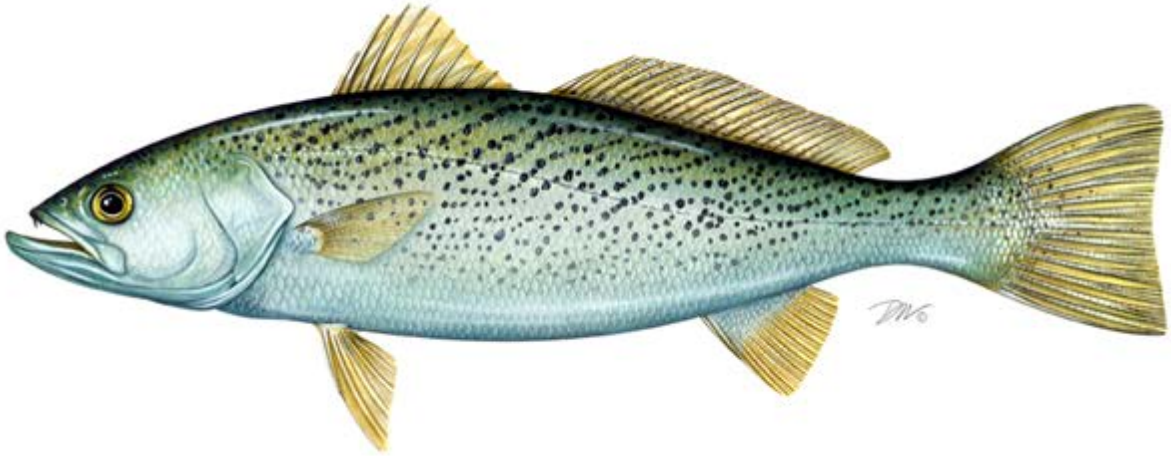
ASMFC Weakfish Stock Assessment Summary



ASMFC Weakfish Management Board
Alexandria, VA
May 5, 2016

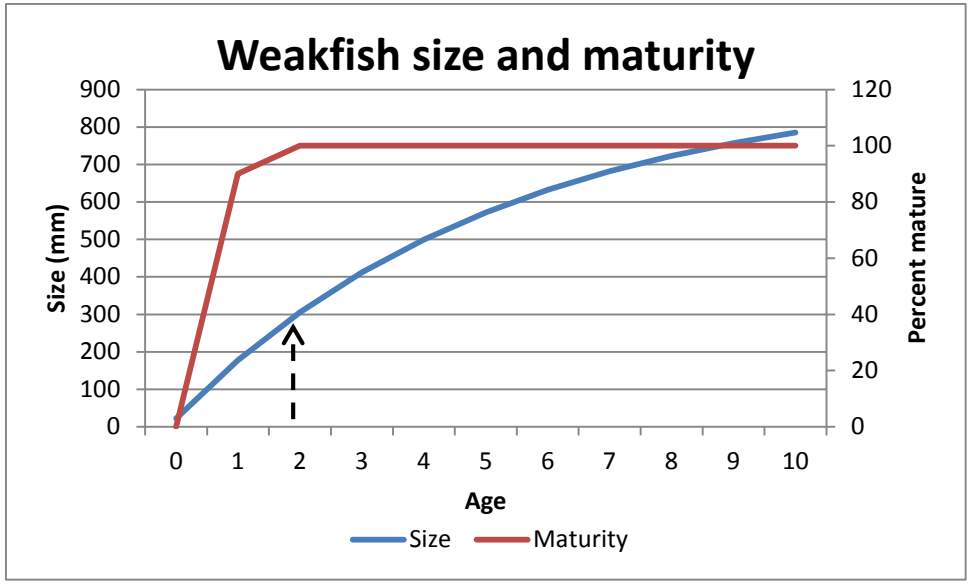
Weakfish stock assessment contributors

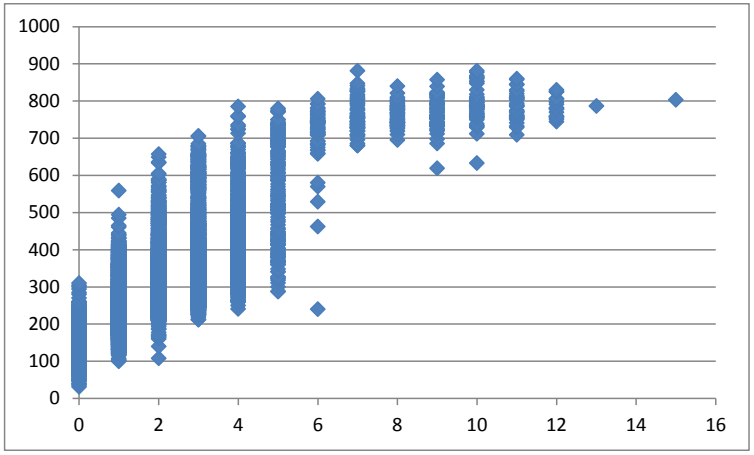
- Jeffrey Brust, chair - NJ DFW
- Dr. Mike Bednarski - MA DMF
- Dr. Edward Hale - DE DNREC
- Angela Giuliano - MD DNR
- Dr. Yan Jiao – Virginia Tech
- Joe Cimino – VMRC, Technical Committee chair
- Laura Lee – NC DMF
- Dr. Katie Drew - ASMFC
- Megan Ware - ASMFC species coordinator

