April 29, 2020

To: **Atlantic Menhaden Management Board**
From: **Ecological Reference Point Work Group and Atlantic Menhaden Technical Committee**
RE: **Exploration of Additional ERP Scenarios with the NWACS-MICE Tool**

At the 2020 Winter Meeting, the Atlantic Menhaden Board accepted the Atlantic menhaden single species, ecological reference point (ERP), and peer review reports for management use. The ecological reference point assessment developed a tool, the NWACS-MICE model, which can be used in conjunction with the single-species assessment model to develop ERPs and harvest strategies that account for Atlantic menhaden's role as a forage fish.

The exact values and definition of the ERPs depend on ecosystem management objectives. The assessment provided example ERPs, which were defined as the level of Atlantic menhaden fishing mortality that would maintain Atlantic striped bass at its biomass target or threshold when Atlantic striped bass were fished at its fishing mortality (*F*) target. For these example ERPs, all other ERP focal species in the model (bluefish, weakfish, spiny dogfish, and Atlantic herring) were fished at status quo (i.e., 2017) levels. It is important to note in 2017, bluefish were overfished and overfishing was occurring and weakfish were depleted with total mortality above the threshold, while spiny dogfish biomass was above the biomass target and fishing mortality was lower than the *F* target. Atlantic herring were not overfished, and overfishing was not occurring in 2017; however, they were below their biomass target and projections indicated the stock could become overfished in 2018 – 2021.

The Atlantic Menhaden Board tasked the ERP Work Group (ERP WG) with conducting additional runs of the NWACS-MICE tool to explore the sensitivity of the ERPs to different assumptions about ecosystem conditions. For each set of assumptions, an ERP target and threshold were calculated using the same definition as the example ERPs:

> **ERP target:** the maximum *F* on Atlantic menhaden that sustains striped bass at their biomass target when striped bass are fished at their *F* target
>
> **ERP threshold:** the maximum *F* on Atlantic menhaden that keeps striped bass at their biomass threshold when striped bass are fished at their *F* target

The ERP WG explored ERPs under the following ecosystem scenarios, i.e., sets of assumptions about the other ERP focal species in the model:

1. All other species are fished at their 2017 status quo level (example ERPs, presented at the 2020 Winter Meeting).
2. All other species are fished at a level that allows them to reach their biomass target.
3. All other species are fished at a level that keeps them at their biomass threshold.

4. Atlantic herring and bluefish are fished at a rate that allows them to reach their biomass target, while spiny dogfish and weakfish are fished at 2017 status quo levels (2017 status quo *F* values for those species are below their *F* target values).

This analysis provides context for the example ERPs developed for the benchmark assessment and shows how the NWACS-MICE tool can be used to explore different ecosystem management objectives and scenarios. These scenarios help to frame ERP discussions within the bounds of existing management objectives for the ERP focal species.

Table 1. ERP Ecosystem Scenarios

ERP Scenario	Striped Bass	Bluefish	Weakfish	Spiny Dogfish	Atlantic herring
1. Example ERPs (2017 status quo)	F target	2017 status quo	2017 status quo	2017 status quo	2017 status quo
2. All at *B* target	F target	F target	F target	F target	F target
3. All at *B* threshold	F target	F threshold	F threshold	F threshold	F threshold
4. Bluefish & herring at *B* target	F target	F target	Status quo	Status quo	F target

Note that for the other ERP focal species, “F target” and “F threshold” are defined as the F rates within the NWACS-MICE model that let these species approximate their biomass targets and thresholds, respectively.

<u>Results</u>

The ERP target and threshold for each scenario are listed in Table 2 and the results of the specific scenarios are summarized in the sections below. To provide context for the reference point values, the Atlantic Menhaden Technical Committee (TC) conducted projections to calculate the probability of exceeding the ERP target and threshold in 2019 – 2021 for each scenario under the current (2019-2021) total allowable catch (TAC) of 216,000 mt (Table 2). Several important caveats will be described after this basic summary of scenario results.

