NOAA FISHERIES

Southeast Fisheries Science Center

Atlantic menhaden stock assessment

Wednesday, February 5, 2020

Atlantic Menhaden Management Board meeting

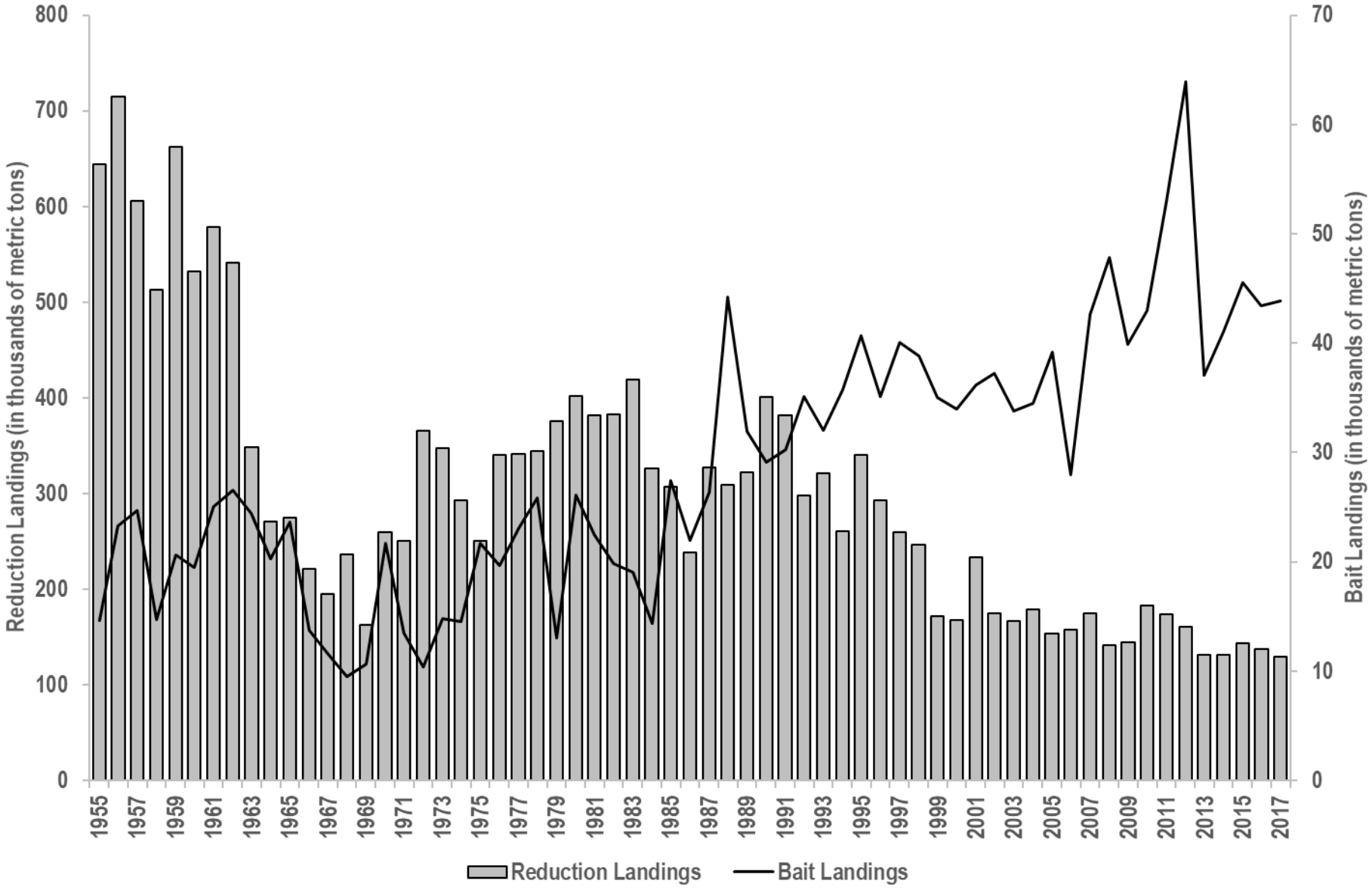
Outline

- Data used
- Major changes from last assessment
- Stock assessment
- Stock status
- Future directions

Data used

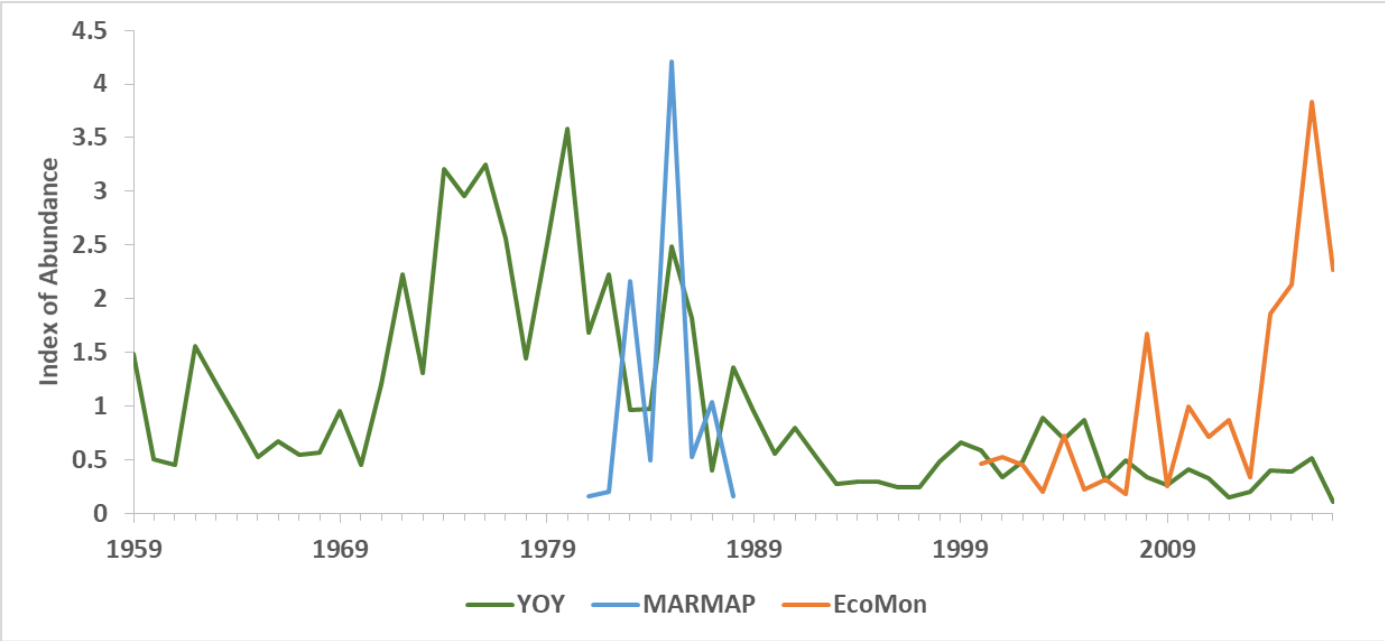
Data used

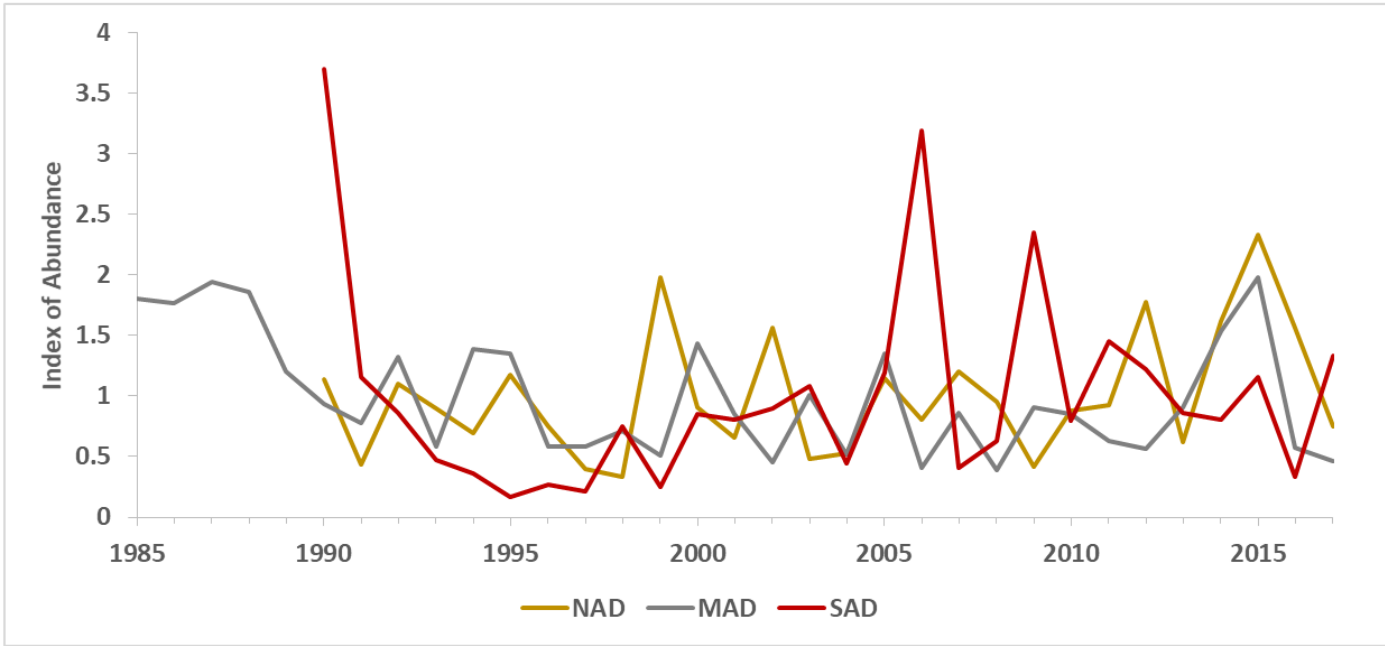
- Life history data
  - Maturity: historical data
  - Natural mortality: age-varying, time constant values; scaled to estimates from the tagging data
  - Growth: estimated from fishery-dependent data
  - Fecundity: updated information from Latour lab


800
700
600
500
400
300
200
100
0
Reduction Landings (in thousands of metric tons)
70
60
50
40
30
20
10
0
Bait Landings (in thousands of metric tons)
1955
1957
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
Reduction Landings
Bait Landings

Data used

- 49 fishery-independent surveys considered
  - Not designed to sample menhaden, but useful for menhaden (and potentially other assessments)
- Needed to meet criteria to be further considered
- Datasets were used to create standardized indices
  - Account for catchability differences due to factors such as time of year or environment


Index of Abundance
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
1959
1969
1979
1989
1999
2009
YOY
MARMAP
EcoMon


Index of Abundance
4
3.5
3
2.5
2
1.5
1
0.5
0
1985
1990
1995
2000
2005
2010
2015
NAD
MAD
SAD

Major changes from last assessment

Major changes from last assessment

- Natural mortality is time constant but age varying
  - Set up like last assessment, but scaled to a value based on reanalysis of tagging data
    - Liljestrand et al 2019
- Fecundity is time and age varying based on updated data from Latour Lab
  - Indeterminate, batch spawning

Major changes from last assessment

- Two new fishery-independent indices of relative abundance
  - Mid-Atlantic Adult Index (MAD) in addition to the southern and northern indices used last time
  - MARMAP and ECOMON ichthyoplankton index fitting to the fecundity

Major changes from last assessment

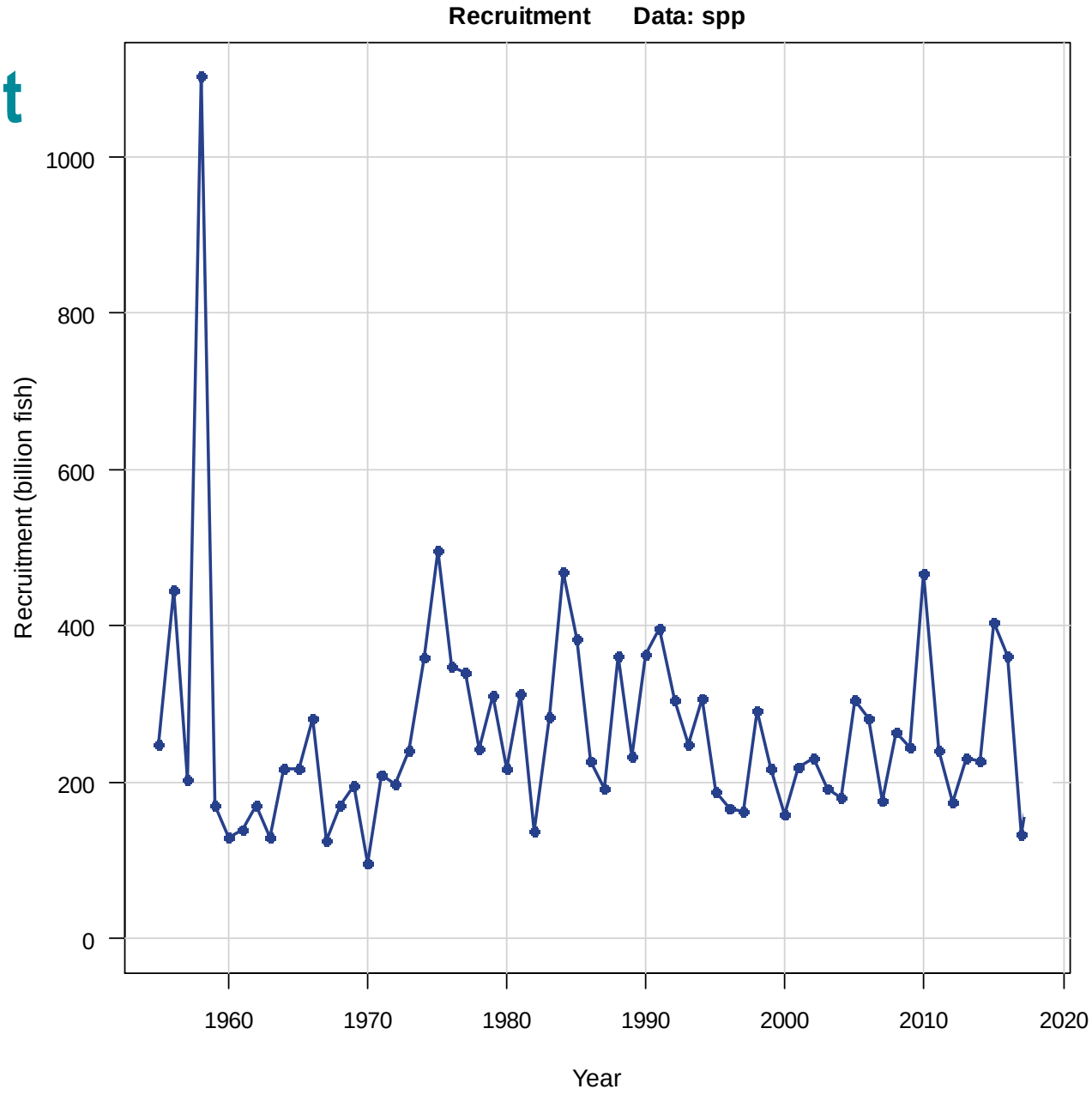
- New likelihood component type for multinomial data
- Uncertainty analysis included MCB (as last time) and a Markov Chain Monte Carlo (MCMC)
  - Demonstrate differences in types of uncertainty
- Recruitment is forecast in projections using non-linear time series methods (NLTS)
  - Best available science for projecting recruitment

