B. ATLANTIC STRIPED BASS ASSESSMENT SUMMARY FOR 2013

State of the Stock:

In 2012, the Atlantic striped bass stock was not overfished or experiencing overfishing relative to the new reference points from the 2013 SAW/SARC57 (Figure B1-B3). Female spawning stock biomass (SSB) was estimated at 61.5 thousand mt (136 million lbs), above the SSB threshold of 57,904 mt, but below the SSB target of 72,380 mt. Total fishing mortality was estimated at 0.188, below the F threshold of 0.213 but above the F target of 0.175.

When compared to the biological reference points currently used in management (ASMFC 2008), the stock is neither overfished nor experiencing overfishing. Female SSB in 2012 is above both the target (46,101 mt) and the threshold (36,000 mt), and F_{2012} is below both the target (0.30) and the threshold (0.34).

Projections:

Five-year projections of female spawning SSB and fishing mortality (Figure B4) were made by using a standard forward projection methodology. If the current fully-recruited F (0.188) is maintained during 2013-2017, or if it increases to the threshold or decreases to the target, the probability of being below the SSB threshold increases until 2015-2016, but declines thereafter. If action to reduce F is delayed until 2014 or 2015, the probability of being below the SSB threshold increases (Figure B5).

If the current removals, meaning landings and dead discards of 3.59 million fish, are maintained during 2013-2017, the probability of the fully-recruited F being above the F threshold increases rapidly starting in 2013 and reaches near 1 by 2014 (Figure B6). If constant removals equal to 50% of the 2012 removals are taken during 2013-2017, the probability of fully-recruited F being above the F threshold is near zero.

Removals:

Commercial landings in the Atlantic striped bass fishery increased from roughly 115,000 fish (313 mt, 800,000 lbs) in 1990 to 913,160 fish (3,332 mt, 7.3 million lbs) in 2004. Since 2005, landings have fluctuated about an average of 988,410 fish (3,162 mt, 6.97 million lbs); however, landings have declined slightly in recent years to about 839,000 fish (2,952 mt, 6.5 million lbs) in 2012. In 2011 and 2012, the commercial coast-wide harvest was comprised primarily of ages 4-10 striped bass, while harvest in Chesapeake Bay fisheries (Maryland, Virginia, and the PRFC) was comprised mostly of ages 3-6. The estimates of dead commercial discards were 625,631 and 795,675 fish for 2011 and 2012. The highest discard losses occurred in anchor gill net, pounds net, and hook-and-line fisheries. Commercial harvest has generally exceeded dead discards since the mid 1990s.

Recreational harvest increased from 163,242 fish (1,010 mt, 2.2 million pounds) in 1990 to 2.78 million fish (14,082 mt, 31 million pounds) in 2006. Since 2006, harvest declined through 2012 to 1.5 million fish (8,740 mt, 19 million pounds). The number of striped bass that die due to discarding increased from 132 thousand fish in 1990 to 1.2 million fish in 1997. Dead discards

have remained around 1.2 million fish through 2003, but increased to the series maximum of 2.1 million fish in 2006. Since 2006, dead discards have declined substantially to 459,954 fish. Total recreational striped bass removals (harvest and dead discards) in 2011 and 2012 were 2.76 million fish and 1.96 million fish, respectively (Figure B7).

Stock Distribution and Identification:

Atlantic coast migratory striped bass live along the eastern coast of North America from the St. Lawrence River in Canada to the Roanoke River and other tributaries of Albemarle Sound in North Carolina (ASMFC 1990). Stocks which occupy coastal rivers from the Tar-Pamlico River in North Carolina south to the St. Johns River in Florida are believed primarily non-migratory and riverine. Historical tagging data suggest they do not presently undertake extensive Atlantic Ocean migrations as do stocks from the Roanoke River north (ASMFC 1990).

The coastal striped bass management unit includes the coastal and estuarine areas of all states and jurisdictions from Maine through North Carolina. The stock assessment includes data from both state and federal waters. Striped bass is currently managed by the Atlantic States Marine Fisheries Commission through Amendment 6 to the Fishery Management Plan. Amendment 6 implements a separate management program for the Chesapeake Bay due to the size availability of striped bass in this area (ASMFC 2003).

The Albemarle-Roanoke stock is currently managed as a non-coastal migratory stock by the state of North Carolina under the auspices of ASFMC. The Albemarle-Roanoke management unit is defined as the striped bass inhabiting the Albemarle, Currituck, Croatan, and Roanoke Sounds and their tributaries, including the Roanoke River.

Data and Assessment:

The striped bass assessment used total catch (harvest, commercial discards, and dead recreational discards) and catch-at-age split into three “fleets”: a Chesapeake Bay fleet, a coastal harvest fleet, and a commercial discard fleet. The assessment also used several fishery-independent indices of abundance for adults (the CT trawl survey, the NEFSC bottom trawl, the NJ bottom trawl survey, the NY ocean haul seine survey, the MD spawning stock survey, and the DE spawning stock electrofishing survey), and for young-of-year and age-1 fish (NY YOY and yearling survey, NJ YOY survey, VA YOY survey, and MD YOY and yearling surveys). Two fishery-dependent indices were used: the MRFSS/MRIP CPUE and the VA poundnet index.

The accepted model for striped bass is a forward projecting statistical catch-at-age model (SCA). The 2013 SCA model is used to estimate fishing mortality, abundance, and spawning stock biomass of striped bass during 1982-2012 from total removals-at-age and fisheries-dependent and fisheries-independent survey indices.

As a complement to the SCA, Jiang *et al.*’s (2007) instantaneous rates tagging model (IRCR) was run on data from the USFWS coast-wide striped bass tagging program through the 2011 tagging year to estimate survival, fishing mortality, and natural mortality.

