Atlantic States Marine Fisheries Commission

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MEMORANDUM

April 22, 2015

To: **Atlantic Menhaden Management Board**
From: **Atlantic Menhaden Technical Committee**
RE: **Recommended Biological Reference Points and Projection Runs**

Biological Reference Points

After consideration of the recommendations from the 2015 Atlantic Menhaden Benchmark Stock Assessment Peer Review Panel, the Technical Committee (TC) recommends that the biological reference points for the Atlantic menhaden population be based on MSP (maximum spawning potential). The percentages should be determined from the minimum and median values of MSP during the time frame 1960-2012, a period during which the TC considers the population to have been sustainably fished. These reference points are therefore based on the historical performance of the population given the fishing pressure that the population has experienced.

As recommended by the Peer Review Panel, and accepted by the TC, the value for fishing mortality reference points will be the geometric mean of fishing mortality on ages-2 to -4. These ages represent the fully selected fishing mortality rates depending upon the year and fishery (i.e., bait and reduction). The fecundity (FEC) reference points match the F reference points meaning they are equal to the fecundity estimated when F reaches equilibrium at its target and threshold MSP levels, respectively. Under these reference points, the stock status is not overfished and overfishing is not occurring (Table 1; Figures 1 and 2). In addition, Monte Carlo bootstrapping (MCB) runs corroborates the assessment finding that the stock status is not overfished and overfishing is not occurring.

Table 1. Biological Reference Points from the 2015 Benchmark Stock Assessment as recommended by the Peer Review Panel and TC. The table also contains the terminal year estimate of F, and FEC (in billions of eggs).

Reference Points/Terminal Year Estimate	Benchmark
$F_{26\%MSP}$ (threshold)	1.26
$F_{57\%MSP}$ (target)	0.38
$F_{70\%MSP}$ (F in 2013)	0.22
$FEC_{26\%MSP}$ (threshold)	86,821
$FEC_{57\%MSP}$ (target)	189,270
FEC_{2013} (FEC in 2013)	170,536

Projections

MCB of the base run of the Beaufort Assessment Model (BAM) was used as the basis for the projections (see Appendix D of 2015 assessment for projection methodology). Projections were run for four years (2014-2017). The duration of projections was short-term in order to maintain at least one age class present in the terminal year of the assessment within the projections.

Landings in 2014 were the same in all runs and were assumed to be 170,800 mt (the 2014 TAC) because final landings data were not available at the time of the projection analysis. Constant landings from 2015 to 2017 were allocated to the bait and reduction fishery in the northern and southern regions using the proportions established in Amendment 2.

The TC explored seven separate projection runs to account for the range of projections requested by the Board. The projections explore a range of TAC levels from status quo to catch levels that existed prior to the implementation of Amendment 2. Specifically, projections were run using the following TAC scenarios:

1) 213,500 mt = average catch from 2009-2011 prior to implementation of Amendment 2
2) 202,825 mt = if Board had implemented a 5% reduction from 2009-2011 average catch
3) 192,150 mt = if Board had implemented a 10% reduction from 2009-2011 average catch
4) 181,475 mt = if Board had implemented a 15% reduction from 2009-2011 average catch
5) 170,800 mt = 2014 TAC (status quo; Amend 2 implemented 20% reduction from 2009-2011 average catch)
6) TAC that has a 50% probability of achieving F target in 2017 (constant catch approach)
7) TAC that has a 50% probability of achieving F target in every year (constant F approach)

No guidance on risk policy was provided by the Management Board for the projection runs that estimate TACs that achieve F target. Therefore, the TC applied a 50% probability of achieving F target as a default.

Projections 1-5

Results in the table below indicate a percent risk of exceeding the F_{target} (Table 2) or the $F_{threshold}$ (Table 3) under the various projected TAC levels that would be held constant for a three year time period (2015-2017). The probability of exceeding the F target decreases over time because of the recruitment assumptions within the projections (median recruitment with variability based on historical recruitment). This means that using median recruitment with historical variability ultimately results in higher levels of recruitment in the projections than recently observed.

Table 2. Percent risk of exceeding the F_{target} for a given TAC scenario.

	TAC (mt)	**2015**	**2016**	**2017**
Percent Risk of exceeding F_{target}	170,800	50%	23%	3%
	181,475	57%	28%	9%
	192,150	62%	35.5%	15%
	202,825	68%	42%	21.5%
	213,500	73%	49.5%	27.5%

Table 3. Percent risk of exceeding the $F_{threshold}$ for a given TAC scenario.

	TAC (mt)	**2015**	**2016**	**2017**
Percent Risk of exceeding $F_{threshold}$ (Overfishing)	170,800	1.5%	0%	0%
	181,475	2%	0%	0%
	192,150	2%	0%	0%
	202,825	3%	<0.5%	0%
	213,500	4%	<1%	0%

Projection 6

The TAC that has a 50% probability of achieving F target in 2017 (constant catch approach) was 246,900 mt (Table 4).

Table 4. Percent risk of a 246,900 mt TAC exceeding F_{target} or $F_{threshold}$. TAC would be held constant for a three year time period (2015-2017).

	2015	**2016**	**2017**
Percent risk of exceeding F_{target}	84%	72%	50%
Percent Risk of exceeding $F_{threshold}$	8.5%	<1%	0%

Projection 7

TAC that has a 50% probability of achieving F_{target} in every year (constant F approach; Table 5). Note the TAC would change each year to ensure a 50% probability of maintaining F at the target.

Table 5. Percent risk of TAC exceeding F_{target} or $F_{threshold}$ for the constant F scenario.

	2015	**2016**	**2017**
TAC (mt)	173,000	223,900	265,900
Percent risk of exceeding F_{target}	50%	50%	50%
Percent Risk of exceeding $F_{threshold}$	1.5%	0%	0%

Figures 3-9 show panels of fecundity, recruits, fishing mortality, and landings for each TAC scenario.