Stock assessment

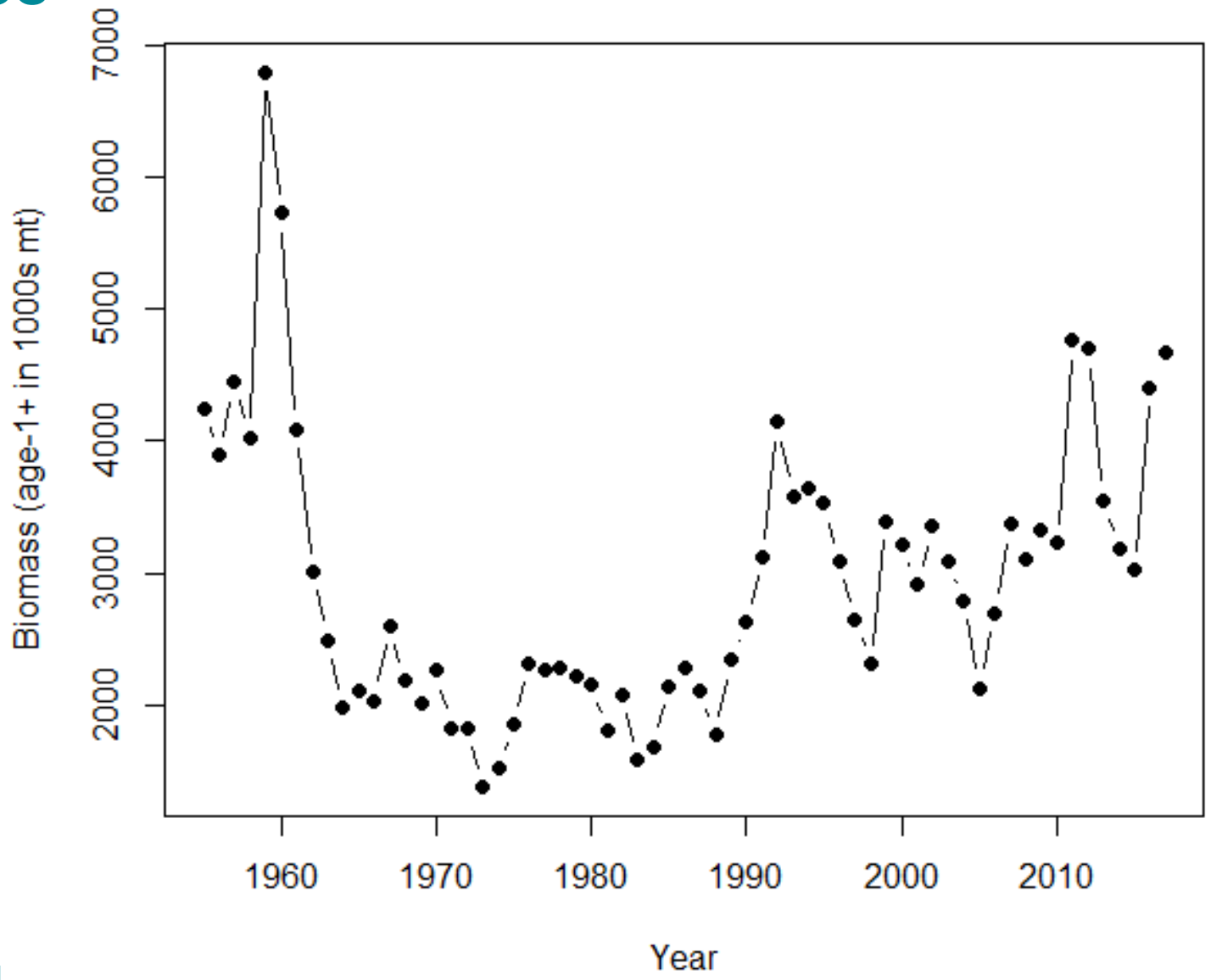
Base run information

- Data were split into northern and southern regions
  - Migration, fishery dynamics, tagging data
  - Better accounts for population dynamics and fishery removals over time

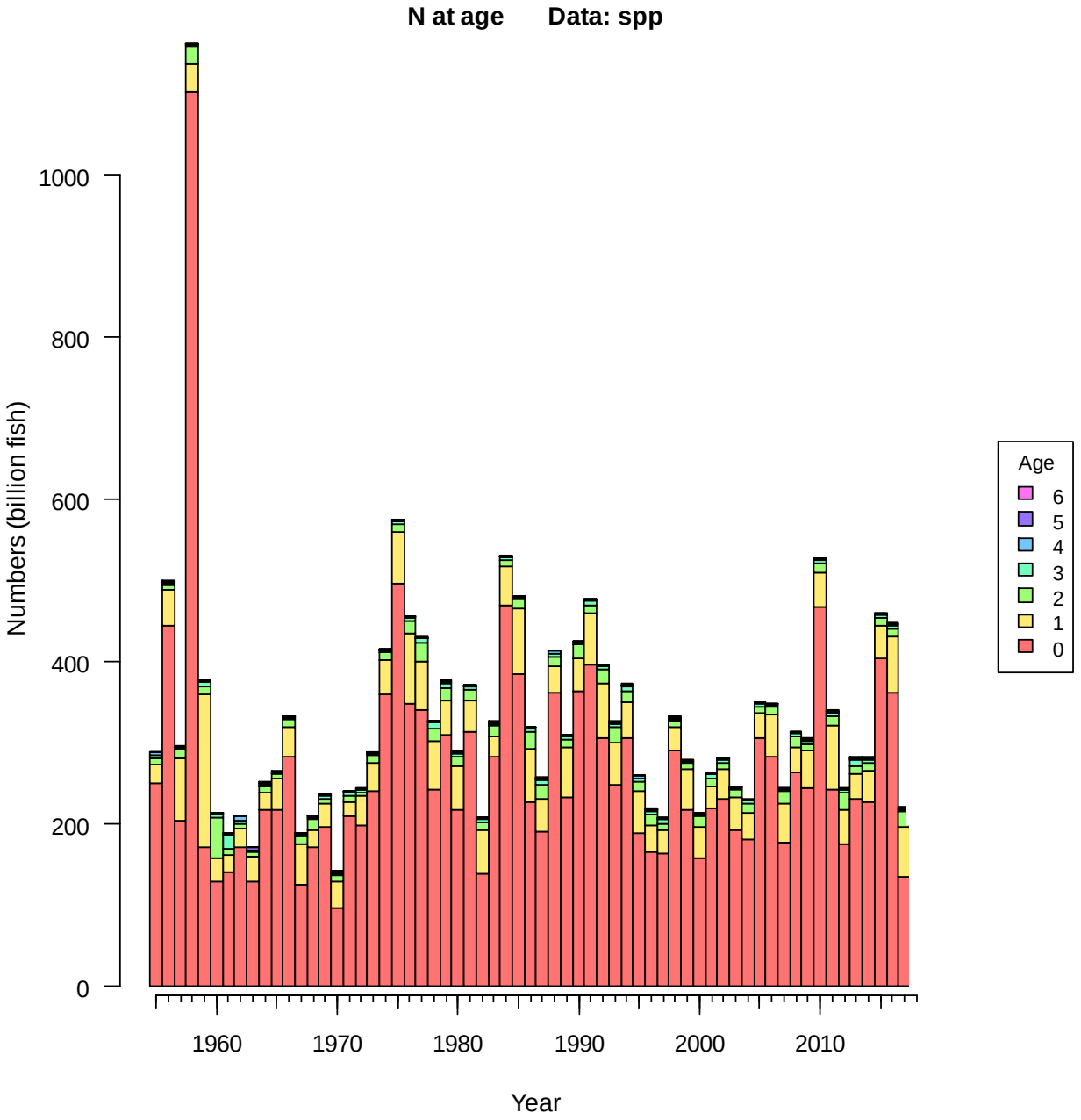
Recruitment



Biomass


Biomass (age-1+ in 1000s mt)
2000
3000
4000
5000
6000
7000
1960
1970
1980
1990
2000
2010
Year

Abundance


N at age Data: spp
Numbers (billion fish)
1000
800
600
400
200
0
1960
1970
1980
1990
2000
2010
Year
Age
6
5
4
3
2
1
0

Characterize uncertainty

- Sensitivity runs
  - Not considered alternate states of nature
  - Used to assess impact of assumptions made in the model
    - E.g., fishery selectivities – a run with selectivity for each fishery as flat topped or asymptotic
    - E.g., inclusion of indices
  - Stock status robust to model assumptions = stock status was same as base run

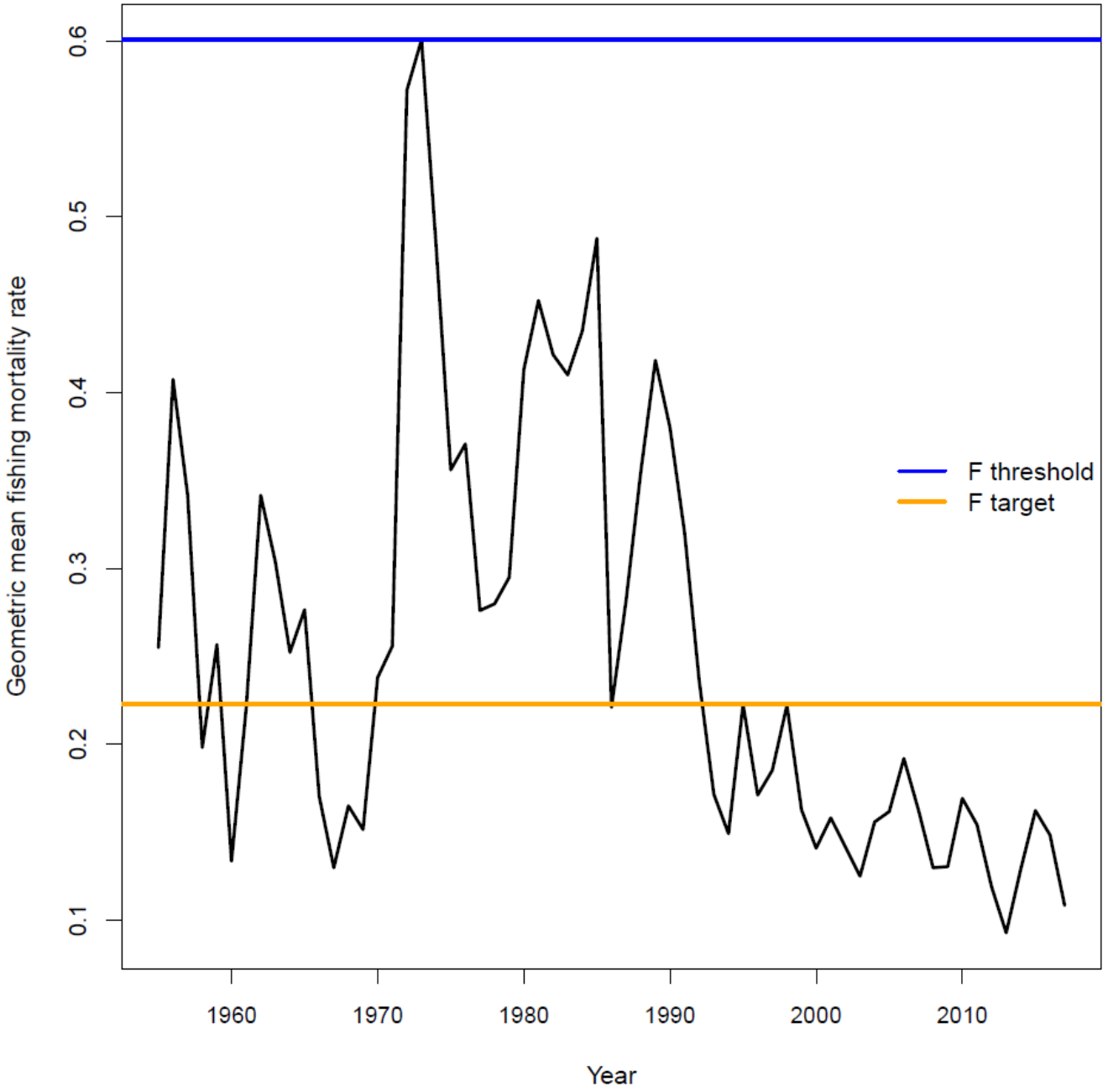
Characterize uncertainty

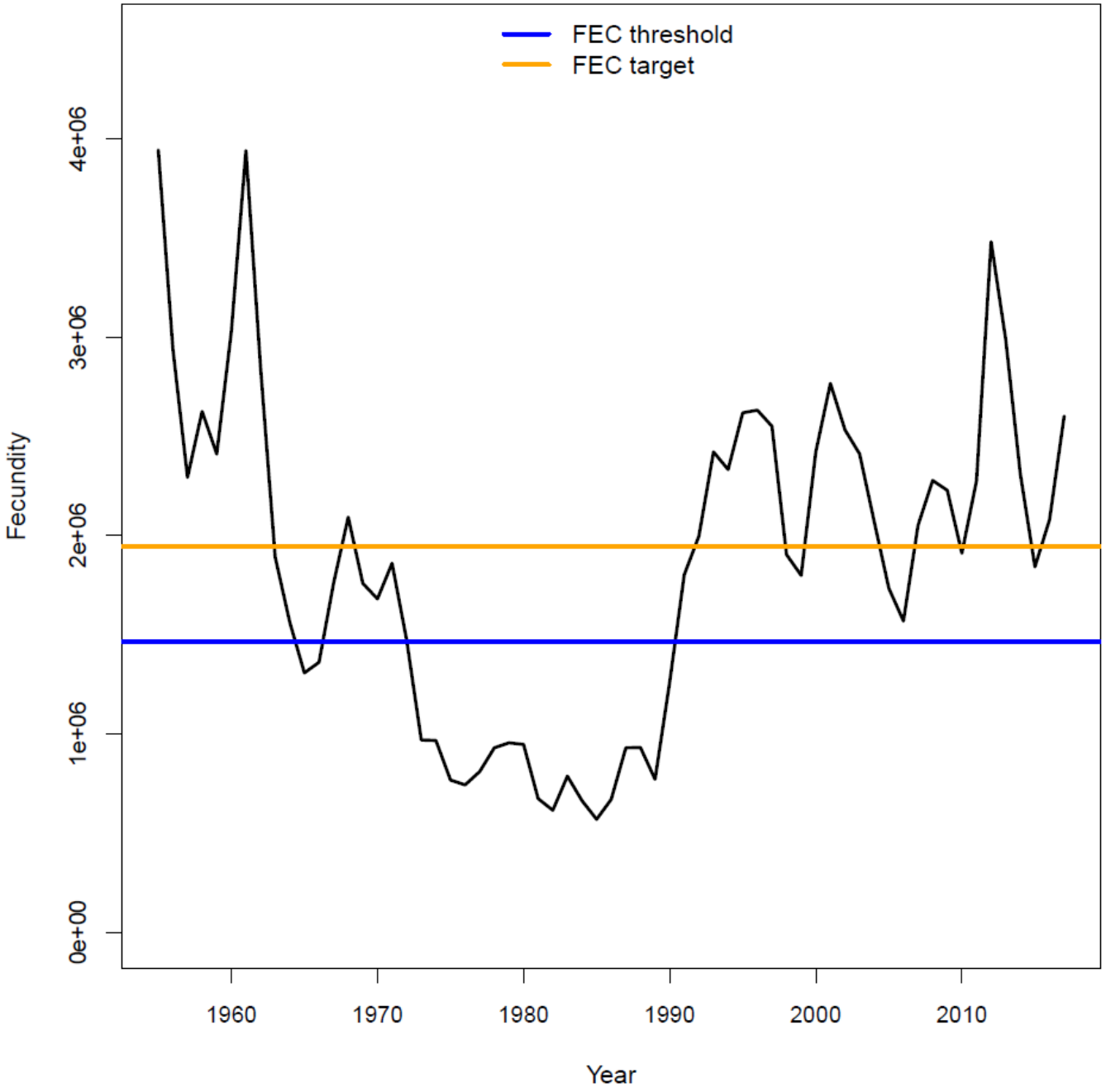
- Monte Carlo bootstrapping (MCB)
  - Accounted for uncertainty in the model assumptions such as natural mortality
  - Stock status was same as base run
- Markov Chain Monte Carlo (MCMC)
  - Accounted for uncertainty in model parameter estimates
  - Stock status was same as base run

Stock status

Reference points

- Currently, using those from last benchmark assessment
  - Threshold = max geo mean F during 1960-2012
  - Target = median geo mean F during 1960-2012
  - Intended as interim reference points
  - Moving toward ecosystem reference points
    - Matt Cieri will be presenting


Geometric mean fishing mortality rate
0.1
0.2
0.3
0.4
0.5
0.6
1960
1970
1980
1990
2000
2010
Year
F threshold
F target
0.60
0.22
F_{2017} = 0.11



FEC_{2017} = 2,601,550

1,945,613

1,463,344

Stock status

- Not overfished and overfishing not occurring
- Reference points were based on historical performance of the fishery
- Sensitivity analyses and uncertainty analyses support stock status of base run

Future directions

Future directions

- Timing of next assessment:
  - Update – 3 years
  - Benchmark – 6 years
- Research recommendations
  - Data collection and assessment methodology
- Dependent upon Board and ERPs


Questions?

Ecological Reference Point Assessment

Matt Cieri, ERP WG Chair

February 5, 2020

Outline

- Introduction
- Models: Inputs and Outputs
- Comparisons
- NWACS-MICE tool: Example ERPs
- Management Advice
- Summary
- Questions and Wrap-up

Ecological Reference Points Working Group

Matt Cieri (Chair), Maine Department of Marine Resources
Kristen Anstead, Atlantic States Marine Fisheries Commission
Mike Celestino, New Jersey Division of Fish and Wildlife
David Chagaris, University of Florida
Micah Dean, Massachusetts Division of Marine Fisheries
Katie Drew, Atlantic States Marine Fisheries Commission
Shanna Madsen, New Jersey Division of Fish and Wildlife
Jason McNamee, Rhode Island Division of Marine Fisheries
Sarah Murray, Atlantic States Marine Fisheries Commission
Amy Schueller, National Marine Fisheries Service
Alexei Sharov, Maryland Department of Natural Resources
Howard Townsend, National Marine Fisheries Service
Jim Uphoff, Maryland Department of Natural Resources

In collaboration with
Andre Buchheister and Max Grezlik, Humboldt State University
Joana Brito, University of the Azores
Genevieve Nesslage and Mike Wilberg, University of Maryland Center for Environmental Science

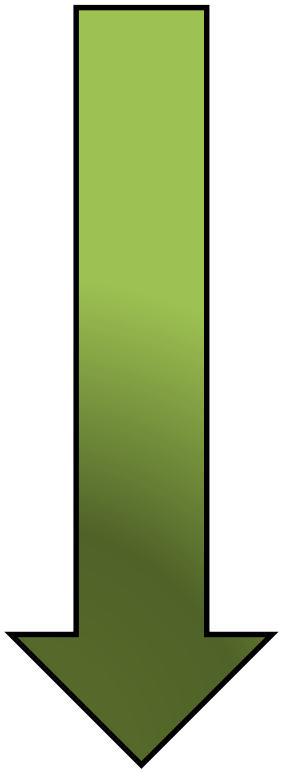
ERP WG TORs

- **Develop models** used to estimate population parameters (e.g., F, biomass, abundance) of Atlantic menhaden **that take into account Atlantic menhaden's role as a forage fish** and analyze model performance.