- Significant input from ASMFC Weakfish Technical Committee

Life history

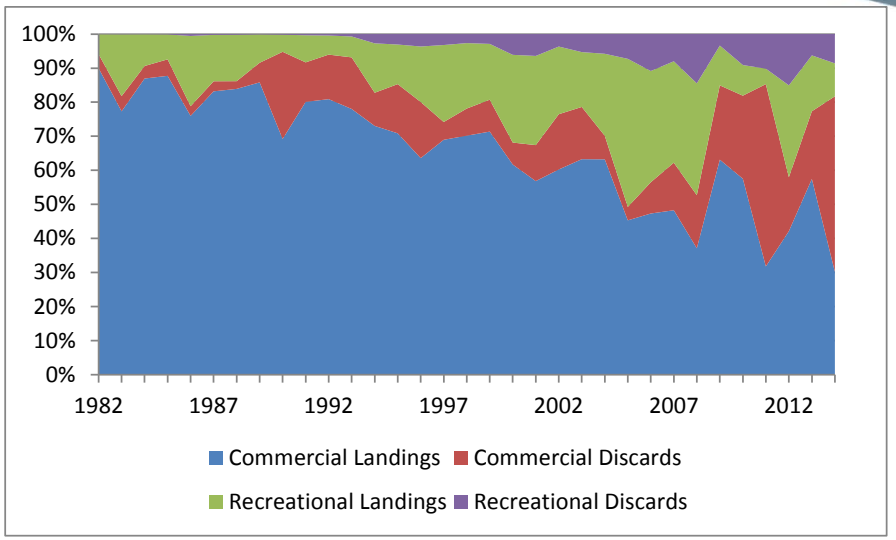
- Moderate life span
  - Oldest recorded was 17
- Highly variable growth
  - Recruit by age 2
- Fast maturity
  - 90% by age 1

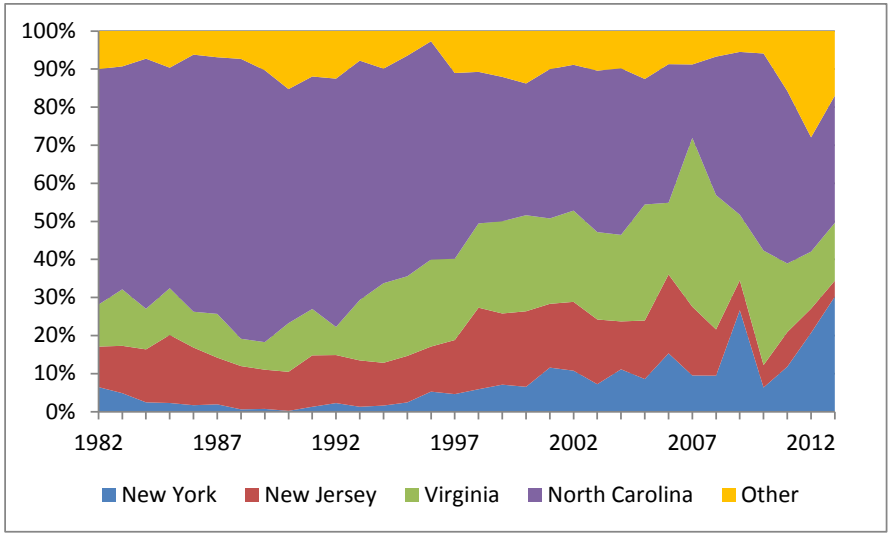




Fishery

- Typical migratory pattern
  - North/inshore in spring
  - South/offshore in fall
- Primarily a commercial species
- Discards becoming more important with recent regulations
- NC, VA, NJ top harvesters for both commercial and recreational





Assessment history

- Most previous assessments conducted using ADAPT VPA
- Signs of non-fishing related changes in productivity (increasing natural mortality) noticed prior to last assessment
- Additional analyses and models to capture these changes
  - Food habits, environmental, predation/competition
- SAW 48 (2009) conclusions
  - Natural mortality is increasing
  - “Extended” models not supported by empirical evidence
  - Accepted model was very simple, non age structured model
  - Population is depleted

Focus for 2016 Assessment

- Continue to explore methods to identify/model changes in natural mortality

- Explore different modeling frameworks better able to handle assumptions and uncertainty

