

ATLANTIC HERRING 2018 BENCHMARK STOCK ASSESSMENT (65TH STOCK ASSESSMENT WORKSHOP)

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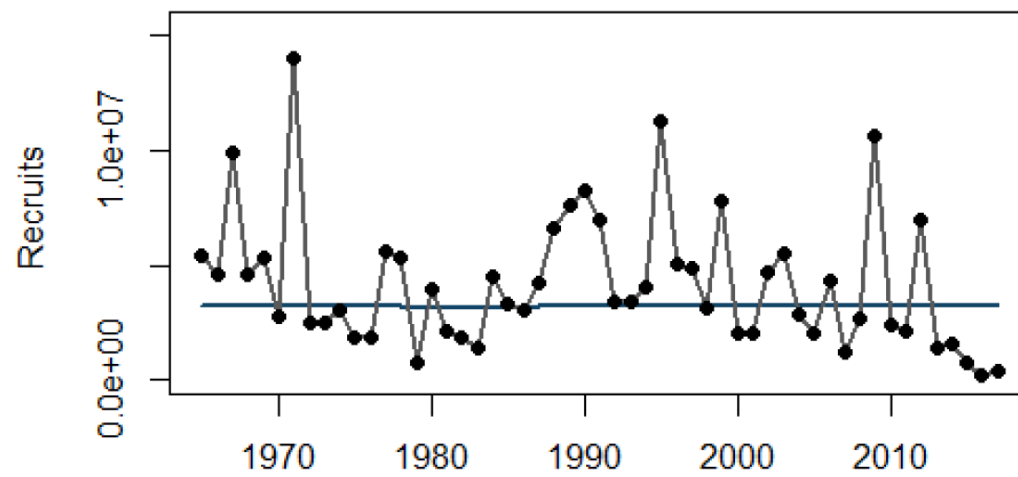
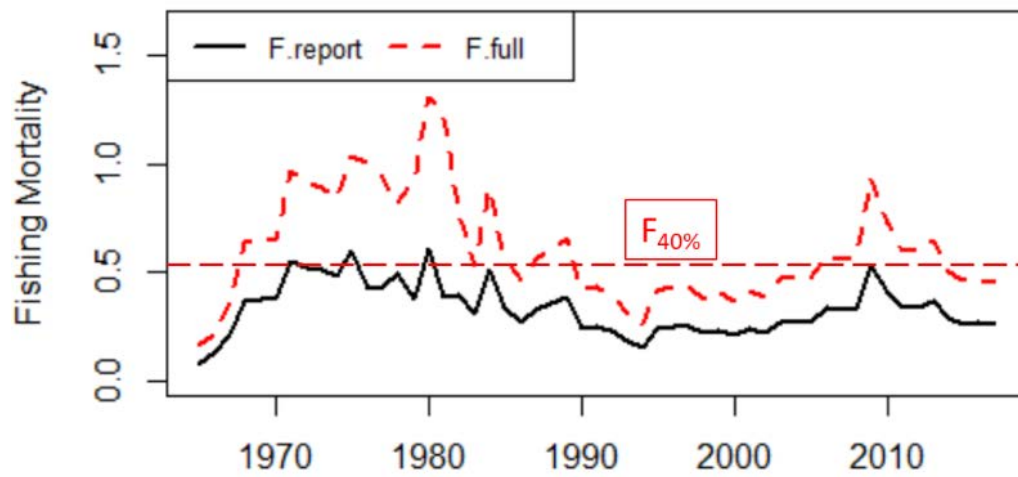
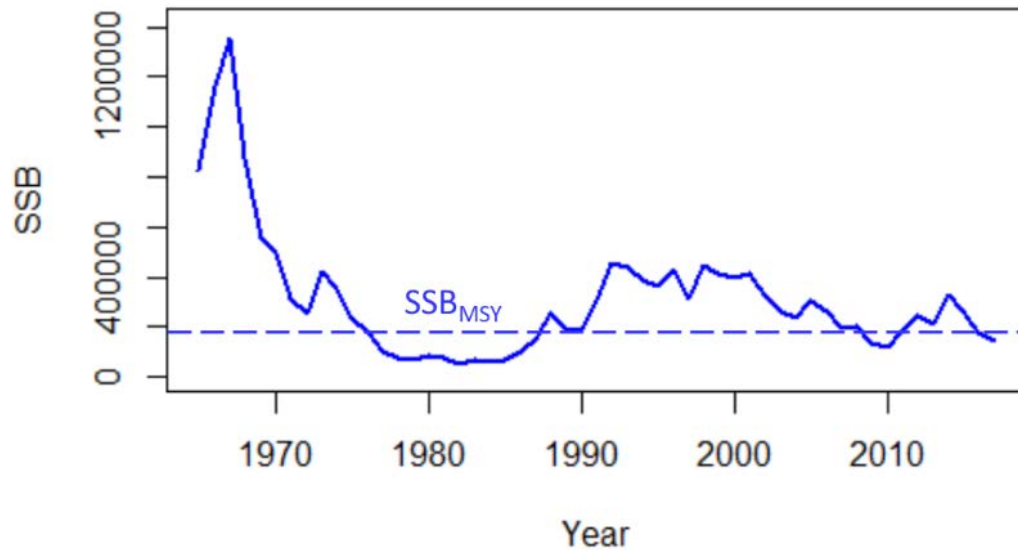
August 5, 2018

