Atlantic States Marine Fisheries Commission

1050 N. Highland Street • Suite 200A-N • Arlington, VA 22201
703.842.0740 • 703.842.0741 (fax) • www.asmfc.org

MEMORANDUM

July 24, 2012

To: **Atlantic Menhaden Management Board**

From: **Jeffrey Brust, Atlantic Menhaden Technical Committee Chairman**

Subject: **Response to "Technical Clarification" Memo**

Statement of the problem

The current overfished definition in the Atlantic menhaden FMP is SSB_{MED} as a target and 50% of SSB_{MED} as a threshold. Since the 2010 benchmark assessment, the Atlantic Menhaden Management Board adopted $F_{30\%}$ and $F_{15\%}$ as the menhaden management F-based overfishing target and threshold, respectively. **The TC warns that there is a technical mismatch between the current overfishing and overfished reference points. The TC recommends that if the Board wishes to manage the stock with an $F_{15\%}$ overfishing definition, then a matching overfished definition ($SSB_{15\%}$) should be adopted as well.**

This memo presents a comparison of $SSB_{15\%}$ and $SSB_{30\%}$ with current SSB_{MED} reference points. See also Appendix 3 of the 2012 update assessment report.

Notes on methods

The term "spawning stock biomass", or "SSB", in the update report and this memo refers to fecundity, or mature ova, *not* the biomass of mature adult menhaden. $SSB_{30\%}$ and $SSB_{15\%}$ reference points associated with $F_{30\%}$ and $F_{15\%}$ were calculated using the same vectors of average fecundity, M, and catch-weighted selectivity in addition to a value of median recruitment using the years 1955-2011. The uncertainty in the terminal year stock status indicators is expressed using the results of the 2,000 bootstrap runs of the base BAM model.

Results

Estimates of $SSB_{30\%}$ and $SSB_{15\%}$ and some exploration of the sensitivity of these results to model configuration are presented in Table 1 and Table 2. **If $SSB_{15\%}$ were adopted for management, the stock would be overfished.** The retrospective analysis, which re-estimates benchmarks annually, demonstrates that if $F_{15\%}$ and $SSB_{15\%}$ benchmarks are used, overfishing has been occurring during six of the last 12 years (Table 1) and the population was overfished during nine of the last 12 years.

The entire time series of $SSB_{30\%}$ and $SSB_{15\%}$ and associated bootstrap confidence intervals are shown in Figure 1 and Figure 2 using the years 1955-2011 for benchmark calculation. Phase plots of the last ten years of fecundity-per-recruit-based estimates are shown in Figure 3 using the years 1955-2011 for benchmark calculation. The results based on $SSB_{30\%}$ and $SSB_{15\%}$ benchmarks indicate that the SSB estimates for the terminal year are all below the threshold (limit) using the years 1955-2011 (Figure 4).

Table 1. Results from base BAM model, sensitivity runs, and retrospective analysis. Median recruitment to age-0 (billions) is labeled as R_{MED}, fishing mortality (F) is full F, and population fecundity (SSB) is in billions of mature ova. Subscripts denote the following MED: median; MED.T: threshold associated with the median; and term: terminal year, which is 2011 for the six rows. * denotes that benchmark calculation is not directly comparable with the base run because of differences in selectivity. This table is the same as Table 22 in the update report.

