Ecological Reference Points for Atlantic Menhaden

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And

The ASMFC ERP Workgroup

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In collaboration with: Andre Buchheister, Genevieve Nesslage, Mike Wilberg

ASMFC Ecological Reference Points Workgroup

- 14 members (+3)
- Formerly the multispecies TC -> BERP -> ERP
- Charged with developing ecological reference points (ERPs) for Atlantic Menhaden
  - Amendment 3 calls for adoption of ERPs as part 2019 assessment
- Management goals and objectives
  - Maintain enough prey to support target biomass of predators
  - Sustainable harvest of menhaden
  - Economic value relative to that of their predators
- Evaluated Lenfest reference points
  - Issues related to biomass vs age structured models, selectivity, predator dependency confounded application
- Nov 2017 – Given 2 more years to develop model-based ERPs

ASMFC Menhaden Management Objectives

	POTENTIAL MANAGEMENT GOALS/OBJECTIVES							
APPROACH	Low disease prevalence	Adequate nutrition levels	Enough prey to support key predator species @ preferred biomass levels	Sustainable AM fishery in light of forage pressure	Better AM recruitment and/or high AM abundance at younger ages	Determine if AM are more economically valuable in the fishery or as forage	Sustainable AM commercial reduction and/or bait fisheries	Manage for a broader-age structure (may lead to re-expansion of historic range)
Ecosystem indicators	x[1]				x			
Nutrition Ref Points	x[1]	x[2]						
Production models								
Steele-Henderson			x	x			x	
Time-varying r				x			x	
Single-species models								
BAM-based forage services ERPs				x	x		x	x
BAM or SS-based time-varying M tuned to consumption index				x	x		x	x
BAM-based MSE				x[3]	x		x	x
Multi-species models								
MSVPA or MSSCAA + BAM projections			x	x	x		x	x
MSSCAA			x	x	x		x	x
Ecopath with Ecosim			x	x	x		x	x

Identification of Important Predators

11 menhaden predator species in NEFSC diet database (1981-2012)