We participated in the 65TH Stock Assessment Workshop (SAW65) process to develop a benchmark stock assessment of Atlantic herring, including attendance at all meetings in the process:

- Data Meeting, February 6-8 2018, Woods Hole MA
- Model Meeting, May 2-4 2018, Waquoit MA
- Stock Assessment Review Committee (SARC), June 27-28 2018, Woods Hole MA

Summary

The SAW65 benchmark assessment produced a new stock assessment method that was accepted by the SARC peer review process. The new benchmark assessment indicates that the stock is not overfished, and overfishing is not occurring. Current spawning biomass (2017 SSB=141 kt) is 75% of the Maximum Sustainable Yield rebuilding target ($SSB_{MSY} = 189$ kt), and current fishing mortality (2017 $F = 0.45$) is 88% of the overfishing proxy ($F_{40\%} = 0.51$). However, the assessment also estimates that recent recruitment has been relatively weak (e.g., below average since 2013, including some of the lowest recruitment estimates in the assessment series). As a result, projected catch limits are expected to substantially decrease. Assuming that half of the 111 kt catch limit is taken in 2018, then the overfishing limit (OFL) is expected to be 29 kt in 2019 (the Council recommended a reduction to 50 kt in 2018), and the catch limit will be less than the OFL, depending on the control rule adopted by the Council. Recognizing the substantial negative economic implications of these catch projections, we conclude that the new benchmark stock assessment of herring is an improvement from the previous benchmark method because of fewer data conflicts and a more retrospectively-consistent stock assessment.



(note that the most recent recruitment estimate is highly uncertain and was not included in projections)

Process

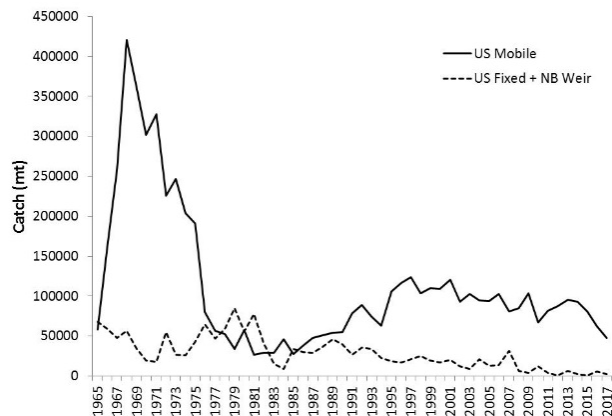
A Working Group (WG) was formed to develop a new benchmark assessment method from the Northeast Fisheries Science Center (NEFSC) and other organizations: Gary Shepherd (NEFSC, WG chair), Jon Deroba (NEFSC, lead assessment scientist), Deirdre Boelke (New England Fishery Management Council staff), Ashleen Benson (Landmark Fisheries, Canada), Matt Cieri (ME Department of Marine Resources), Sarah Gaichas (NEFSC), Chris Legault (NEFSC), John Manderson (NEFSC). The WG Chair moderated a relatively open and inclusive process in which other participants were invited to meetings, encouraged to actively participate and included in WG correspondence. WG decisions, methods, results and interpretations were well documented in the WG report.