Tables 6 and 7 show the allocation of the different projection run TACs by state/jurisdiction using Amendment 2 allocation.

Uncertainty in Projections

Projections should be interpreted in light of the model assumptions and key aspects of the data. Some major considerations are the following:

- In general, projections of fish stocks are highly uncertain, particularly over the long-term (e.g., beyond five years).
- Although projections included many major sources of uncertainty, they did not include structural (model) uncertainty. That is, projection results are conditional on one set of functional forms used to describe population dynamics, selectivity, recruitment, etc.
- Fisheries were assumed to continue fishing at their estimated current proportions of total effort (for bait and reduction fisheries), using the estimated current selectivity patterns. New management regulations that alter those proportions or selectivities would likely affect projection results.
- All of the projections assume median recruitment over time. So if future recruitment is characterized by runs of large or small year classes, possibly due to environmental or ecological conditions, stock trajectories may be affected.
- Projections apply the Baranov catch equation to relate F and landings using a one-year time step, as in the assessment. The catch equation implicitly assumes that mortality occurs throughout the year. This assumption is violated when seasonal closures are in effect, introducing additional and unquantified uncertainty into the projection results.

Table 6. Allocation (in pounds) to states/jurisdiction under the different potential TAC scenarios using Amendment 2 allocation after 1% of the TAC has been set aside for Episodic Events. This table contains potential TACs associated with the constant harvest projection runs 1 through 6.

Metric Tons	170,800	181,475	192,150	202,825	213,500	246,900
Pounds	376,549,096	400,083,415	423,617,733	447,152,052	470,686,370	544,320,678
After Set Aside	372,783,605	396,082,580	419,381,556	442,680,531	465,979,506	538,877,471
ME	146,787	155,962	165,136	174,310	183,484	212,189
NH	112	119	126	133	140	162
MA	3,126,024	3,321,400	3,516,777	3,712,153	3,907,530	4,518,825
RI	66,779	70,952	75,126	79,300	83,473	96,532
CT	65,034	69,099	73,163	77,228	81,292	94,010
NY	206,695	219,614	232,532	245,451	258,369	298,788
NJ	41,721,164	44,328,737	46,936,309	49,543,882	52,151,455	60,310,043
DE	49,230	52,307	55,384	58,460	61,537	71,164
MD	5,116,874	5,436,678	5,756,483	6,076,287	6,396,092	7,396,698
PRFC	2,314,174	2,458,810	2,603,446	2,748,082	2,892,718	3,345,256
VA	318,066,790	337,945,964	357,825,138	377,704,313	397,583,487	459,781,559
NC	1,836,948	1,951,757	2,066,566	2,181,375	2,296,185	2,655,400
SC	-	-	-	-	-	-
GA	-	-	-	-	-	-
FL	66,995	71,182	75,370	79,557	83,744	96,845

Table 7. Allocation (in pounds) to states/jurisdiction using Amendment 2 allocation after 1% of the TAC has been set aside for Episodic Events. This table contains the constant F projection run 7 TAC scenario.

Year	2015	2016	2017
Metric Tons	173,000	223,900	265,900
Pounds	381,399,260	493,614,418	586,208,458
After Set Aside	377,585,267	488,678,274	580,346,373
ME	148,678	192,422	228,517
NH	113	147	174
MA	3,166,289	4,097,873	4,866,567
RI	67,639	87,539	103,960
CT	65,872	85,252	101,244
NY	209,358	270,955	321,781
NJ	42,258,556	54,691,853	64,951,156
DE	49,864	64,535	76,641
MD	5,182,782	6,707,658	7,965,906
PRFC	2,343,982	3,033,628	3,602,687
VA	322,163,669	416,950,551	495,163,696
NC	1,860,609	2,408,036	2,859,745
SC	-	-	-
GA	-	-	-
FL	67,858	87,823	104,298