- Develop reference points appropriate for non-equilibrium conditions

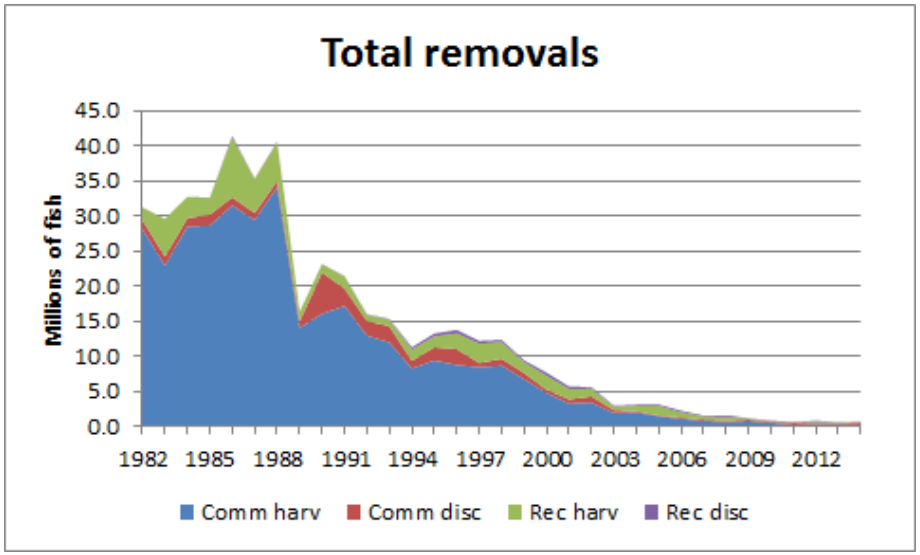
Data sources

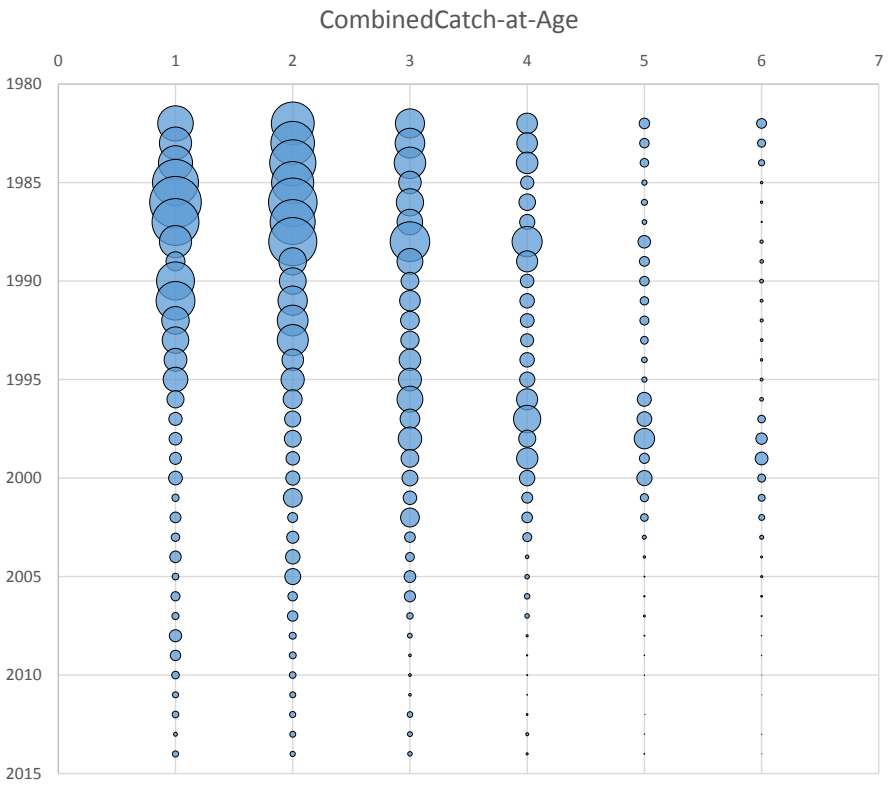
- Commercial harvest
- Commercial discards
- Recreational harvest
- Recreational discards

- Fishery independent abundance indices (state surveys)
- Fishery dependent indices (MRFSS/MRIP CPUE)

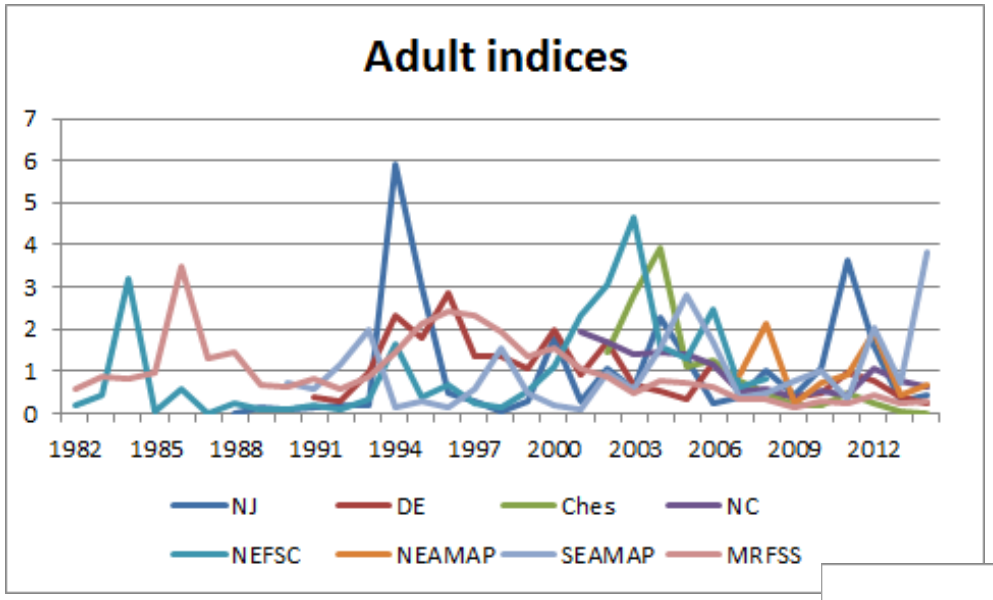
- Fishery dependent and independent biological data

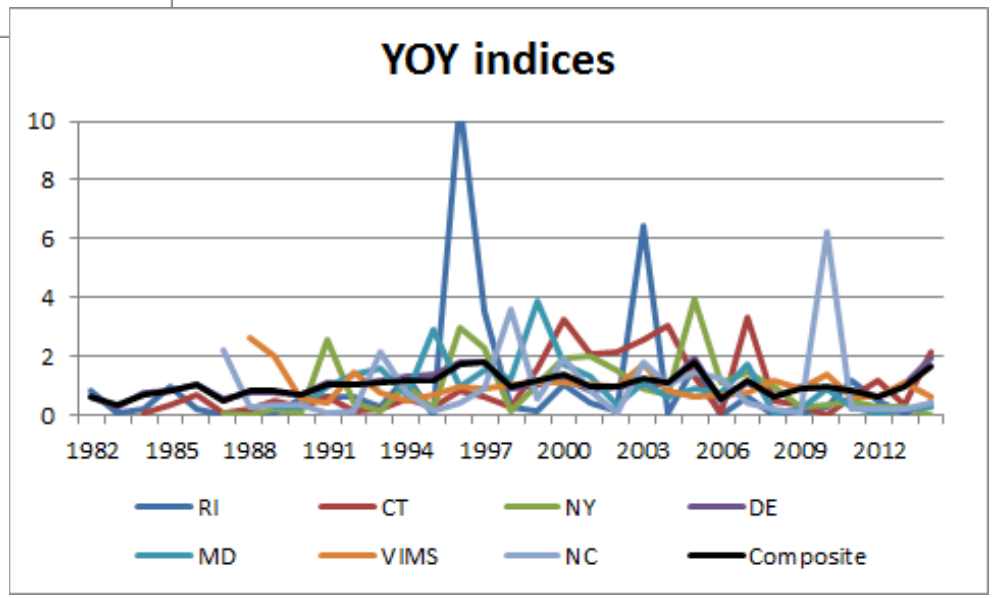
Harvest


Total removals
Millions of fish
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1982 1985 1988 1991 1994 1997 2000 2003 2006 2009 2012
Comm harv
Comm disc
Rec harv
Rec disc