Biological Reference Points:

Biological reference points for striped bass based on the previous assessment and ASMFC (2008), and currently used as thresholds in management are F_{MSY} (0.34) and an SSB proxy which is equivalent to the 1995 spawning stock biomass. The SSB target was calculated as 125% of the 1995 SSB, and the F target was defined as an exploitation rate of 24% or F=0.3. The estimate for F_{MSY} was derived using the results of the 2008 SCA assessment in which four stock-recruitment models were considered; a Ricker, a log-normal Ricker model, a Shepherd and a log-normal Shepherd model. The TC used a model averaging approach among the four results, producing an estimate of F_{MSY} = 0.34 (range of 0.28-0.40).

For this 2013 SAW/SARC57 assessment, the basis of SSB_{Target} and $SSB_{Threshold}$ remain the same, but the values have been updated. The procedure for estimating fishing mortality reference points used a stochastic projection drawing recruitment from empirical estimates of age-1 abundance from 1990 onwards (Figure B8) and a distribution of starting population abundance at age. The F threshold is the fishing mortality that will produce the $SSB_{Threshold}$ (=SSB_{1995}) as a long term average. The F target is the fishing mortality that will produce SSB_{Target} (=125%SSB_{1995}) as a long term average. This resulted in an F_{Target} = 0.175 corresponding to the SSB_{Target} of 72,380 mt (160 million lbs), and an $F_{Threshold}$ = 0.213 corresponding to the $SSB_{Threshold}$ of 57,904 mt (128 million lbs) (Figure B3). This procedure provides internally consistent SSB and F reference points. Values of MSY were explored using parametric stock-recruit relationships, but these were not regarded as reliable.

Fishing Mortality:

Fully-recruited F in 2012 is 0.188 (Figure B2). Total fishing mortality has been declining since a peak in 2006. The tag-based model gave similar results in terms of total mortality. The retrospective analysis indicated that terminal year fishing mortality was slightly overestimated in previous years (Figure B10).

Recruitment:

Striped bass experienced a period of strong recruitment from 1993-2003, followed by a period of lower recruitment from 2004-2009 (although not as low as the early 1980s, when the stock was overfished) (Figure B9). The 2011 year-class was strong, but early observations from Maryland's juvenile index indicate the 2012 year class was very weak. Retrospective analysis of recruitment revealed no consistent pattern of over- or underestimation (Figure B10).

Stock Biomass:

Female SSB grew steadily from 1982 through 2003 when it peaked at about 81 thousand mt (178 million lbs). Female SSB has declined since then and was estimated at 61.5 thousand metric tons (135 million lbs) in 2012 (Figure B1). Total biomass increased from 18,609 mt (41 million lbs) in 1982 to its peak at 221,774 mt (489 million lbs) in 1999. Total biomass declined through 2011, but increased in 2012 due to the strong 2011 year-class. The retrospective analysis indicated that terminal year SSB was slightly underestimated in previous years (Figure B10).

Special Comments:

Estimates of total biomass over the entire time period in this assessment are larger than estimates from the previous assessment because of the higher estimates of natural mortality on younger age classes derived from tag-based models. As a result the SSB reference point estimates are higher, although the basis is the same.

F reference points have been calculated to be consistent with the SSB reference points. Previously F reference points were calculated independently of SSB reference points and led to inconsistencies.

The estimate of recreational dead discards is sensitive to the assumed value of post-release mortality and this may result in a high error on these estimates.

References:

ASMFC. 1990. Source document for the supplement to the Striped Bass FMP - Amendment #4. Washington (DC): ASMFC. Fisheries Management Report No. 16. 244 p.

ASMFC. 2003. Amendment #6 to the Interstate Fishery Management Plan for Atlantic Striped Bass. Washington (DC): ASMFC. Fisheries Management Report No. 41. 63 p.

ASMFC. 2008. 2008 Review of the Atlantic States Marine Fisheries Commission Fishery Management Plan for Atlantic Striped Bass (*Morone saxatilis*). Washington, DC. 25 p.

Jiang H, Pollock KH, Brownie C, Hoenig JM, Latour RJ, Wells BK, Hightower JE. 2007. Tag return models allowing for harvest and catch and release: evidence of environmental and management impacts on striped bass fishing and natural mortality rates. North American Journal of Fisheries Management 27:387-396.

Total Catch of Atlantic Striped Bass (millions of fish) by Fishery

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Max[1]	Min[1]	Mean[1]
Commercial Harvest	0.87	0.91	0.97	1.05	1.02	1.01	1.04	1.03	0.93	0.84	1.23	0.01	0.65
Commercial Discards	0.26	0.46	0.79	0.19	0.60	0.30	0.61	0.25	0.63	0.80	0.80	0.04	0.34
Recreational Harvest	2.55	2.55	2.44	2.79	2.52	2.47	2.04	1.99	2.23	1.50	2.79	0.04	1.25
Recreational Dead Releases[2]	1.32	1.53	1.63	2.10	1.45	1.13	0.72	0.56	0.53	0.46	2.10	0.03	0.76

[1]: Minimum, maximum, and mean catch based on 1982-2012 data.
[2]: Assuming a 9% mortality rate on fish released alive.