Figures

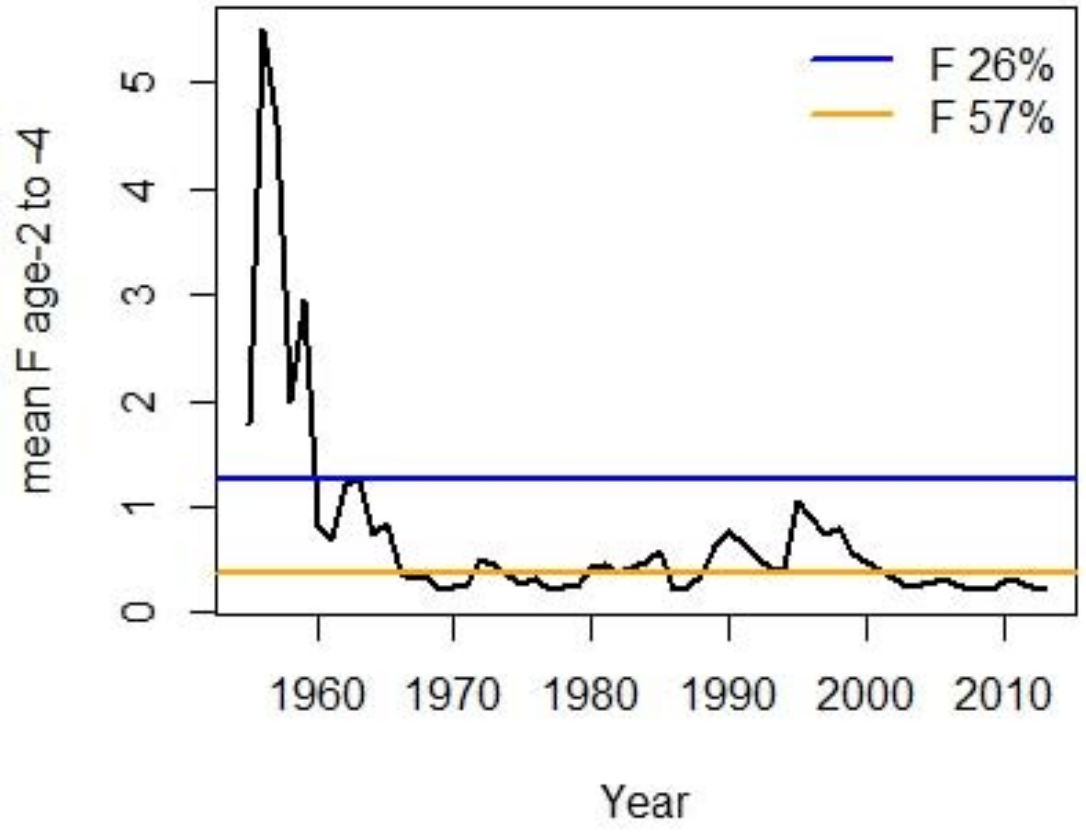

Figure 1. The geometric mean fishing mortality rate of ages-2 to -4 versus the recommended fishing mortality reference points with the blue line as the threshold and the orange line as target.

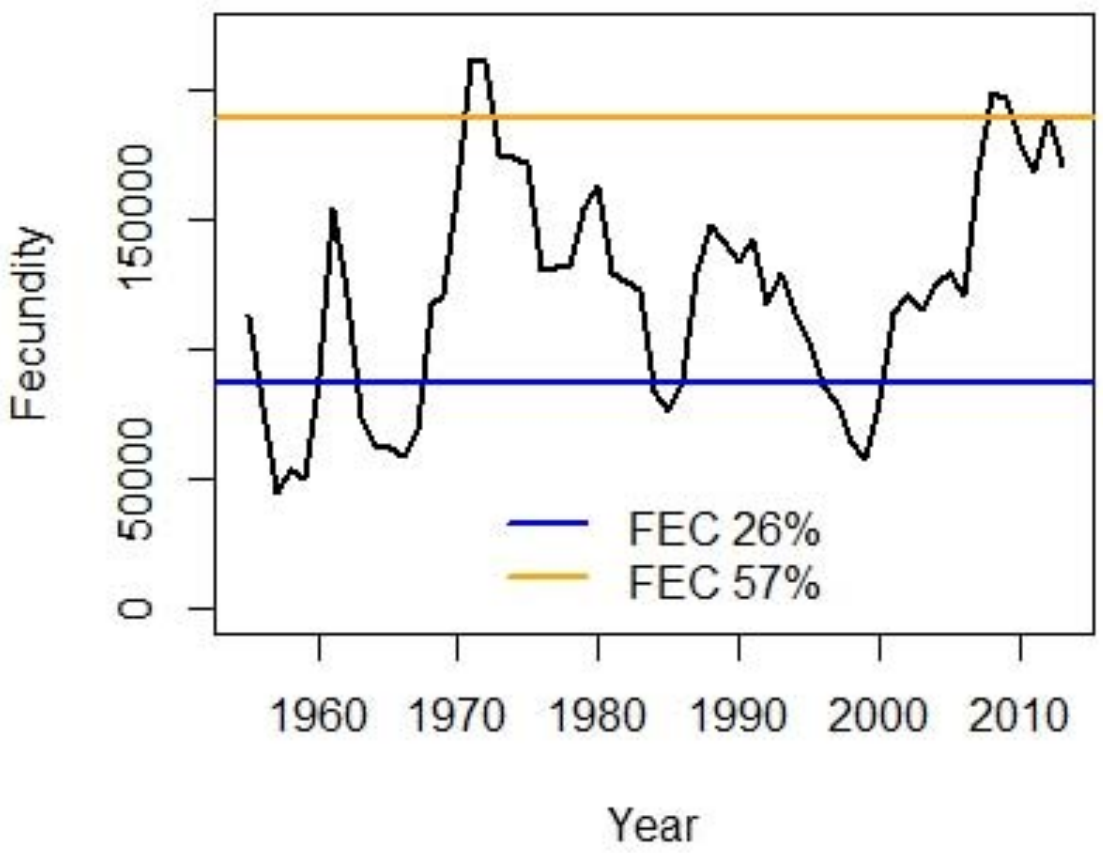

Figure 2. The fecundity versus the recommended fecundity based reference points with the blue line as the threshold and the orange line as the target.