The SARC included external reviewers who are global experts in advanced stock assessment modeling: Pat Sullivan (SARC chair, Cornell University & New England SSC), Cathy Dichmont (Australia), Geoff Tingley (New Zealand), and Coby Needle (Scotland). The SARC chair moderated a relatively open process and recognized input from all participants. The SARC provided a rigorous and constructive review and accepted the new benchmark assessment.

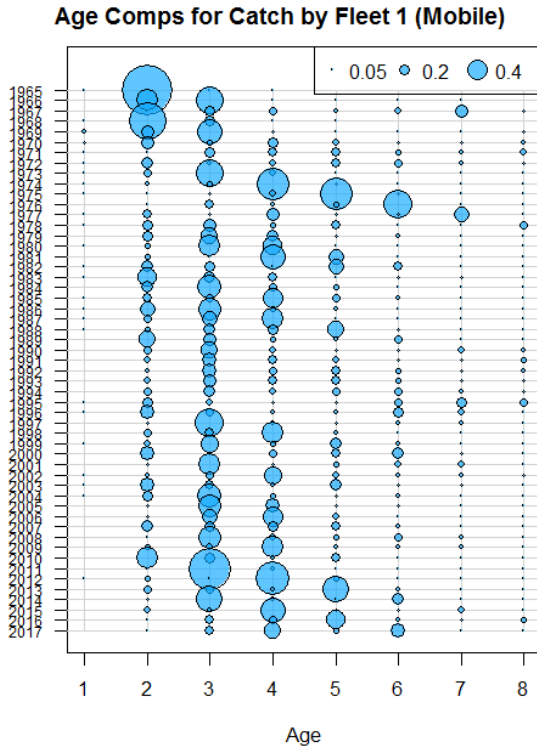
Data Meeting

All available data were reviewed, and several decisions were made about data used in the stock assessment:

- Fishery Data
 - The herring stock has multiple spawning components (Georges Bank, Gulf of Maine and Scotian Shelf), but the assessment assumes a single stock (Georges Bank and Gulf of Maine) due to the inability to parse the catch into stock of origin.
 - Catch information from ME logbooks is reliable for use in the assessment.
 - Discards represent $\leq 1\%$ of the total catch, and there is no evidence that slippage is significant.
 - Catch was modeled as two fleets: fixed and mobile gears. However, some differences in length distributions between purse seine and mid-water trawls suggests that the two mobile gears may have different size selectivity. The WG decided to account for the difference by evaluating the contribution of each fleet over time and allowing selectivity to change among time periods.



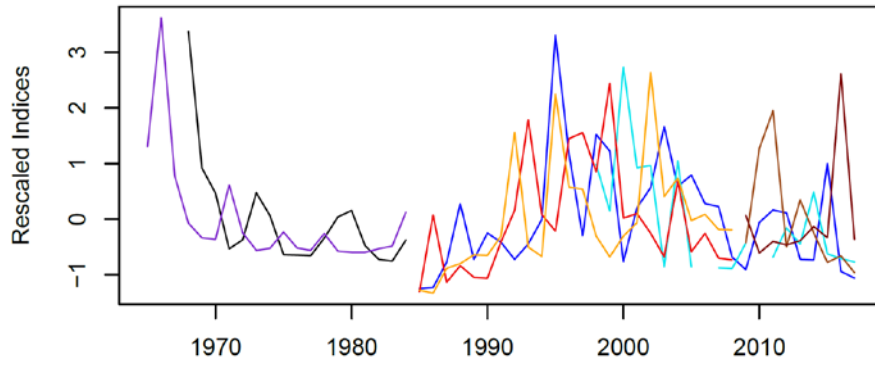
Recent catch has been ~100kt, almost entirely from mobile gear