Current Status of Atlantic Striped Bass

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Min[3]	Max[3]	Mean[3]
Female SSB (thousands of mt)	81.43	79.32	79.66	74.24	71.91	69.90	67.91	65.88	65.59	61.51	4.1	81.4	47.7
Total Abundance (millions of fish)	174.77	243.49	190.20	170.67	138.30	147.30	123.21	135.44	169.87	215.21	32.1	251.1	151.5
Age-1 Abundance (millions of fish)	76.71	160.13	87.40	82.80	59.05	80.41	55.94	76.56	108.57	143.55	18.3	183.4	87.1
Maximum F-at-Age	0.185	0.218	0.229	0.263	0.231	0.236	0.195	0.190	0.228	0.188	0.033	0.947	0.173

[3]: Minimum, maximum, and mean based on 1982-2012 model estimates.

	SARC46 and ASMFC 2008		**Updated (SARC57, 2013)**	
Reference Point	Definition	Value	Definition	Value
$\mathbf{F_{Threshold}}$	F_{MSY}	0.34	F projected to obtain $SSB_{Threshold}$	0.213
$\mathbf{F_{Target}}$	24% Exploitation rate	0.30	F projected to obtain SSB_{Target}	0.175
$\mathbf{SSB_{Threshold}}$	Estimate of 1995 SSB	36,000 mt	Estimate of 1995 SSB	57,904 mt
$\mathbf{SSB_{Target}}$	125% of $SSB_{Threshold}$	46,101 mt	125% of $SSB_{Threshold}$	72,380 mt

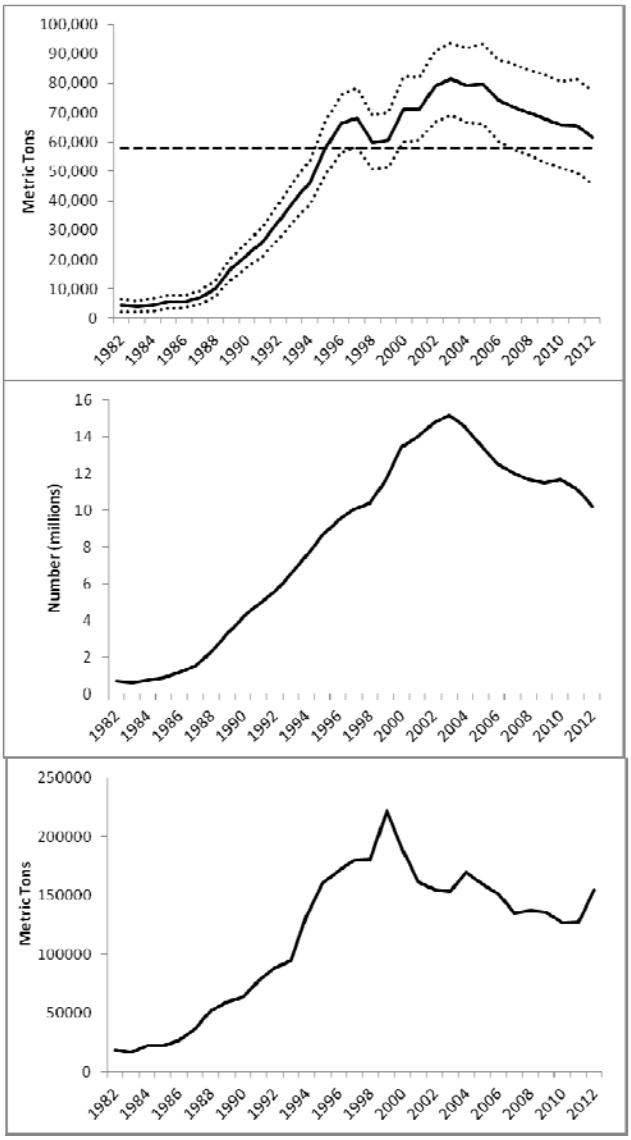

Figure B1. Striped bass. Estimates of A) female spawning stock biomass by year (solid line), B) female spawning stock numbers, and C) total January-1 biomass . Dotted lines equal 95% confidence intervals. Dashed line is the female spawning stock biomass threshold (1995 value).