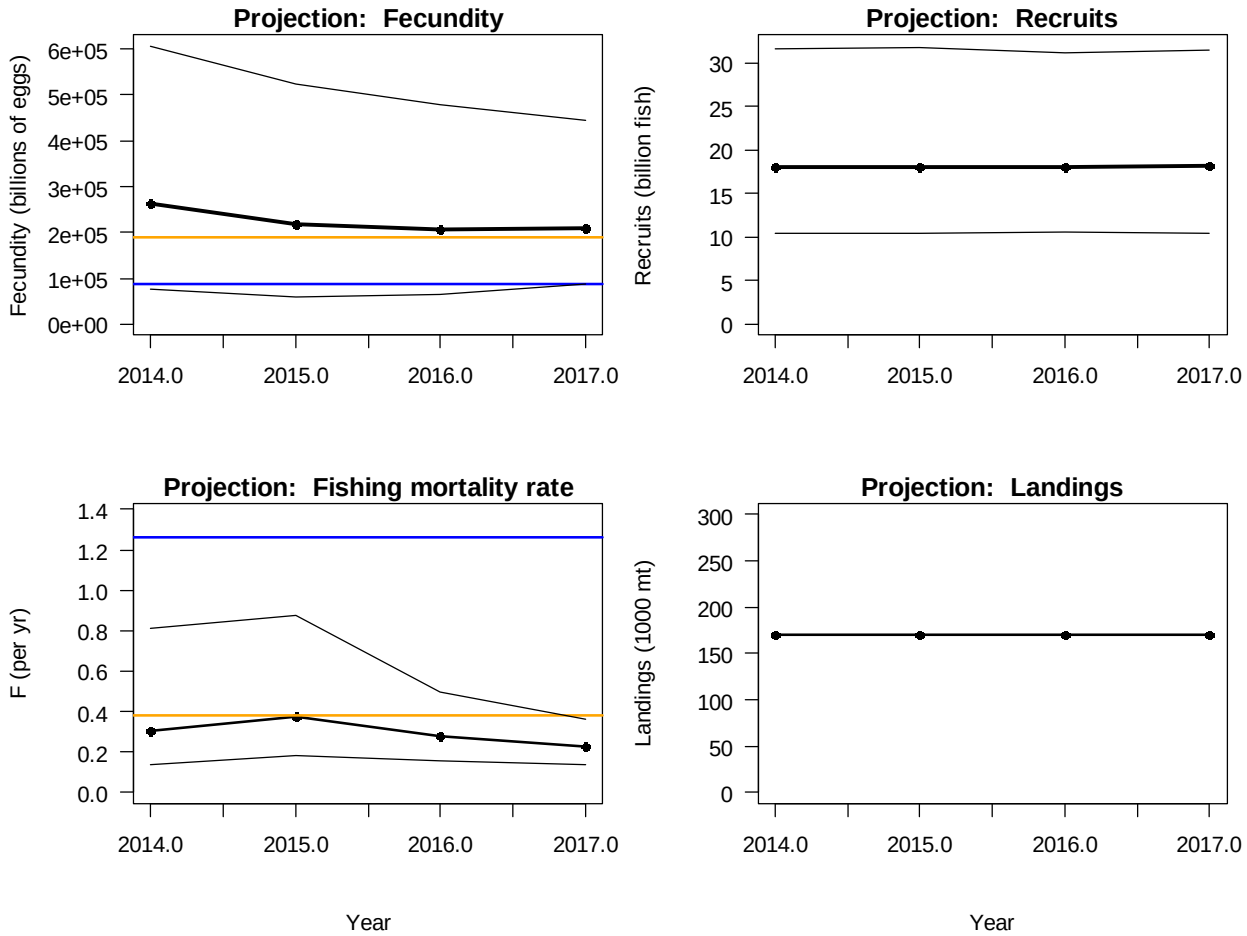

Figure 3. Projection panels for 170,800 mt TAC. Fecundity, recruits, geometric mean fishing mortality (*F*) over ages-2 to -4, and landings over time based on constant landings and median recruitment with variability based on estimated deviations for each MCB run. The solid flat line in the landings panel is the constant landings specified in the model (170,800 mt). The solid flat lines in the fishing mortality rate and fecundity panels are the threshold (blue) and target (orange) benchmark values recommended by the TC from the base run.