Run	R_{MED}	F_{MED}	$F_{MED.T}$	SSB_{MED}	$SSB_{MED.T}$	F_{term}/F_{MED}	$SSB_{term}/SSB_{MED.T}$	$F_{15\%}$	$F_{30\%}$	$SSSB_{15\%}$	$SSB_{30\%}$	$F_{term}/F_{15\%}$	$F_{term}/F_{30\%}$	$SSB_{term}/SSB_{15\%}$	$SSB_{term}/SSB_{30\%}$
Base run	12.61	2.06	1.02	19092	9546	1.83	1.4	1.34	0.62	30551	61100	3.36	7.22	0.44	0.22
*cR dome-shaped selectivity	12.52	1.95	0.97	18090	9045	1.77	1.39	1.25	0.64	30326	60650	3.31	6.51	0.41	0.21
omit JAI	12.72	2.15	0.97	18365	9182	1.88	1.47	1.34	0.62	30809	61618	3.54	7.6	0.44	0.22
omit PRFC	12.61	2.06	1.02	19140	9570	2.07	1.32	1.34	0.62	30561	61123	3.82	8.2	0.41	0.21
median effective N	11.96	1.51	0.85	22043	11021	2.07	1.26	1.18	0.57	28993	57989	3.26	6.74	0.48	0.24
*cR and cB dome-shaped selectivity	14.84	1.4	0.33	23575	11787	1.04	3.67	1.09	0.65	35953	71906	1.51	2.52	1.2	0.6
Retrospective 2010	12.85	2.17	0.96	18337	9169	1.71	1.23	1.33	0.62	31342	62686	3.31	7.11	0.36	0.18
Retrospective 2009	13.09	2.29	0.99	17594	8797	1.71	1.88	1.33	0.62	32014	64027	2.75	5.9	0.52	0.26
Retrospective 2008	13.12	2.23	0.96	18198	9099	0.9	2.2	1.32	0.62	32300	64599	1.56	3.35	0.62	0.31
Retrospective 2007	13.09	2.32	0.95	17180	8590	1.09	1.48	1.31	0.61	32406	64812	2.3	4.93	0.39	0.2
Retrospective 2006	13.14	2.27	0.99	17679	8839	0.95	2.5	1.3	0.61	32627	65251	1.46	3.13	0.68	0.34
Retrospective 2005	13.26	2.29	1.02	17560	8780	0.37	4.77	1.3	0.61	33006	66008	0.63	1.34	1.27	0.63
Retrospective 2004	13.25	2.3	1	17318	8659	0.49	3.06	1.3	0.61	33009	66020	0.94	2	0.8	0.4
Retrospective 2003	13.26	2.32	0.98	17077	8539	0.47	2.74	1.29	0.6	32983	65963	0.91	1.95	0.71	0.35
Retrospective 2002	13.89	2.26	0.98	17940	8970	0.58	4.31	1.27	0.6	34252	68498	0.89	1.89	1.13	0.56
Retrospective 2001	14.58	2.26	0.97	18570	9285	0.29	6.42	1.26	0.6	35757	71518	0.5	1.06	1.67	0.83
Retrospective 2000	14.6	2.26	0.97	18266	9133	0.43	2.41	1.26	0.59	35483	70970	0.85	1.81	0.62	0.31

Table 2. Summary of benchmarks and terminal year (2011) values estimated for the base BAM model. Fishing mortality rate is full F, and SSB is fecundity in billions of mature ova. The benchmarks were calculated using two time periods: 1955-2011 and 1990-2011. This table is the same as Table 23 in the update report.

Benchmarks and Terminal Year Values	Base BAM Model Estimates 1955-2011	Base BAM Model Estimates 1990-2011
Median Age-0 Recruits (billions)	12.61	8.96
Threshold (Limit): F_{MED}	2.06	1.51
Target: $F_{MED.target}$	1.02	1.04
$F_{30\%}$	0.62	0.7
$F_{15\%}$	1.34	1.53
F_{2011}	4.5	4.5
F_{2011}/F_{MED}	1.83	2.5
$F_{2011}/F_{30\%}$	7.22	6.43
$F_{2011}/F_{15\%}$	3.36	2.94
Target: SSB_{MED}	19,092	25,186
Threshold (Limit):		
$SSB_{MED.thresh}$	9,546	12,593
$SSB_{30\%}$	61,100	49,537
$SSB_{15\%}$	30,551	24,767
SSB_{2011}	13,334	13,334
$SSB_{2011}/SSB_{threshold}$	1.4	1.05
$SSB_{2011}/SSB_{30\%}$	0.22	0.27
$SSB_{2011}/SSB_{15\%}$	0.44	0.54

Figure 1. Estimates of the population fecundity (SSB) relative to the limit $SSB_{15\%}$ from the base BAM model (connected points) using benchmarks calculated over 1955-2011. Shaded area represents the 90% confidence interval of the bootstrap runs. This figure is the same as Figure 73 in the update report.