- **Develop methods** to determine reference points and total allowable catch for Atlantic menhaden **that account for Atlantic menhaden's role as a forage fish.**

ERP Models

Simple



Complex

Model (Abbreviation)
Surplus production model + time-varying r (**SPM TVr**)
Steele-Henderson surplus production model (**SPM S-H**)
Multi-species statistical catch-at-age model (**VADER**)
Ecopath with Ecosim with limited predator/prey field (**NWACS-MICE**)
Ecopath with Ecosim full model (**NWACS-Full**)

NWACS-MICE streamlined version of **NWACS-Full**

Model Comparisons

- ERP WG evaluated the models based on comparisons of:
  - **Model performance**, including estimates of age-1+ biomass and exploitation rate from each model compared with BAM output
  - Ability to **address management objectives**

Management Advice

- ERP WG recommends a combination of the BAM single-species model and the NWACS-MICE model as a tool for managers to evaluate trade-offs between menhaden harvest and predator biomass to establish reference points and quotas

MODEL INPUT AND OUTPUT

ERP Species

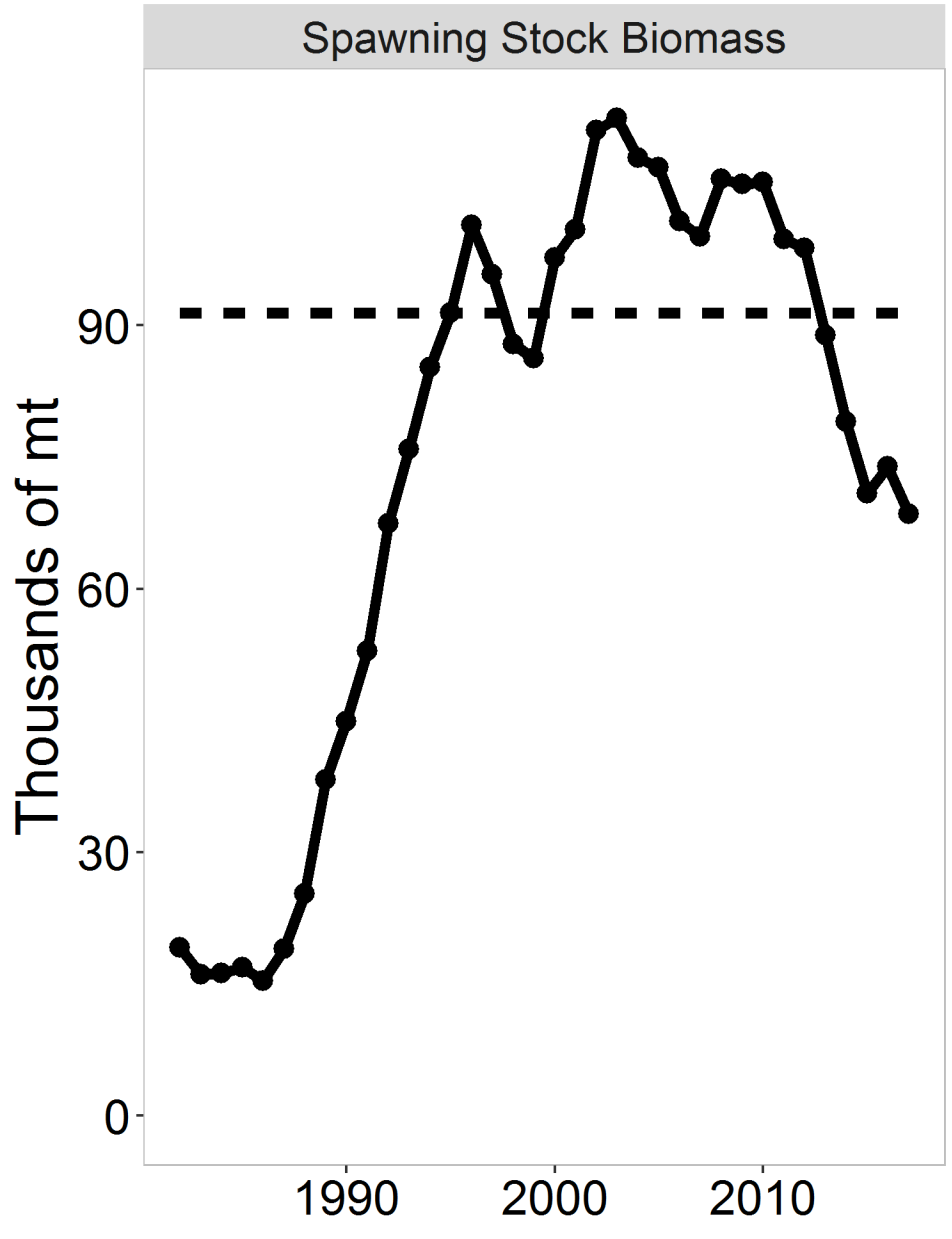
- The ERP WG identified a subset of key ERP species to incorporate into the models
- Not all models use all species
- Some models use more predators and/or prey groups

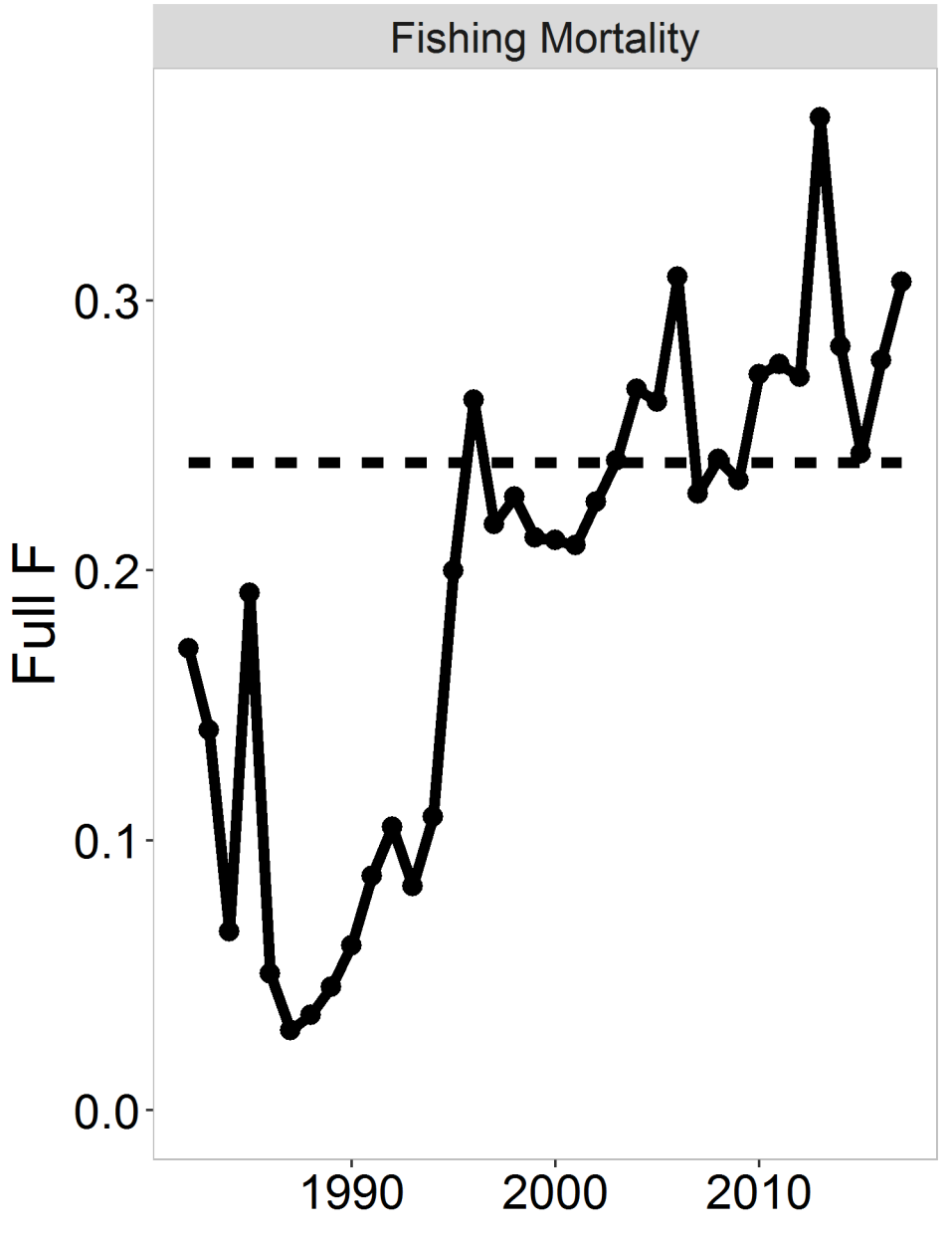
ERP Species

- Prey species
  - Atlantic menhaden
  - Atlantic herring
- Predator species
  - Bluefish
  - Spiny dogfish
  - Striped bass
  - Weakfish

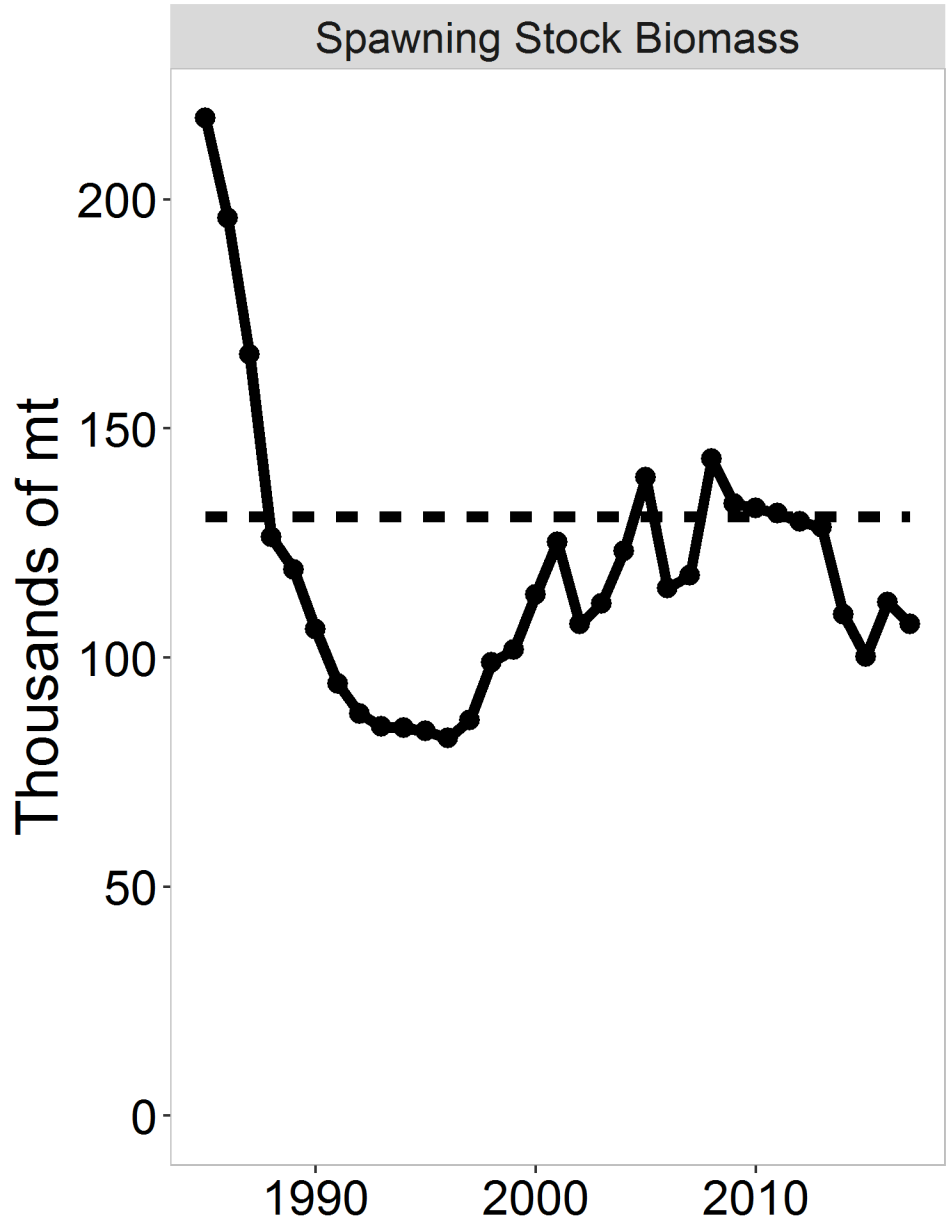
→ All species had a benchmark assessment or assessment update with data through 2017 available