CombinedCatch-at-Age
0 1 2 3 4 5 6 7
1980
1985
1990
1995
2000
2005
2010
2015

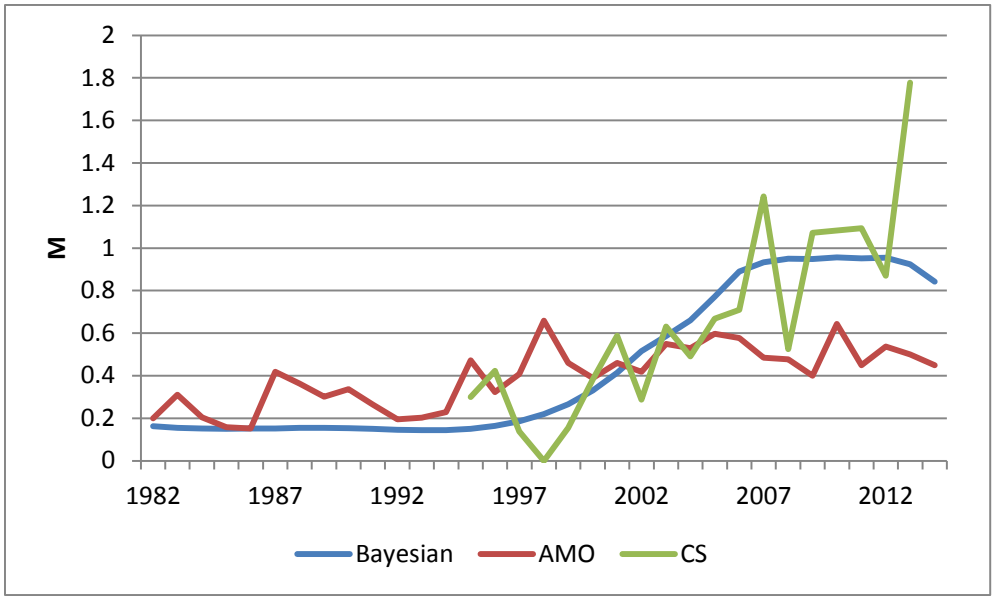
Indices


Adult indices
7
6
5
4
3
2
1
0
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
NJ
DE
Ches
NC
NEFSC
NEAMAP
SEAMAP
MRFSS


YOY indices
10
8
6
4
2
0
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
RI
CT
NY
DE
MD
VIMS
NC
Composite

Time varying M

- Several methods inconclusive
  - Food habits
  - Time varying growth
- Several models support hypothesis
  - Catch survey analysis
  - Bayesian model
  - AMO vs Bayesian M
- Scale varies but timing is consistent
- Potential for predation/competition



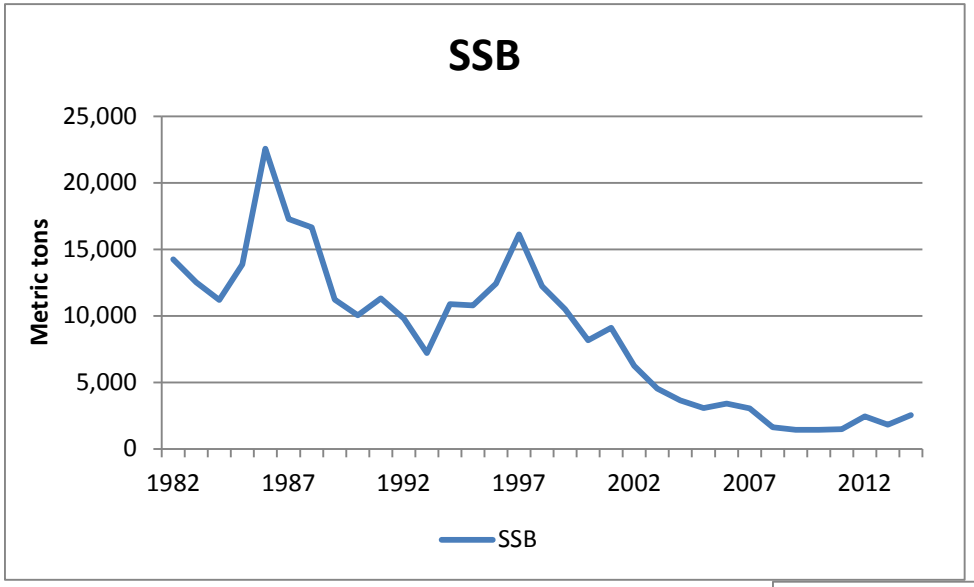
Candidate models

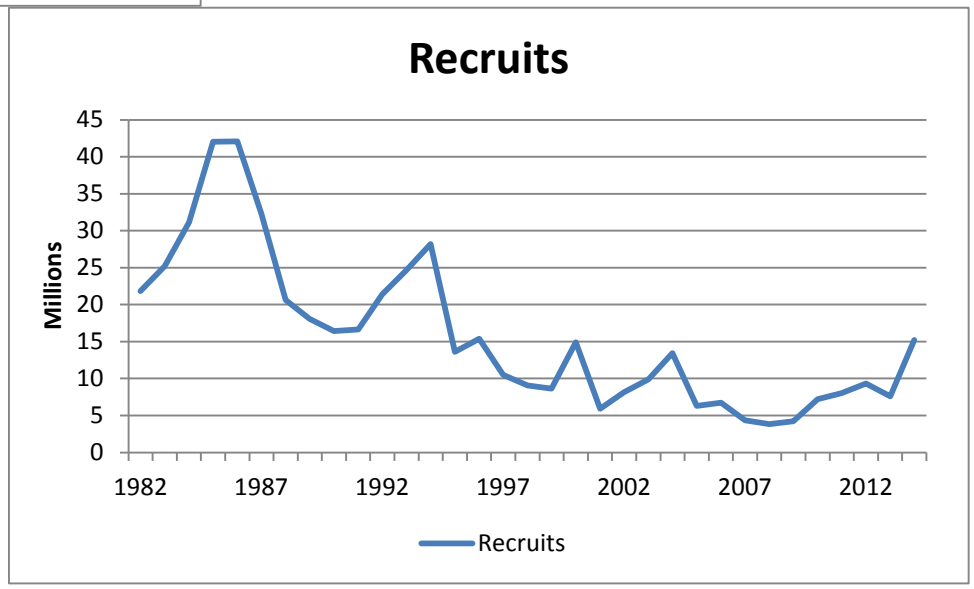
- Continuity runs

- ASAP statistical catch at age
  - Better than VPA at handling uncertainty in catch