Table 2: ERP targets and thresholds under different ecosystem scenarios, and the probability of exceeding the ERP values under the current TAC for 2019 - 2021

	Atlantic Menhaden Full *F* equivalent		**Probability of exceeding ERP target**			**Probability of exceeding ERP threshold**		
Scenario	**ERP target**	**ERP threshold**	2019	2020	2021	2019	2020	2021
1. Example ERPs	0.19	0.57	60%	71%	66%	0%	0%	0%
2. All at *B* target	0.36	*	0%	3%	6%	0%	0%	0%
3. All at *B* threshold	0.03	0.32	100%	99.5%	99.5 %	0%	13%	13%
4. Bluefish & herring at B target	0.35	*	0%	5%	7%	0%	0%	0%
	Target	**Threshold**	**Probability of exceeding single-species target**			**Probability of exceeding single-species threshold**		
Single species BRPs	0.31	0.86	0%	0%	17%	0%	0%	0%

*****: When Atlantic herring were at their biomass target and striped bass were fished at their *F* target, the ERP threshold was undefined, meaning none of the Atlantic menhaden *F* values explored pushed striped bass to their biomass threshold.

Scenario 1: Example ERPs

The example ERPs were presented at the 2020 Winter meeting. In this scenario, Atlantic striped bass were fished at its *F* target, while all other species were fished at the 2017 status quo level. The example ERP target and threshold were lower than the single-species target and threshold, but the *F* in 2017 on Atlantic menhaden was below both the example ERP target and threshold.

The current (2019-2021) TAC of 216,000 mt resulted in a 60-71% probability of exceeding the example ERP target, and a 0% chance of exceeding the example ERP threshold.

Scenario 2: All at biomass target

In Scenario 2, when all species were at their biomass targets, the ERP target was higher than the example ERP value (Scenario 1; Table 2). Rebuilding bluefish to their target biomass has the potential to have a negative impact on striped bass compared to the status quo scenario where bluefish are overfished. Bluefish compete with striped bass for Atlantic menhaden and other prey and are predators of juvenile striped bass. However, the negative impact of higher bluefish biomass was outweighed by the positive impact of rebuilding Atlantic herring to its biomass target (nearly double the 2017 biomass). Because there were more Atlantic herring available to striped bass as an alternate prey species, Atlantic menhaden could be fished at a higher *F* without causing striped bass to fall below its biomass target. The ERP threshold was undefined in this scenario because, as long as striped bass was fished at its *F* target and Atlantic herring biomass approached its biomass target, increasing *F* on Atlantic menhaden would not drive striped bass to its threshold over the range of *F* values explored (Figure 1).

The current (2019-2021) TAC of 216,000 mt resulted in a 0-6% chance of exceeding the ERP target in this scenario, and a 0% chance of exceeding the ERP threshold.

Scenario 3: All at biomass threshold

In Scenario 3, where all other species are fished to threshold biomass levels, the ERP target and threshold values were lower than in the example ERP values (Scenario 1; Table 2). When Atlantic herring are fished to their threshold biomass, the fishing pressure on Atlantic menhaden must be lower in order to leave enough prey in the water to keep striped bass at its biomass target and threshold.

The current (2019-2021) TAC of 216,000 mt resulted in a 100% probability of exceeding the ERP target in this scenario, but a 0-13% chance of exceeding the ERP threshold.

Scenario 4: Bluefish and Atlantic herring at target

Scenario 4, where Atlantic herring and bluefish are at their target biomass levels and weakfish and spiny dogfish are at their status quo levels, is almost identical to Scenario 2, the all-at-target scenario (Scenario 2; Table 1). They are so similar because the effect of the rebuilt Atlantic herring biomass on striped bass far outweighs the small effects of shifting weakfish and spiny dogfish biomass from the target to the 2017 status quo scenario. In this run, the ERP threshold is also undefined because increasing *F* on Atlantic menhaden would not drive striped bass to its threshold over the range of *F* values explored (Figure 1).

The current TAC resulted in a 0-7% chance of exceeding the ERP target in this scenario, and a 0% chance of exceeding the ERP threshold.