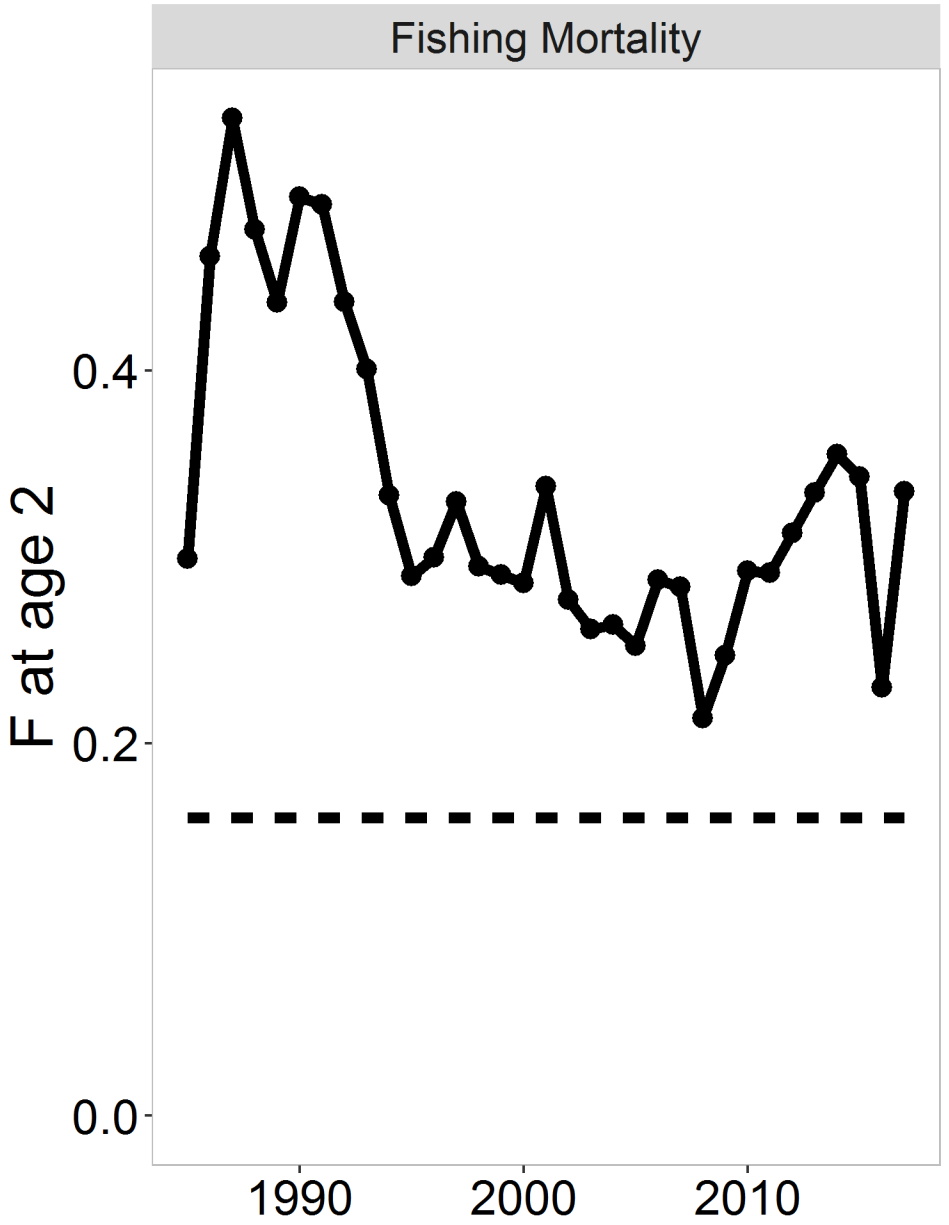
Striped Bass



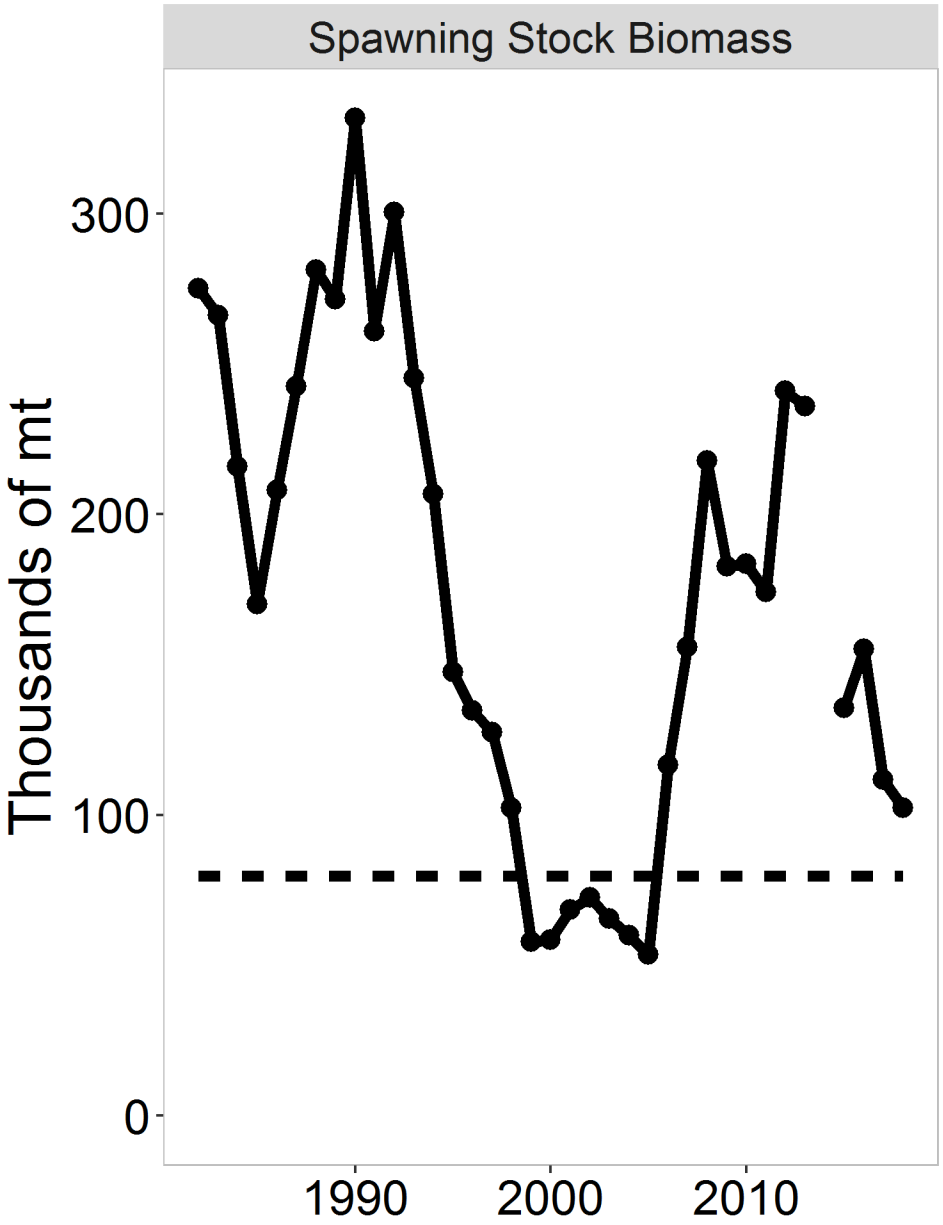


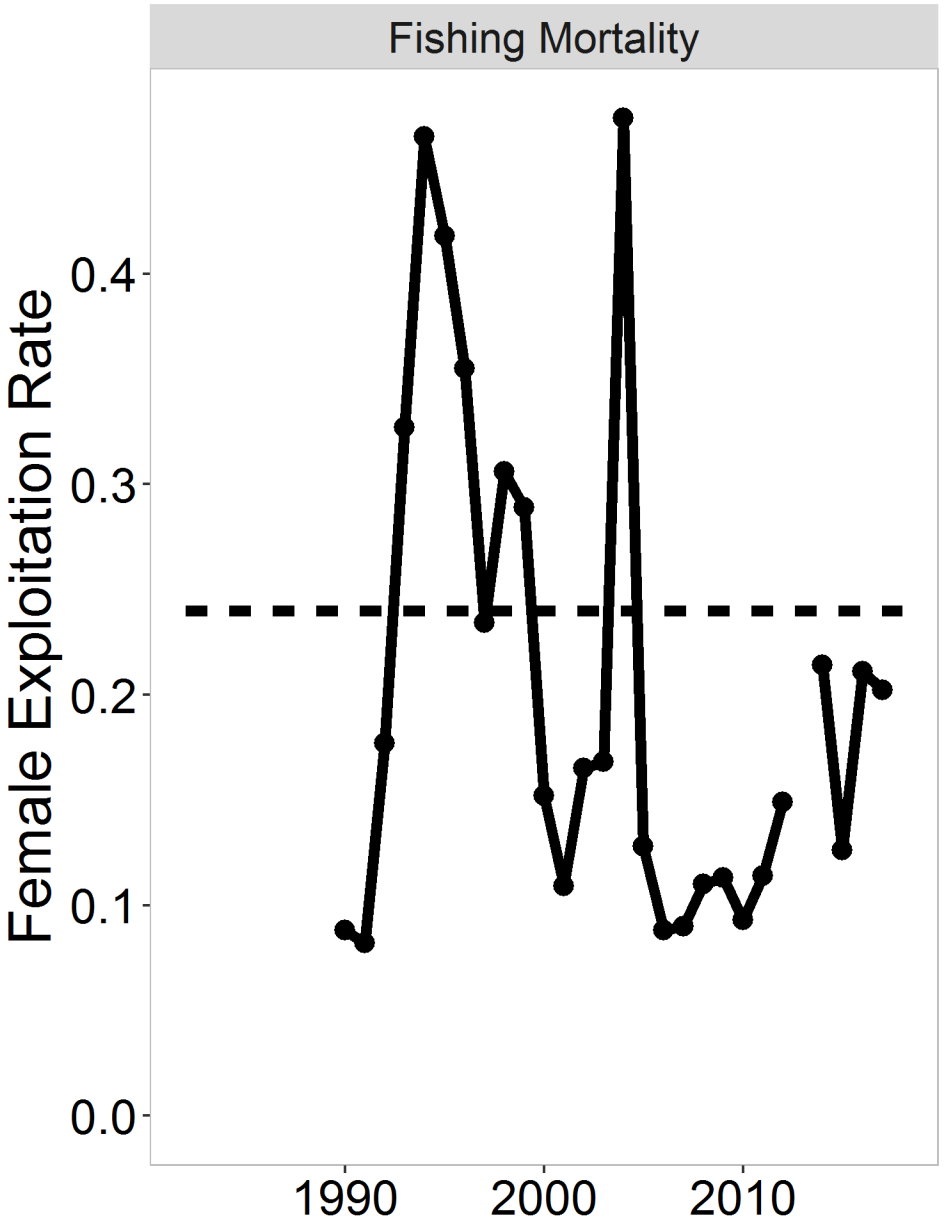
Bluefish


Spawning Stock Biomass
Thousands of mt
200
150
100
50
0
1990
2000
2010

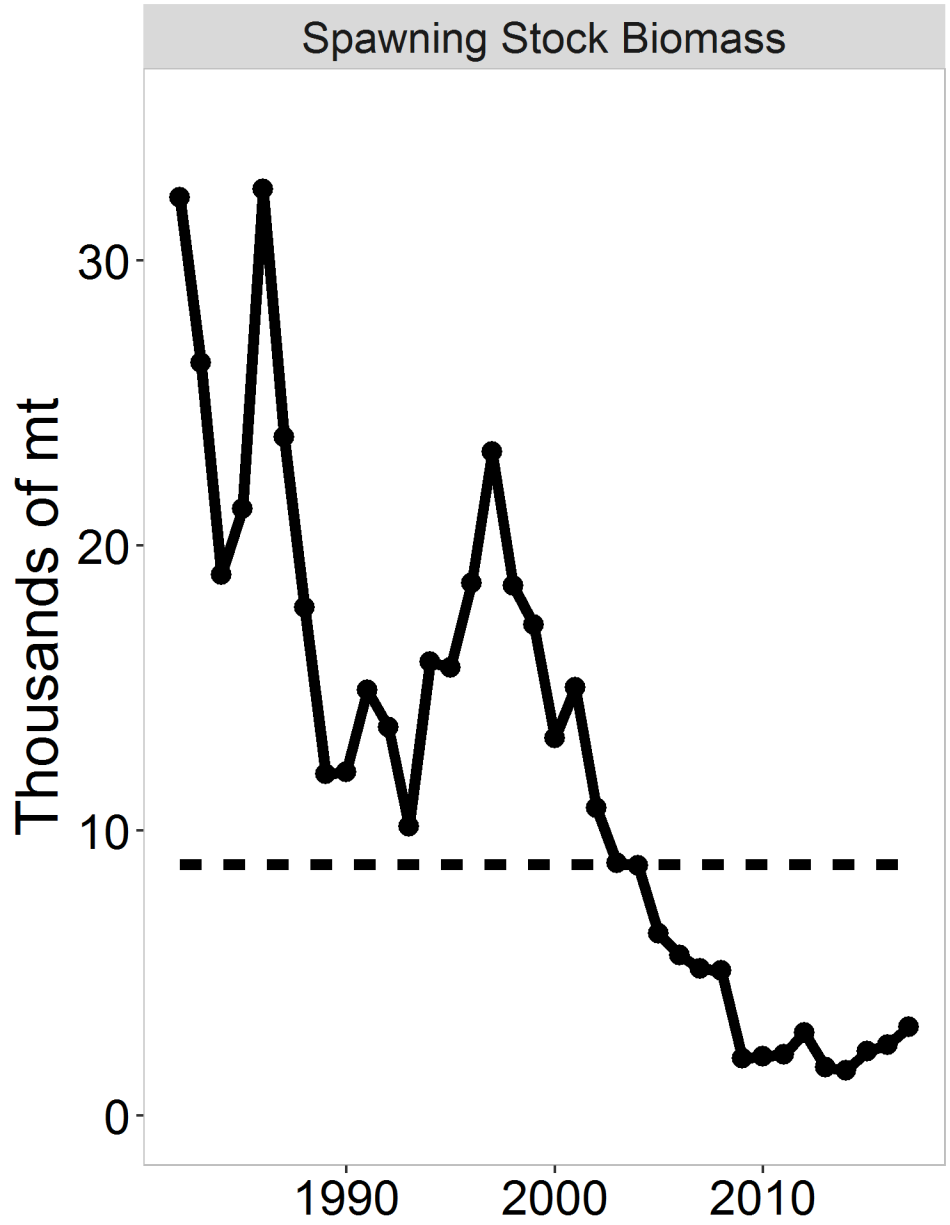

Fishing Mortality
F at age 2
0.4
0.2
0.0
1990
2000
2010

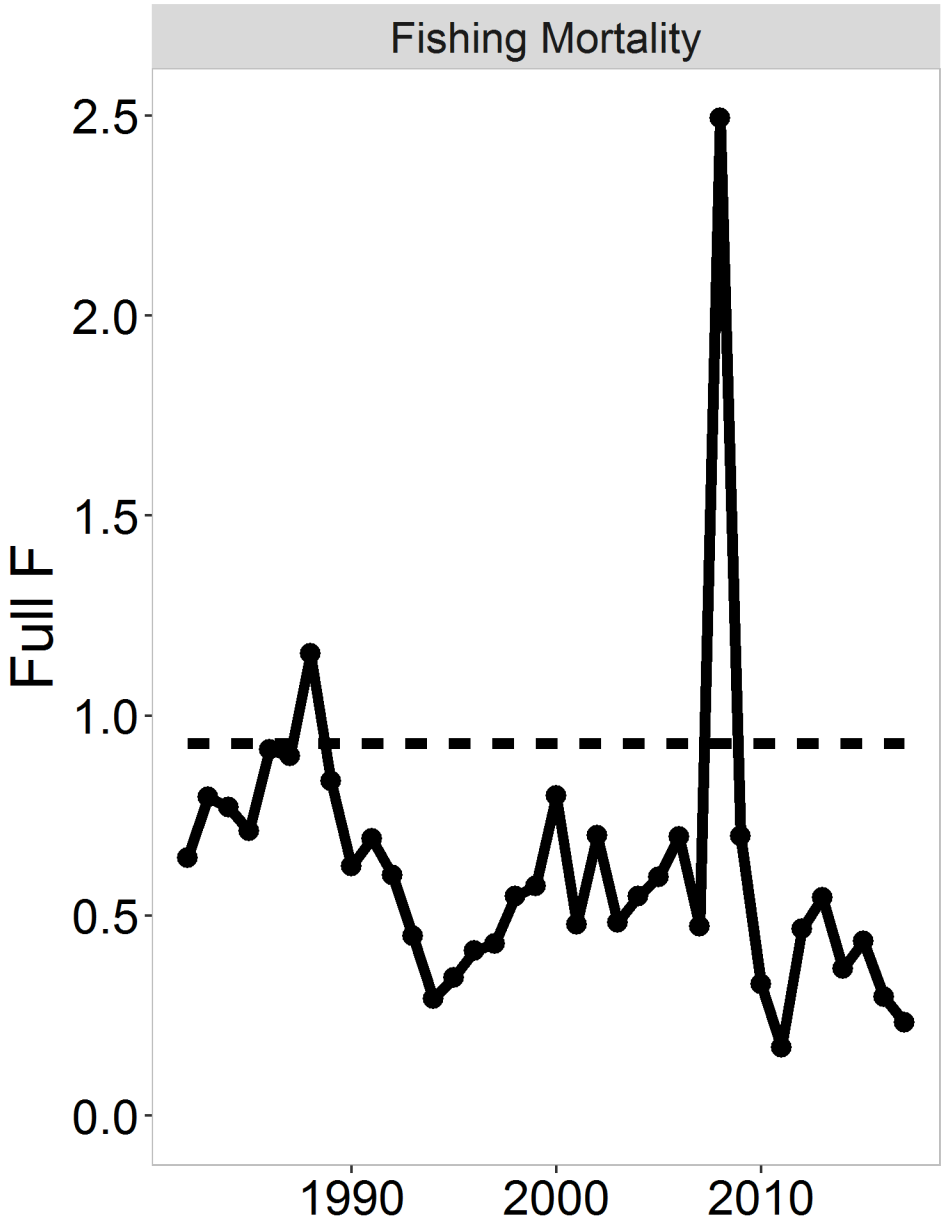
Spiny Dogfish





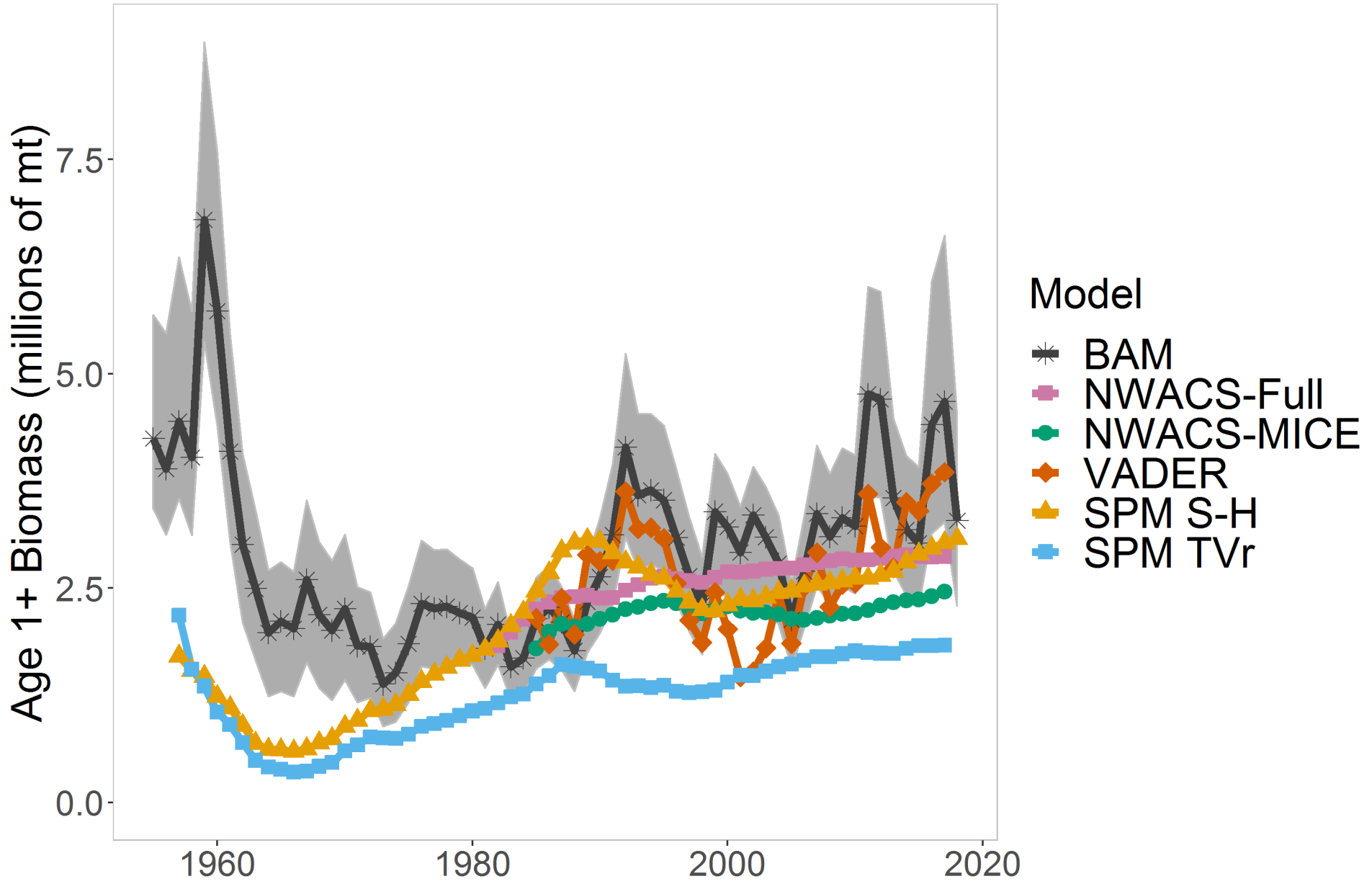
Weakfish


Spawning Stock Biomass
Thousands of mt
30
20
10
0
1990
2000
2010

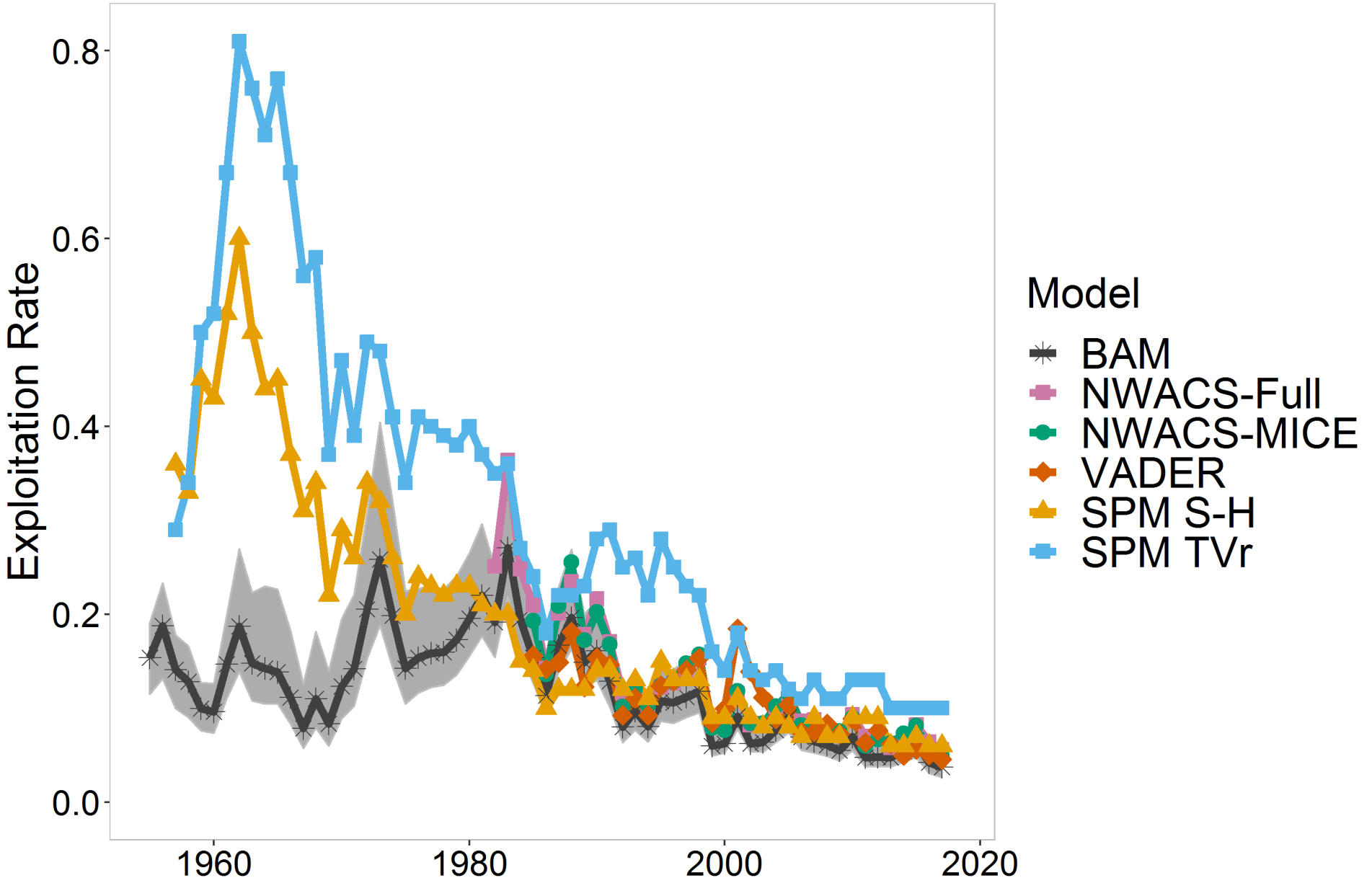

Fishing Mortality
Full F
2.5
2.0
1.5
1.0
0.5
0.0
1990
2000
2010

COMPARISON

Age 1+ Menhaden Biomass



Exploitation Rate



Model Performance

- Estimates of biomass and exploitation rate from the ERP models are very similar to each other and to estimates from BAM in both scale and trend
  - ERP models were parameterized with the same inputs (landings, indices, life history information) as the BAM – and in some cases with output from BAM

Ecosystem Management Objectives

EMO Workshop (September 2015) identified fundamental objectives for ecosystem management of Atlantic menhaden

- Sustain menhaden to provide for fisheries
- Sustain menhaden to provide for predators
- Provide stability for all types of fisheries
- Minimize risk to sustainability due to changing environment

<u>Important</u> to have a tool that can be updated on management time scales

Addressing Management Objectives

	FUNDAMENTAL OBJECTIVES											
	Sustain menhaden to provide for fisheries				**Sustain menhaden to provide for predators**				**Provide stability for all types of fisheries**		**Minimize risk due to changing environment**	
	PERFORMANCE MEASURES				**PERFORMANCE MEASURES**				**PERFORMANCE MEASURES**		**PERFORMANCE MEASURES**	
	Abundance/ biomass of menhaden	Menhaden yield	Age Composition	Historical distribution (Age comp as proxy)	Abundance/ biomass of predators	Predator yield objectives	Predator nutrition	Prey availability relative to predator distribution	Stability in yield for directed menhaden fisheries	Stability in yield for non-menhaden fisheries	*Model explicitly considers uncertainty about future environment for menhaden*	*Model explicitly considers uncertainty about future environment for predators*