$$C = B \cdot P \cdot R \cdot W \cdot T$$

B = swept area biomass

P = prop. B in model domain

R = daily ration

W = proportion menhaden in diet

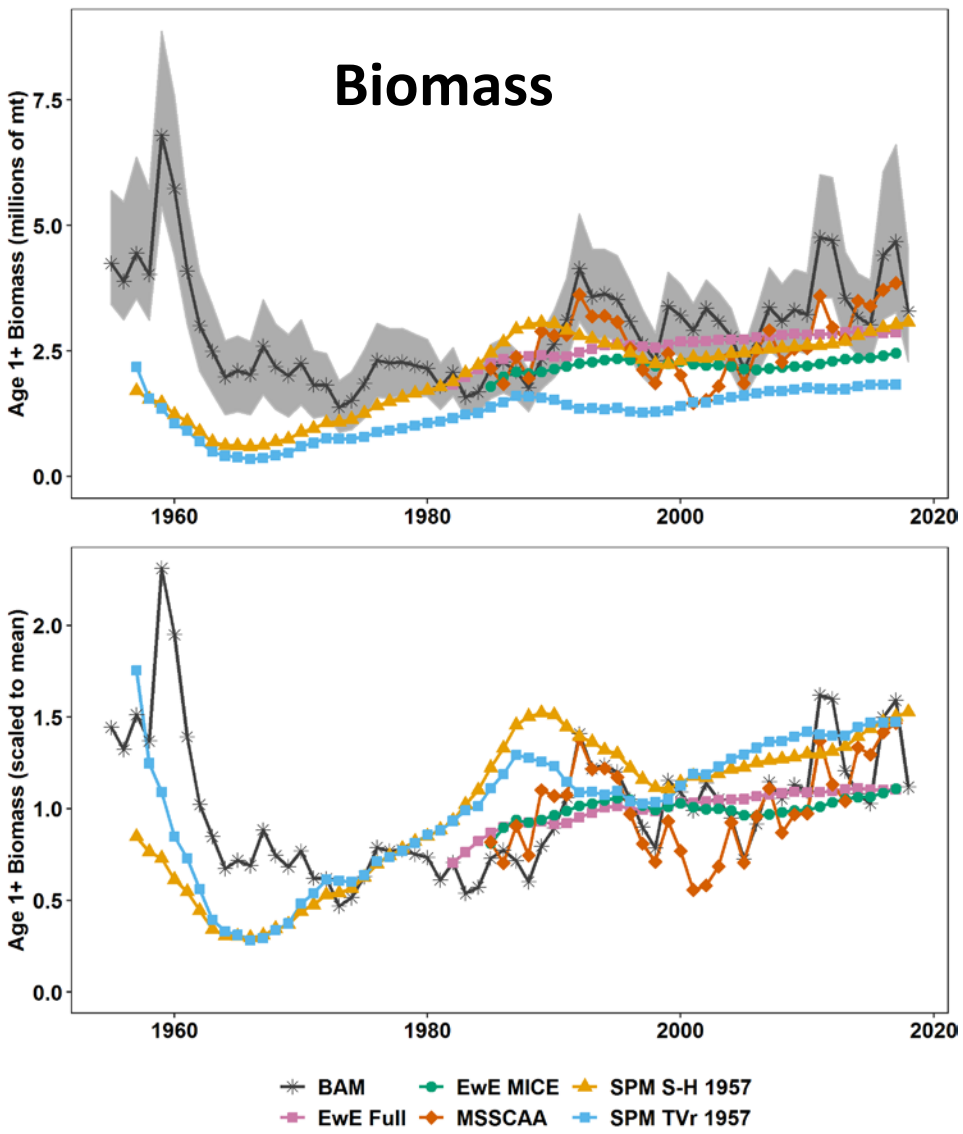
T = prop. year in model domain

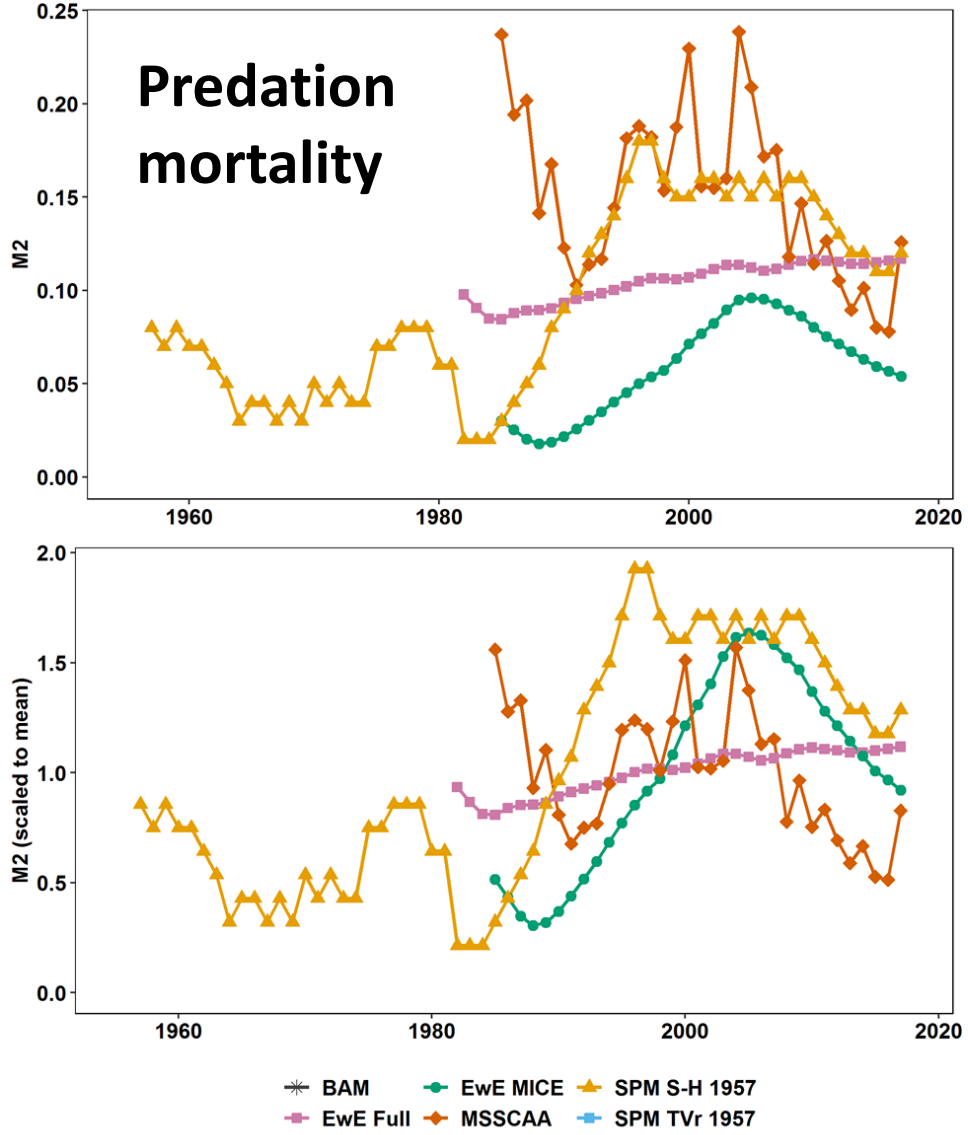
Predators	Estimated Consumption (mt)				Ranked levels of consumption			
	1 year	5 year	10 year	All years '81+	1 year	5 year	10 year	All years
Spiny dogfish	142,945	96,032	85,633	80,476	1	1	1	1
Striped bass	4,052	30,602	17,794	7,817	2	2	2	2
Bluefish	1,466	2,050	2,197	2,609	3	3	3	3
Weakfish	463	377	1,007	787	4	5	4	4
Smooth dogfish	447	588	901	757	5	4	5	5
Atlantic angel shark	345	181	139	142	6	7	7	6
Clearnose skate	35	31	18	10	8	8	8	10
Dusky shark	-	-	3	101	-	-	10	8
Goosefish	259	212	146	125	7	6	6	7
Sandbar shark	-	7	6	16	-	9	9	9
Spiny butterfly ray	4,245	4,639	6,438	4,738	2*	3*	3*	3*

