
2027	0	9.337	10.272	0	9.324	10.262	7.7
2028	0	9.379	10.305	0	9.368	10.3	7.7
2029	0	9.434	10.351	0	9.427	10.347	7.7
2030	0	9.479	10.38	0	9.473	10.376	7.8

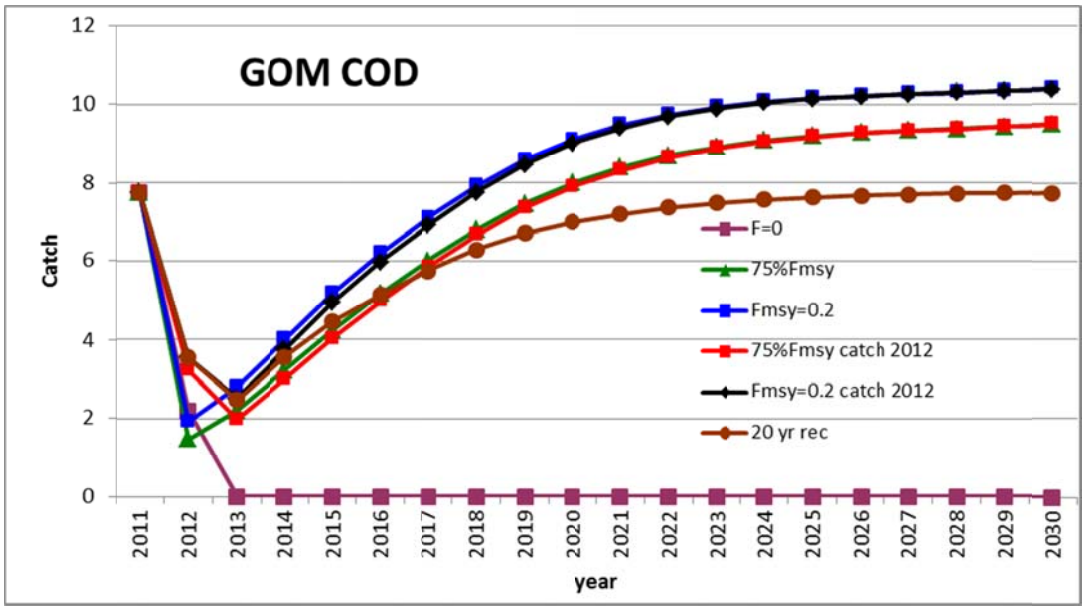


Table 4 – Fishing mortality for F-based strategies

Year	F=0	75%Fmsy	Fmsy=0.2	F=0 Adjusted for 2012 catch	75%Fmsy Adjusted for 2012 catch	Fmsy=0.2 Adjusted for 2012 catch	F_{MSY} using 20-year rec. stream
2011	0.92	0.92	0.92	0.92	0.92	0.92	0.92
2012	0	0.15	0.2	0.233	0.356	0.397	0.397
2013	0	0.15	0.2	0	0.15	0.2	0.2
2014	0	0.15	0.2	0	0.15	0.2	0.2
2015	0	0.15	0.2	0	0.15	0.2	0.2
2016	0	0.15	0.2	0	0.15	0.2	0.2
2017	0	0.15	0.2	0	0.15	0.2	0.2
2018	0	0.15	0.2	0	0.15	0.2	0.2
2019	0	0.15	0.2	0	0.15	0.2	0.2
2020	0	0.15	0.2	0	0.15	0.2	0.2
2021	0	0.15	0.2	0	0.15	0.2	0.2
2022	0	0.15	0.2	0	0.15	0.2	0.2
2023	0	0.15	0.2	0	0.15	0.2	0.2
2024	0	0.15	0.2	0	0.15	0.2	0.2
2025	0	0.15	0.2	0	0.15	0.2	0.2
2026	0	0.15	0.2	0	0.15	0.2	0.2
2027	0	0.15	0.2	0	0.15	0.2	0.2
2028	0	0.15	0.2	0	0.15	0.2	0.2
2029	0	0.15	0.2	0	0.15	0.2	0.2
2030	0	0.15	0.2	0	0.15	0.2	0.2