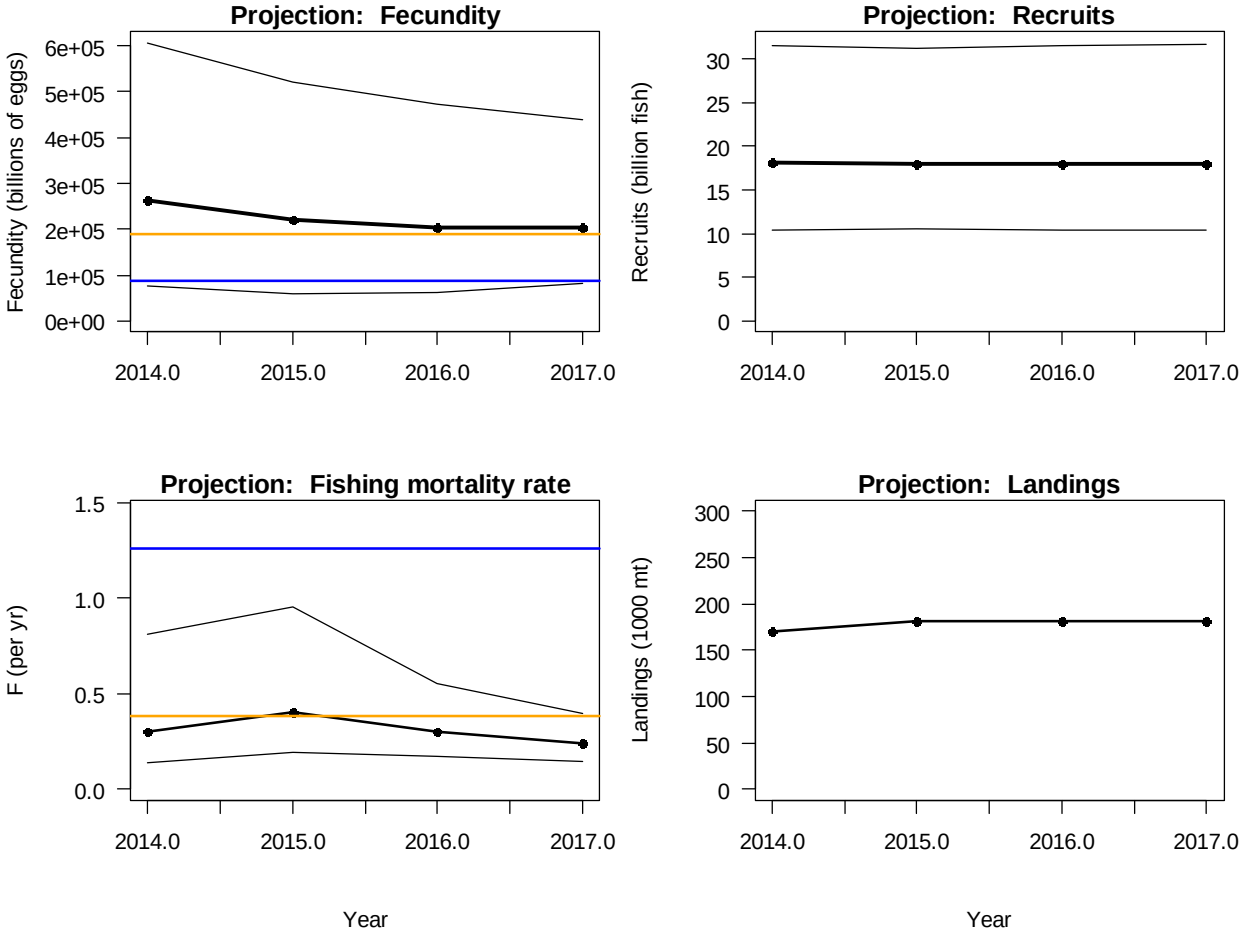

Figure 4. Projection panels for 181,475 mt TAC. Fecundity, recruits, geometric mean fishing mortality (*F*) over ages-2 to -4, and landings over time based on constant landings and median recruitment with variability based on estimated deviations for each MCB run. The solid flat line in the landings panel is the constant landings specified in the model (181,475 mt). The solid flat lines in the fishing mortality rate and fecundity panels are the threshold (blue) and target (orange) benchmark values recommended by the TC from the base run.

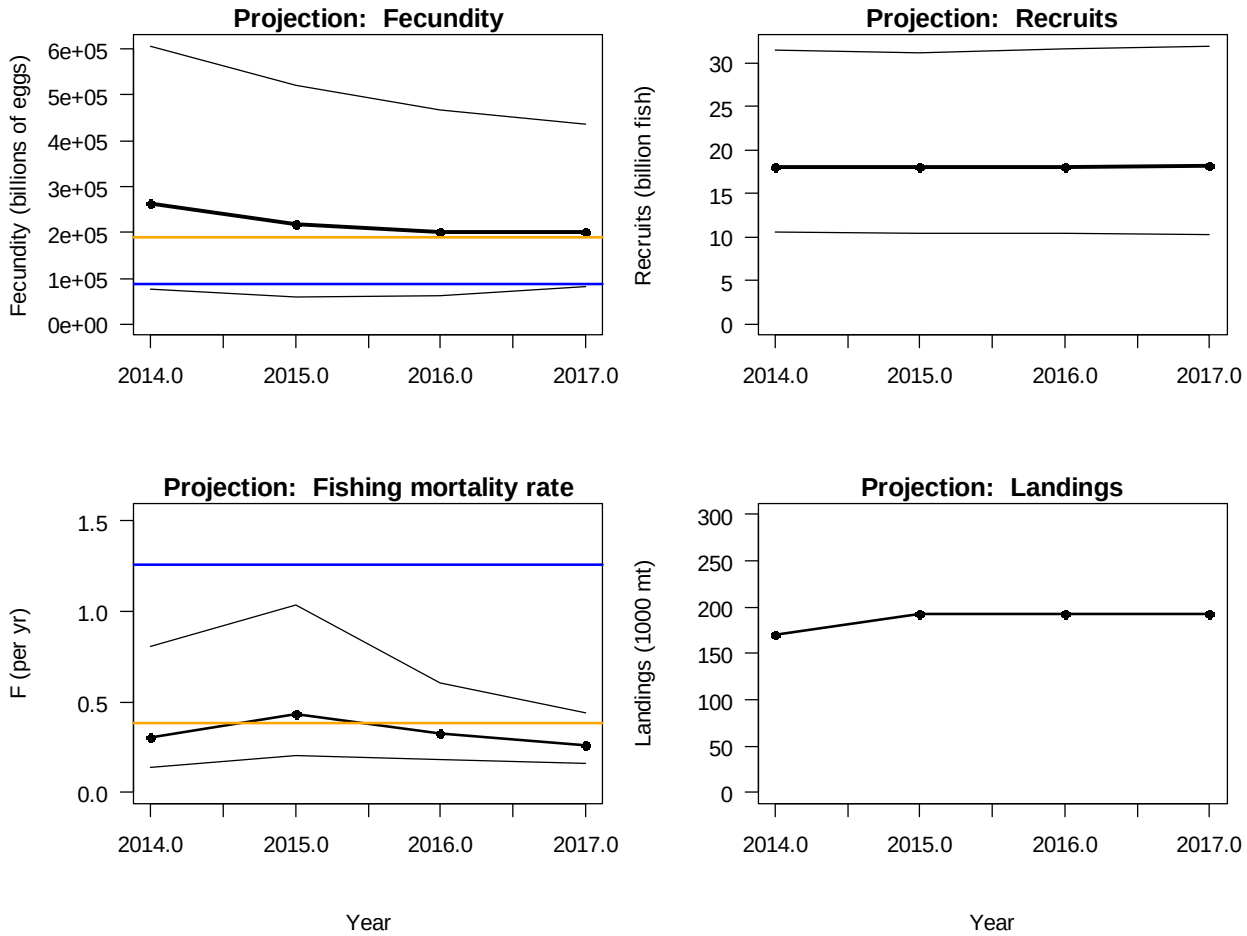

Figure 5. Projection panels for 192,150 mt TAC. Fecundity, recruits, geometric mean fishing mortality (*F*) over ages-2 to -4, and landings over time based on constant landings and median recruitment with variability based on estimated deviations for each MCB run. The solid flat line in the landings panel is the constant landings specified in the model (192,150 mt). The solid flat lines in the fishing mortality rate and fecundity panels are the threshold (blue) and target (orange) benchmark values recommended by the TC from the base run.