ERP Models

Beaufort Assessment Model (BAM)	• Amy Schueller • Single species stock assessment
Surplus Production with time-varying *r*	• Genny Nesslage and Mike Wilberg • Changes in menhaden productivity; no causal inference
Surplus Production with predation	• Jim Uphoff and Alexei Sharov • Predation mortality and predation losses; no feedback to predator
Multispecies SCA	• Jason McNamee • Age structured model with predation; no feedback to predator (yet)
EwE model of intermediate complexity (EwE-MICE)	• David Chagaris, Andre Buchheister, and Joana Brito • 17 model groups: menhaden and ERP focal species **Preferred Model by ERP WG**
Ecopath with Ecosim (EwE)	• Andre Buchheister, Max Grezlik, et al. • Full ecosystem model of Northwest Atlantic Continental Shelf (NWACS)

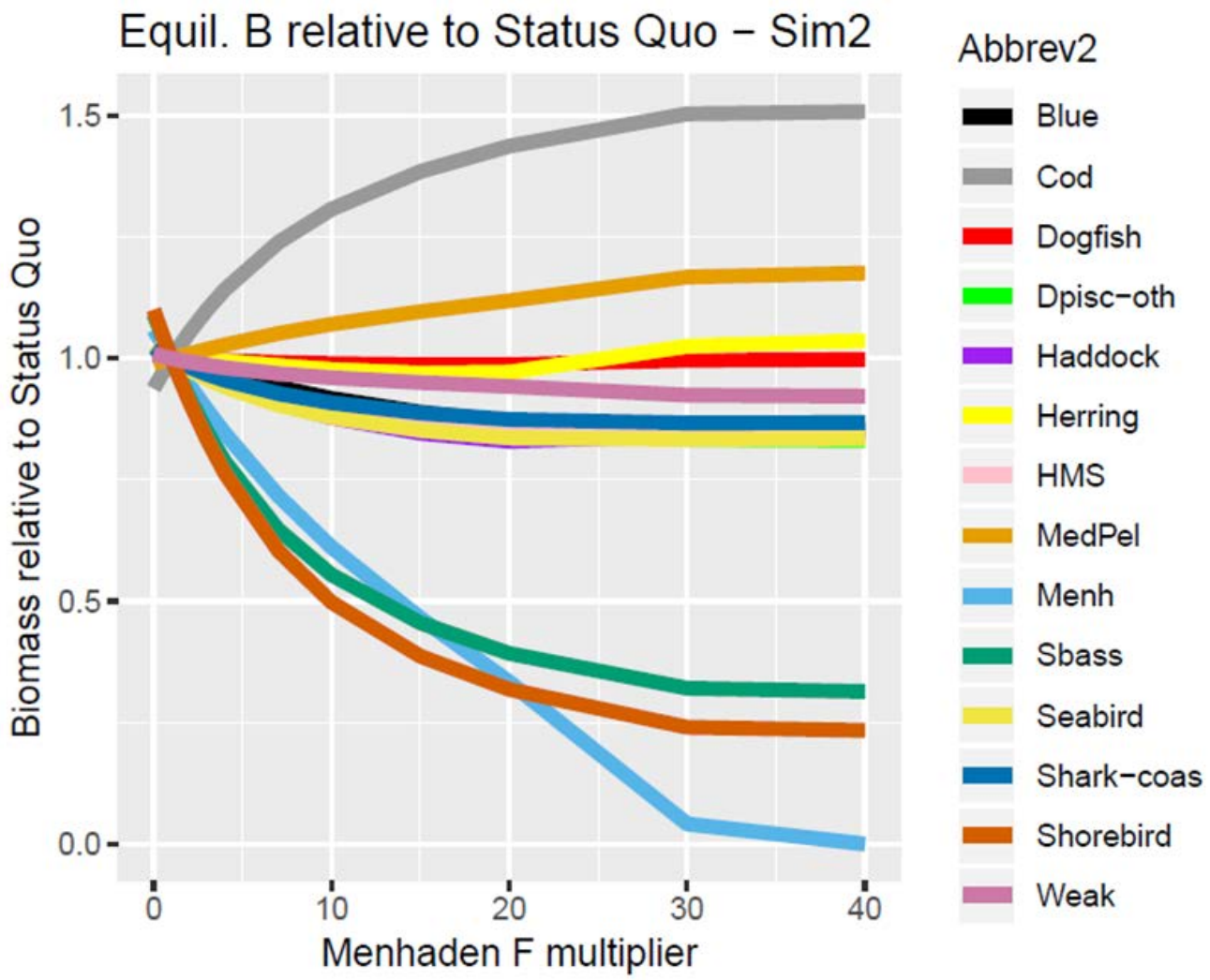
ERP Model Comparisons





Ecosystem Sensitivities to Menhaden Harvest

The full NWACS EwE model identified striped bass and nearshore piscivorous birds as the two most sensitive groups to menhaden harvest

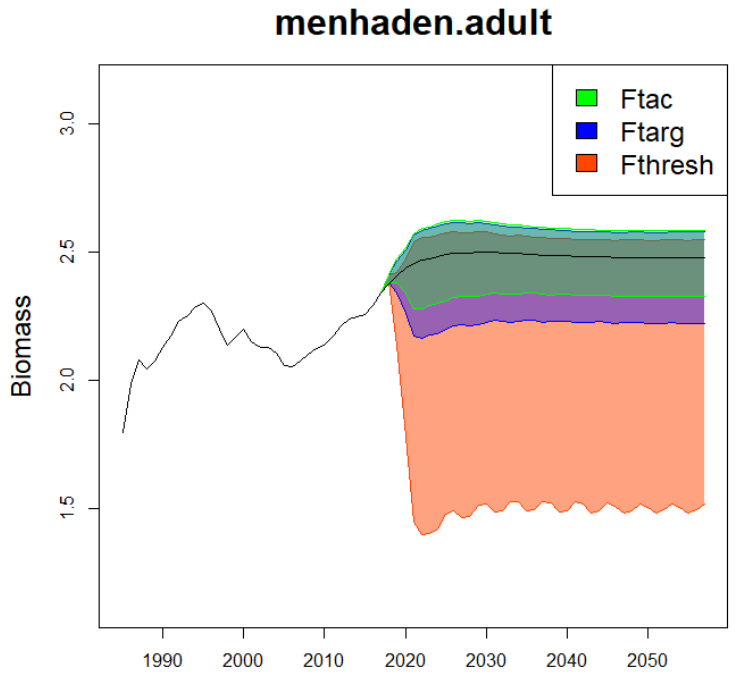


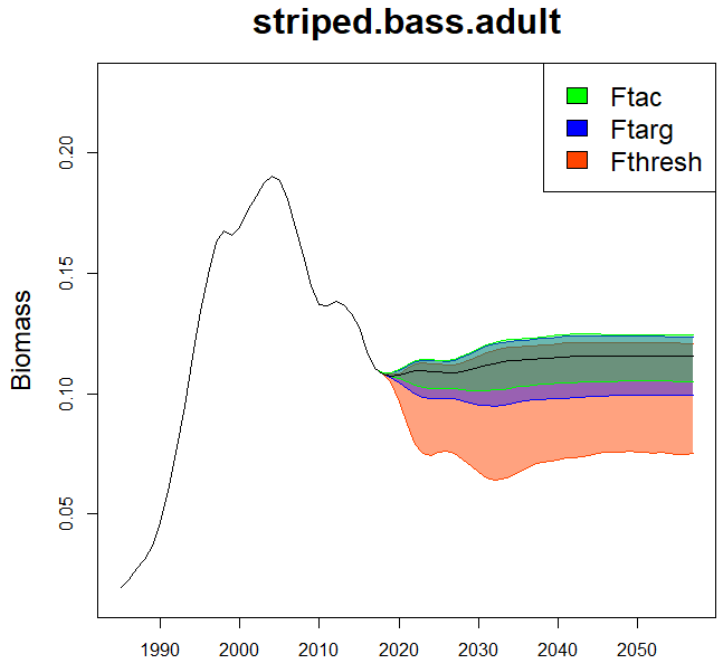
Screening BAM Reference Points in EwE-MICE