Age composition of the fishery suggest strong 2008 and 2011 yearclasses, but little contribution from more recent yearclasses

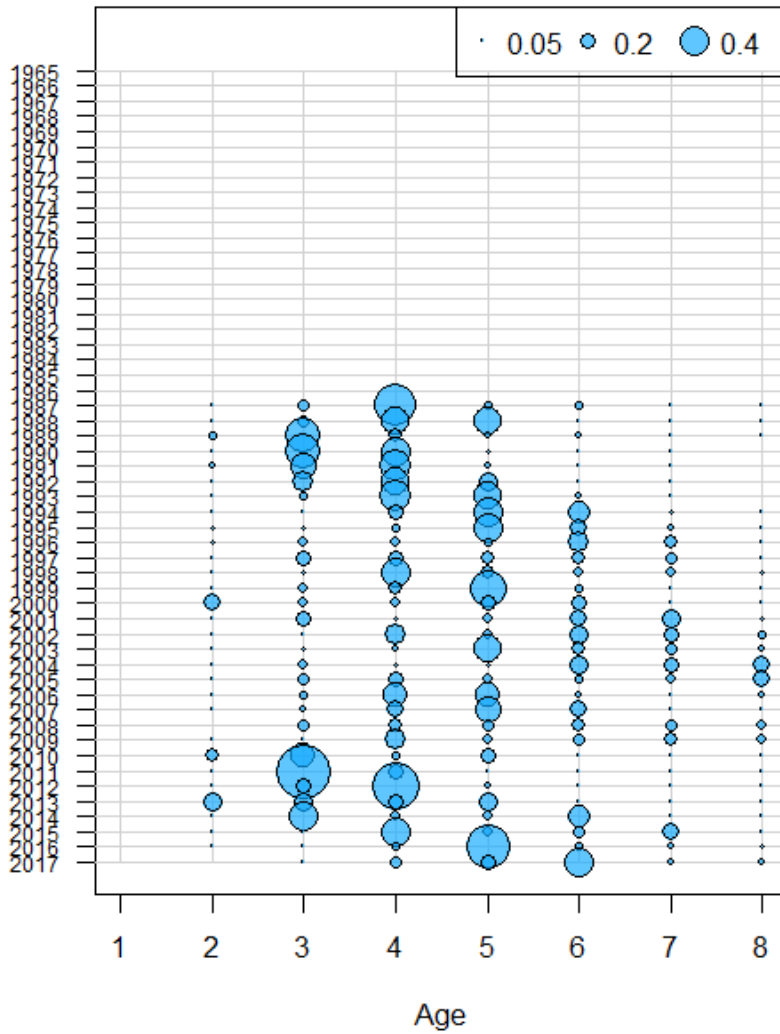
- Age composition for the US fixed gear was not sampled in some recent years, so the Canadian fixed gear age composition was used in those years because the US and Canadian fixed gear fisheries are similar. The Canadian fixed gear fishery is mostly by weirs, catching mostly small herring (age 1 and 2) sold as sardines. The US fixed gear fishery is also mostly weirs, and geographically very close to the Canadian fishery.
- Maturity-at-age was estimated for each year using autumn samples from mobile gear, because commercial samples include more immature fish.
- Survey Data
 - NEFSC surveys were considered to be a single series split as separate Bigelow and Albatross time series.
 - The fall 2017 survey did not include strata 5-12 (southern New England), so an adjustment factor was applied to account for missing area.
 - Acoustic data from NEFSC trawl surveys were developed for the entire survey area.
 - An index of abundance based on herring sampled in predator stomachs was considered, but the index was highly sensitive to the selected predators and was not included in the assessment model.
 - The NEFSC winter bottom trawl survey was not included in the assessment model because of inconsistent spatial coverage.
 - The MA inshore survey and ME/NH inshore survey were not included in the assessment model because the inshore spatial coverage is unlikely to consistently cover the area of distribution.

- Herring consumption estimates were updated and improved to provide annual estimates.