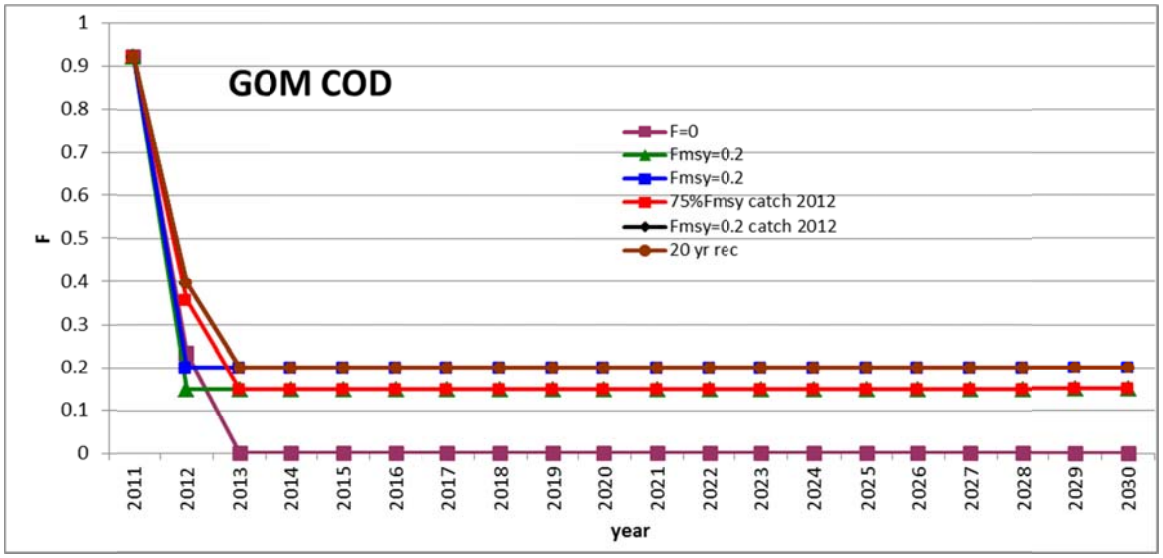


Table 5 – SSB for F-based strategies

Year	F=0	75%Fmsy	Fmsy=0.2	F=0 Adjusted for 2012 catch	75%Fmsy Adjusted for 2012 catch	Fmsy=0.2 Adjusted for 2012 catch	F_{MSY} using 20-year rec. stream
2011	9.478	9.478	9.478	9.478	9.478	9.478	9.478
2012	10.121	9.844	9.754	9.696	9.482	9.413	9.375
2013	16.651	14.892	14.357	14.631	13.337	12.938	12.601
2014	25.839	21.499	20.292	23.476	19.926	18.905	17.802
2015	36.742	28.442	26.243	34.057	26.917	24.999	22.446
2016	49.019	35.35	31.969	45.926	33.762	30.669	26.529
2017	62.562	42.115	37.314	59.131	40.547	36.116	30.295
2018	76.474	48.304	42.101	73.138	46.953	41.055	33.794
2019	91.815	54.819	46.977	88.853	53.678	46.149	37.323
2020	105.471	60.114	50.893	102.945	59.222	50.23	39.529
2021	116.834	64.108	53.666	114.721	63.33	53.15	41.109
2022	126.695	67.282	55.866	124.808	66.698	55.449	42.353
2023	134.801	69.621	57.452	133.259	69.174	57.113	43.297
2024	141.382	71.257	58.551	140.156	70.914	58.317	43.945
2025	146.993	72.607	59.27	145.988	72.319	59.135	44.435
2026	151.39	73.519	59.822	150.619	73.322	59.694	44.733
2027	155.103	74.174	60.309	154.421	74.026	60.23	45.036
2028	157.88	74.887	60.618	157.326	74.784	60.565	45.231
2029	160.558	75.184	60.823	160.113	75.106	60.765	45.375
2030	162.543	75.476	61.024	162.15	75.438	61.001	45.449