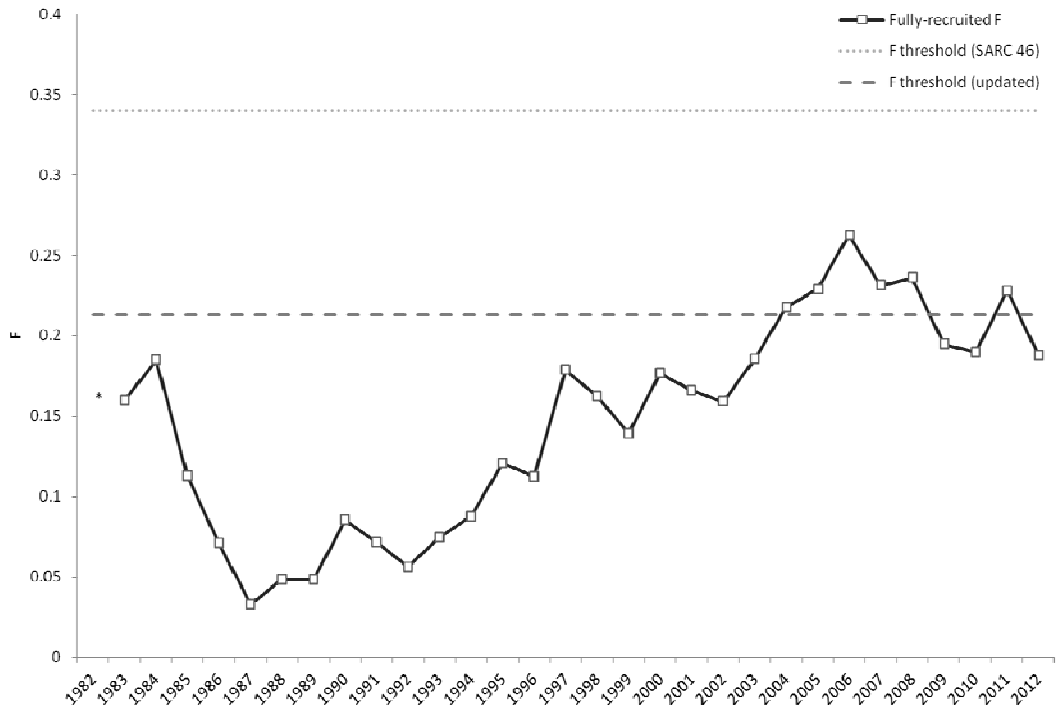

Figure B2. Striped bass. Fully recruited F relative to current (SARC 46) and updated (this SAW/SARC57 assessment) F threshold values. * indicates that the F for 1982 is not included on this graph as the model estimate was considered unrealistically high and unreliable.

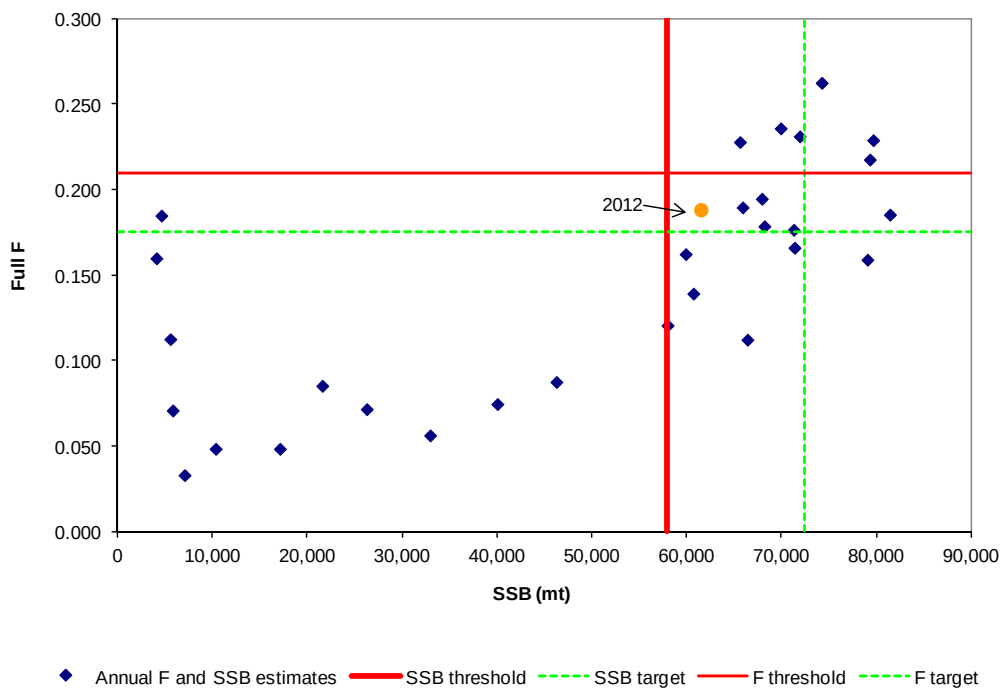

Figure B3. Striped bass. Annual estimates of F vs. SSB. Solid vertical and horizontal lines represent the SSB and F threshold reference points from SAW/SARC57, respectively, and dashed lines represent the target values. The orange circle represents the 2012 values for F and SSB.