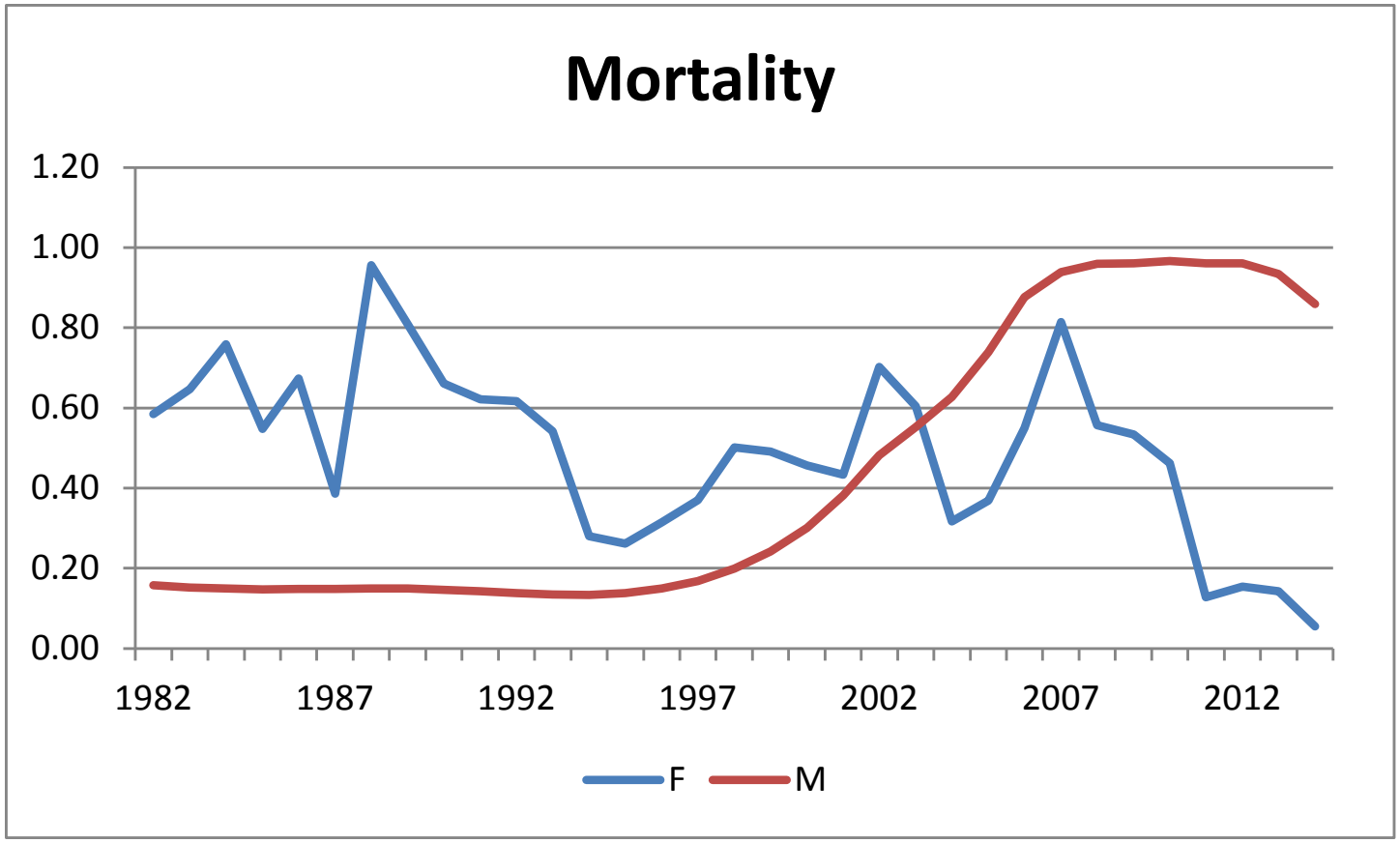
- Bayesian age structured model
  - Preferred model
  - Estimates M internally
  - Allows for spatial-temporal changes in stock distribution