Surface plots

The ERP WG reproduced the rainbow surface plots for striped bass, bluefish, and weakfish for each of the additional scenarios (Figures 2-4). These plots show the effect of striped bass *F* and Atlantic menhaden *F* on striped bass biomass and on two of its competitor species. The biomass of both bluefish and weakfish was higher when *F* on striped bass was high and *F* on Atlantic menhaden was low – that is, when striped bass biomass is driven down by fishing and more Atlantic menhaden biomass is available for bluefish and weakfish. Bluefish biomass was lower when striped bass *F* was low and Atlantic menhaden *F* was high. In contrast, weakfish biomass declined as both Atlantic menhaden and striped bass *F* approached zero indicating that top down predation impacts from striped bass are stronger than the bottom-up effects of menhaden on weakfish. These effects were most noticeable at the extremes of striped bass and Atlantic menhaden *F*.

Uncertainties

The ERP WG and TC noted several sources of uncertainty in this analysis that need further exploration to better understand the sensitivity of the model and the uncertainty in the ERPs.

First, in these scenarios, species are fished at rates which allow them to approximate their threshold or target biomass values. However, the fishing rates applied in NWACS-MICE do not always correspond to the *F* targets and thresholds in the FMPs, in particular for bluefish and Atlantic herring. This is due to structural differences between the NWACS-MICE model and the single-species assessments, as well as differences in how reference points are defined under the different management systems (i.e., ASMFC vs. federally managed stocks). This mismatch between single-species reference points and an ecosystem model is not surprising, but it does mean that scenarios where species are fished at their single-species *F* targets could provide different ERP estimates and may not result in all species being at their biomass targets.

Second, the relationship between Atlantic herring and striped bass was very strong in these runs and was sensitive to the model estimates of how vulnerable Atlantic herring were as prey to striped bass. In the scenario where Atlantic herring were fully rebuilt, the model predicted that Atlantic herring would account for a much higher proportion of striped bass diets than is currently observed coastwide. Although Atlantic herring are an important component of striped bass diets in some regions and seasons, the model may be overestimating the importance of Atlantic herring on a coastwide, annual level. More work is needed to explore the parameterization of the striped bass-Atlantic herring relationship in the NWACS-MICE model to understand the sensitivity of the ERPs to this relationship. In addition, the scenarios examined here only looked at ecosystems where Atlantic herring were fully rebuilt or at its biomass threshold. More work should be done to explore the relationship under different, possibly more realistic Atlantic herring biomass levels given the uncertainty in its future recruitment.

Finally, weakfish was unable to rebuild under any of the *F* values explored here. This is consistent with the single-species assessment which indicated natural mortality has increased on weakfish and remains at high levels, keeping the stock below its biomass threshold. The cause of this increase in natural mortality is unclear, and may be related to environmental conditions, or predation by or competition with marine mammals or other species outside this menhaden-focused model. If natural mortality is reduced in the future and the stock is able to rebuild, the ERP targets and threshold values estimated here may be different.

<u>Next Steps</u>

Based on the results of this work, the ERP WG recommends the following additional analyses to be completed before the next Board meeting. These analyses will help the Board to better understand the sensitivity of the ERPs to different ecosystem assumptions and sources of uncertainty, as well as provide context for Board discussions around risk and ecosystem management objectives.

- Explore alternate Atlantic herring biomass scenarios given the uncertainty in future Atlantic herring recruitment

- Explore sensitivity to model parameterization of the Atlantic herring – Atlantic striped bass relationship
- Explore scenarios where other ERP focal species are fished at their single-species F reference points