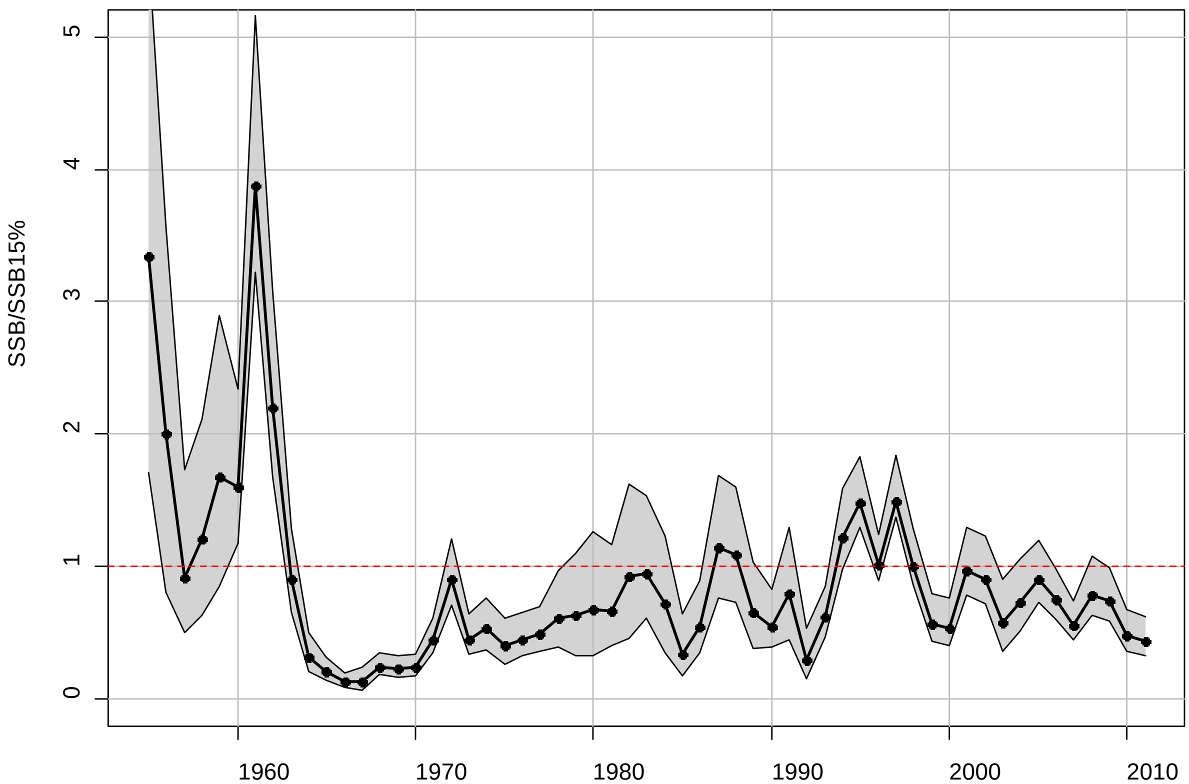


Figure 2. Estimates of the population fecundity (SSB) relative to the target $SSB_{30\%}$ from the base BAM model (connected points) using benchmarks calculated over 1955-2011. Shaded area represents the 90% confidence interval of the bootstrap runs. This figure is the same as Figure 74 in the update report.