Bayesian model results

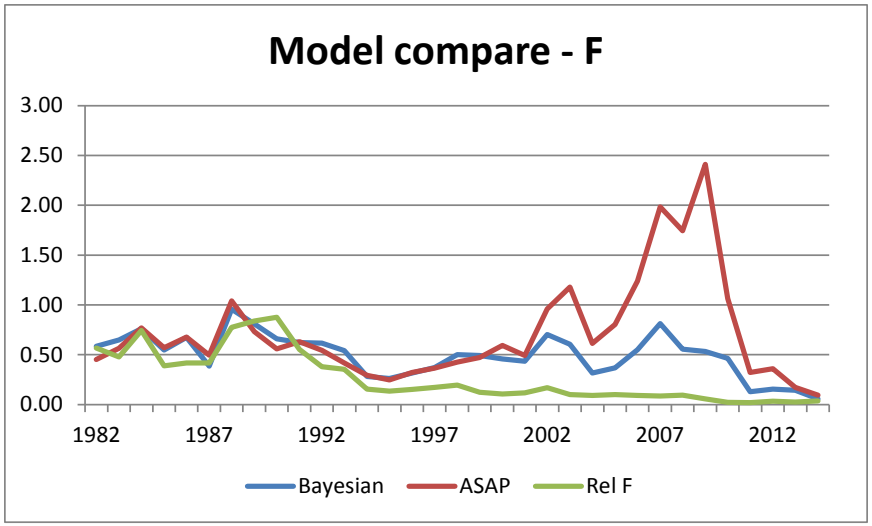


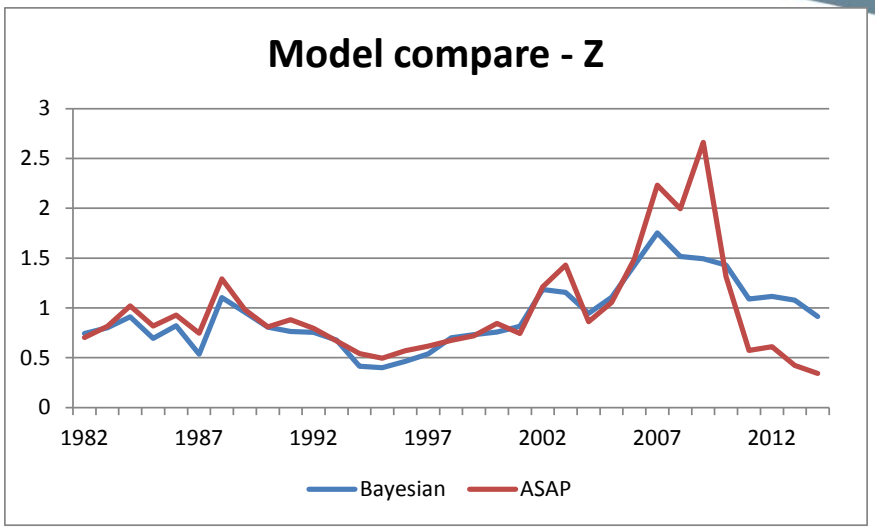


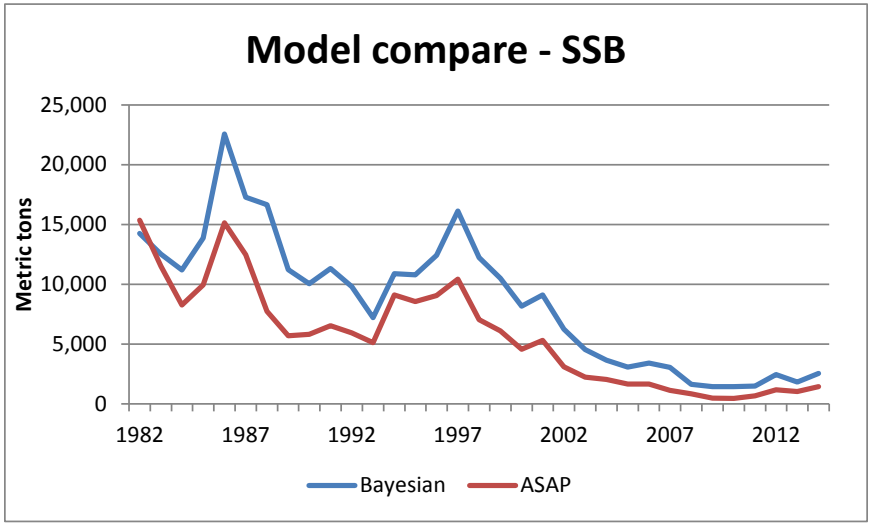
Bayesian model results

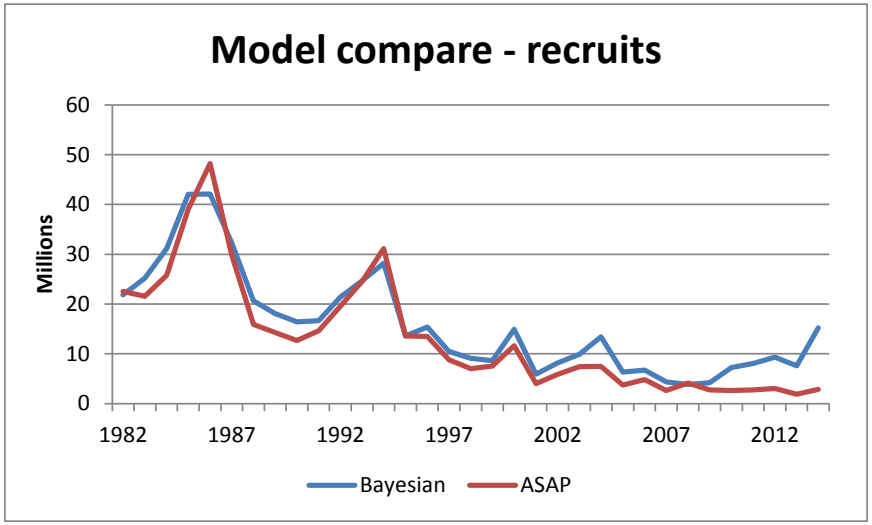


Model comparison









Current reference points

- No F reference points
  - Considered uninformative without a reliable way to estimate F under conditions of increasing M

- SSB target: a level of SSB that is 30% of an unfished stock

- SSB threshold: a level of SSB that is 20% of an unfished stock

Proposed Z reference points

- Z-based reference points
  - Takes into account both F and M
  - Works for models with changing M (more accurate F estimates) and constant M (Z values more accurate than F values)

- Calculated using time-series average M = 0.43

- $Z_{targ} = Z_{30\%} = 0.93$

- $Z_{thresh} = Z_{20\%} = 1.36$

Proposed SSB reference points

- SSB target uninformative under conditions of changing M

- TC proposes an SSB threshold for management response based on the average M projections

  → 30% of equilibrium SSB expected under average M conditions

- $SSB_{thresh} = SSB_{30\%} = 6{,}880$ MT

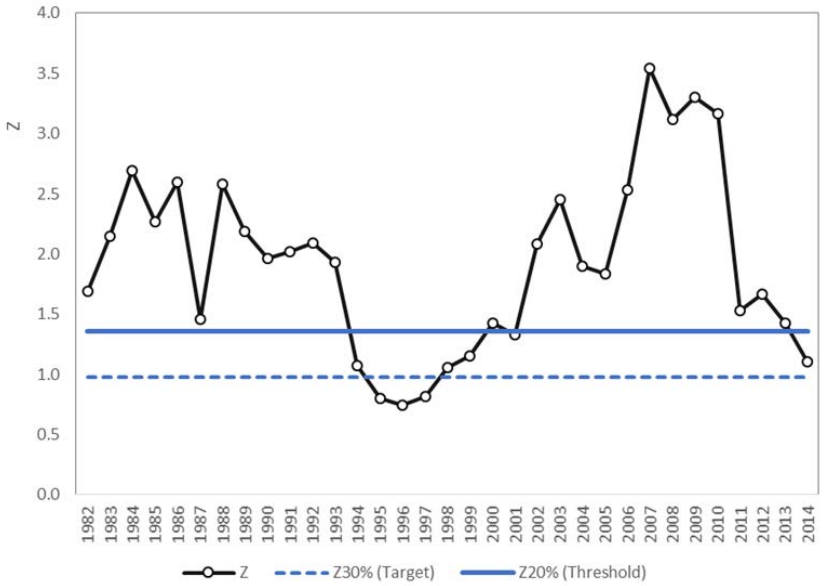
2-stage control rule

1. Evaluate SSB
   i. If SSB < $SSB_{threshold,}$ the stock is depleted and fishing mortality should be constrained
   ii. If SSB > $SSB_{threshold,}$ evaluate Z reference points.