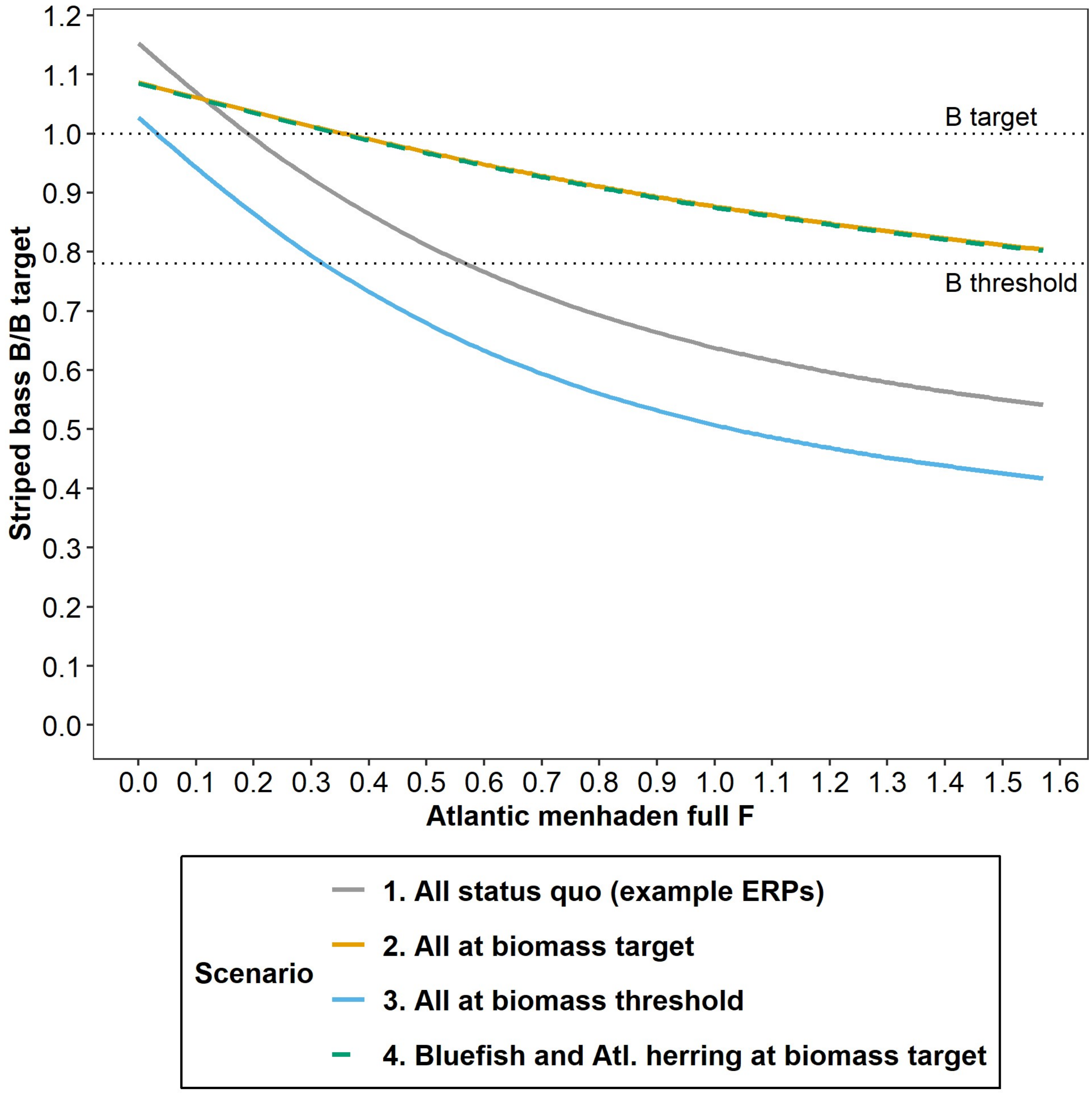

Figure 1: Striped bass biomass levels relative to their biomass target under different levels of Atlantic menhaden F for different ecosystem scenarios. Striped bass are fished at their *F* target in all scenarios.