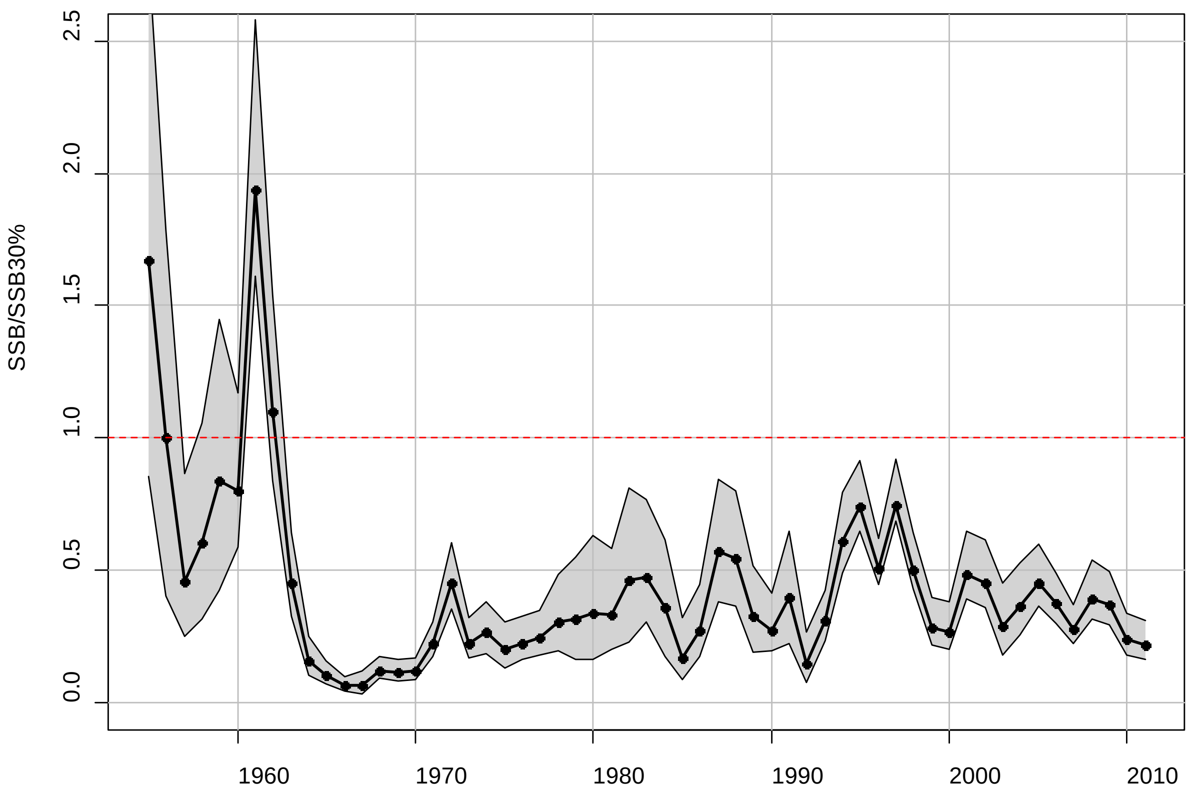


Figure 3. Phase plot of recent estimates of SSB (FEC, or billions of mature ova) and total full fishing mortality rate from the base BAM model with fecundity-per-recruit based benchmarks calculated using the years 1955-2011. Solid vertical and horizontal lines indicate the targets and limits for each respective axis. Double digit number in circles indicates the year of the point estimate (e.g. 08 = 2008). This figure is the same as Figure 75 in the update report.