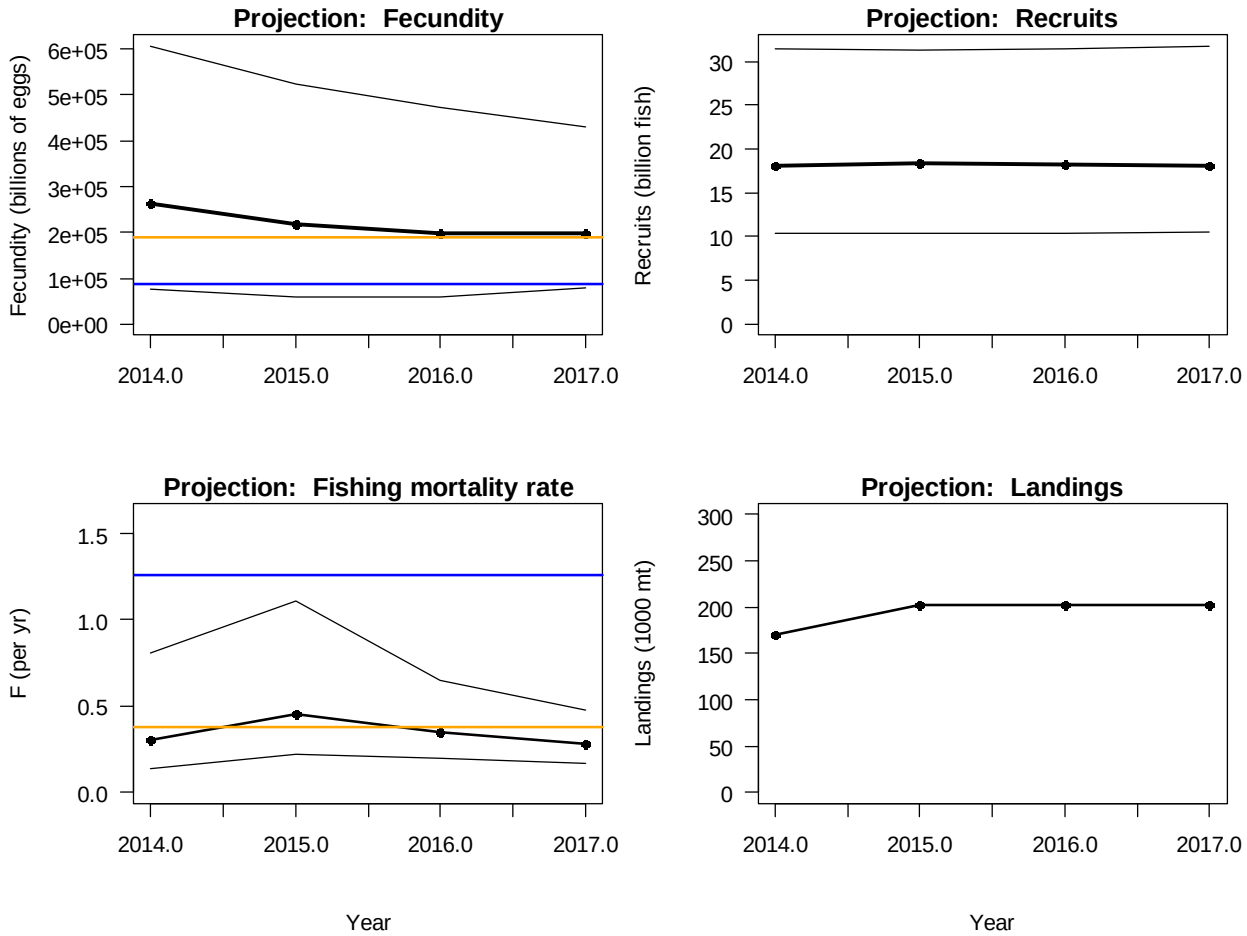

Figure 6. Projection panels for 202,825 mt TAC. Fecundity, recruits, geometric mean fishing mortality (*F*) over ages-2 to -4, and landings over time based on constant landings and median recruitment with variability based on estimated deviations for each MCB run. The solid flat line in the landings panel is the constant landings specified in the model (202,825 mt). The solid flat lines in the fishing mortality rate and fecundity panels are the threshold (blue) and target (orange) benchmark values recommended by the TC from the base run.