- BAM projection scenarios
  - Current TAC, F_{target}, $F_{threshold}$
  - MC bootstraps with uncertainty in M and Fecundity

- 500 trials for each menhaden F scenario screened for predator effects in Ecosim

- All other species held constant at status quo F_{2017}

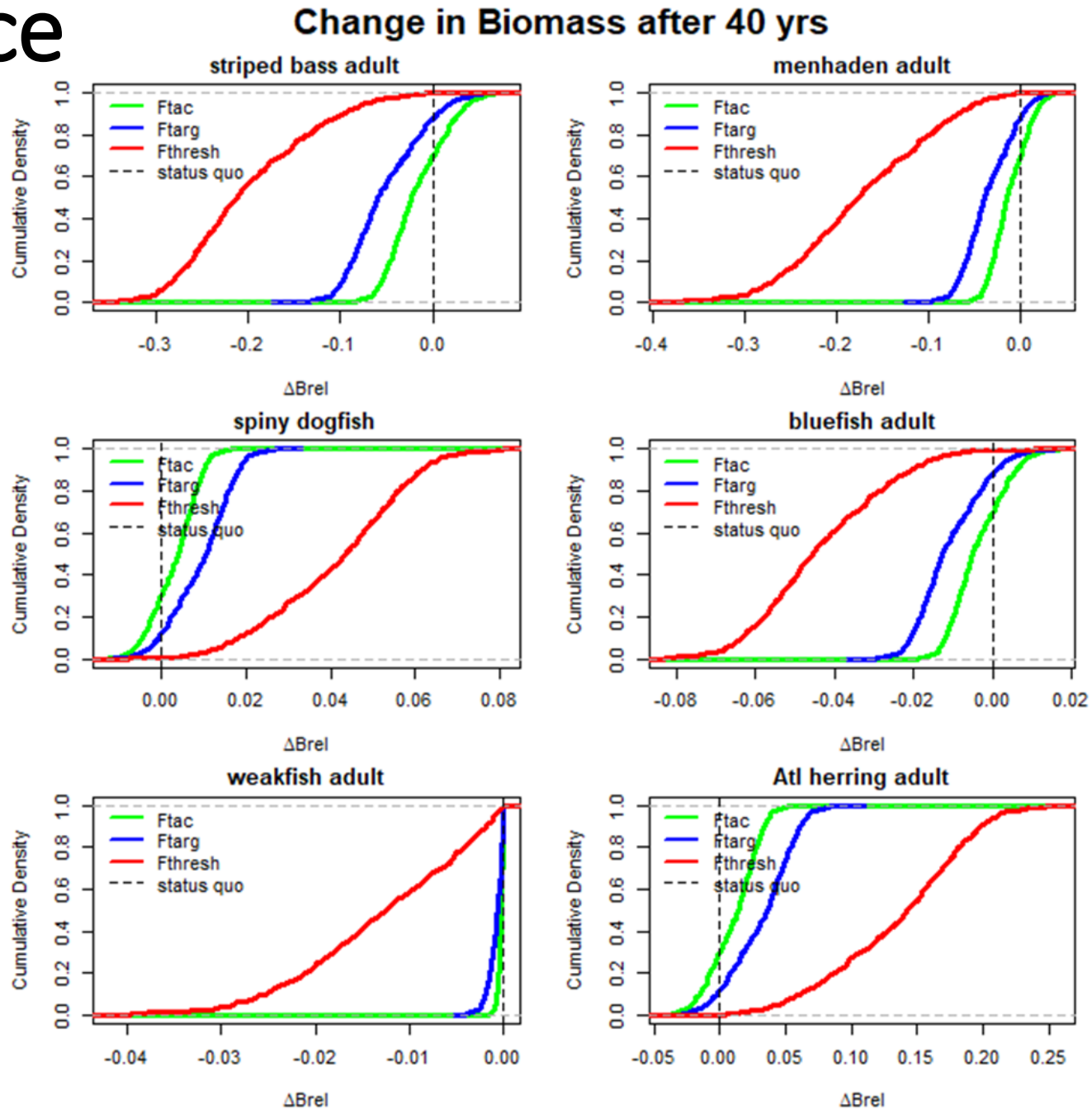




Screening BAM Reference Points in EwE-MICE

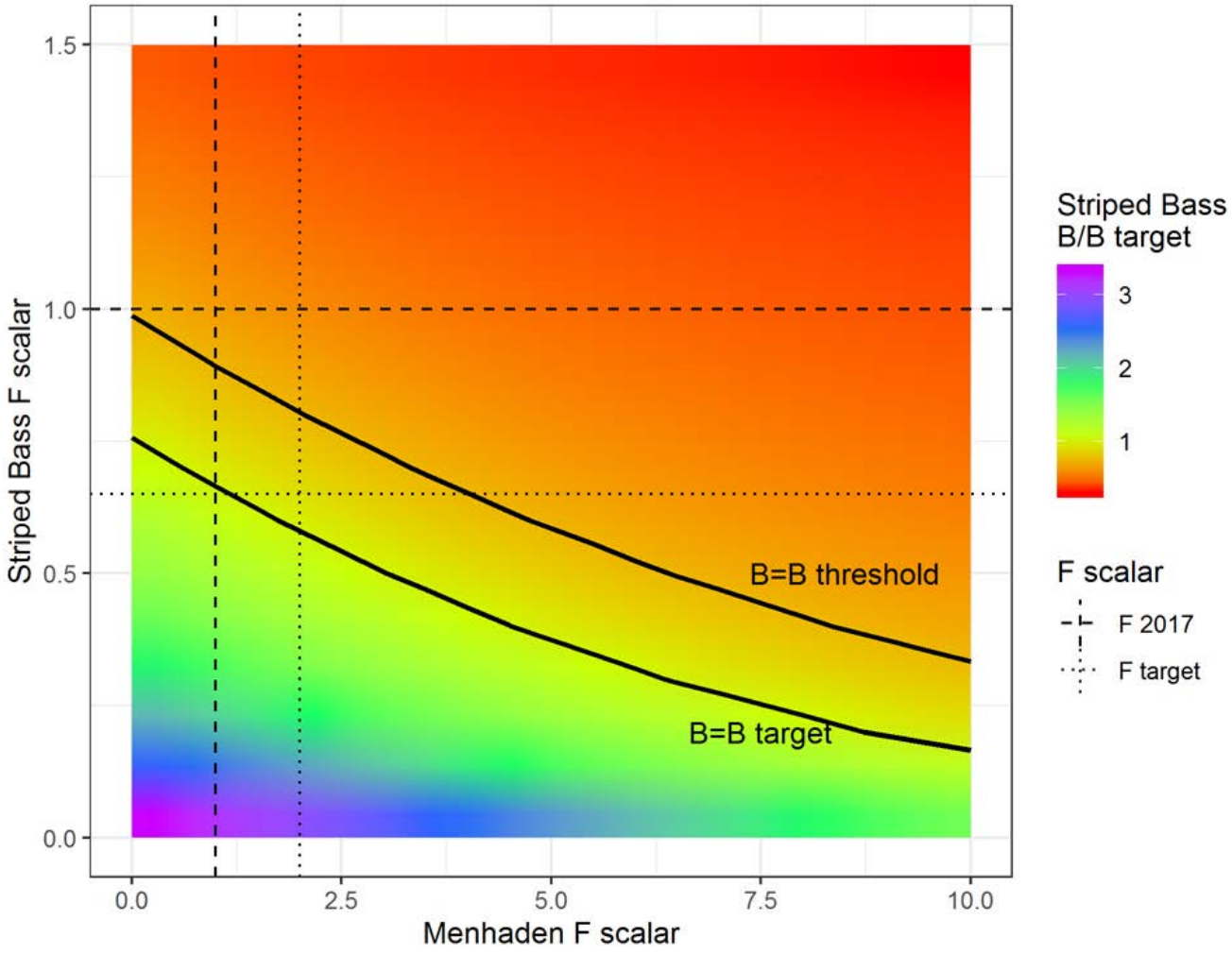
Quantify risk of predator declines over short (4 yrs) and long term (40 yrs)

- Current TAC
  - not expected to cause declines by more than 10% over short or long term
- F target = $2*F_{current}$
  - Short term: no declines below 10%
  - Long term: striped bass decline by 10-15% in just 10% of trials
- F threshold = $5.5*F_{current}$
  - Short term: SB decline by 10-15% in 58% trials; and by 15%-20% in 12% of the trials
  - Long term: SB decline by 10-15% in 90% of trials, and by 20%-40% in 56% of trials