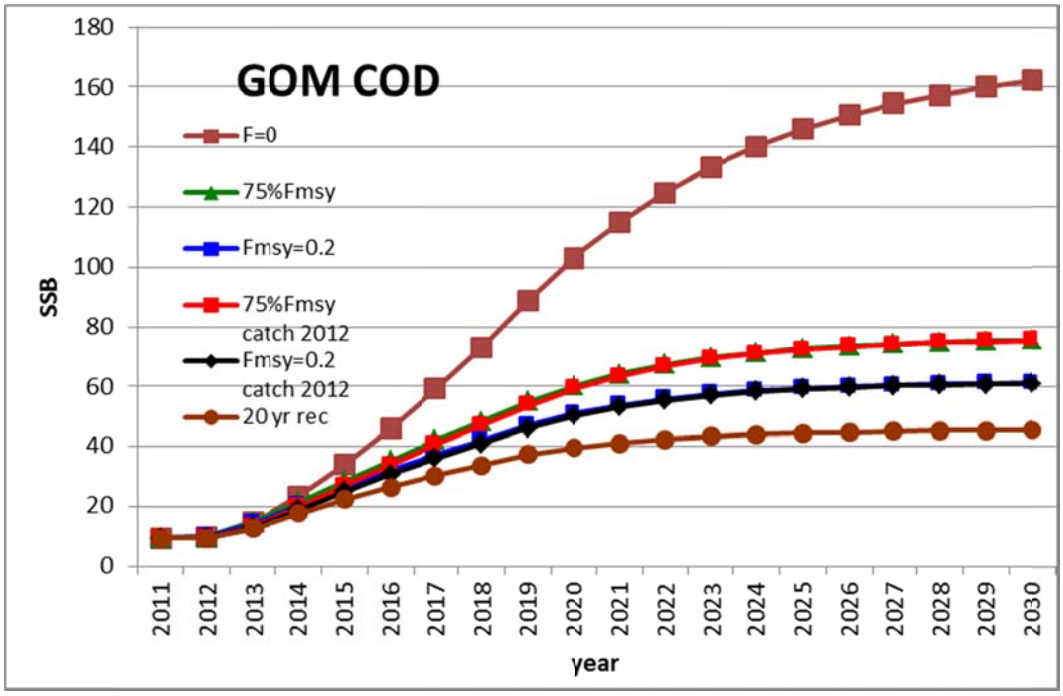


Table 6 - Probability SSB is more than 7,300 mt for F-based strategies

Year	F=0	75%Fmsy	Fmsy=0.2	F=0 Adjusted for 2012 catch	75%Fmsy Adjusted for 2012 catch	Fmsy=0.2 Adjusted for 2012 catch	F_{MSY} using 20-year rec. stream
2011	0.811	0.811	0.811	0.811	0.811	0.811	0.811
2012	0.817	0.801	0.794	0.776	0.758	0.755	0.753
2013	0.997	0.992	0.99	0.974	0.947	0.935	0.927
2014	1	1	1	1	0.99	0.998	0.997
2015	1	1	1	1	1	1	1
2016	1	1	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

GOM Cod Catch Projection Output
Catch Scenario Projections

Table 7 – Calendar year catches for five management scenarios. Catches in thousands of metric tons. Highlighted cells are constant catch years. (1) Projection assumes F_{MSY} in 2014 and beyond