Survey indices are relatively noisy, but all surveys indicate a low stock in 2017

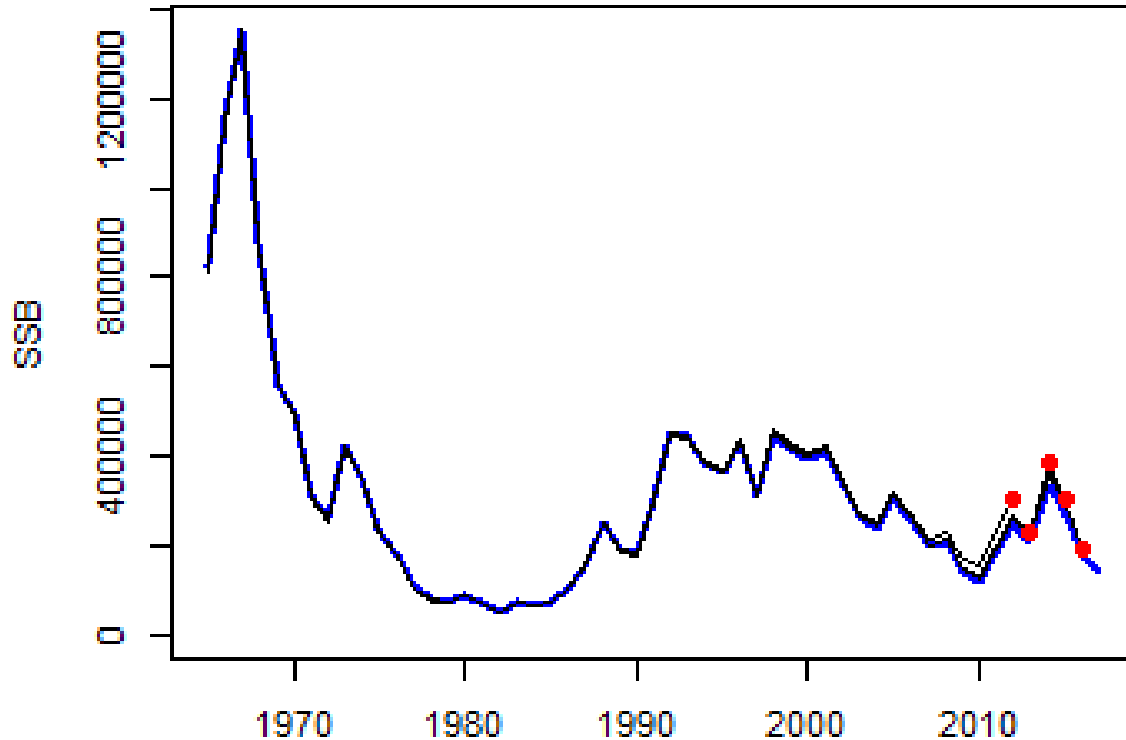
Age Comps for Index 3 (Shrimp)



Similar to fishery data, survey age compositions suggest strong 2008 and 2011 yearclasses, but little contribution from more recent yearclasses