Predator-Prey Surface Plots

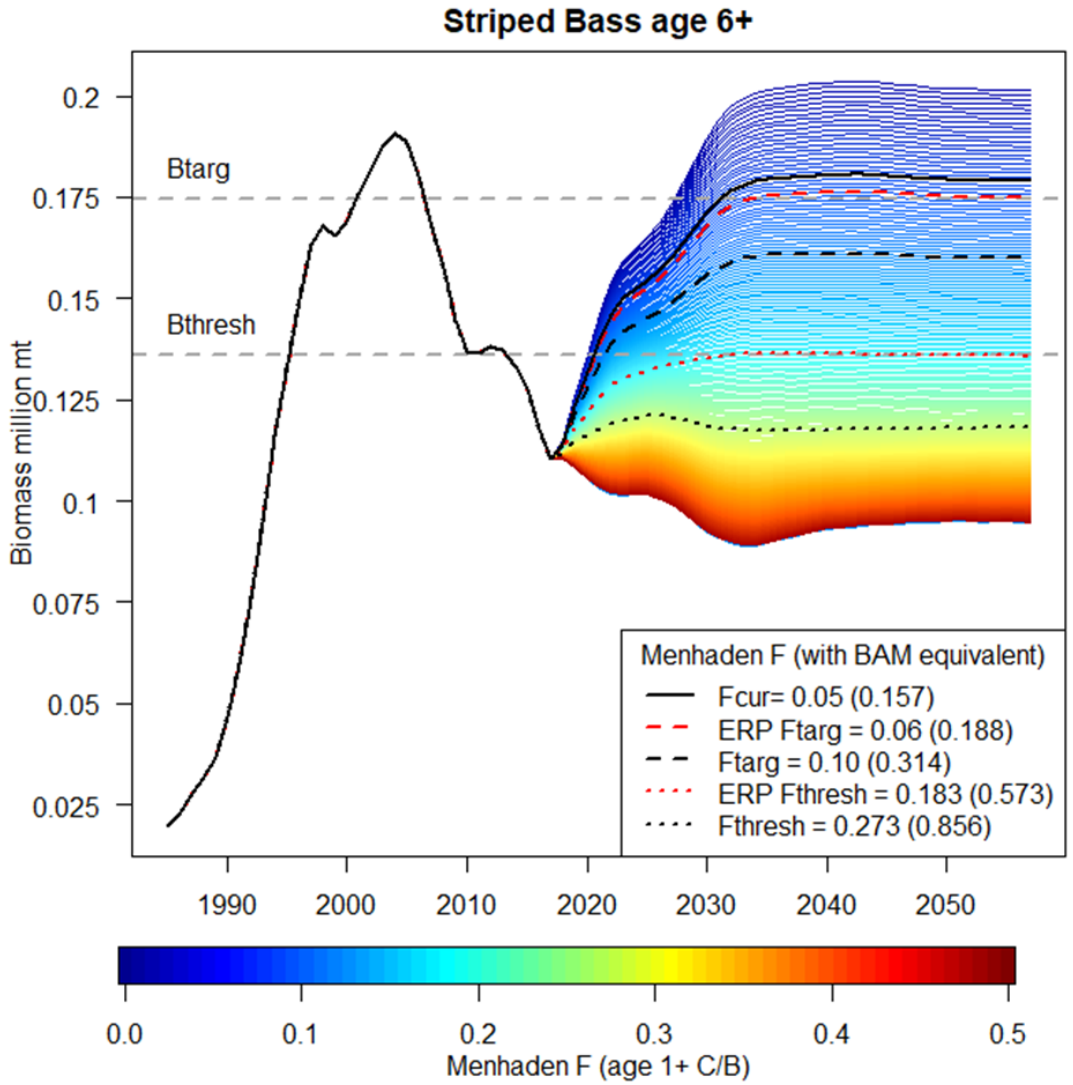
- Equilibrium biomass across range of menhaden and striped bass F combinations
- Reveals tradeoffs in predator-prey harvest rates



Ecological Reference Points

- ERPs based on striped bass response to menhaden F
  - the most sensitive fish predator in both EwE models