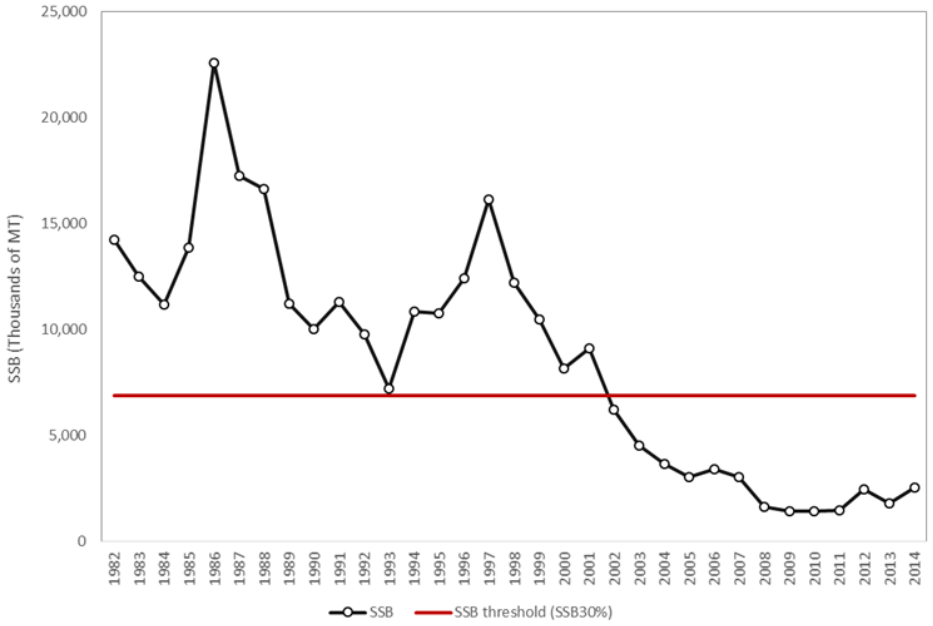
2. Evaluate Z
   i. If Z > $Z_{threshold}$, total mortality is too high and F should be constrained
   ii. If Z_{target} < Z < $Z_{threshold}$, limited F would be allowed
   iii. If Z < Z_{target}, F would be managed with F_{SPR} reference points to allow sustainable fishing

Stock status

Mortality



SSB

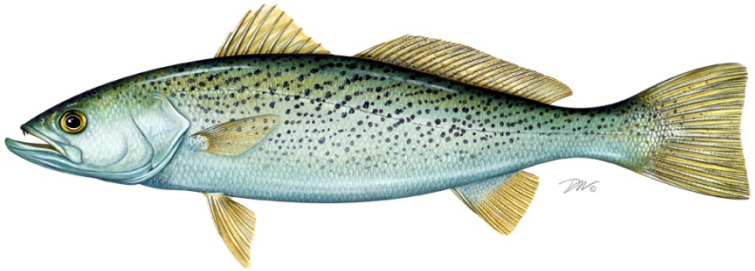


Stock status

	Threshold	Target	2014 Value
SSB	6,880 MT	n.a.	2,548 MT
Z	1.36	0.93	1.11
F	0.93	0.55	0.25

- $SSB_{2014} < SSB_{threshold}$: stock is **depleted**
- $Z_{target} < Z_{2014} < Z_{threshold}$: Total mortality between target and threshold, but only in terminal year
- TC recommends Z below threshold and SSB above threshold for 2+ consecutive years before action is taken

Weakfish Stock Assessment Peer Review Report



Presented to ASMFC

Weakfish Management Board

May 5, 2016

ASMFC Stock Assessment Peer Review Process

Weakfish Stock Assessment Subcommittee and TC

- Developed a new coast wide assessment for weakfish

Scientific Peer Review Panel

- Chair + 2 additional Technical Reviewers, with combined expertise in population dynamics, stock assessment modeling, statistics, and weakfish biology
- Scientific review focusing on data inputs, assessment quality

Products

- Stock Assessment Report and Review Panel Report (for Board and TC), and Assessment Overview (public)

  http://www.asmfc.org/species/weakfish

  (to be posted online following Spring Meeting)

ASMFC Stock Assessment Peer Review Process

Weakfish Stock Assessment Review Workshop
Virginia Beach
March 30-April 1, 2016

Review Panel:

Dr. Patrick Sullivan (Chair), Cornell University, Department of Natural Resources

Dr. Jeffrey Buckel, North Carolina State University, Center for Marine Sciences and Technology

Dr. Jonathan Deroba, NMFS Northeast Fisheries Science Center, Population Dynamics Branch

Review Panel Overall Findings

- Stock assessment passed peer review
  - stock is depleted
  - overfishing is not occurring in 2014
  - total mortality is below the threshold but above the target

- Panel finds stock assessment acceptable for management use

Review Terms of Reference

ToR 1: *Evaluate the collection, presentation, and treatment of fishery-dependent and fishery-independent data in the assessment.*

Panel Conclusions

- Although well explored, several sources of bias in removal estimates remain
- MRFSS/MRIP statistics challenging for use as abundance index
- Density dependence may be operating on age-0 fish
- Standardization methods in the assessment adequate, well documented, and appropriate

Review Terms of Reference

ToR 1: *Evaluate the collection, presentation, and treatment of fishery-dependent and fishery-independent data in the assessment.*

Panel Recommendations:

- Continue to evaluate the quality of removal estimates and recreational indices of abundance

- Examine sensitivity of model runs with age-0 inputs included and excluded

Review Terms of Reference

ToR 2*: Evaluate evidence for constant or recent systematic changes in natural mortality, predator-prey dynamics, productivity, and/or discard mortality.*

Panel Conclusions:

- Time varying M is difficult to estimate, but dramatic changes in weakfish biomass over time and very low levels of harvest currently observed may allow M estimation to be possible
- Due to corrections in discard analyses made by TC, less evidence for discard mortality as causing recent decreases in abundance
- Clear cycles of weakfish abundance over time, but the underlying cause of cycles remains unknown

Review Terms of Reference

ToR 2*: Evaluate evidence for constant or recent systematic changes in natural mortality, predator-prey dynamics, productivity, and/or discard mortality.*