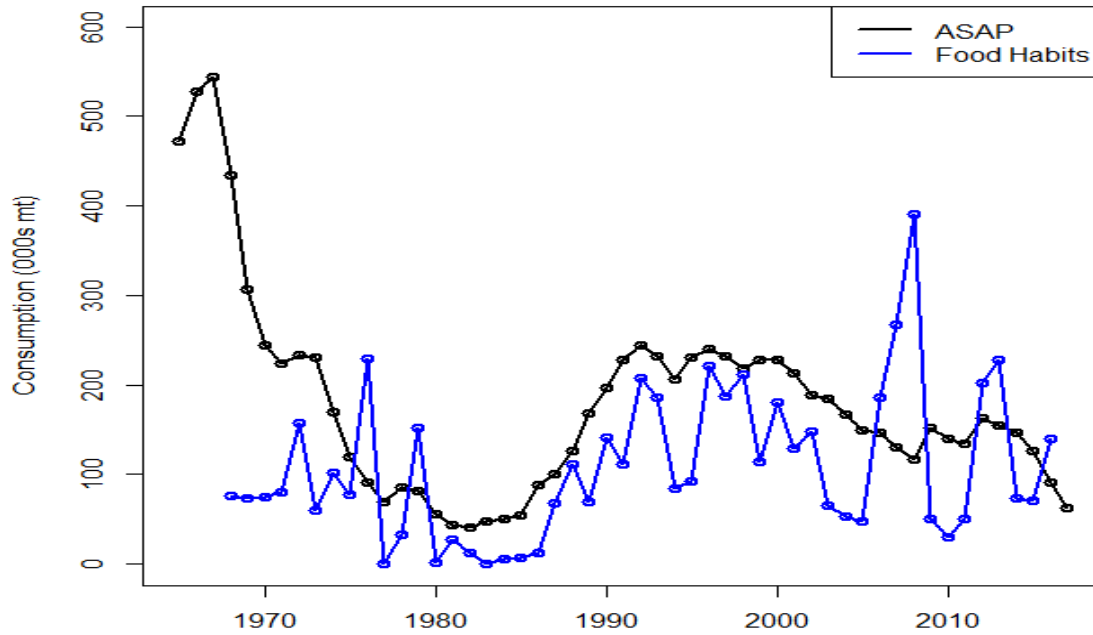
Model Meeting

A major retrospective pattern emerged in updates of the previous benchmark method, developed in 2012 (SAW54). Several model revisions were developed to produce a more retrospectively consistent assessment.