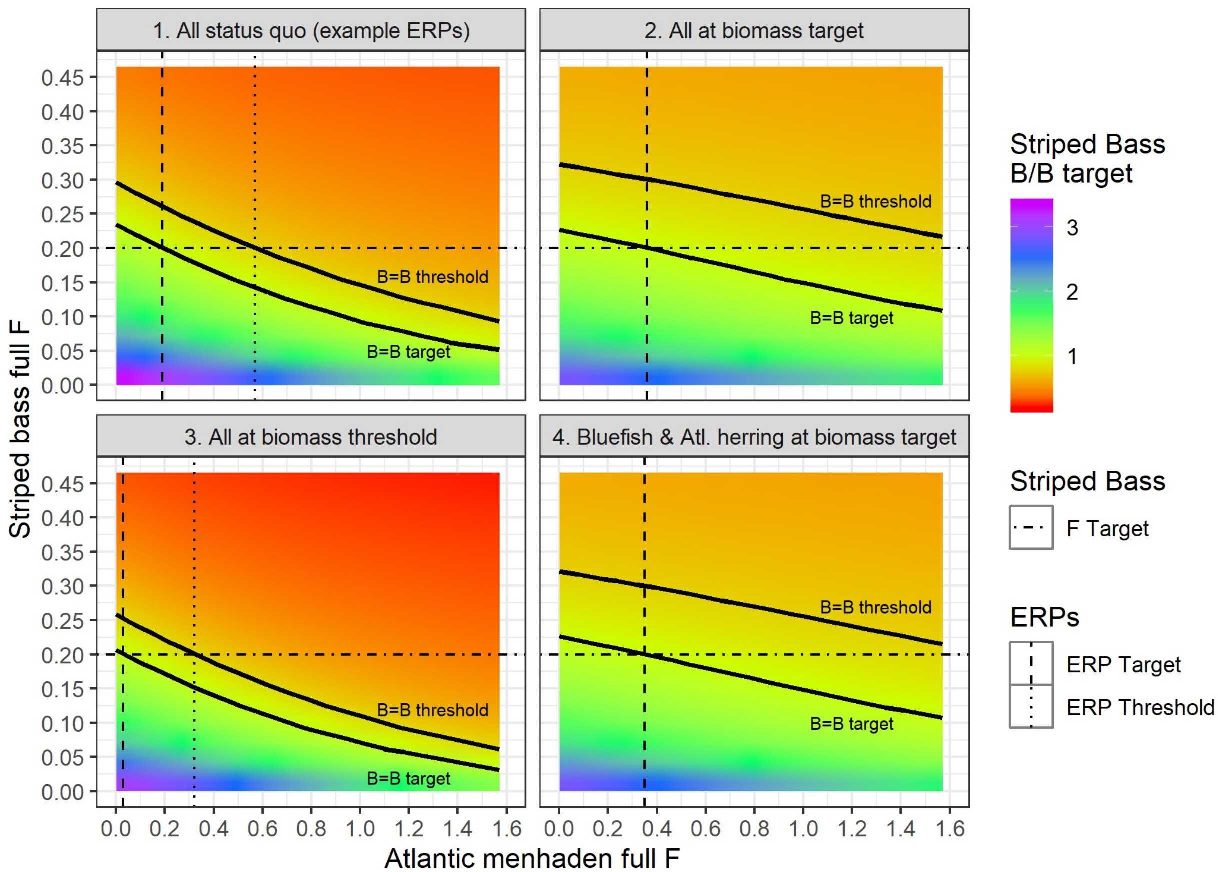

Figure 2. Striped bass surface plots showing the long-term equilibrium striped bass biomass relative to the biomass target under different combinations of striped bass *F* and Atlantic menhaden *F*. The solid black contour lines indicate combinations of striped bass *F* and Atlantic menhaden *F* where striped bass biomass will be equal to the biomass threshold or target. Each plot represents a different ecosystem scenario (Scenarios 1-4, Table 1).