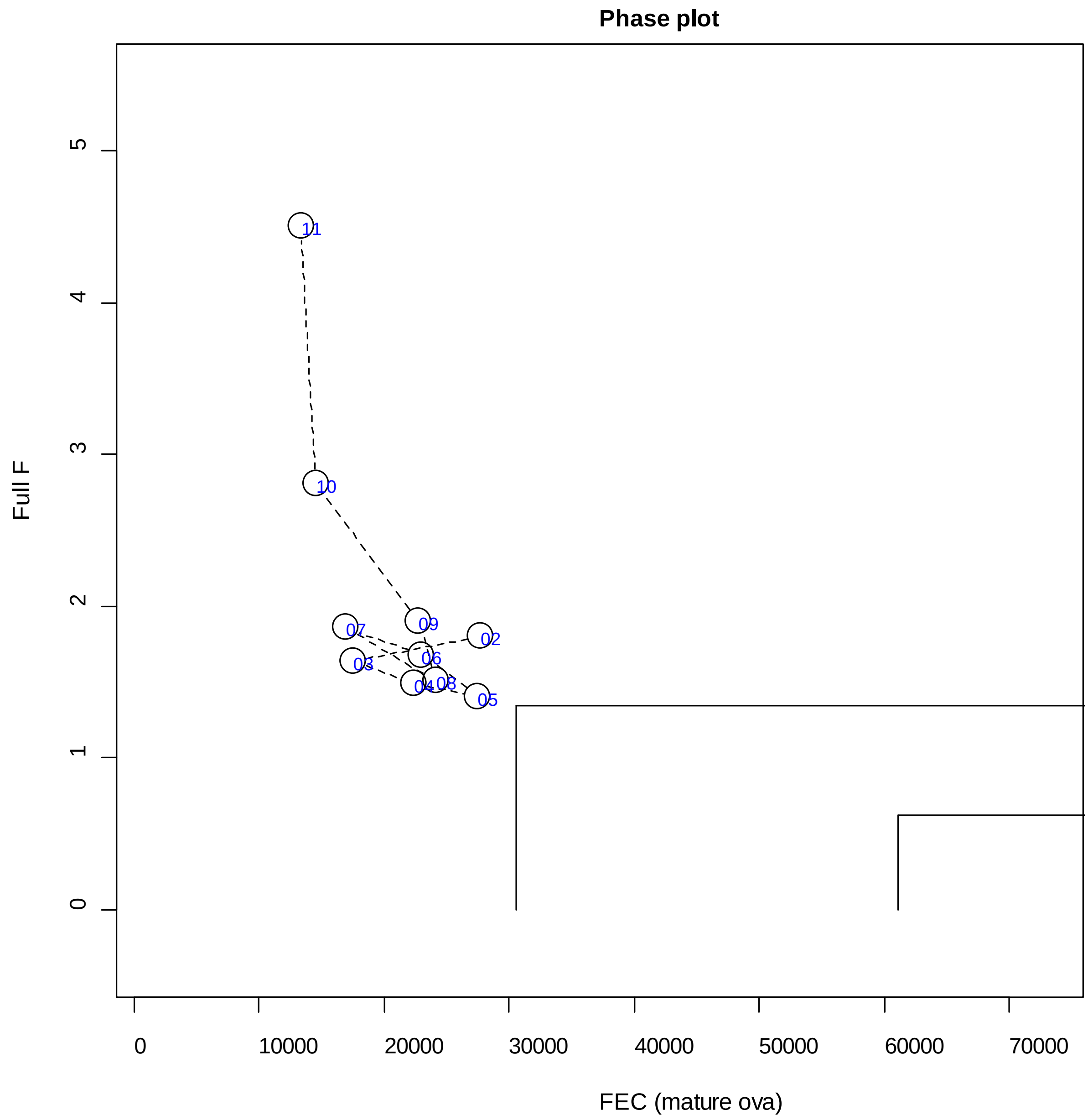
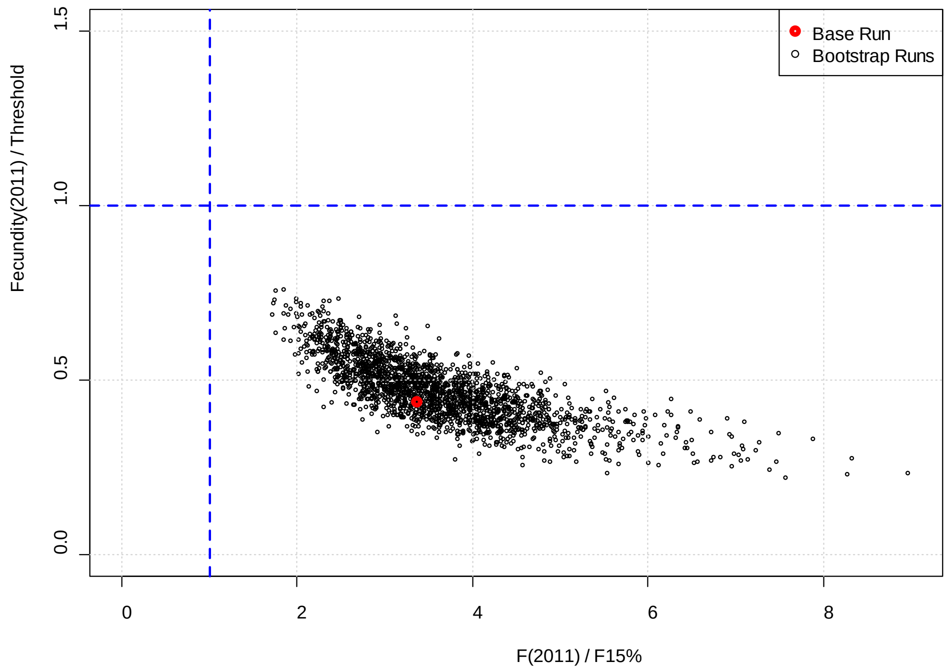