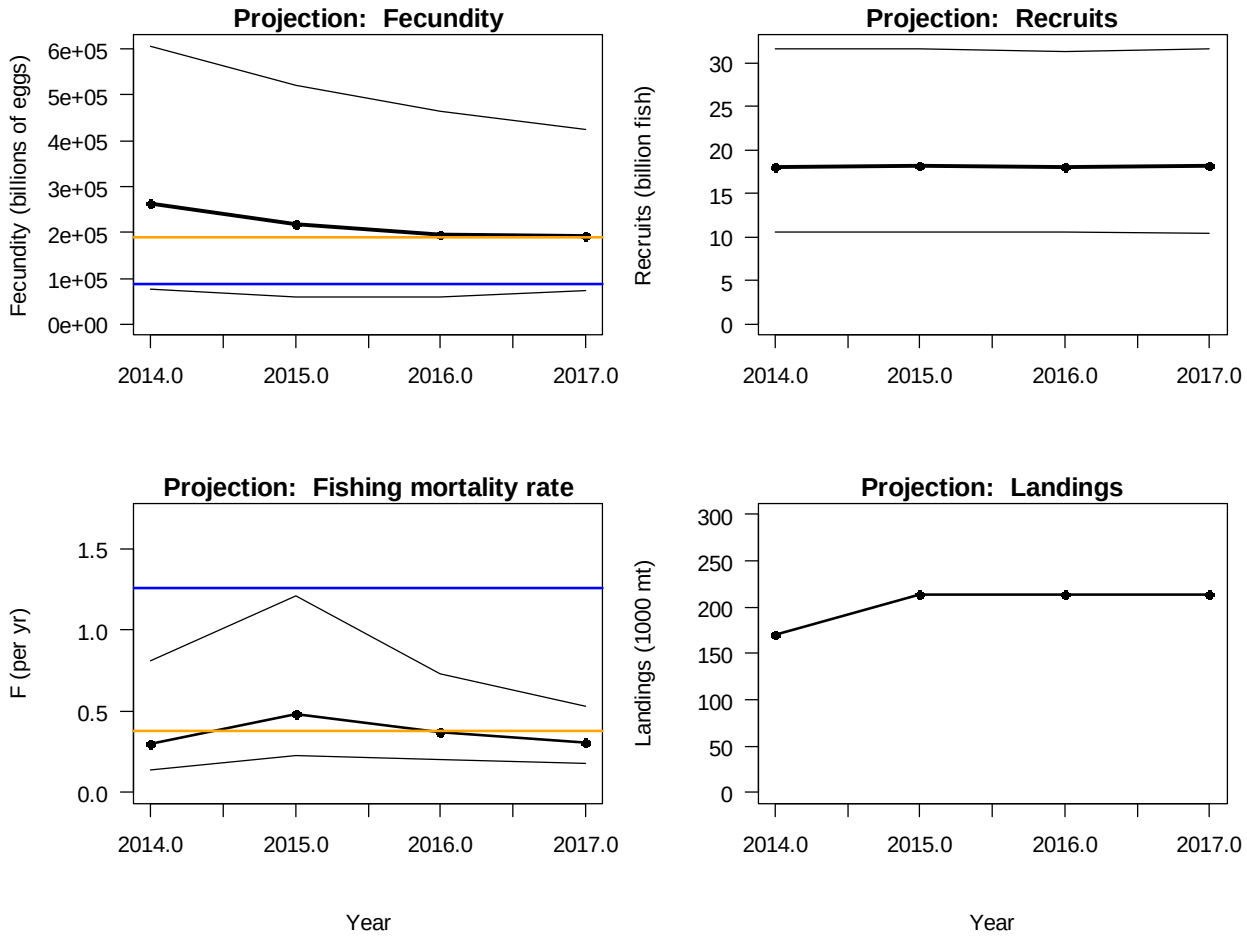

Figure 7. Projection panels for 213,500 mt TAC. Fecundity, recruits, geometric mean fishing mortality (*F*) over ages-2 to -4, and landings over time based on constant landings and median recruitment with variability based on estimated deviations for each MCB run. The solid flat line in the landings panel is the constant landings specified in the model (213,500 mt). The solid flat lines in the fishing mortality rate and fecundity panels are the threshold (blue) and target (orange) benchmark values recommended by the TC from the base run.

