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EAFM Recreational Summer Flounder Management Strategy Evaluation

Summary of Process, Outcomes, and Potential Application

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Background

This briefing document provides a summary on the overall process, general outcomes, and potential application regarding the recreational summer flounder management strategy evaluation (MSE)[1]. Development of this MSE is part of the continued implementation of the Mid-Atlantic Fishery Management Council's (Council) Ecosystem Approach to Fisheries Management (EAFM) structured framework process. Through the EAFM process, the Council identified summer flounder as a high-risk stock and agreed to conduct an MSE that would focus on discards in the recreational fishery. The overall objectives of this MSE are to (1) evaluate the biological and economic benefits of minimizing discards and converting discards into landings in the recreational summer flounder fishery, and (2) identify management procedures to effectively realize these benefits.

A technical work group and core stakeholder group worked collaboratively to complete this task and the MSE successfully met the objectives identified by the Council and Atlantic States Marine Fisheries Commission's Summer Flounder, Scup, and Black Seas Bass Management Board (Board). The performance of eight different management procedures under three different states of the world (scenarios) were assessed using a suite of biological, social, and economic performance metrics (e.g., stock biomass and fishing mortality as well as angler welfare and ability to keep a fish). Results from the MSE suggest there are management procedures that outperform status quo management at reducing discards and converting those discards into harvest while limiting risk to the summer flounder stock.

All MSE model outputs (by performance metric, operating model alternative, and state) can be found here - https://bit.ly/fluke-mse-metrics.

Why an MSE?

MSE's are a tool that allows scientists, managers, and stakeholders to identify and test different management strategies and their ability to achieve desired, and often conflicting, management objectives before implementation. By utilizing an MSE to

[1] To find more information about the entire summer flounder MSE project, please see: https://www.mafmc.org/actions/summer-flounder-mse.

evaluate the objectives associated with this project, the Council and Board can consider new and more comprehensive information regarding the performance of traditional recreational management strategies within an ecosystem context and align the EAFM process and the typical recreational management process.

Two models were developed as part of this project, an operating/biological model and an implementation/recreational demand model, which are coupled within an MSE simulation framework that is designed to emulate summer flounder stock dynamics, both commercial and recreational fisheries, and the management system. Together these models and the MSE framework simulate the summer flounder population, its ecosystem, and different management procedures of interest while also considering key uncertainties and ecosystem drivers. This MSE won't specify a single outcome or strategy that will solve and address all management issues or concerns associated with recreational summer flounder discards. It will, however, provide the Council and Board an opportunity to evaluate and balance different management procedures and their associated biological, social, and economic trade-offs that best address their management objectives.

The Recreational Summer Flounder MSE Process

This MSE was structured into two different phases – a public scoping and stakeholder engagement phase, followed by a management considerations and model development phase – each lasting about one year. Stakeholder participation and input is a critical component of a successful MSE and since the MSE process was relatively new to the Mid-Atlantic, an extensive and inclusive stakeholder process was developed as part of phase 1 for this project (Figure 1). A variety of scoping and outreach initiatives were conducted covering a range of targeted audiences that offered different levels of engagement for input. The goal of this approach was to invest a significant amount of time early in the process on education and outreach and then continued, targeted feedback throughout the process to ensure better outcomes at the end of the project. The public response and interest, in terms of the total number of participants and the diversity of feedback, was very high for all steps in phase 1.