Single-Species												
BAM	X	X	X	X					X		*	
Multi-Species												
S-H	X	X					proxy		X		*	*
SPMTVr	X	X							X		*	*
VADER	X	X	X	X	X	X	proxy	*	X	X	*	*
NWACS	X	X	X	X	X	X	proxy	*	X	X	*	*

*: Indicates it is possible to modify the model to meet that performance objective, but would require extensive additional work

Address Management Objectives

- VADER and NWACS are the only models that provide information on predator biomass and fishing mortality

- Only NWACS models include “bottom-up” feedback to evaluate effects of menhaden biomass/F on predator population dynamics (current implementation of VADER does not)

MANAGEMENT ADVICE

Management Advice

- The NWACS models allow us to explore the effects of menhaden harvest on predator abundance and biomass
- While the BAM captures menhaden population dynamics better than the NWACS models
- The NWACS-MICE is a streamlined approach, requiring less time and resources than the NWACS-Full
  - updatable within the management timeframe
  - based on comparisons with the NWACS-Full, striped bass were a reasonable proxy for other sensitive groups not included in the NWACS-MICE

Management Advice

- ERP WG recommends a combination of the BAM single-species model and the NWACS-MICE model as a tool for managers to evaluate trade-offs between menhaden harvest and predator biomass

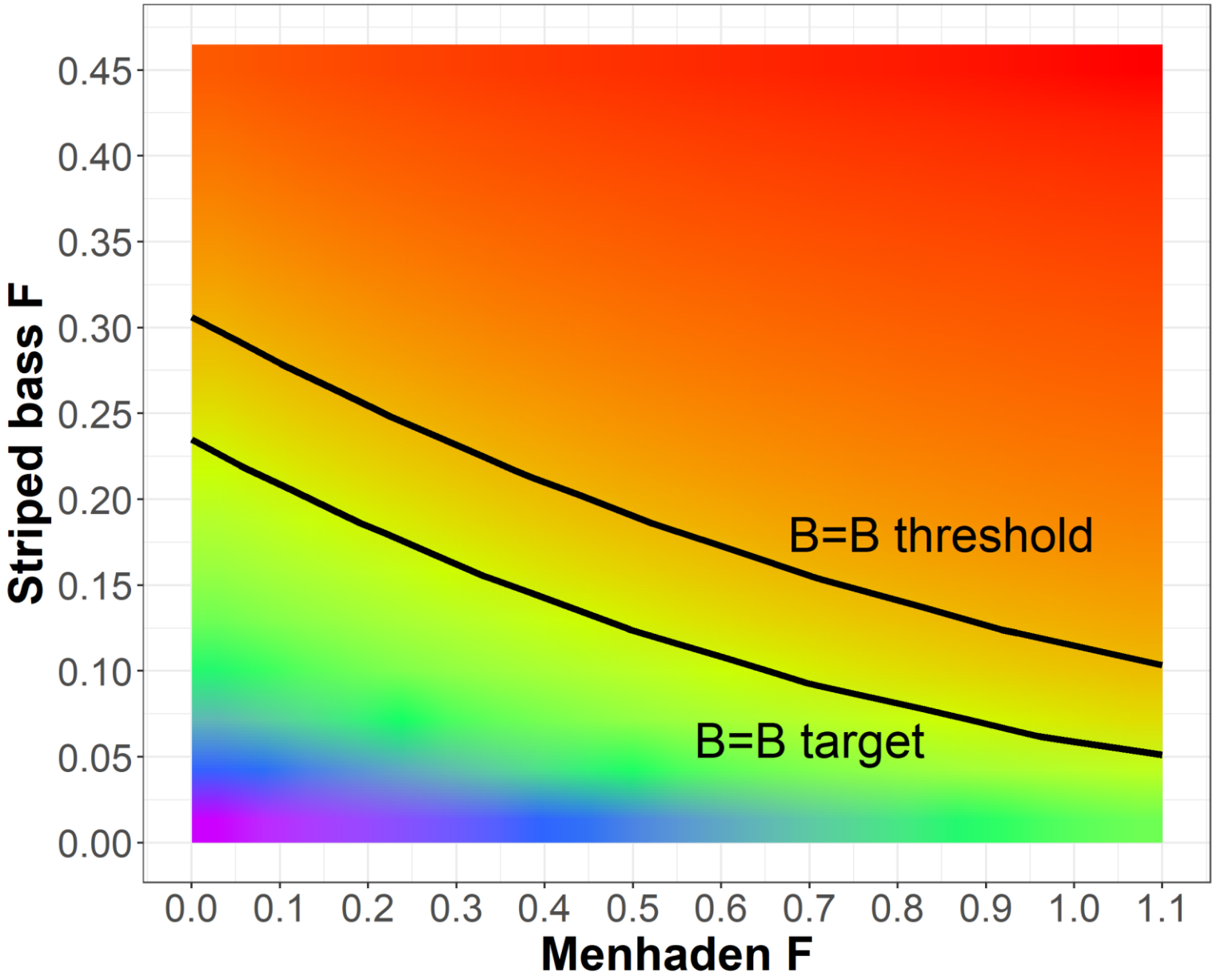
THE NWACS-MICE TOOL AND EXAMPLE

Ecological Reference Points

- There is no one "right" answer: the target and threshold levels of F for Atlantic menhaden depend on the management objectives for the ecosystem
  - Where do you want your predator populations to be?
  - What do you want your predator fisheries to look like?

→ NWACS-MICE can illustrate the tradeoffs between menhaden F and predator F/biomass