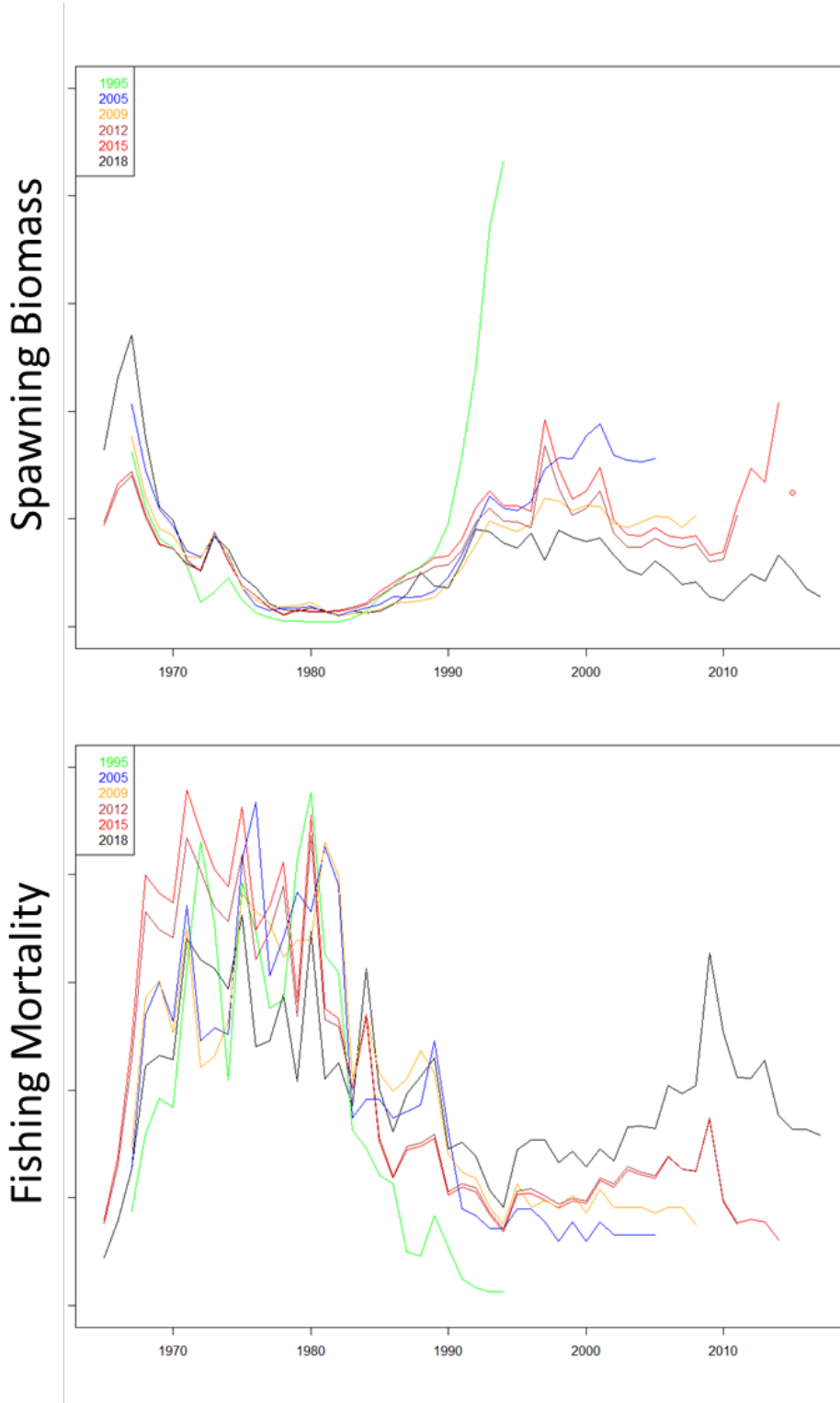


Modeling Approach - Several different modeling approaches were considered including the statistical catch-at-age model used in the previous benchmark assessment (ASAP, Age Structured Assessment Program), a more advanced model used in other regions of the US and internationally (SS, Stock Synthesis), and a state-space model that is used extensively in Europe and other regions (SAM, State-space Assessment Model). Although SS has advantages of fitting directly to length samples and incorporating the spatial structure in the herring fishery, some estimation problems were not resolved. Similarly, SAM has the advantage of allowing for process error in the assumed population dynamics, but the application was not fully-developed as a basis for management advice. Although ASAP does not have some of the advanced features of SS or SAM, WG members and the broader scientific community in the region are more familiar with it, and the herring application has received more attention to resolve estimation problems, and many different configurations of ASAP were considered by the WG to recommend the new benchmark method. Although we accept the decision to maintain ASAP as the benchmark method, we also recognize that investing equal time and attention to alternative models has the potential to substantially improve the herring assessment and other assessments in the region.

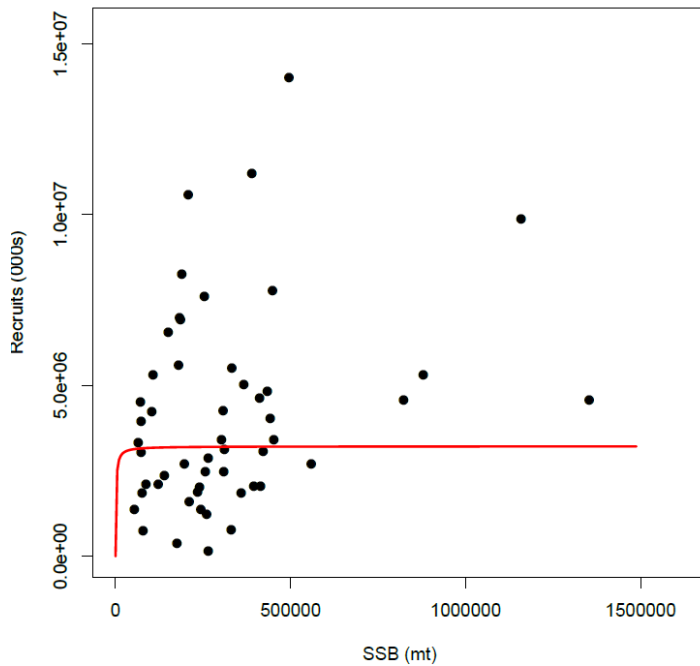
Natural Mortality Assumption - Several alternative assumptions were considered for natural mortality: 1) based on previous estimates of consumption, as in the 2012 benchmark assessment, 2) same approach using improved consumption estimates and 3) constant mortality (age and time constant value). The benchmark method was rejected because of the re-emergence of a major retrospective pattern, and the new benchmark method was based on a constant natural mortality rate ($M=0.35$), and the resulting natural mortality is similar to the updated consumption estimates.