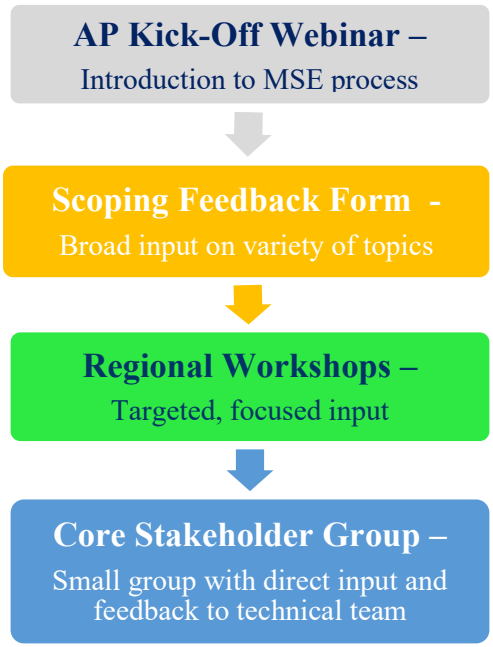

Figure 1. Process and approach to Phase 1 (public scoping and stakeholder engagement) of the recreational Summer Flounder MSE.

All of the input received in phase 1 was synthesized and used as a starting point and idea generator for the second phase of the project. Through a series of five webinar and in-person workshops, a small core group of diverse stakeholders collaborated with an MSE technical work group (Table 1) to identify the different management considerations and priorities and develop the decision tools and modeling framework necessary to address the management interests. Each workshop would build off the work conducted at the previous workshop as the core stakeholder group members would identify, refine, and prioritize management objectives, performance metrics, management procedures,

management tradeoffs, key uncertainties and assumptions, data considerations, and model outputs. Following each workshop, the technical work group would then work to incorporate this feedback into the development of the biological and recreational demand models given the model structure, capabilities and limitations, the availability and uncertainty of the data elements, and the overall project focus and deadlines. This collaborative and iterative process between the two groups was a positive experience that worked very well to help ensure a common understanding, general agreement, and support for the process and project outcomes.

Management and Modeling Considerations

Here we describe the rationale by the core group and technical work group for the development and prioritization of the different management components and model alternatives that comprised the simulation experimental design that were evaluated within the MSE framework.

Management Objectives

While the Council identified the overall project objectives when originally agreeing to conduct an MSE, they are quite broad and don't explicitly provide direction or guidance for other important management considerations. For example, management may also be interested in a goal to ensure that any management alternatives developed to address recreational discards don't significantly disadvantage one state, region, or sector. To help identify additional management objectives to be considered by the MSE, potential management objective themes or categories were identified during public scoping and were then refined by the core group and approved by the Council and Board. These expanded management objectives, listed below, are intended to help us define and understand what a successful recreational fishery would look like that minimizes discards and discard mortality.

1. Improve the quality of the angler experience
2. Maximize the equity of anglers' experience
3. Maximize stock sustainability
4. Maximize the socio-economic sustainability of the fishery

Management procedures

Management procedures represent example recreational management regulations (i.e., size, season, and possession limits) to be evaluated relative to different performance metrics (details below) and identify which procedures best meet the four different management objectives. The management procedures considered here are not intended to specify an exact set of recreational regulations that would be implemented in 2023 or future date. Rather, these management procedures are examples intended to represent the range and scope of regulations the fishery is likely to operate in and are of interest to management and stakeholders. In addition, it was important to consider management procedures that were different enough from one another in order to evaluate the relative differences in performance. Should the Council and Board express interest in certain management procedures or particular procedure categories (e.g., current regions, new regions, coastwide, slot limits), more refined alternatives would be developed and analyzed for consideration and potential implementation in 2023 or beyond.

The management procedures consider different size limits, including slots, season length adjustments, coastwide options, and existing and different regional configurations. Other management tools or actions (e.g., reporting requirements, hook/terminal tackle) were discussed and proposed by stakeholders but not included in the analysis because there was either a lack of data to inform the impact of those regulations or not enough time for them to accurately and appropriately be modeled.

The same management procedure was implemented for an entire 26-year projection period (13 new/updated stock assessments and specification cycles). This was done for a few reasons. First, given the time scales at which summer flounder stock dynamics operate (e.g., growth, recruitment, sex ratios, generation time), it would be difficult to evaluate the benefits and/or effects on the summer flounder stock under continually changing regulations. In addition, the goal of the MSE is to provide strategic advice and information regarding the "long-term" performance of different management procedures on both the stock and fishery.