<u>Panel Recommendations:</u>

- Factors influencing the estimability of a time varying M should continue to be monitored and addressed
- Sensitivity of time varying M estimates to constraints imposed by Bayesian model priors should also be explored further
- A correlative and/or mechanistic link between weakfish natural mortality and predictor variables would be useful for population projections

Review Terms of Reference

ToR 3: *Evaluate the methods and models used to estimate population parameters and biological reference points.*

Panel Conclusions:

- Bayesian statistical catch at age model is appropriate and justified for use in making management decisions, with caveats to be considered
- External evidence of temporal changes in M was inconclusive; parameter estimates may be confounded by other processes
- Spatial asynchrony (disconnect) in population density to account for inconsistent index trends could also confounded by other processes

Review Terms of Reference

ToR 3: *Evaluate the methods and models used to estimate population parameters and biological reference points.*

Panel Recommendations:

- Models often over fit the data through inclusion of time-varying parameters; exercise caution when interpreting the results
- Biological reference points based on historical performance will need updating later as *M* and stock productivity likely change in the future
- Using historical recruitment indices to create projections should also be re-examined in the future as stock productivity changes
- Plus-group minimum age: Review Panel recommends sensitivity analysis in future assessments to evaluate effect of selecting various plus-group minimum ages on model results

Review Terms of Reference

ToR 4: *Evaluate the sensitivity and retrospective analyses performed to determine model stability and consequences of model assumptions*

Panel Conclusions:

- Sensitivity to a range of data inputs well addressed and understood; given assessment model structure, outcomes were robust

- Remaining retrospective patterns observed are small and not cause for concern relative to management action

Review Terms of Reference

ToR 4: *Evaluate the sensitivity and retrospective analyses performed to determine model stability and consequences of model assumptions*

Panel Recommendations:

- Absence of retrospective patterns does not indicate model is necessarily accurate or appropriate; continue to perform retrospective analyses in future assessments

Review Terms of Reference

ToR 5: *Evaluate the methods used to characterize uncertainty in estimated parameters*

Panel Conclusions:

- The preferred Bayesian M4 age-structured assessment model, from both the TC and Review Panel, appropriately incorporates the uncertainty present at several levels through the use of Bayesian hierarchical modeling

- Markov Chain Monte Carlo algorithm used in the estimation of Bayesian population modeling facilitates probabilistic predictions of key model outputs, including estimates of the probability of being above or below critical threshold levels

Review Terms of Reference

ToR 5: *Evaluate the methods used to characterize uncertainty in estimated parameters.*

Panel Recommendations:

- Use of the uniform distribution as an "uninformative" prior for many components of the Bayesian hierarchical model should be updated following Gelman's (2006) recommendations. The uniform distribution can put too high a level of variation on the tails, inadvertently and perhaps unknowingly resulting in parameter estimates bumping up against the boundaries

Review Terms of Reference

ToR 7: *Recommend best estimates of stock biomass, abundance, and exploitation from the assessment for use in management*

Panel Conclusions:

- The Bayesian M4 age-structured assessment model and associated spawning biomass per recruit (SPR) reference points under an assumed $M = 0.43$ provides the best estimates for determining stock biomass, abundance, exploitation rates, and total mortality for use in management.

Review Terms of Reference

ToR 7: *Recommend best estimates of stock biomass, abundance, and exploitation from the assessment for use in management.*

Panel Recommendations:

- In the future, if the stock shows signs of recovery, alternative yield-per-recruit, spawner-per-recruit, production modeling, and management strategy evaluation approaches should be used for determining updated exploitation rates as capacity for stock growth will likely have changed due to changes in mortality and other drivers of production.

- The Bayesian M4 assessment model itself, however, should continue to be applicable as long as data inputs and incorporated biological processes are appropriately updated.

Review Terms of Reference

ToR 8: *Evaluate the choice of reference points and the methods used to estimate them. Recommend stock status determination from the assessment.*

Panel Conclusions:

- It is difficult to determine a fixed set of reference points for any population that does not exhibit a stable equilibrium, such as weakfish, where as yet unknown drivers of changes to natural mortality (*M*) and stock production are highly variable

- The Weakfish Technical Committee has proposed a set of total mortality reference points (*Z*) to establish a practical control rule that should be useful for management.

Review Terms of Reference

ToR 8: *Evaluate the choice of reference points and the methods used to estimate them. Recommend stock status determination from the assessment.*

Panel Recommendations:

- The yield-per-recruit SPR reference points derived from this assessment that assume an $M = 0.43$ should be updated when stock productivity appears to increase as this would indicate that changes in mortality and other drivers of stock production have altered and the current short-term estimates of the reference points should be updated.

Review Terms of Reference

ToR 9: *Review the research, data collection, and assessment methodology recommendations provided by the TC; make any additional recommendations to improve future assessments.*

Current Research Recommendations

- Estimate weakfish mortality through independent approaches (e.g. tagging, alternative models) to corroborate mortality trends in the current assessment model.
- Evaluate predation of weakfish, by an expanded suite of predators (e.g., marine mammals), including leveraging ongoing ASMFC work on multispecies models by including weakfish as both predator and prey.
- Continue to monitor weakfish diets over a broad regional and spatial scale, with emphasis on new studies within estuaries.

Review Terms of Reference

ToR 9: *New Panel Research Recommendations*

- Conduct simulations with the proposed Z based control rules, or thresholds/targets in a time varying environment to explore alternative management options that may be more optimal.
- Conduct a meta-analysis of all factors influencing natural mortality to see if the aggregate effect shows stronger statistical likelihood of occurrence than the significance shown by each individual factor on its own.
- Transfer Bayesian model code from current software to more broadly accessible program; explore the new models applicability for other stocks.
- Conduct a simulation-estimation analysis to explore the estimability of time trends in natural mortality.
- Continue to improve processes for organizing and collecting data from different agencies and sources to assure timely and high quality data input into the model.

Review Panel Overall Findings

- The Review Panel concluded the Bayesian M4 catch-at-age model is the best available for conducting an assessment at this time and is therefore suitable for estimating the status of the stock
- Stock is depleted but overfishing is not occurring in 2014 and total mortality is between the target and the threshold
- Conduct an assessment update in 2 years (2018) and a benchmark assessment in 5 years (2021)