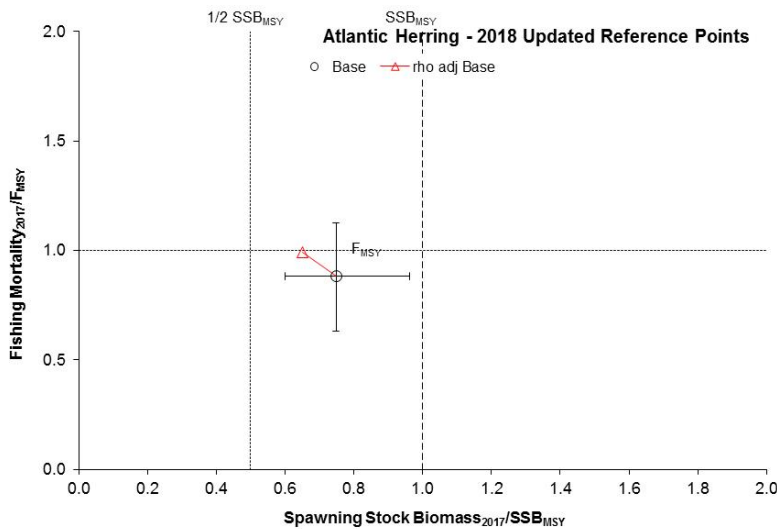
Major Change in Perception - The new benchmark methods fits the fishery and survey data well and has no major diagnostic problems. However, the new assessment method and recent data provide a substantially different perception of the stock and fishing mortality (black line, below, presents new estimates compared to those from previous assessments).



Management Reference Points - The stock-recruitment relationship is either not strong or not well estimated with the available data, so maximum sustainable yield (MSY) reference points could not be reliably estimated, and proxy reference points were based on maintaining 40% of maximum spawning potential. The overfishing limit was defined as $F_{40\%}$ (0.51) and long-term projection at $F_{40\%}$ produced a B_{MSY} proxy of 189kt and a MSY proxy of 112 kt. There was some discussion by the WG of the potential for a recent regime shift, but the WG concluded that there have been previous series of below average recruitment, and there is no evidence of a regime shift.



Stock Status – The new benchmark method did not have a major retrospective pattern, so estimates were not retrospective adjusted for determination of stock status. The assessment indicates that the stock is not overfished (2017 SSB = 75% of SSB_{MSY}), and overfishing is not occurring (2017 F = 88% of $F_{40\%}$).



Short-Term Projections – The WG produced projections that account for uncertainty in recent recruitment as well as uncertainty in future recruitment. The most recent estimate of recruitment was highly uncertain and replaced with the 2013-2017 distribution of recruitment. Future recruitment was based on the distribution of recruitment from the entire assessment time series.

Initial projections assumed full uptake of the 2018 catch limit (111 kt), but based on preliminary results from the assessment, the Council recommended a reduction of 2018 catch to 50 kt. However, even with the reduced 2017 catch, projections suggest a high probability of the stock decreasing to an overfished state in 2019.

Conclusions

Despite the substantial change in perception and the stark stock projections, we conclude that the model developed by the WG is a great improvement over the previous assessment, with fewer data conflicts and retrospective consistency. Survey trends, age structure and model estimates all indicate a much lower stock than the previous assessment. The strong 2008 and 2011 yearclasses are now past their peak biomass, and their biomass is expected to decline while recent yearclasses do not appear to be abundant. However, the WG concluded that there is no reason to expect continued low recruitment.

In hindsight, recent assessments were biased high, as suspected from the retrospective pattern and the 'biased assessment' scenario in the Councils' Management Strategy Evaluation. Therefore, performance of alternative control rules should now be based on the 'unbiased assessment' scenarios, and the 'biased assessment' scenarios are no longer relevant. The New England Council will decide on a control rule at their September 25-27 2018 meeting. On October 10, the Council's SSC will recommend Acceptable Biological catch based on the SAW65 assessment projections and the Council's adopted control rule.

Considering that much of the projected stock decrease is based on recent recruitment estimates, 'data updates' (similar to those provided to the Mid Atlantic Council) would help to monitor future recruitment. If observed recruitment is different than the estimated or projected recruitment, an operational update in the near future would provide better information for fishery management.