There were seven different alternative management procedures evaluated that were grouped into four different categories based on similar configurations. Details on each management procedure alternative are provided below and the management procedure number and shorthand description in parentheses is the same in all of the background materials included with this agenda item.

Status Quo/Current Region Breakdown Alternatives

The 2019 regional regulations were specified as status quo and are the baseline regulations which other alternative management procedures are compared and evaluated against. The 2019 regulations were selected as the status quo/baseline regulations for a variety of reasons. First, regulations remained relatively unchanged from 2019 – 2021 and managers and stakeholders likely have a good understanding of management performance and angler satisfaction with these regulations. In addition, when model development was started in 2020 and into 2021, the 2019 recreational data was the most complete dataset available. The 2020 data includes imputed data because of the loss of sampling due to COVID-19 and the 2021 data was not available until the spring of 2022. Regulations for many states changed in 2022 and the technical work group did not want to use 2022 regulations given the lack of data on their performance and to minimize conflating the MSE project goals and the desire to predict 2022 harvest.

Management procedure alternatives #2 and #3 would retain the existing regional configuration but consider the implications of a reduction in the minimum size for all states or, for many states, extending the open season. Under management procedure #2, states/regions would retain their existing regulations but the minimum size within each state/region would be dropped by 1 inch in an effort to increase angler retention, reduce discards, and lower the proportion of female harvest. Management procedure #3 would retain the same size and possession limits for each state/region but would extend the season length, for most states, into April and October. This would allow for greater overlap in season with other fisheries and hopefully minimize discards of summer flounder when other fisheries are open and summer flounder are available.

Management Procedure #	Procedure Explanation
1 (status quo)	Status Quo - 2019 regulations
2 (minsize-1)	2019 regulations except for a 1 inch decrease in minimum size within each state, but not to go below a minimum of 16 inches
3 (season)	2019 regulations except season of April 1 - Oct 31 for all states

Modified Regional Breakdown Alternative

Management procedure #4 would consider a different regional breakdown and each state within a region would have the same management measures. The same regional breakdown as currently implemented for black sea bass was considered here. This alternative was developed to address feedback received from stakeholders interested in reducing regulatory complexity and increasing state angler equity while also allowing for some modifications and liberalizations from the current regulations.

Management Procedure #	Procedure Explanation
4 (region)	**New Regional Breakdown:** **MA - NY:** 5 fish possession, 18 inch minimum size, season of May 1 - Sept 31 **NJ:** 4 fish possession, 17 inch minimum size, season of May 1 - Sept 31 **DE - NC:** 4 fish possession, 16 inch minimum size, season of May 1 - Sept 31

Coastwide Alternatives

Historically, the recreational summer flounder fishery was managed under coastwide regulations with one set of regulations for all states. There was a lot of stakeholder interest in considering coastwide measures again given real or perceived inequities in regulations between the states and different sectors. Coastwide management measures would reduce management complexity, make enforcement easier, and may provide for more predictable stock responses to regulations.

Management procedure #5 was initially considered by the core group as a potential lower bound option that would greatly minimize the possession and size limit in order to increase the potential that trips, for any sector, would produce a fish to take home. The 14 inch minimum size limit would align with the commercial minimum size for consistency across sectors and potentially reduce the harvest of female summer flounder. After reviewing the initial model results for this alternative, the core group agreed to remove this alternative given the extremely low possession limit and the likelihood that this option may lead to increased discards as anglers are likely to continue fishing despite catching a 14 inch in the hopes of retaining larger fish.

Management procedure #6 represented a coastwide option that was generally in the middle of all the existing state regulations (pre-2022) with components in some states more liberal and some more restrictive. This option is also generally within the range of

recent options considered for non-preferred coastwide measures.