Year	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
2012	2.7	3.55	4.3	6.339	7.779
2013	2.7	3.55	4.3	7.075	8.302
2014	3.885	3.55	4.3	2.315	1.803
2015	5.074	4.791	4.3	3.535	3.011
2016	6.111	5.854	5.468	4.774	4.289
2017	7.015	6.811	6.472	5.887	5.432
2018	7.838	7.658	7.383	6.927	6.533
2019	8.522	8.397	8.168	7.801	7.477
2020	9.045	8.942	8.774	8.511	8.266
2021	9.421	9.341	9.211	8.97	8.778
2022	9.71	9.653	9.548	9.43	9.271
2023	9.914	9.871	9.798	9.679	9.571
2024	10.06	10.029	9.97	9.855	9.783
2025	10.155	10.127	10.076	9.995	9.944
2026	10.217	10.2	10.161	10.135	10.099
2027	10.267	10.252	10.224	10.192	10.165
2028	10.304	10.297	10.28	10.255	10.234
2029	10.35	10.344	10.333	10.302	10.281
2030	10.378	10.374	10.365	10.287	10.277

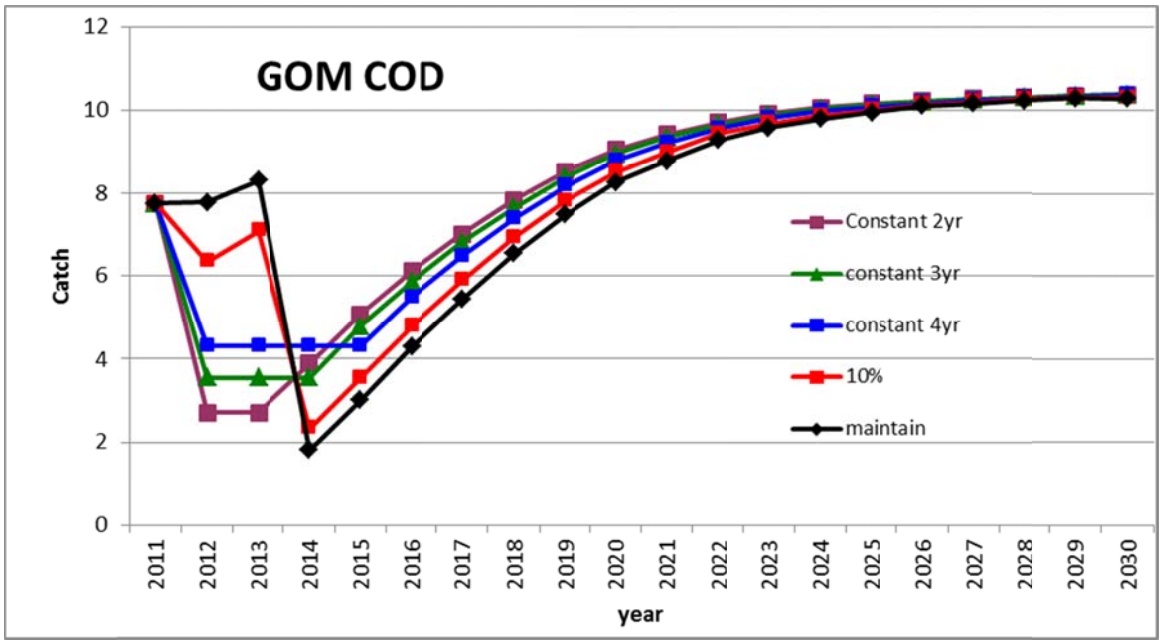


Table 8 – Fishing mortality for five management scenarios. Highlighted cells exceed F_{MSY}.