Example Trade Off Evaluation



Equilibrium or long term F

Striped bass B/B target

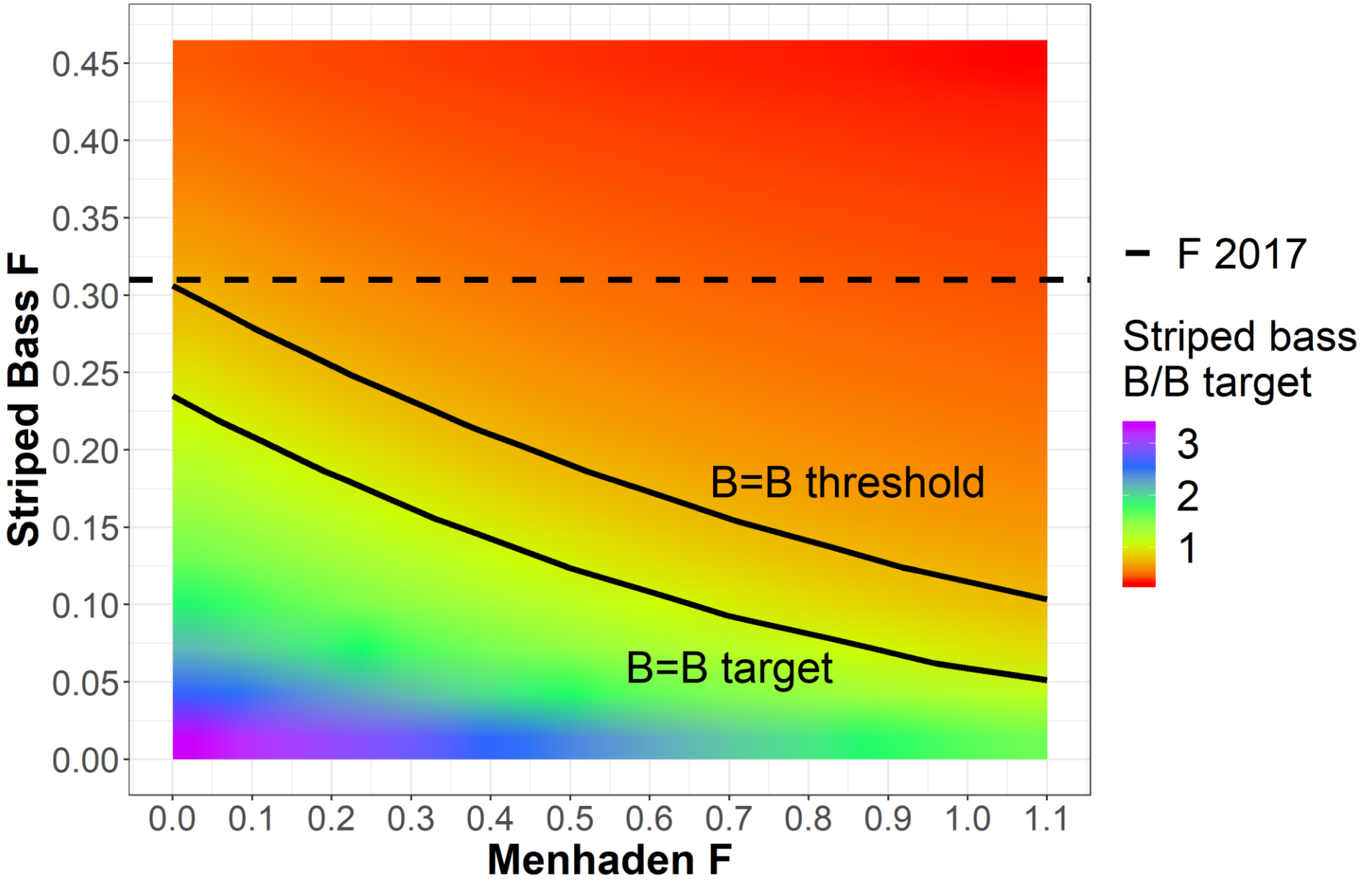
3

2

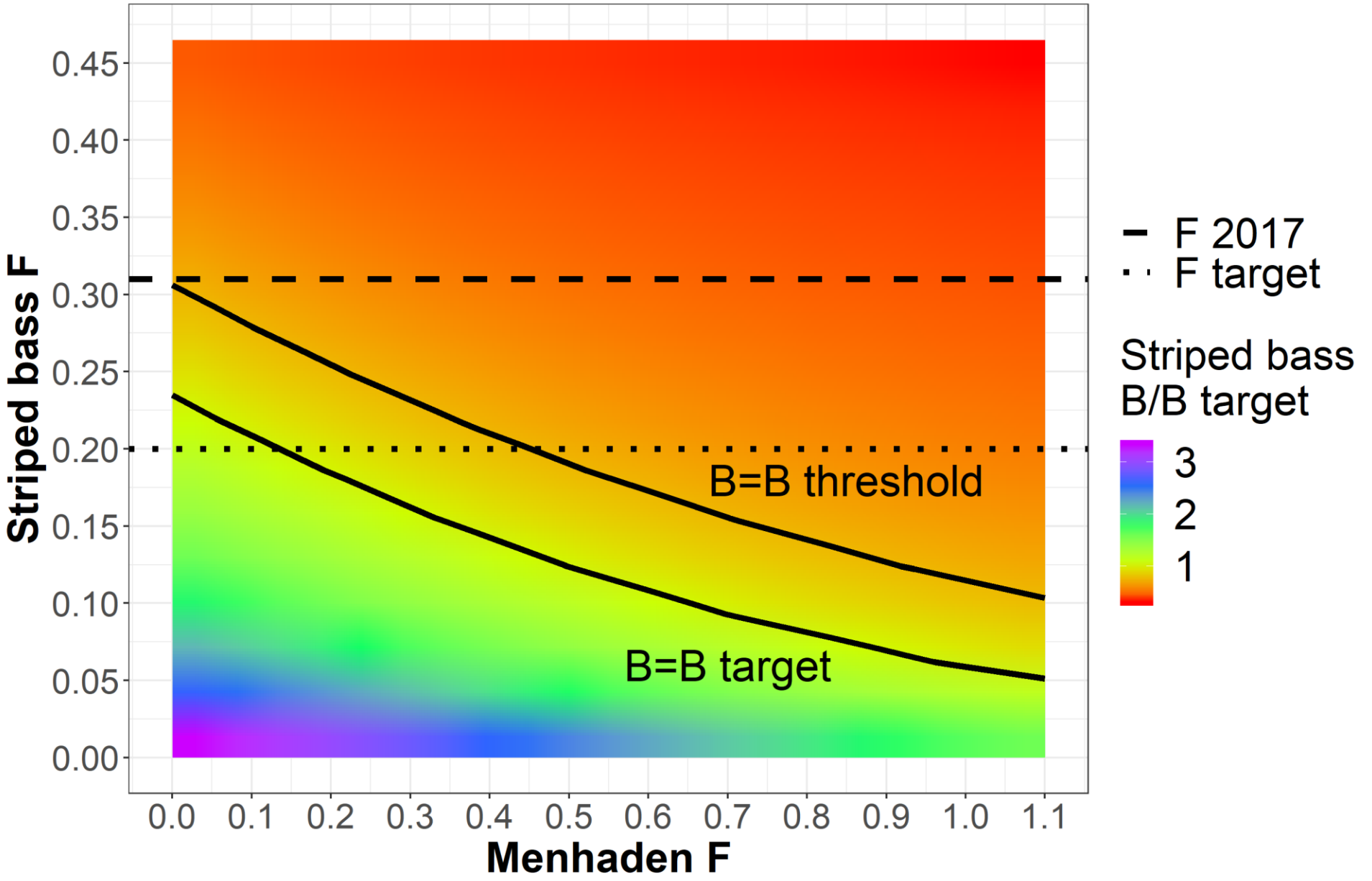
1

other species fished at F_{2017}

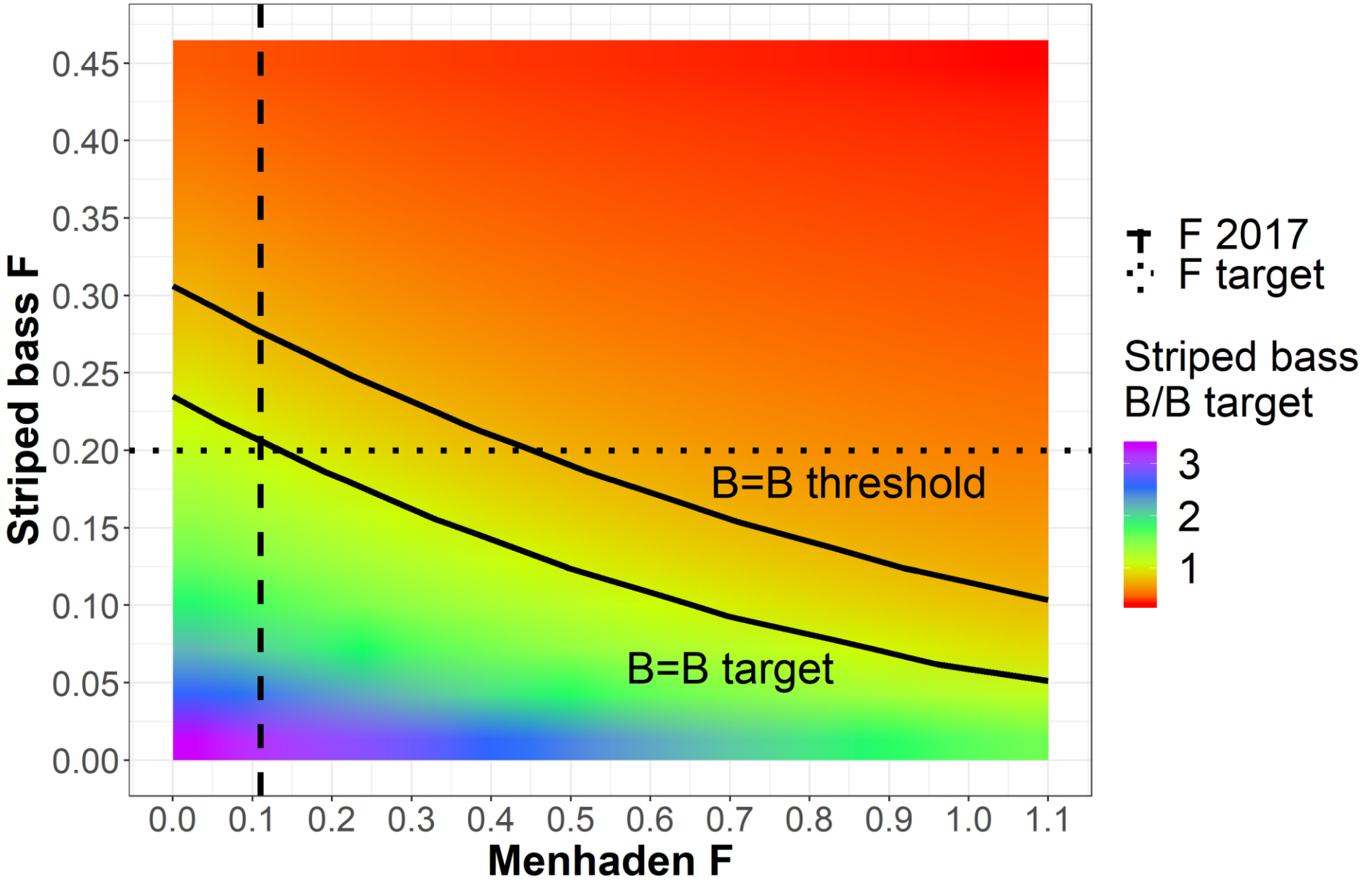
Example Trade Off Evaluation



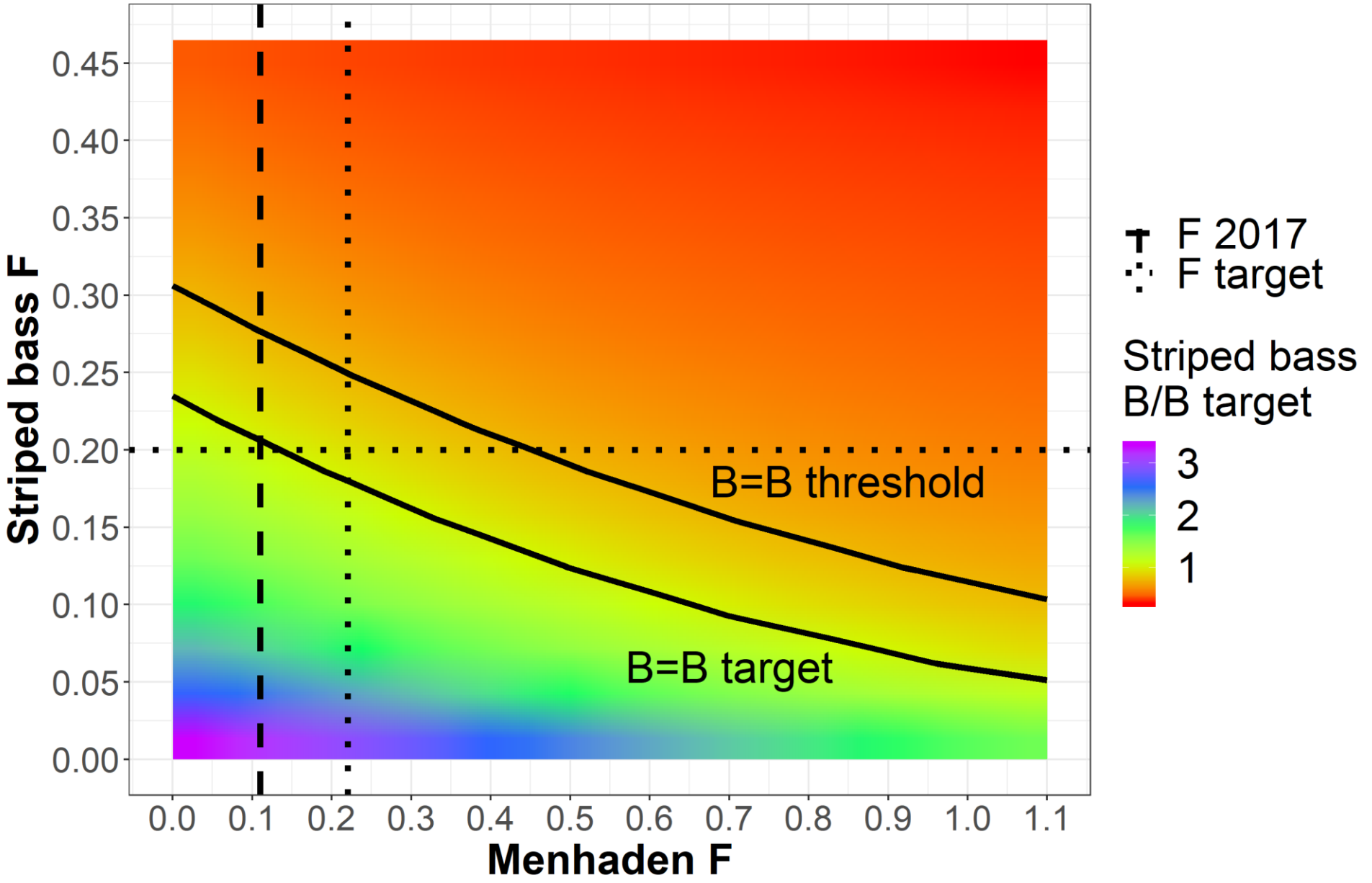
Example Trade Off Evaluation



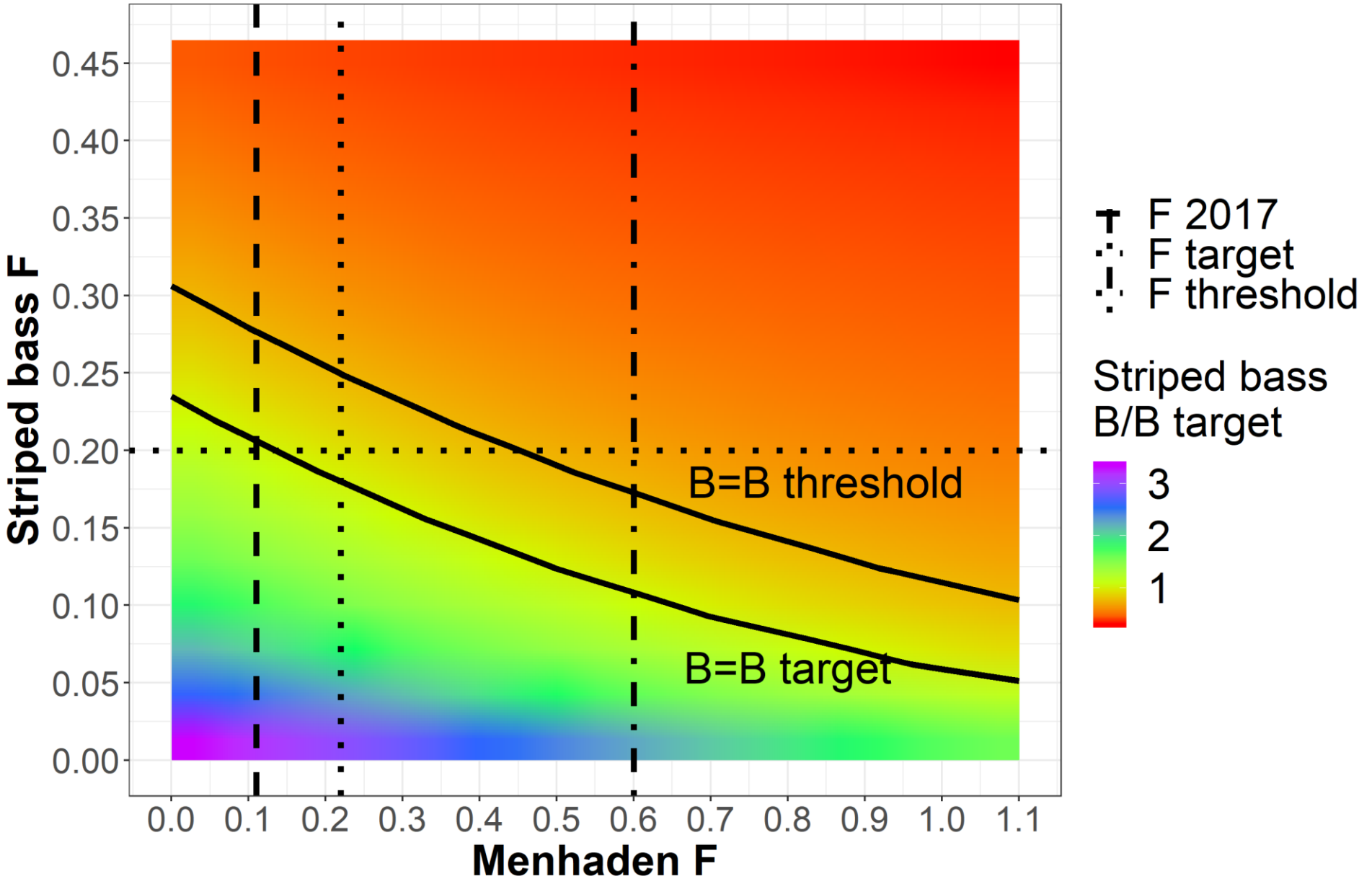
Example Trade Off Evaluation



Example Trade Off Evaluation



Example Trade Off Evaluation



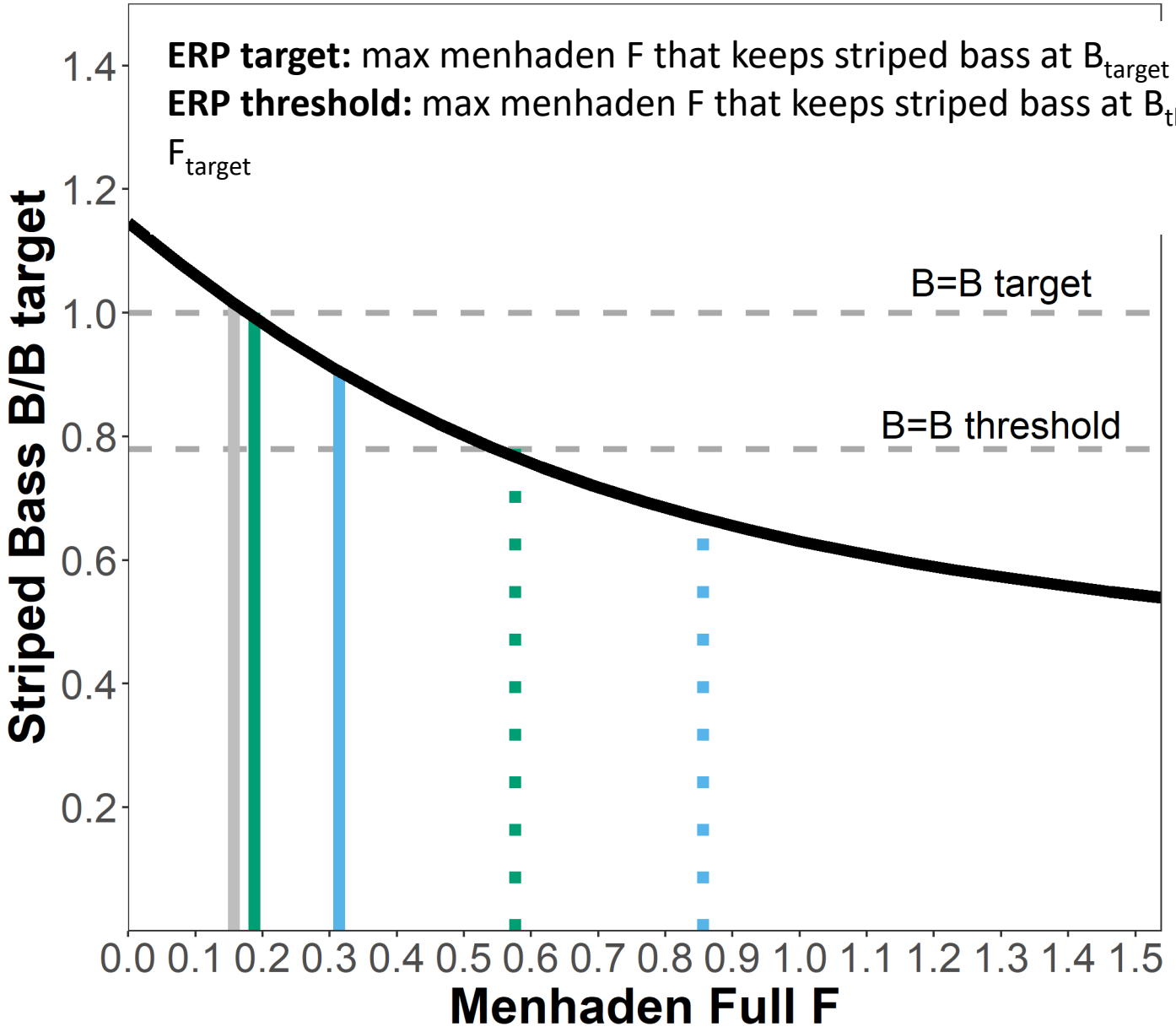
Example ERP Target & Threshold

- NWACS-MICE found striped bass was the most sensitive fish predator to menhaden harvest, so ERPs that sustains striped bass should also maintain less sensitive predators
- NWACS-Full found striped bass and piscivorous shorebirds to be the most sensitive, and that birds responded similarly to striped bass
- **ERP target:** maximum F on menhaden that sustains striped bass at their B target when striped bass are fished at their F target
- **ERP threshold:** maximum F on menhaden that keeps striped bass at their B threshold when striped bass are fished at their F target

Example ERP Target & Threshold

ERP target: max menhaden F that keeps striped bass at B_{target} when fished at F_{target}

ERP threshold: max menhaden F that keeps striped bass at $B_{threshold}$ when fished at F_{target}