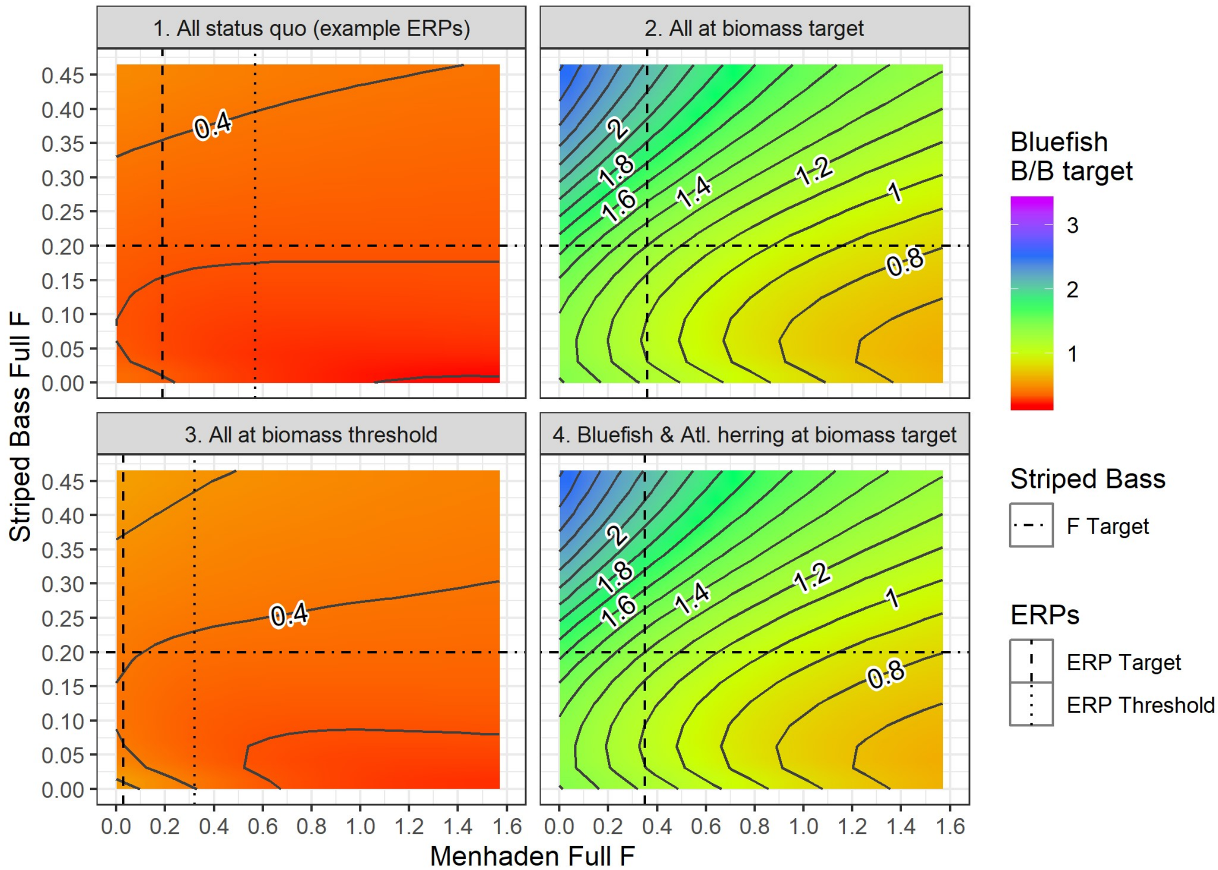

Figure 3. Bluefish surface plots showing the long-term equilibrium bluefish biomass relative to the biomass target under different combinations of striped bass F and Atlantic menhaden *F*. Each plot represents a different ecosystem scenario (Scenarios 1-4, Table 1).