Year	Catch Constant 2yr	Catch constant 3yr	Catch constant 4yr	Increase Jan 1 Biomass 10% to 2014	Maintain Jan 1 Biomass to 2014
2011	0.92	0.92	0.92	0.92	0.92
2012	0.292	0.398	0.499	0.82	1.1
2013	0.2	0.292	0.385	0.87	1.3
2014	0.2	0.2	0.268	0.2	0.2
2015	0.2	0.2	0.2	0.2	0.2
2016	0.2	0.2	0.2	0.2	0.2
2017	0.2	0.2	0.2	0.2	0.2
2018	0.2	0.2	0.2	0.2	0.2
2019	0.2	0.2	0.2	0.2	0.2
2020	0.2	0.2	0.2	0.2	0.2
2021	0.2	0.2	0.2	0.2	0.2
2022	0.2	0.2	0.2	0.2	0.2
2023	0.2	0.2	0.2	0.2	0.2
2024	0.2	0.2	0.2	0.2	0.2
2025	0.2	0.2	0.2	0.2	0.2
2026	0.2	0.2	0.2	0.2	0.2
2027	0.2	0.2	0.2	0.2	0.2
2028	0.2	0.2	0.2	0.2	0.2
2029	0.2	0.2	0.2	0.2	0.2
2030	0.2	0.2	0.2	0.2	0.2

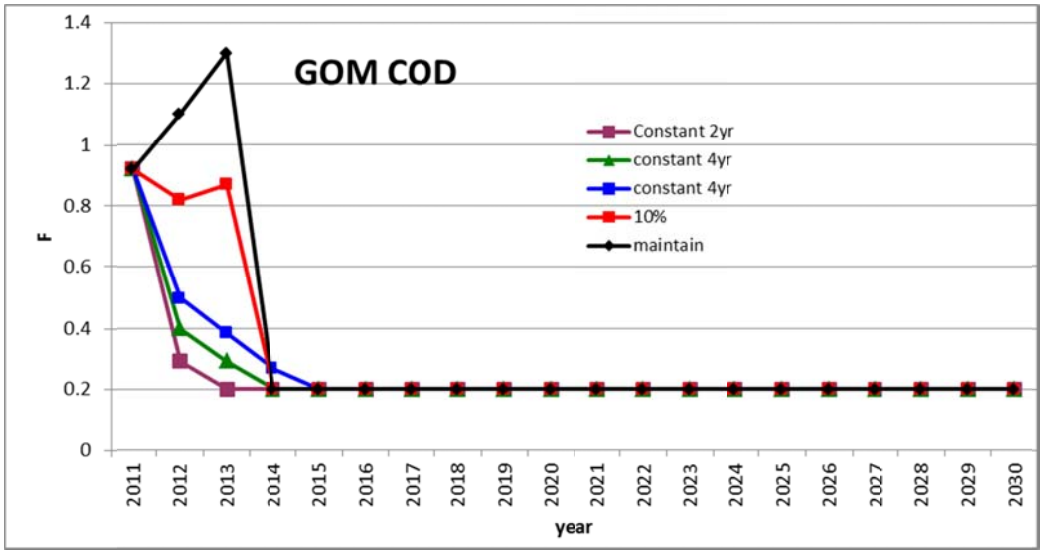


Table 9 – SSB or Jan 1 Biomass for five management scenarios

	SSB					Jan 1 Biomass	
Year	Catch Constant 2yr	Catch constant 3yr	Catch constant 4yr	Increase Jan 1 Biomass 10% to 2014	Maintain Jan 1 Biomass to 2014[(1)]	Increase Jan 1 Biomass 10% to 2014	Maintain Jan 1 Biomass to 2014
2011	9.478	9.478	9.478	9.478	9.478	16.313	16.313
2012	9.593	9.411	9.239	8.687	8.265	15.774	15.774
2013	13.664	12.723	11.888	9.342	7.725	17.372	15.787
2014	19.644	18.023	16.393	11.745	9.219	19.125	15.95
2015	25.745	24.237	21.942	17.634	14.999	26.466	23.398
2016	31.426	29.968	27.84	23.819	21.256	33.664	30.641
2017	36.806	35.435	33.479	29.636	27.085	40.316	37.394
2018	41.693	40.493	38.688	35.338	32.909	46.499	43.885
2019	46.626	45.598	43.952	41.138	38.928	52.96	50.492
2020	50.552	49.768	48.434	46.363	44.52	58.532	56.485
2021	53.41	52.819	51.807	50.039	48.608	62.639	61.149
2022	55.631	55.177	54.432	53.202	52.147	66.156	64.95
2023	57.274	56.93	56.323	55.334	54.56	68.493	67.67
2024	58.407	58.141	57.643	57.016	56.37	70.014	69.346
2025	59.199	59	58.618	57.947	57.597	71.232	70.793
2026	59.737	59.603	59.317	58.935	58.644	72.479	72.131
2027	60.268	60.169	59.946	59.71	59.531	73.303	73.11
2028	60.597	60.513	60.331	60.149	59.958	73.694	73.523
2029	60.777	60.716	60.599	60.486	60.38	73.96	73.833
2030	61.012	60.972	60.889	60.573	60.504	74.03	73.961