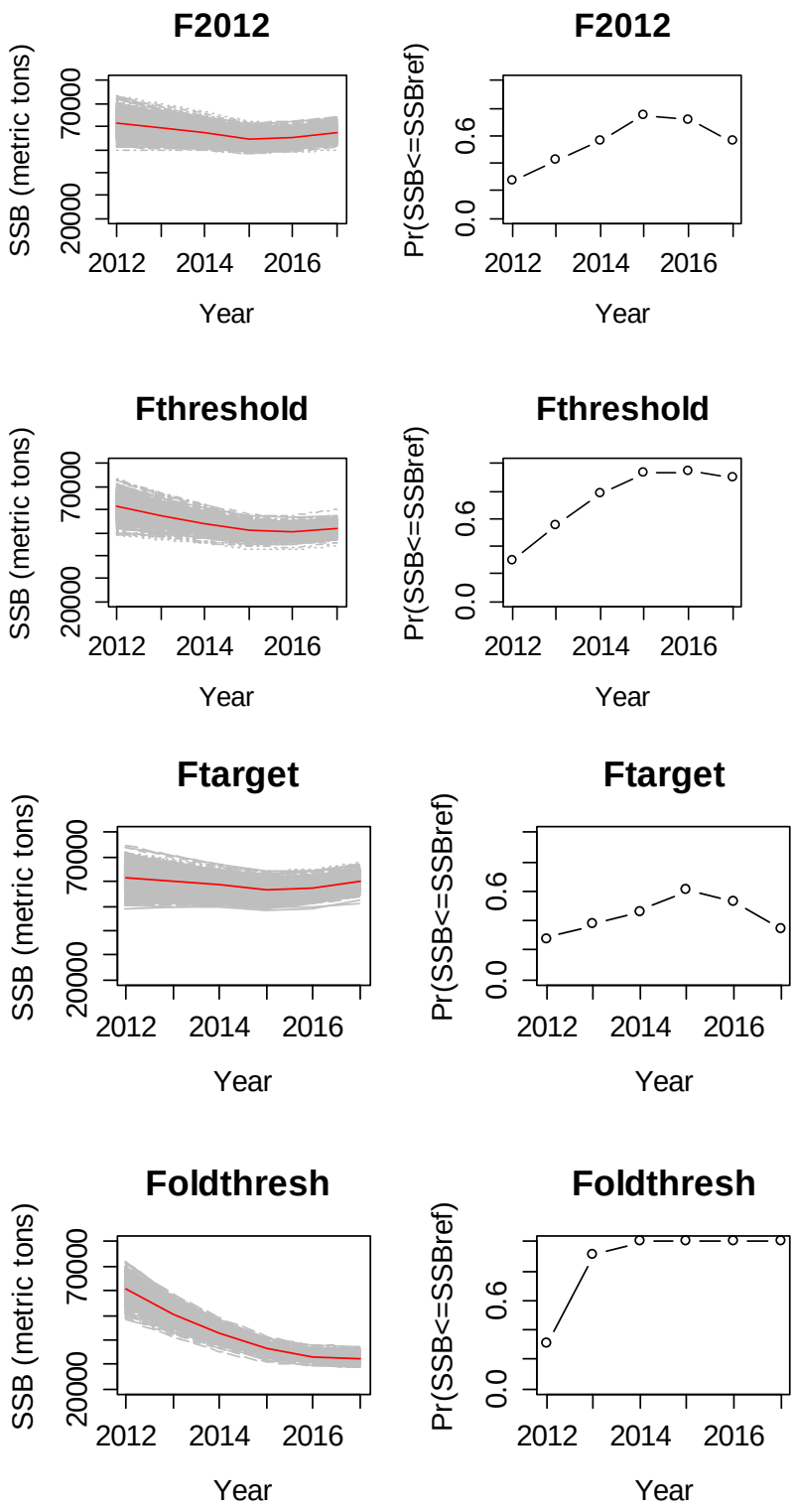

Figure B4. Striped bass. SSB trajectories and probability of being overfished under constant F scenarios.

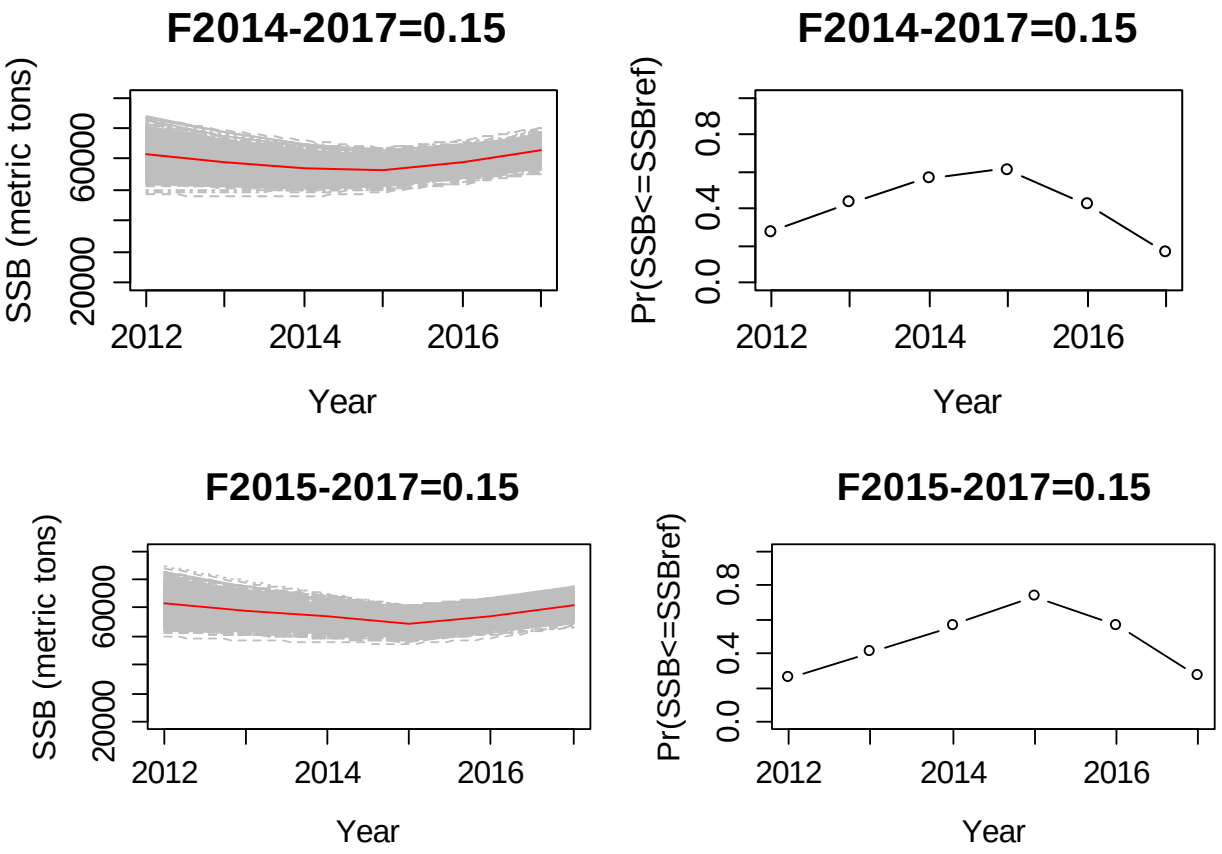

Figure B5. Striped bass. Effects of delaying reduction in F until 2014 (top) or 2015 (bottom) on SSB trajectories and probability of being below the SSB threshold.