- Status quo
- ERP Target
- BAM Target
- ERP Threshold
- BAM Threshold

other species fished at their status quo levels

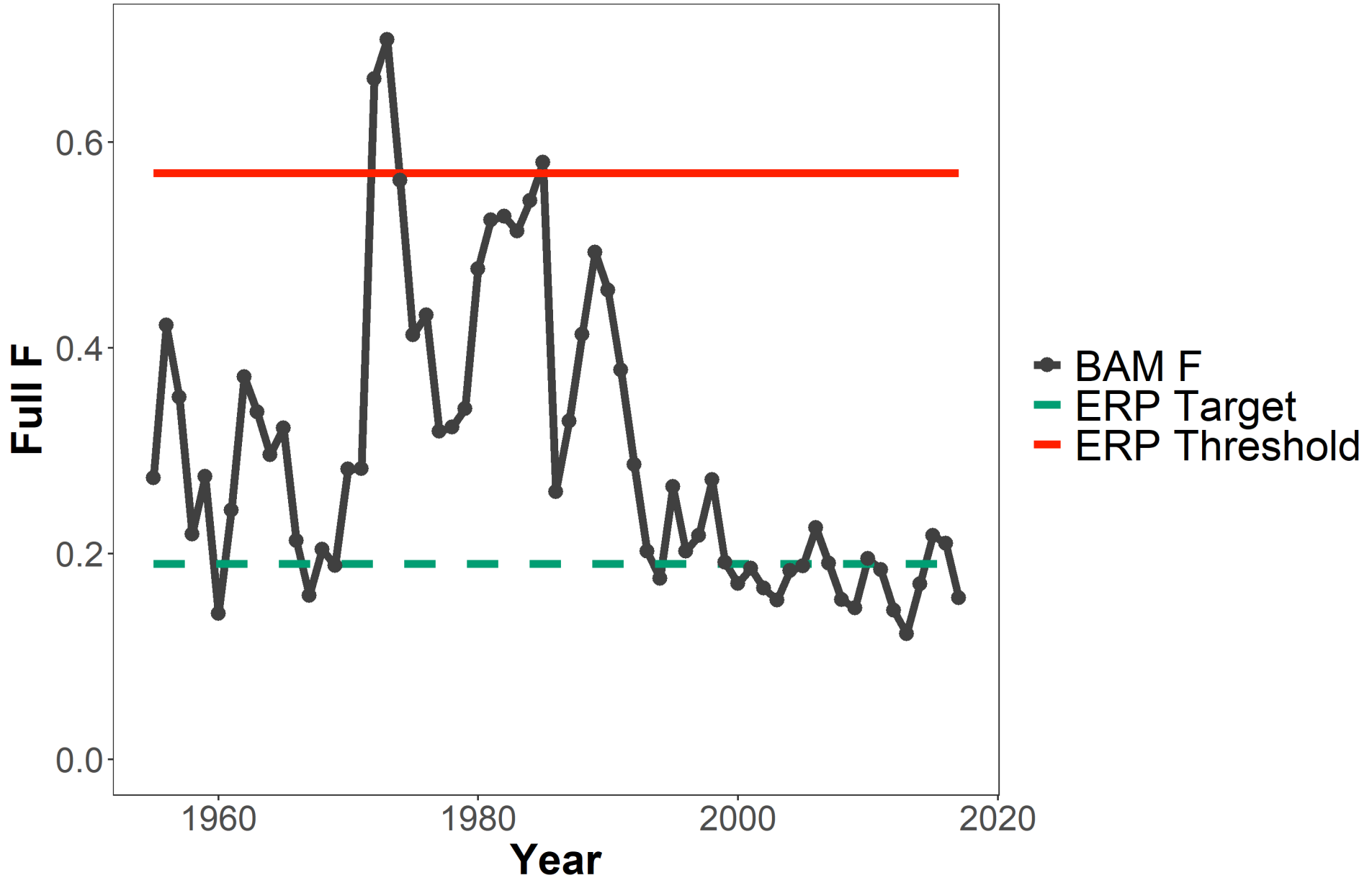
Example ERP Target & Threshold

Reference Point	ERP	Single Species	F 2017
F Target	0.19	0.31	0.16
F Threshold	0.57	0.86	

- To meet current striped bass management objectives, the F target and threshold for Atlantic menhaden should be lower than the single-species target and threshold

- Current F is below the ERP target and threshold, indicating the stock is not experiencing overfishing

Example ERP Target & Threshold



Management Advice

This tool will allow the Board and Commission to evaluate the trade-offs between Atlantic menhaden F and predator biomass in a quantitative, transparent way to set ERPs that reflect ASMFC's objectives

Next step: instructions from the Board about other scenarios to explore to help the Board evaluate tradeoffs and set final ERPs

Summary

- Tasked with developing a tool to examine the trade-offs between menhaden catch and role as a forage fish
- Developed a tool using BAM model and NWACS-MICE to evaluate trade-offs
- Provided example ERPs to illustrate how this tool can be used in setting ERPs
- Next steps: further explorations other scenarios to help the Board with these trade-offs

Ecological Reference Points Working Group

Matt Cieri (Chair), Maine Department of Marine Resources
Kristen Anstead, Atlantic States Marine Fisheries Commission
Mike Celestino, New Jersey Division of Fish and Wildlife
David Chagaris, University of Florida
Micah Dean, Massachusetts Division of Marine Fisheries
Katie Drew, Atlantic States Marine Fisheries Commission
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Sarah Murray, Atlantic States Marine Fisheries Commission
Amy Schueller, National Marine Fisheries Service
Alexei Sharov, Maryland Department of Natural Resources
Howard Townsend, National Marine Fisheries Service
Jim Uphoff, Maryland Department of Natural Resources

In collaboration with
Andre Buchheister and Max Grezlik, Humboldt State University
Joana Brito, University of the Azores
Genevieve Nesslage and Mike Wilberg, University of Maryland Center for Environmental Science

QUESTIONS

Review Panel Reports
Menhaden and Ecological Reference Point Stock Assessments

Atlantic Menhaden Fishery Management Board

February 5, 2020

Stock Assessment Peer Review Process

- Atlantic Menhaden SAS and Technical Committee developed new single species assessment
- Ecological Reference Points Work Group developed new ERP assessment
- SEDAR Stock Assessment Review Workshop
  November 4-8, 2019 in Charleston, South Carolina
- Scientific review focused on data inputs, model results and sensitivity, and overall quality of assessments

Products

- SEDAR Stock Assessment Reports
- http://sedarweb.org/sedar-69

Stock Assessment Review Process

Scientific Peer Review Panel

- Chair + 4 additional Technical Reviewers, with expertise in
  - Forage Fish Biology and Predator-Prey Relationships
  - Population Dynamics and Statistics
  - Stock Assessment and Ecosystem Modeling

Dr. Michael Jones (Chair), Michigan State University

Dr. Sarah Gaichas, NMFS NEFSC, Woods Hole

Dr. Daniel Howell, Norwegian Institute of Marine Research, Bergen

Dr. Ken Frank, Canada Department of Fisheries and Oceans, Halifax

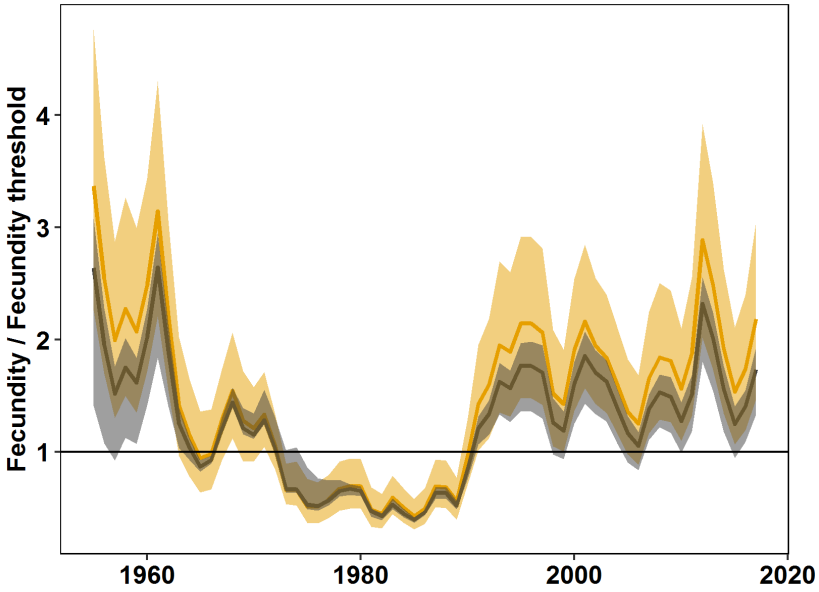
Dr. Laurence Kell, SeaPlus, United Kingdom

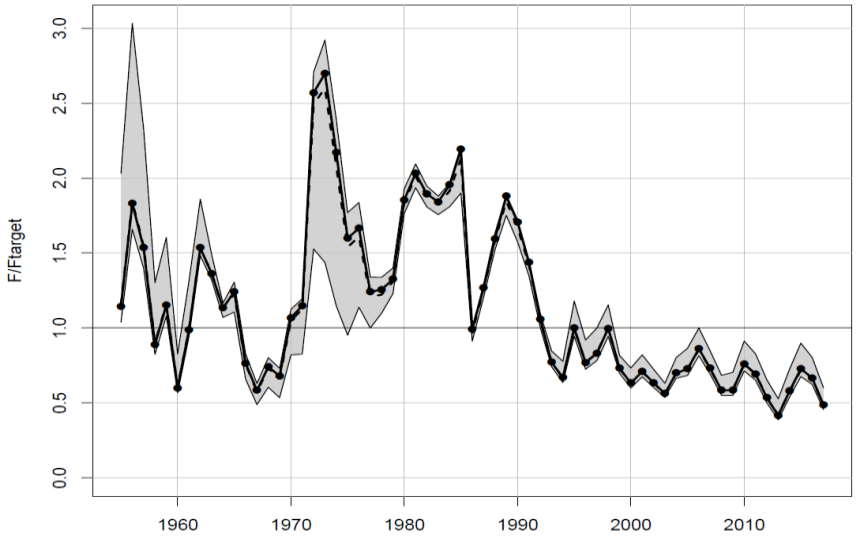
SEA++ Sustainable oceans, sustainable planet.

Fisheries and Oceans Canada

Review Panel Overall Findings

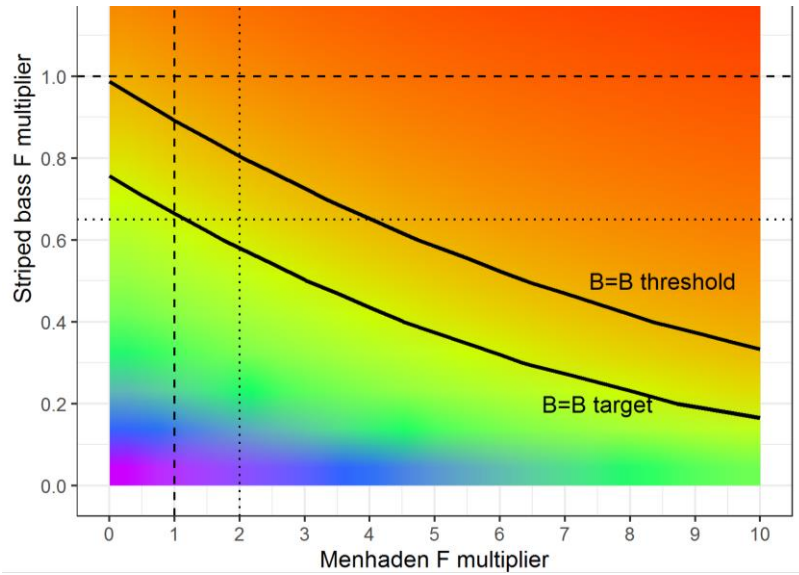
- Single Species Assessment
  - Assessment model is mature and SAS conclusions are defensible; examination of uncertainty was thorough
  - Atlantic menhaden are neither overfished nor experiencing overfishing
  - Current reference points seem appropriate, until ecosystem reference points are adopted

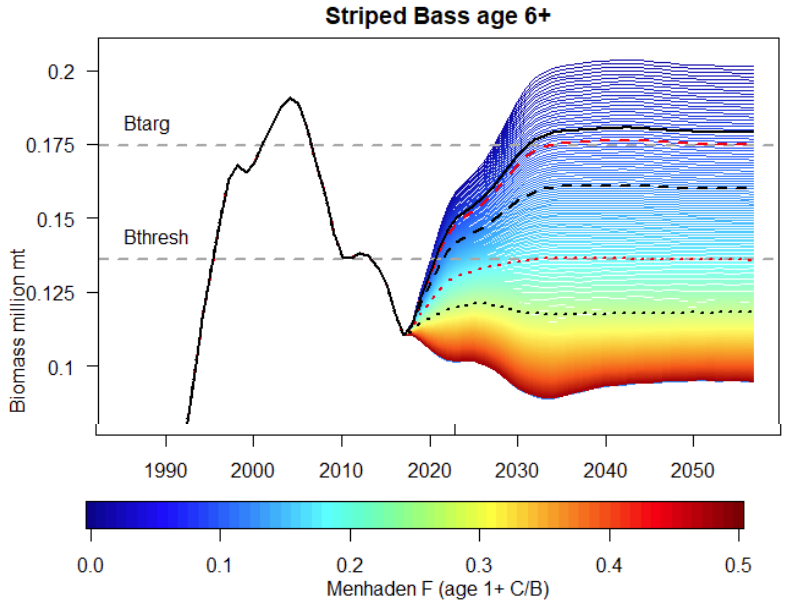




Review Panel Overall Findings

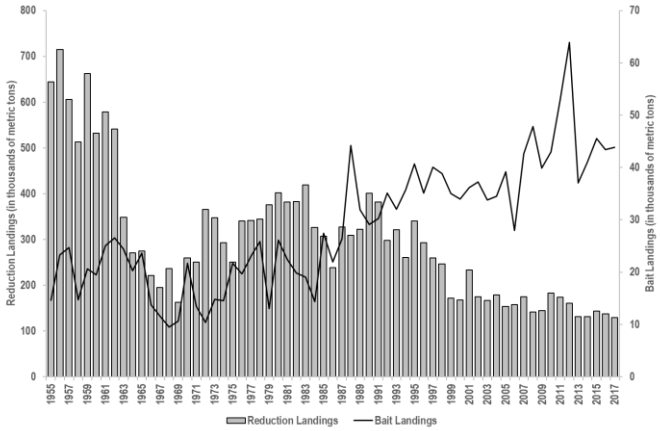
- Ecological Reference Points Assessment
  - Impressive examination of candidate models for ERP determination
  - Agree with ERP WG recommendations about preferred models (BAM + NWACS-MICE) to use for management decisions
  - Analysis is sufficiently advanced and ready for consideration in management decisions





Review Findings – Single Species

✓ **ToR 1:** Data used in assessment

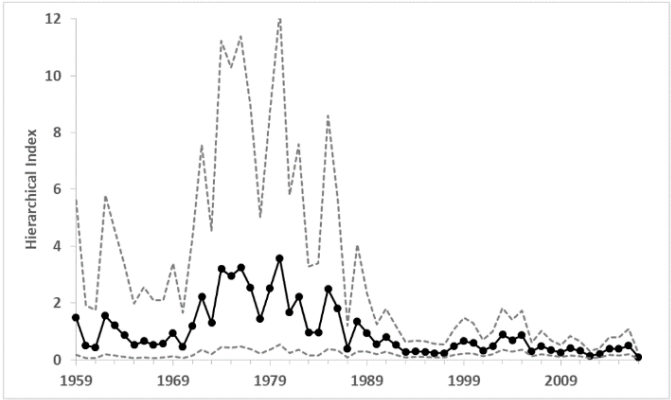


Panel Conclusions

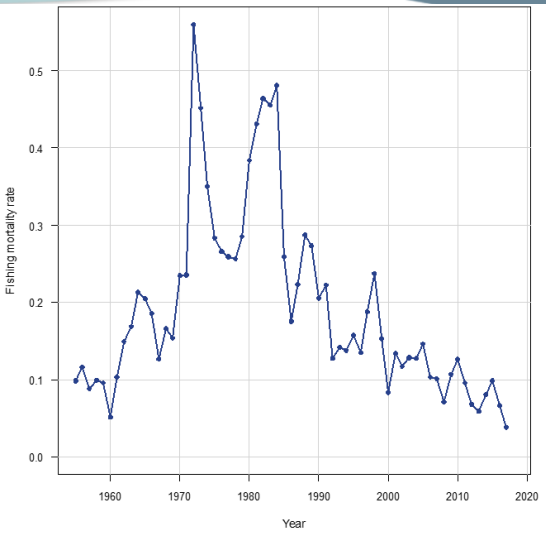
- Approve decisions about which data to include
- Limited coverage of larger, older fish

Recommendation 1: *Add surveys representing larger, older fish*

Recommendation 2: *Consider alternative methods for combining survey data*



Review Findings – Single Species



✓ **ToR 2:** Assessment Model(s)

Panel Conclusions

- BAM is a "mature", well-established model
- Major changes to fecundity and natural mortality components of model are defensible and justified
- Model sometimes exhibits convergence issues

Recommendation 1: *Evaluate model stability further to increase confidence in fits to data*