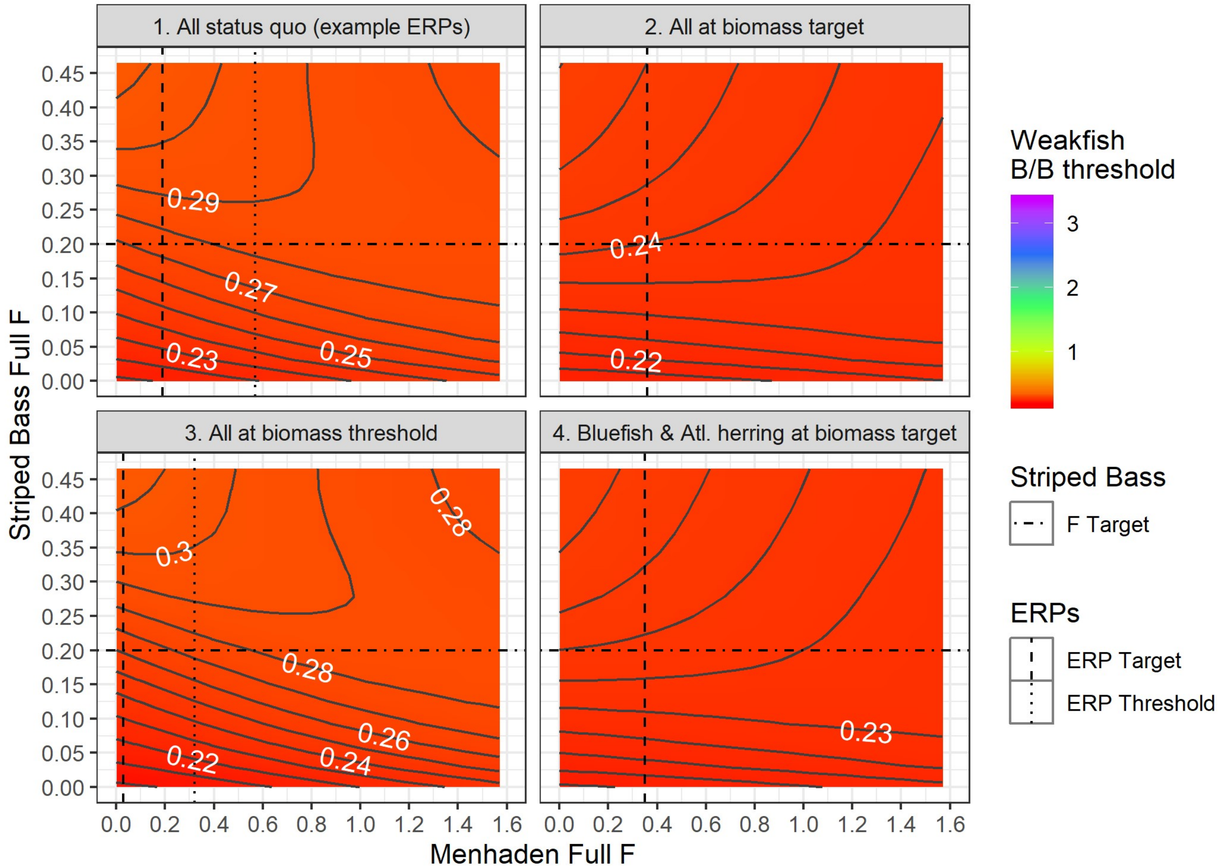

Figure 4. Weakfish surface plots showing the long-term equilibrium weakfish biomass relative to the biomass target under different combinations of striped bass *F* and Atlantic menhaden *F*. Each plot represents a different ecosystem scenario (Scenarios 1-4, Table 1).

From: Duke Gosney
To: Comments
Subject: [External] Menhaden Public Comment
Date: Monday, April 27, 2020 12:34:09 PM

Please distribute to the Atlantic Menhaden Management Board Meeting Webinar for public comment on May 5, 2020, 10:45 – 11:45 a.m.

Dear members of the Atlantic Menhaden Management Board,

My name is Garrison Duke Gosney. I live and work in the State of Delaware as an Air Force Officer but I am also a concerned Virginia resident having spent most of my life on the banks of the Potomac River in my hometown of Heathsville, Virginia enjoying the natural benefits of the Chesapeake Bay ecosystem. I care deeply for the resource at hand and support more strict regulation on the purse-seine reduction industry.

Menhaden are the sole keystone species of the Chesapeake Bay and the entire Atlantic seaboard. Their profound impact on the health of the ecosystem cannot be overstated. An unbridled population is essential for water quality, pollution control, erosion control, and the prosperity of every marine, wetland, and vegetative specie that live therein. Menhaden therefore should be analyzed not a single species but as the ecological kingpin of interrelated species. They should not be managed for the profitability and survivability of a single industry, but rather for the health and proliferation of the entire Atlantic marine ecosystem.

It is probably true that if conditions stay about the same, the reduction industry could go on for some time catching about the same number of menhaden each year due to ineffectively high harvest caps and increasingly productive technologies. However, wetlands are shrinking, waters are warming, pollution is increasing, algal blooms are proliferating, hypoxia is intensifying, and dead zones are expanding. From an ecological point of view, there is simply no downside to limiting or even banning the industrial slaughter of menhaden. If left untouched, menhaden could return to their immense historic population and be welcomed as a wonderful natural control mechanism for Man’s destructive tendencies.

I urge you to consider the vital importance and gravity of menhaden as a forage fish, because your management decisions will impact not only to the State of Virginia and the Chesapeake Bay, but to every tidal river, bay, and body of water that touches the Eastern United States. My family and I strongly support effective, long-term conservation of menhaden along the Atlantic coast and in the Chesapeake Bay.

The ASMFC should support a management option that ensures striped bass and other game fish have abundant forage, and that menhaden are allowed to fulfill their foundational role in the marine ecosystem, even if that means a substantial decrease or abolishment of industrialized reduction fishing. It is crucial for the marine ecosystem we depend on.

Sincerely,

Garrison Duke Gosney