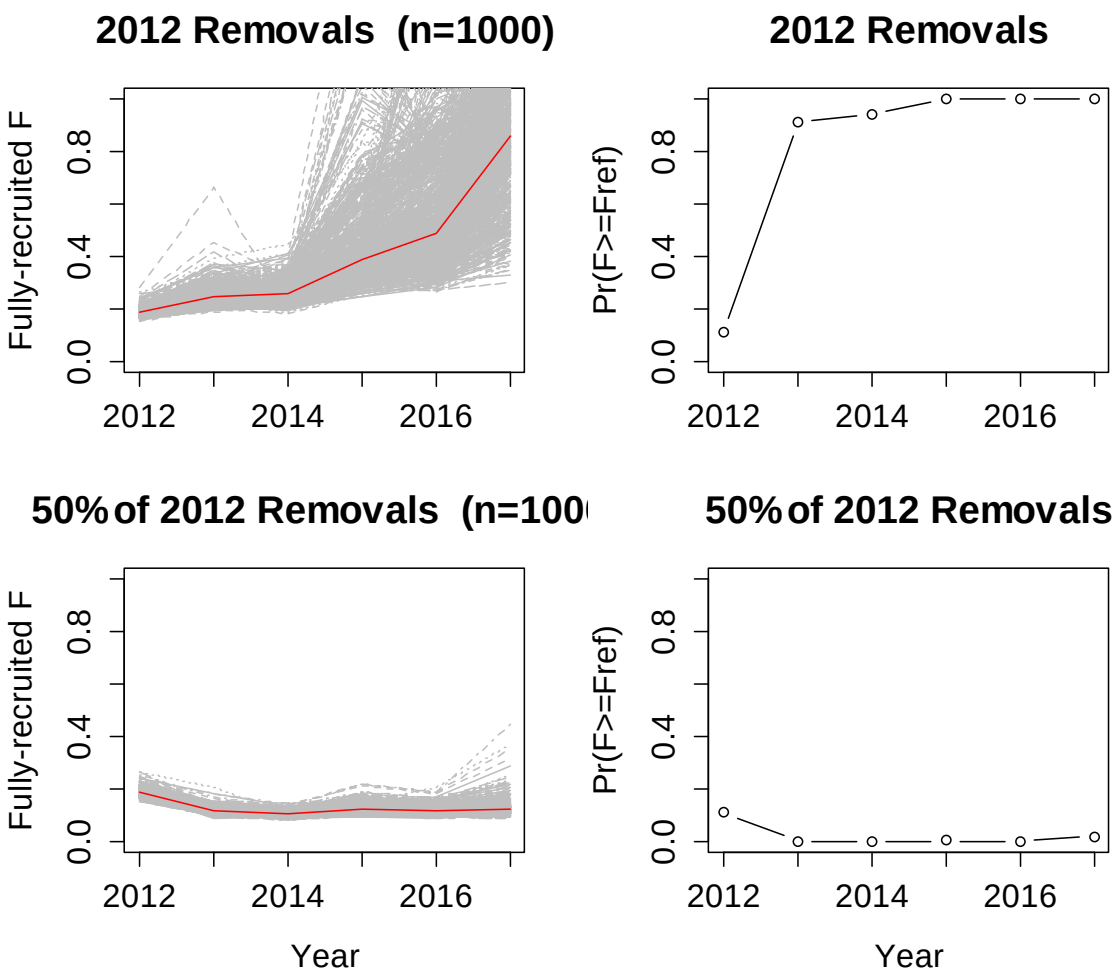

Figure B6. Striped bass. SSB trajectories and probability of overfishing under constant catch scenarios.

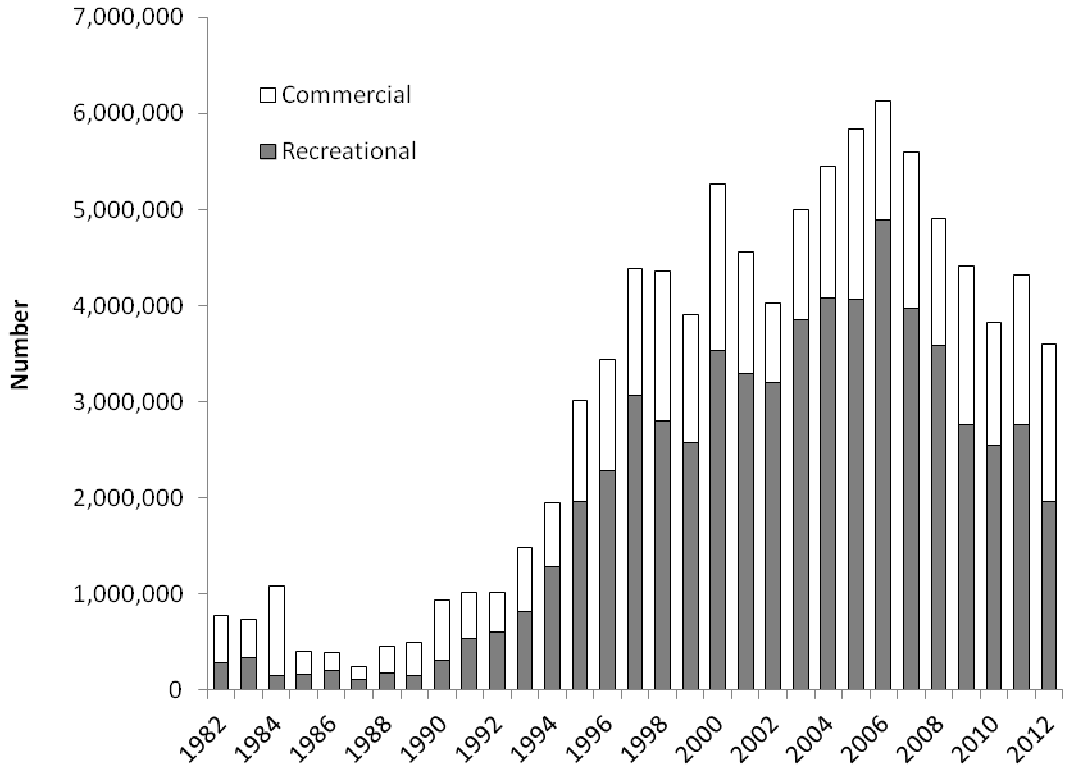

Figure B7. Total catch (numbers of fish) of Atlantic striped bass by fishery.