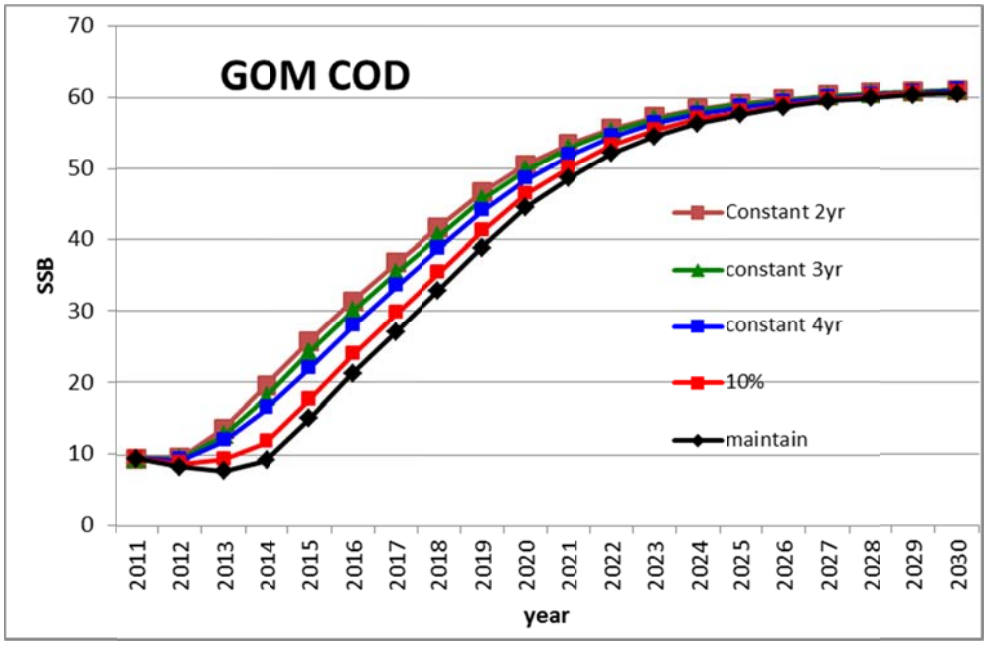


Table 10 – Probability SSB is more than 7,300 mt for five management scenarios

Year	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
2012	0.766	0.755	0.736	0.71	0.66
2013	0.952	0.921	0.881	0.869	0.617
2014	0.996	0.981	0.96	0.989	0.897
2015	0.99	0.992	0.974	1	0.998
2016	1	0.998	0.981	1	1
2017	1	1	0.993	1	1
2018	1	1	0.997	1	1
2019	1	1	0.998	1	1
2020	1	1	0.999	1	1
2021	1	1	0.999	1	1
2022	1	1	1	1	1
2023	1	1	1	1	1
2024	1	1	1	1	1
2025	1	1	1	1	1
2026	1	1	1	1	1
2027	1	1	1	1	1
2028	1	1	1	1	1
2029	1	1	1	1	1
2030	1	1	1	1	1

Table 11 –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. See text for details. 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 consider the difference between the fishing year and the calendar year. The PDT will revise these values prior to the SSC meeting.

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