Recommendation 2: *The BAM model is acceptable for providing management advice*

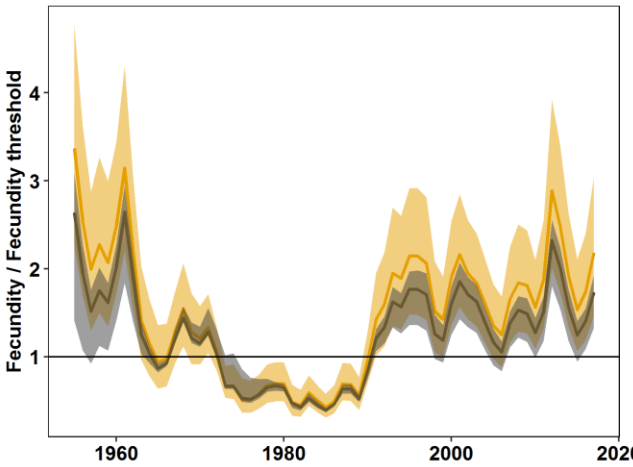
Review Findings – Single Species

✓ **ToR 3,4:** Treatment of uncertainty

Panel Conclusions

- Appreciated extensive examination of model sensitivity and uncertainty
- Sensitivity analysis highlights importance of good survey data on older fish
- Conclusions about stock status are generally robust to uncertainty

Recommendation 1: *Try to combine the two methods of propagating uncertainty into an integrated analysis*



***ToR 5** – there was no minority report

Review Findings – Single Species

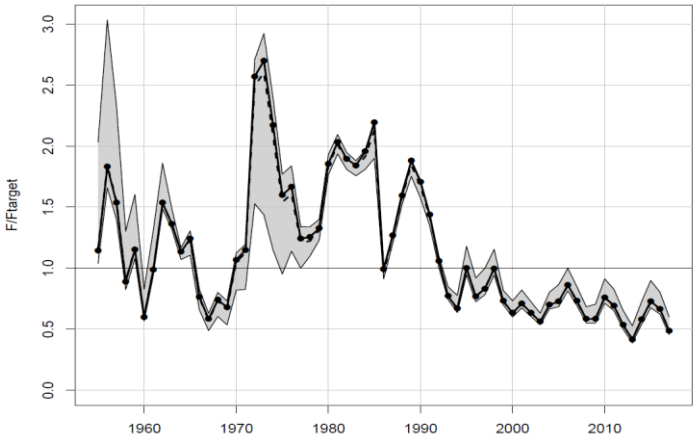
✓ **ToR 6,7:** Assessment results, stock status, reference points

Panel Conclusions

- Agree with SAS conclusions about stock status (not overfished or overfishing)
- Current reference points appropriate for single species management

Recommendation 1: *Plan for eventual replacement of single species RPs with Ecological Reference Points*

Recommendation 2: *Examine methods for assessing prediction skill of forecasts*



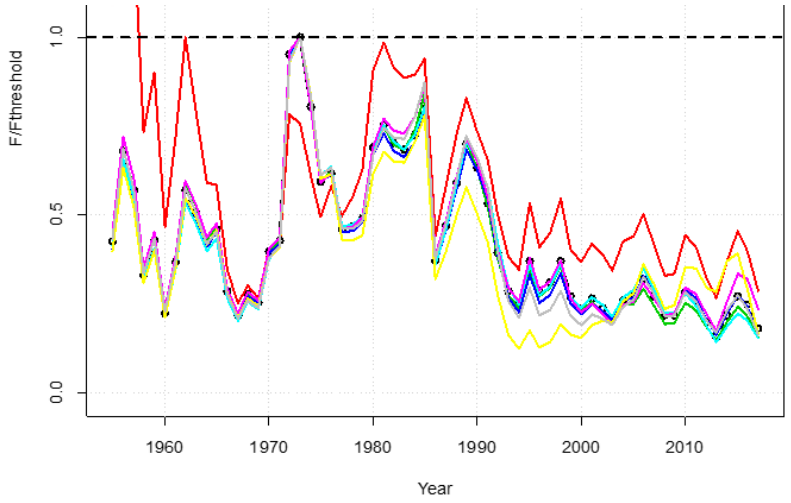
Review Findings – Single Species

✓ **ToR 8:** *Research, data collection, assessment methods*

Panel Conclusions

- Generally support SAS recommendations for research and data collection
- Emphasize importance of better assessment of older fish

Recommendation 1: *Support idea of MSE, but urge (a) deliberation about necessary complexity and (b) integration with ERP process*

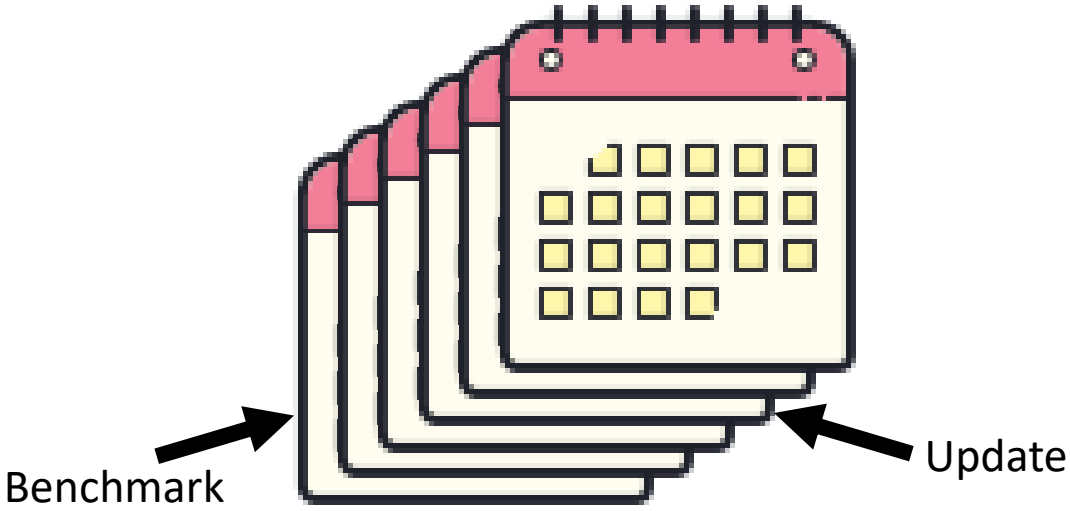


Review Findings – Single Species

✓ **ToR 9:** Timing of future benchmarks and updates

Panel Conclusions

- Agrees with SAS recommendation: update – 3 years, benchmark – 6 years
- May need to re-think timing if coordination with other species' assessments becomes desirable



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Review Findings - ERP

✓ **ToR 1,2:** Data used in assessment

Panel Conclusions

- Support decisions of ERP WG for data used in assessment models
  - Includes use of Reduction CPUE index for production models
- Appropriate use of diet data, noting these data provide limited coverage

Recommendation 1: *Explore other diet data sources (e.g., meta-barcoding of stomach samples)*

Recommendation 2: *Further review of spiny dogfish data for multispecies catch-at-age model*

Recommendation 3: *Develop data pedigree for EwE models*

Review Findings - ERP

✓ **ToR 3:** Methods and models used for ecosystem assessment

Panel Conclusions

- Excellent evaluation of pros/cons of five models used to consider Menhaden as a forage species
- Agree with WG recommendation to use BAM + NWACS-MICE for development of ERPs.

Recommendation 1: *Retain multi-species catch-at-age model (VADER) as future candidate for development of ERPs*

Table 1. ERP models explored and the fundamental management objectives they address.

	FUNDAMENTAL OBJECTIVES											
	Sustain menhaden to provide for fisheries				Sustain menhaden to provide for predators				Provide stability for all types of fisheries		Minimize risk to sustainability due to changing environment	
	PERFORMANCE MEASURES				PERFORMANCE MEASURES				PERFORMANCE MEASURES		PERFORMANCE MEASURES	
	Abundance/ biomass of menhaden	Menhaden yield objectives	Age Composition	Historical distribution (Age comp as proxy)	Abundance/ biomass of predators	Predator yield objectives	Predator nutrition	Prey availability relative to predator distribution	Stability in yield for directed menhaden fisheries	Stability in yield for non-menhaden fisheries	*Model explicitly considers uncertainty about future environment for menhaden*	*Model explicitly considers uncertainty about future environment for predators*
Single-Species Models												
BAM Statistical Catch-at-Age Model (current model)	X	X	X	X					X		*	
Multi-Species Models												
Surplus Production												
Steele-Henderson	X	X					X (proxy)		X		*	*
Time-varying r	X	X							X		*	*
Multi-species Catch-at-Age (MSSCA)	X	X	X	X	X	X	X (proxy)	*	X	X	*	*
Ecopath with Ecosim (EwE)	X	X	X	X	X	X	X (proxy)	*	X	X	*	*

*: Indicates it is possible to modify the model to meet that performance objective, but would require extensive additional work

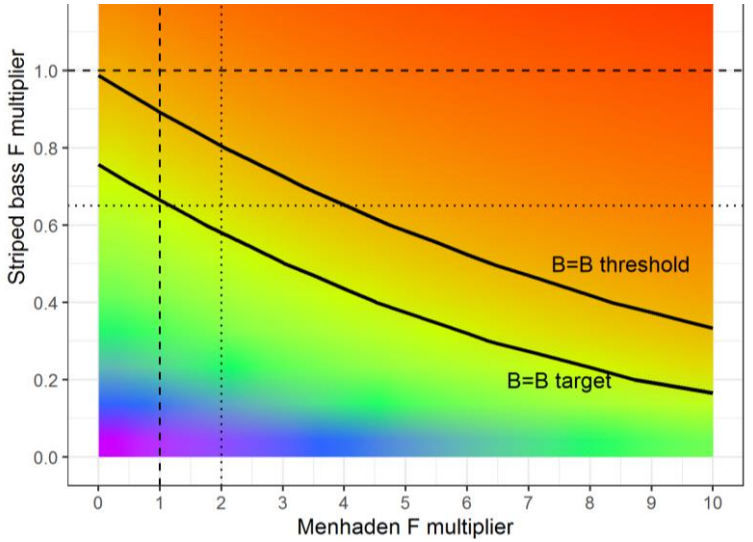
Review Findings - ERP

✓ **ToR 4:** Methods used to estimate reference points

Panel Conclusions

- Very impressive advancements since 2015 assessment
- Examples in ERP report should be viewed as illustrations of an approach, not conclusive guidance for RP values
- Notwithstanding this, methods and models are ready to use to guide management decisions

Recommendation 1: *Begin dialogue with managers about reference points for menhaden that account for their role as a forage species*



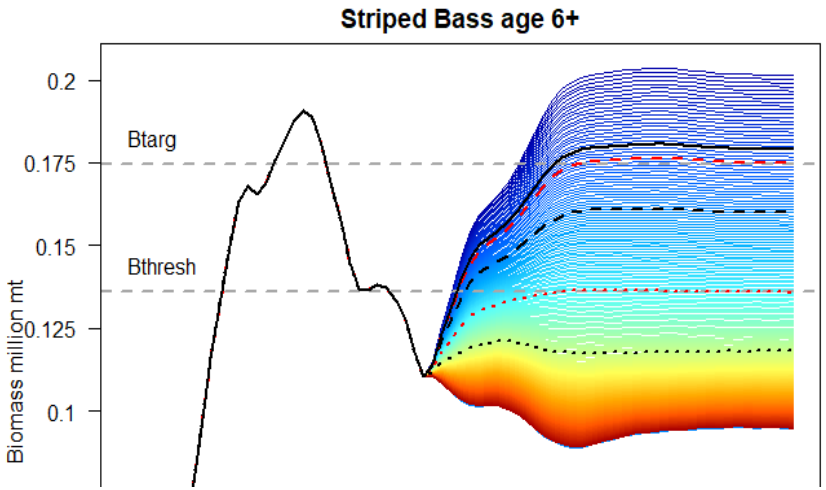
Review Findings - ERP

✓ **ToR 5,6:** Treatment of uncertainty

Panel Conclusions

- Sensitivity and uncertainty analysis was focused on NWACS-MICE
- Examination of model sensitivity to uncertainty about predation mortality indicated robustness of conclusions about important trade-offs

Recommendation 1: *Will need to add sensitivity analysis for VADER if this model is used more in the future*



***ToR 7** – there was no minority report

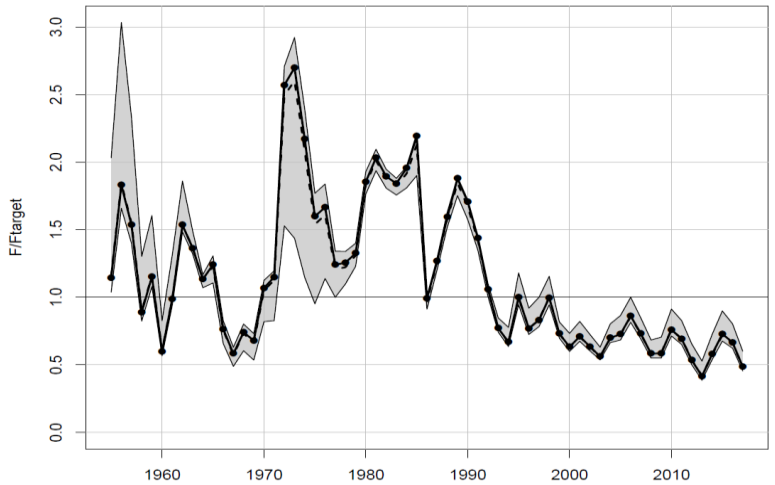
Review Findings - ERP

✓ **ToR 8:** Stock Status

Panel Conclusions

- Single species assessment is currently the best tool for stock status

Recommendation 1: *Move towards development of reference points that account for species interactions, working together with managers*



Review Findings - ERP

✓ **ToR 9:** Research, data collection and assessment

Panel Conclusions

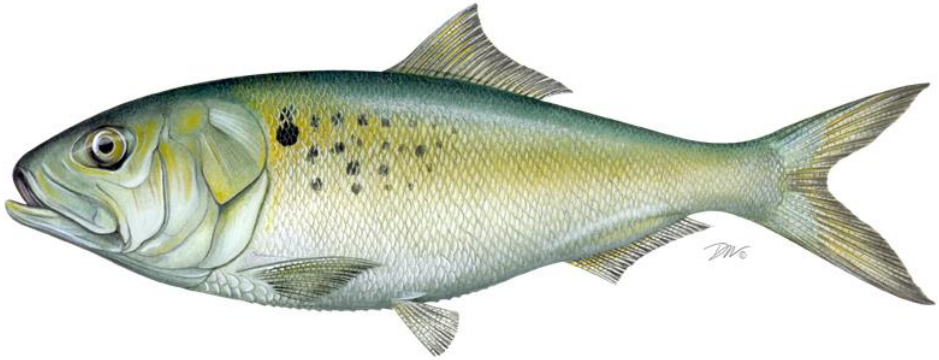
- Generally agree with recommendations of WG

Recommendation 1: *Several specific research suggestions listed in review report (e.g., simulation testing of EwE models)*

Recommendation 2: *Support idea of MSE, but urge (a) deliberation about necessary complexity and (b) integration with single species MSE*

Virginia Institute of Marine Science

Management Response: Next Steps



Atlantic Menhaden Management Board

February 5, 2020

Next Steps

- Short Term:
  - Identify ERPs for menhaden
  - Incorporate ERPs into the FMP

- Long Term:
  - Continue to pursue EBFM
  - Initiate higher-level discussions with the Policy Board and Commission

Identify ERPs for ATM

- There is no one “right” ERP for menhaden because the appropriate harvest level for menhaden depends on the management objectives for the ecosystem

- ERP WG recommends a combination of the BAM single-species model and the NWACS-MICE model as a tool to evaluate trade-offs between menhaden harvest and predator biomass

ERP Example: Striped Bass

- $\boldsymbol{ERP_{target}}$ = 0.19 = the maximum F on ATM that would sustain STB at their $\mathbf{SSB_{target}}$ when striped bass are fished at their $\boldsymbol{F_{target}}$.

- $\boldsymbol{ERP_{threshold}}$ = 0.57 = the maximum F on ATM that would sustain STB at their $\mathbf{SSB_{threshold}}$ when striped bass are fished at their $\boldsymbol{F_{target}}$.

- In this example, it is assumed that all other predator/prey species are being fished at status quo (2017 levels).

Identify ERPs for ATM

- ERP WG recommends exploring additional scenarios to examine the impact of different predator objectives on ERP reference points

ERP Scenario	Striped Bass	Bluefish	Weakfish	Spiny Dogfish	Atlantic herring
✓ **Example**	F target	Status quo	Status quo	Status quo	Status quo
# 2	F target	F target	F target	F target	F target
# 3	F threshold	F threshold	F threshold	F threshold	F threshold
# 4	F target	F target	Status quo	Status quo	F target

Identify ERPs for ATM

The ERP WG needs guidance to explore other scenarios to help the Board evaluate tradeoffs and set final ERPs

- Are these proposed scenarios acceptable?
- Is the Board satisfied with focusing the analysis on predator targets and thresholds from the existing FMPs, or should other values be considered?
- Does the Board want to see other scenarios?

→ ERP WG can bring the proposed scenarios back in May, additional work will take longer

Incorporate ERPs into FMP

- Changes to the reference points can be made through Board action or through Adaptive Management

- Varying levels of public input
  - Board action today, or at any future meeting
  - Addendum = ~6 months (scoping)
  - Amendment = ~1 year (2 rounds of scoping)

Long Term Goals

- Continue to pursue ecosystem-based fishery management
  - Pursue MSE?
  - Initiate dialog with Policy Board to pursue EBFM and integrated board decision making

- Questions?