Figure 4. Scatter plot of the 2011 estimates relative to the $F_{15\%}$ and $SSB_{15\%}$benchmarks (limits) from the 2,000 bootstrap estimates from the base BAM model. All years 1955-2011 were used to calculate the benchmarks. This figure is the same as Figure 75 in the update report.



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Subject: **Response to "Technical Clarification" Memo**

On June 21, 2012, the Atlantic Menhaden Technical Committee received a memo (M12-050) from Dr. Louis Daniel, Chair of the Atlantic Menhaden Management Board tasking the TC to address certain areas of concern prior to the August 2012 Board meeting. The concerns stem from a number of issues identified during the stock assessment update that undermine the TC's confidence in the assessment results to provide management advice. The Board's request focused the TC's attention on identifying the major concerns with the assessment, and providing alternatives for moving forward under the Amendment 2 framework. The specific requests, and the TC responses, are described in detail below.

Board task 1:
Complete the Assessment Update for inclusion in the briefing materials for the Board.

TC Response:
The stock assessment update is complete. The full report, including text, tables, figures, and appendices, is available with the August 2012 meeting materials.

Board task 2:
Highlight any concerns that the TC has regarding the model output and its use for supporting management decisions.

TC Response:
The five main concerns identified by the Technical Committee are:

- Overweighting of the age composition data.
- Lack of spatial modeling to address changes in the fishery over time.
- Lack of a coastwide adult abundance index.
- Poor fit to the PRFC index.
- Strong retrospective pattern.

The first three were identified by the 2009 peer review panel as potential short comings of the model which could not be addressed during the update process, while the remaining two undermine the TC's confidence in the terminal year estimates. The five issues together cast considerable doubt on the accuracy of the estimates from this update stock assessment. Additional details on these five issues and their implications are discussed in Section 10 of the stock assessment update report.

M12-55

Board task 3a:
Provide additional quantitative or qualitative data that will provide insight to the Board on the status of the menhaden stock (e.g. recruitment levels, catch age composition, survey trends).

TC Response:

Assessment
The TC's overall level of comfort with the underlying data sources and results used in this assessment has not changed appreciably during this update. However, treatment of data sources within the model deserves close attention during the next benchmark. The TC offers the following statements regarding the update data sources to help guide management:

- Reduction landings trends are reliable.
  - Note the ASMFC-imposed 109,020 t per year annual cap in Chesapeake Bay has never been exceeded.
  - Note also that since 2008, the Reedville reduction plant has self-imposed daily and/or weekly vessel landings quotas because catches often exceeded the factory's processing capacity.
- Catch-at-age for the reduction fishery is reliable.
  - Given enough consecutive years of data, good year classes can be identified and year class strength can be tracked over time.
- Commercial bait landings trends are less reliable, but are unlikely to match or exceed reduction landings.
  - Commercial bait landings have risen across the time series and reached a record high in 2011.
- There is still no coastwide adult survey to provide fishery-independent information about coastwide trends in the stock.
- The MSVPA-X indicated that forage demands from increasing bluefish and striped bass stocks have increased consumption rates on menhaden.
- The TC is concerned about the representativeness of the PRFC and JAI indices in reflecting true changes in stock conditions.