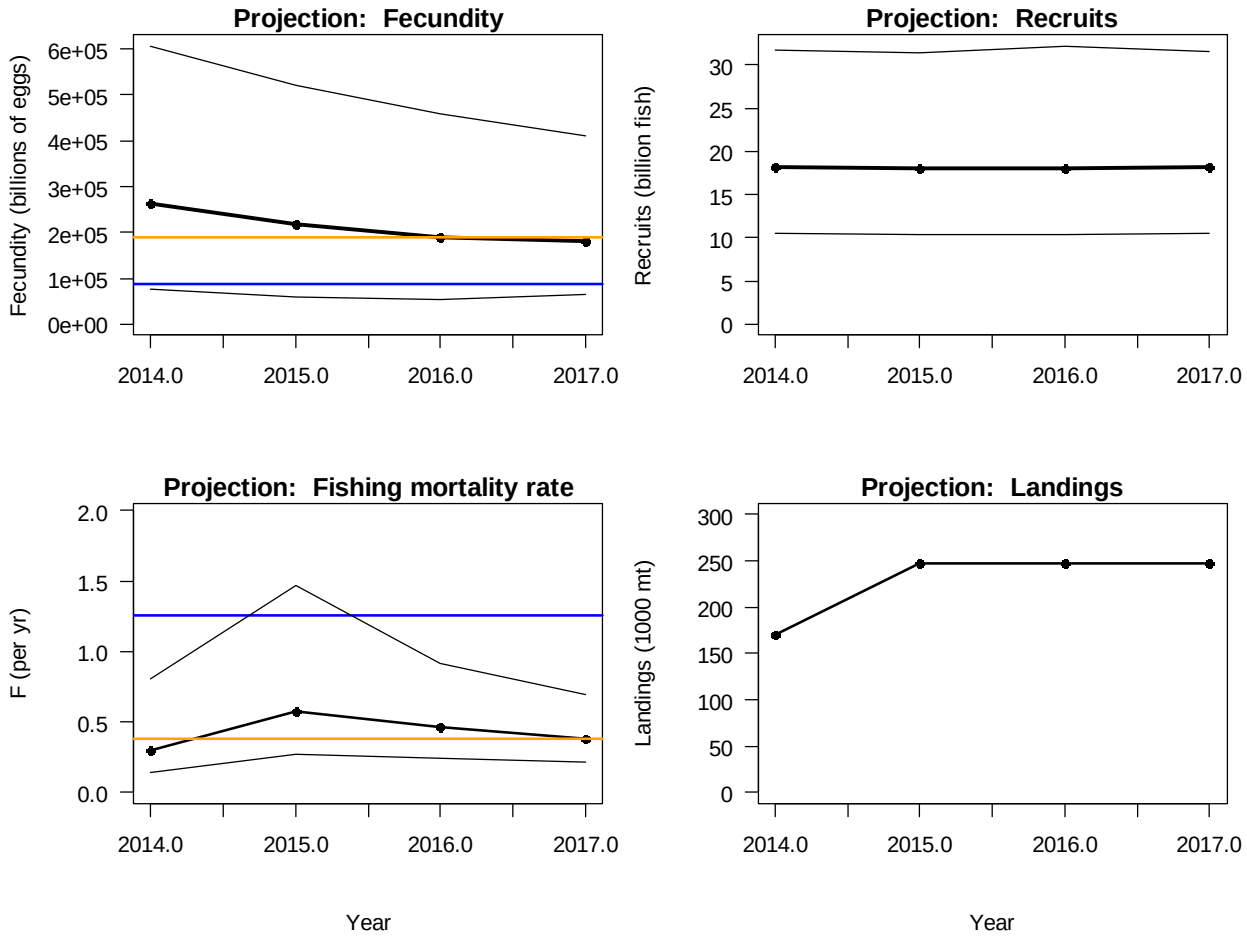

Figure 8. Projection panels for 246,900 mt TAC. Fecundity, recruits, geometric mean fishing mortality (*F*) over ages-2 to -4, and landings over time based on median recruitment with variability based on estimated deviations for each MCB run. The orange line in the fishing mortality rate panel is the target rate of 0.38, and the blue line in the fishing mortality rate panel is the threshold rate of 1.26. The orange line in the fecundity panel is the target value, while the blue line in the fecundity panel is the threshold value. The landings values are constant at 246,900 mt with a 50% probability of achieving F target in 2017.

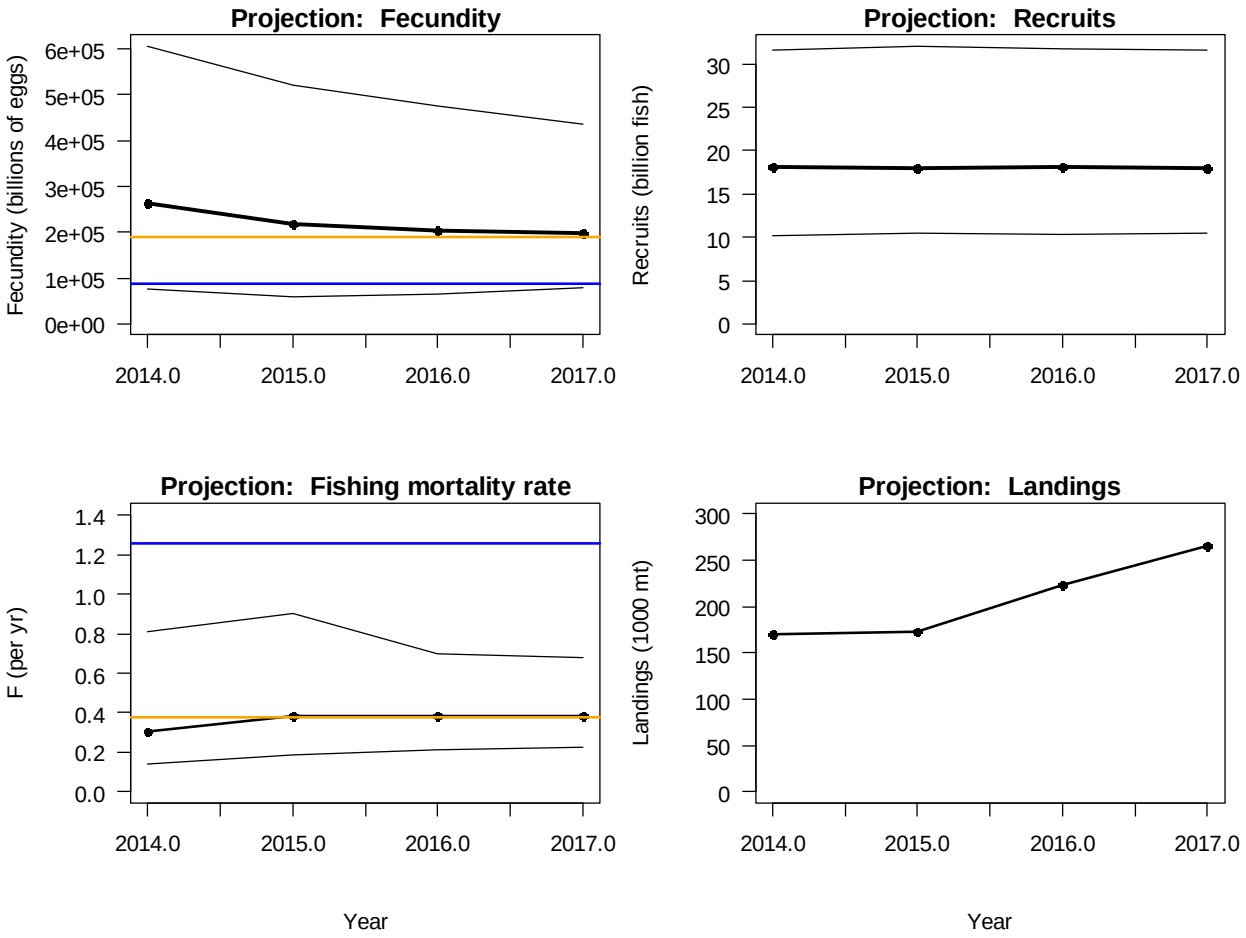

Figure 9. Projection panels for constant F scenario. Fecundity, recruits, geometric mean fishing mortality (*F*) over ages-2 to -4, and landings over time based on median recruitment with variability based on estimated deviations for each MCB run. The orange line in the fishing mortality rate panel is the target rate of 0.38, and the blue line in the fishing mortality rate panel is the threshold rate of 1.26. The orange line in the fecundity panel is the target value, while the blue line in the fecundity panel is the threshold value. The TAC changes each year to maintain a 50% probability of F being at F target.