Management Procedure #	Procedure Explanation
5	1 fish possession limit, 14 inch minimum size, May 15 - Sept 15 – removed
6 (c3@17)	3 fish possession limit, 17 inch minimum size, May 1 - Sept 30

Slot Limit Alternatives

Slot limits within the recreational summer flounder fishery have been considered and analyzed on several occasions and a maximum size limit for federal waters was recently added to the FMP so that slot limits could be implemented if there was an interest from management. Many stakeholders expressed a lot of interest in considering slot limits and noted the successful use of slot limits in other recreational fisheries. Two different types of slot limit options were developed for this MSE and these options were modeled and considered to be implemented at the coastwide level.

Management procedure #7 is based on management measures implemented in 2022 by New Jersey and modified based on feedback from the core group and comments made by the ASMFC Technical Committee when they reviewed New Jersey's proposal. This alternative would allow for one smaller fish between 16 and 19 inches and then two fish greater than 19 inches. Allowing for one small fish is intended to provide for increased opportunities for anglers to take home one fish across modes and states while retaining a two fish possession at a larger size could constrain harvest yet allow anglers the ability to take home a trophy fish.

Management procedure #8 would implement a true slot and would not allow for the harvest of summer flounder greater than 20 inches. This alternative is intended to provide for greater opportunities to retain a fish across states and modes, while also reducing the amount of larger female harvest.

Management Procedure #	Procedure Explanation
7 (c1@16-19)	**Modified slot:** 1 fish from 16 inches - 19 inches, 2 fish 19 inches and greater, May 1 - Sept 31
8 (slot)	**True slot limit**: 3 fish possession limit between 16 inches and 20 inches, May 1 - Sept 31

Performance Metrics

Quantifiable performance metrics are used to evaluate the success of a particular management procedure in achieving the desired management objectives. The metrics considered here were compiled from survey responses, refined and prioritized by the core group, turned into measurable units by the technical work group, and calculated using the outputs from the different MSE models. Different metrics were specified for each of the four management objectives and calculated at either the trip, state/region, or coastwide level. In addition, several metrics are calculated relative to the modeled baseline or *status quo* (i.e., 2019 recreational) regulations to determine if an alternative

management procedure represented an improvement or a less favorable outcome. In addition, these performance metrics were calculated across three different operating model configurations (more information below) to test how robust the performance of these different management procedures will be under different ecosystem conditions and management drivers.

The core group expressed a lot of interest in calculating performance metrics by mode given the differential impacts changing regulations, particularly minimum size limits, are likely to have by mode. However, the technical work group expressed concerns given the limited and variable recreational data by mode, particularly at the state, wave, or trip level needed for some of the metric calculations at the mode level. In addition, the technical work group noted the significant amount of information and outcomes already being generated from the MSE model outputs (17 metrics by state or region, across 7 management procedures, for 3 different operating models) could make interpretation and summarizing difficult. However, the technical work group did indicate the modeling framework is built in a way that it could be adapted to evaluate mode specific outcomes and this may be an area of future exploration. The core group and technical work group also discussed a number of other metrics that might evaluate changes in non-compliance rates, changes in discard mortality rates, and regulatory complexity. However, given time constraints, data availability, output complexity, and modeling assumptions, as well as the relative importance of those metrics to the stakeholders, these metrics were considered a lower priority and removed from consideration in the results presented here.

Listed below are the 17 final performance metrics, by management objective, that were prioritized by the core group and calculated by the technical work group:

<u>Management Objective 1: Improve the quality of the angler experience</u>

1. Percent of trips that harvest one fish
2. Average number of harvested fish per trip
3. Consumer surplus* per trip
4. Percent of trips harvesting a trophy fish (>28 inches)

* Consumer surplus – a measure of the amount of money anglers would be willing to pay to see a management procedure implemented. An economic calculation of angler satisfaction.