Retrospective bias problems identified during the assessment update are not unique to the BAM (i.e., this is not the result of a coding error or a minor parameterization issue within BAM). The problem may not be resolved without careful review, vetting, and re-analysis of input data sources and model structure.

The TC cannot agree on the issue of correcting for retrospective pattern given the directional changes in bias over the last 11 years.

Stock status and reference points

Although the Technical Committee could not come to consensus on the utility of the terminal year point estimates of F and SSB for management advice, there was consensus that the status determinations were likely robust. In other words, the ratio of $F_{2011}/F_{15\%}$ is likely greater than 1.0 (overfishing is occurring), and $SSB_{2011}/SSB_{MED.T}$ is likely greater than 1.0 (the stock is not overfished), but the exact magnitude of these ratios could not be determined. This statement in supported both quantitatively and qualitatively. Quantitatively, results of the sensitivity runs (albeit limited) and bootstrap analysis indicated the results of stock status were robust to uncertainty in the data and parameterization as specified in this update. Qualitatively, the 2009 benchmark stock assessment concluded that overfishing was occurring, and Addendum V reference points significantly reduced the overfishing threshold (from approximately $F_{8\%}$ to $F_{15\%}$). As harvest levels have increased since 2008 and there has been no significant increase in stock size, overfishing is still likely occurring.

The TC notes that there is a theoretical mismatch between the $F_{15\%}$ overfishing definition recently adopted by the Board and the $SSB_{MED.T}$ in the FMP (*i.e.* the fishing mortality and biomass reference points are in different "currency"). The TC recommends that if the Board wishes to adopt an $F_{15\%}$ overfishing definition, that a matching overfished definition ($SSB_{15\%}$) be adopted as well. This issue is further discussed in Appendix 3 of the stock assessment update report.

Reference points evaluated in the stock assessment update report are intended to be interim reference points while the Technical Committee addresses the Board task of developing ecosystem reference points. Although MSP based reference points were identified as a viable interim option by the Technical Committee, the TC has not had the opportunity to evaluate whether the selected reference points achieve a specific management objective other than generically increasing Atlantic menhaden biomass. The TC reiterates its support for the Multiple Objective Decision Analysis (MODA) process to help the Board identify specific management objectives necessary for development of ecosystem reference points.

Board task 3b:
Also, provide recommendations on potential steps to achieve the Board selected biological reference points.

TC Response: During the February 2012 Management Board meeting, the Technical Committee presented preliminary results of projection analysis that estimated the probability of achieving the Board selected reference points over a range of time frames (1 to 5 years) under different constant harvest scenarios. The analysis was expected to be re-run following completion of the 2012 stock assessment update, and the results would be presented to the Board for potential use in setting harvest levels under Amendment 2. However, given the uncertainty in the results of the update stock assessment, the Technical Committee has concluded that, although, the projection results provide information on stock response given harvest reductions, they should not be used to establish harvest limits for the fishery.

As an alternative to using projections to set TACs, ad hoc approaches are used by several regional Fishery Management Councils for species with poor assessment data or uncertain stock assessment results. Typically, in these situations, most Councils use their landings/catch data as the only reliable means of setting harvest limits. A document entitled “Calculating Acceptable Biological Catch for Stocks that have reliable Catch Data Only” was recently published (ORCS 2011), and serves as guidance to set interim removal levels under these conditions.

To summarize the ORCS report; generally an average of the last 3-5 years of landings are used as this reflects recent history. A precautionary multiplier is then applied to decrement the average landings and set a harvest limit. Decision of the appropriate multiplier is cautiously decided based on factors such as life history, ecological function, stock status, and an understanding of exploitation. Typically this multiplier can range from 0.85 to 0.25 (Table 1).