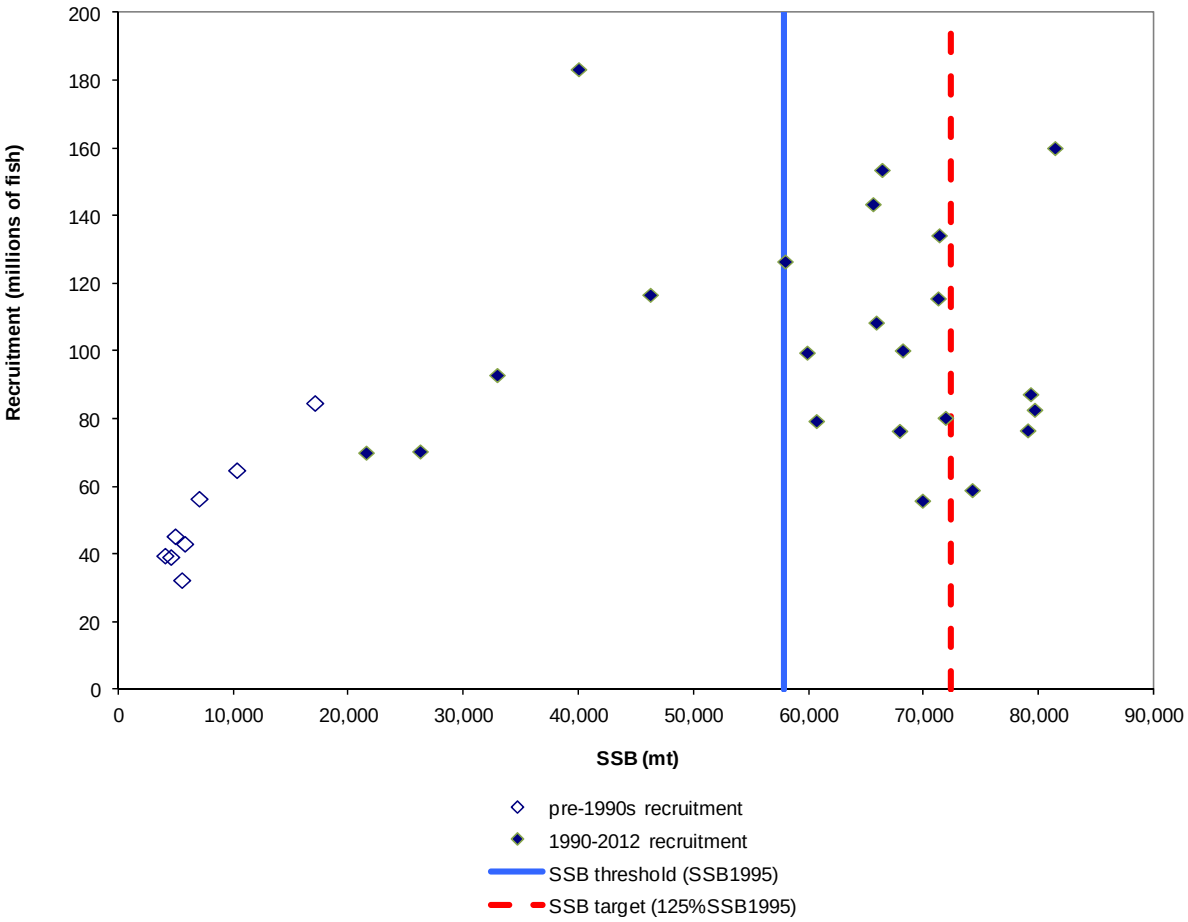

Figure B8. Striped bass. Recruitment estimates used to develop F reference points vs. spawning stock biomass. Pre-1990s estimates of recruitment were not used in F reference point projections. Vertical lines indicate SSB reference points from SAW/SARC57.