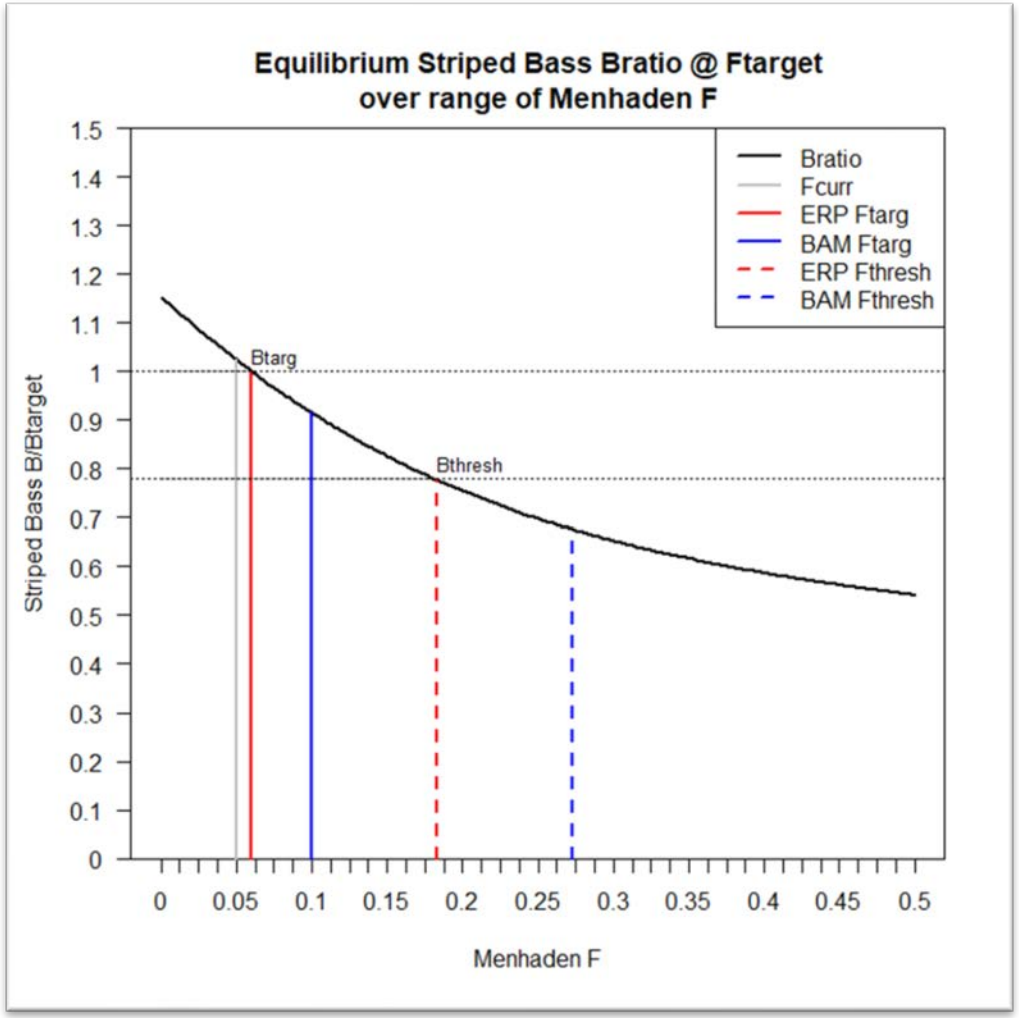
- Long term projections under striped bass F_{target} over range of menhaden F
  - Other species held constant at status quo



Ecological Reference Points

- **ERP F_{target}** = max. menhaden F that maintains striped bass at B_{target} when fished at F_{target}
  - 20% increase from $F_{current}$
  - 40% reduction of BAM F_{target}
- **ERP $F_{threshold}$** = max. menhaden F that maintains striped bass at $B_{threshold}$ when fished at B_{target}
  - 266% increase from $F_{current}$
  - 33% reduction of BAM $F_{threshold}$

Ref. Pt.	EwE F	BAM F_{full}
$F_{current}$	0.050	0.157
ERP F_{target}	0.060	0.188
F_{target}	0.100	0.314
ERP $F_{threshold}$	0.183	0.573
$F_{threshold}$	0.273	0.856



Disclaimer

These models have not undergone peer review and the reference points provided have not been presented to, accepted, or otherwise endorsed by the ASMFC Menhaden Management Board

The ERPs are as much conceptual as they are operational. We anticipate requests for additional analysis at the peer review and by the Board before final values are chosen.

This is a first attempt at providing a ERPs that take into consideration the tradeoffs of forage fish harvest and predator impacts. The policy choice is a value-based decision to be made by managers.

Next Steps and Research Recommendations

- Next Steps
  - October 21: Report out to peer review panel
  - November 4-8: SEDAR review
  - February 2020: presentation to Menhaden Board
  - Additional work contingent on conclusions of peer review panel

- Research Recommendations
  - Expand fish diet collections
  - Collect/synthesize data on non-fish predators and non-assessed species
  - Continue development of multispecies SCA (i.e. predator feedback)
  - Continue development of EwE models
  - Work towards incorporating seasonal and spatial dynamics