Table 1. Summary of ad-hoc approaches used by Fishery Management Councils to set harvest limits in data poor situations.

Council	Species group	Multiplier	Comments
New England	Atlantic herring	1	Not OF, OF not occurring
New England	Red crab	1	Based on stock status
Carribean		0.85	Used to set ABC and ACL
New England	Groundfish	0.75	
Pacific		0.75	Used to set ABC
Pacific	Groundfish	0.5	Used to set OY
Pacific	Coastal pelagics	0.25	Used to set ABC

In the New England approach, the multiplier was chosen at 1.0 suggesting catch be maintained at current levels. The rationale was that the stock was not overfished and overfishing was not likely to be occurring. Other evidence, such as size at age, also indicated that the overall stock status was good. Further, landings were well monitored and discards of the target stock were low.
In the case of the Pacific Fishery Management Council the multiplier was set at 0.25. This number reflected the importance of herring as forage for stellar Sea Lions and other endangered mammals, the high level of exploitation, and the fact that Pacific Herring spawn in discreet and vulnerable aggregations (when they are targeted by the fishery).

It should be noted that the multiplier is never set at a value >1.0; indicating that catch should not be allowed to increase in these uncertain situations. Table 2 provides some additional decision making framework information that goes into the choice of a multiplier.

Table 2. The method table showing possible actions for determining ABC based on different fishery impact categories and expert opinion. Taken from the workshop report of the 2nd National SSC meeting (From ORCS, 2011).

Historical Catch	Expert Judgment	Possible Action
Nil, not targeted	Inconceivable that catch could be affecting stock	Not in fishery; Ecosystem Component; SDC not required
Small	Catch is enough to warrant including stock in the fishery and tracking, but not enough to be of concern	Set ABC and ACL above historical catch; Set ACT at historical catch level. Allow increase in ACT if accompanied by cooperative research and close monitoring.
Moderate	Possible that any increase in catch could be overfishing	ABC/ACL = f(catch, vulnerability) So caps current fishery
Moderately high	Overfishing or overfished may already be occurring, but no assessment to quantify	Set provisional OFL = f(catch, vulnerability); Set ABC/ACL below OFL to begin stock rebuilding

ABC = Acceptable Biological Catch ACL = Annual Catch Limit
ACT = Annual Catch Target OFL = Overfishing Level

For Atlantic menhaden; the stock is likely experiencing overfishing given the recent changes in reference points (ASMFC 2012). Overall, Atlantic menhaden have low vulnerability given their short life history, age at spawning, rapid growth, and fecundity. However, menhaden also serve as forage for other valuable commercial and recreationally important species. While landings history data are good, some significant uncertainties remain in recruitment due to natural variability. As such Table 3 outlines some possible options using a 3 or 5 year average of the catch, with the addition of potential multipliers to be used on those catch values. Typically Councils and their SSC's dictate the multipliers in 0.25 increments, given the other uncertainties involved.

Table 3. Estimated harvest levels (thousand MT) for a range of uncertainty correction factors.

Probability of reducing overfishing decreases moving towards a multiplier of 1.

Average	Multiplier					
	1	0.9	0.8	0.75	0.5	0.25
3-year	213.5	192.2	170.8	160.2	106.8	53.4
5-year	209.5	188.5	167.6	157.1	104.7	52.4

It should be noted that, at this time, these are provided only as information for the Management Board; the Technical Committee has not had time to review these as a group to determine which (if any) would be appropriate for use in managing the Atlantic menhaden stock.

Reference

ORCS-Berkson, J., L. Barbieri, S. Cadrin, S. L. Cass-Calay, P. Crone, M. Dorn, C. Friess, D. Kobayashi, T. J. Miller, W. S. Patrick, S. Pautzke, S. Ralston, M. Trianni. 2011. Calculating Acceptable Biological Catch for Stocks That Have Reliable Catch Data Only (Only Reliable Catch Stocks – ORCS). NOAA Technical Memorandum NMFS-SEFSC-616, 56 P.