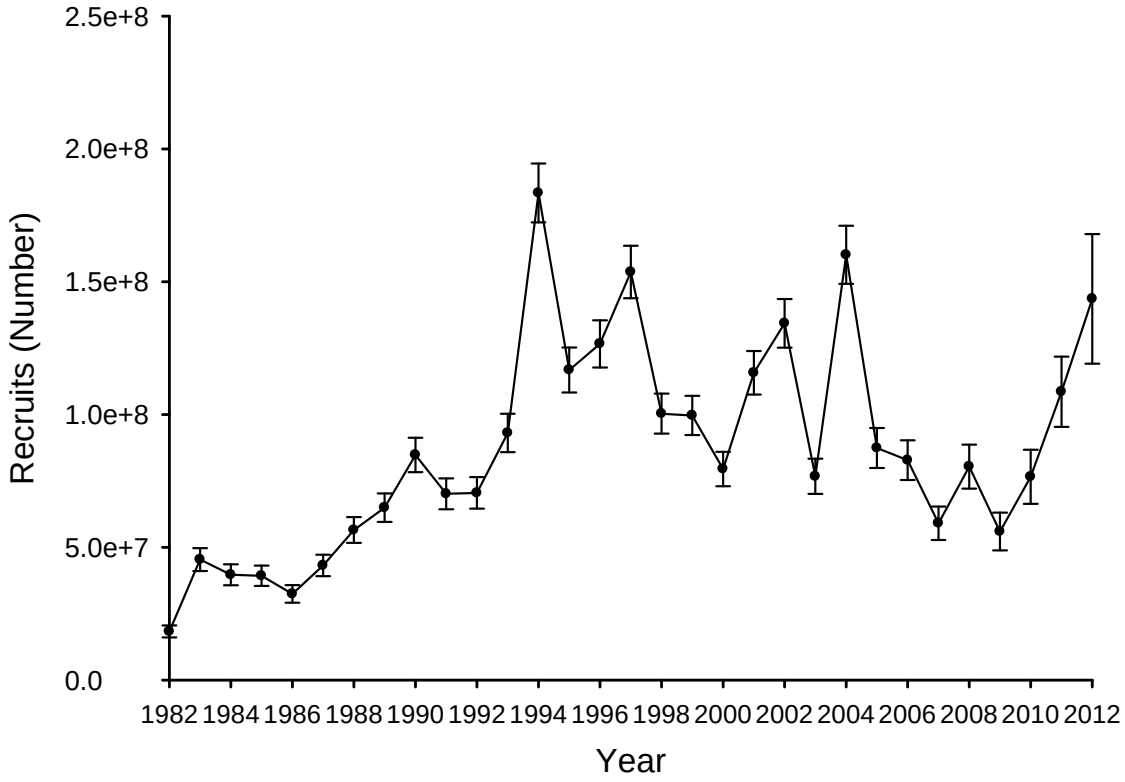

Figure B9. Model-estimated recruitment of age-1 striped bass. Error bars indicate ±1 SD.

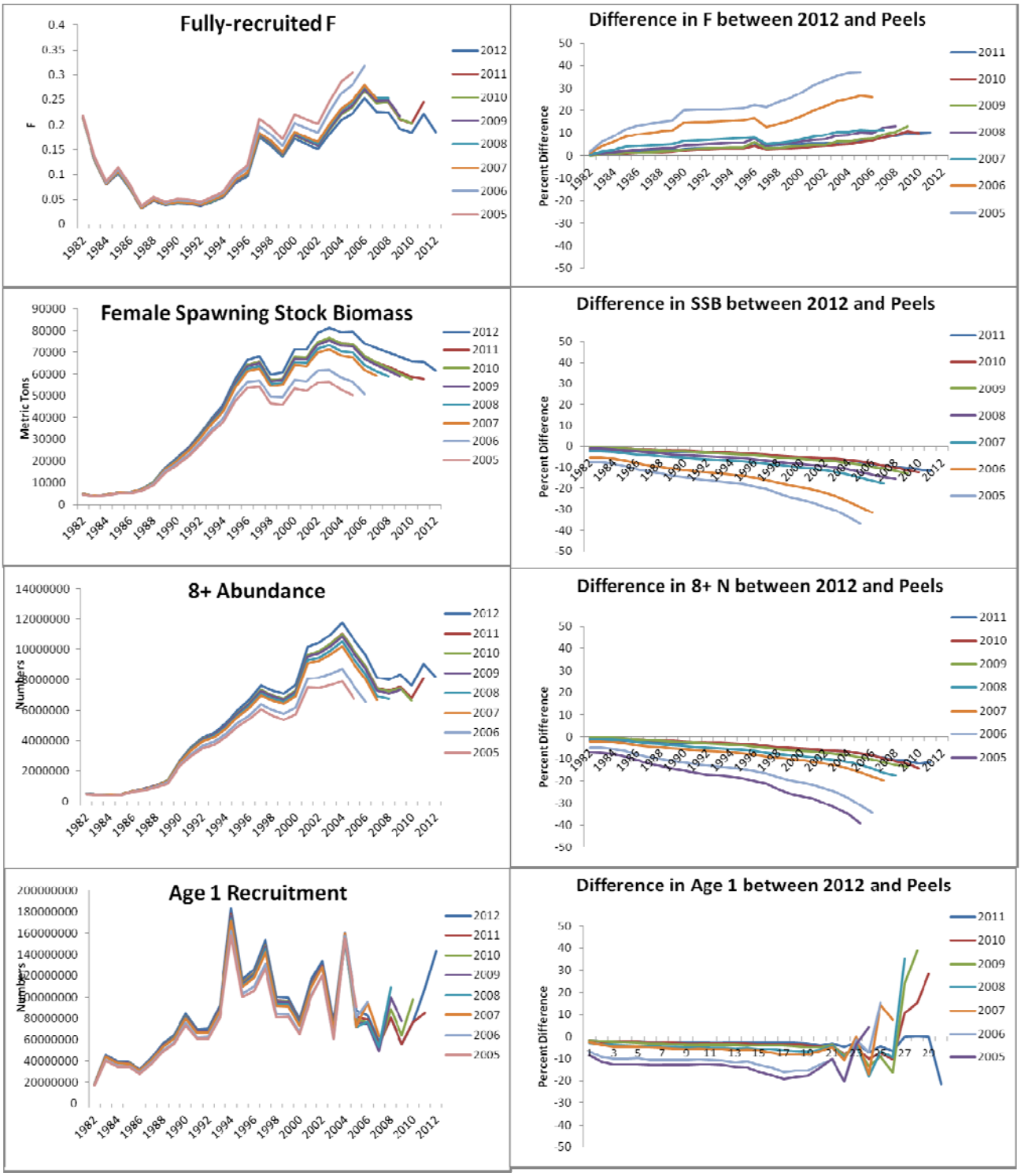

Figure B10. Retrospective analysis for preferred configuration of the striped bass SCA model.