<u>Management Objective 2: Maximize the equity of anglers' experience</u>

5. Percent change in chance of a trip with a harvested fish
6. Percent difference across states in chance of a trip with a harvested fish
7. Change in retention rate (harvested:discarded)
8. Change in retention rate across states

<u>Management Objective 3: Maximize stock sustainability</u>

9. Percent chance the stock is overfished
10. Percent chance of overfishing
11. Total spawning stock biomass (mature males and females)
12. Average number of discards per trip
13. Change in recreational removals (harvest and dead discards)

14. Percent of harvest that are female

Management Objective 4: Maximize the socio-economic sustainability of fishery

15. Total number (millions) of summer flounder trips
16. Percent change in consumer surplus (angler satisfaction) by state (across all trips)
17. Percent change in fishery investment (e.g., sales, income, employment)

These metrics, and the four management objectives, were also used in a trade-off based decision analysis designed to evaluate how well each management procedure achieves the stated management goals for the project. To determine the overall performance of a particular management procedure, an overall score for each management procedure was calculated by having core group members rank and weight the objectives and associated metrics to understand their overall relative importance. Objectives and metrics that were weighted more heavily (i.e., more important) contributed more to the overall score than those that were considered less important. The final score for each management procedure can then be used to evaluate the relative performance and associated trade-offs a management procedure may have in meeting the overall management objectives.

Alternative Operating Model Scenarios

Three different operating model scenarios were developed for this MSE, 1) a baseline model, 2) an MRIP bias model and, 3) a stock distribution change model. These different model configurations incorporate some of the critical uncertainties (e.g., data, biology, climate, etc.) identified through stakeholder scoping and by the technical work group. They are intended to evaluate how different management procedures perform under these different assumptions about the "true" summer flounder population. All seven management procedures were run under each operating model scenario and the same 17 performance metrics were produced for each management procedure to allow for comparisons across the different operating model scenarios.

MRIP bias alternative

Stakeholders and the core group consistently raised concerns about Marine Recreational Information Program (MRIP) data and their belief that MRIP overestimates the total number of summer flounder trips, catch, and harvest. The MRIP bias model scenario was developed to understand the potential management and fishery implications under different recreational catch and effort assumptions. This scenario was not an evaluation of the MRIP program or the accuracy and reliability of the data. For model runs in this scenario, instead of using the catch and effort point estimate, the lower bound of the 95% confidence interval of the MRIP estimates were used. These lower catch and effort estimates were used to calibrate the recreational demand model and to adjust the stock dynamics in the biological model to account for the lower recreational catch history.

Stock distribution change alternative

As mentioned earlier, this MSE is part of the Council's implementation of its EAFM guidance document. Prior to initiating the MSE, the Council developed a conceptual model that considered risk factors and ecosystem elements affecting summer flounder and its fisheries[2]. The conceptual model identified stock distribution changes as the most

[2] For more information about the summer flounder EAFM conceptual model, please visit: https://www.mafmc.org/eafm.

linked risk factor with potential implications across the summer flounder ecosystem (e.g., stock productivity, science, and management). Historical stock distribution information by region was used to inform future potential changes in the spatial distribution of the stock over time and the implications for future availability of summer flounder to recreational anglers along the coast (Figure 2). This scenario provides an opportunity to evaluate if changes in summer flounder availability could undermine the effectiveness of implemented management measures.

Additional details and information on the model structure, data elements, and assumptions of the operating model scenario configurations can be found in the model reports by Dr. Fay and Dr. Carr-Harris.

Overview of MSE Outcomes

Listed below are some of the key findings and outcomes from the MSE. Additional results, including details explaining the outcomes, can be found in the MSE Results Summary document included as background material.

- Under the baseline operating model scenario, all management procedure alternatives, except for one, outperformed the status quo alternative (MP#1) across a majority of performance metrics including those that reduce recreational discards and provide for increased harvest opportunities (Figure 3 and Table 2).
- No management procedure resulted in the stock becoming overfished. Most had low risk of overfishing, while two had increased risk of overfishing (Figure 3).
- Under different states of the world (scenarios), relative performance of the different management procedures are the same as those observed under the baseline, but outcomes are slightly degraded with the MRIP bias scenario and more degraded with the distribution shift scenario (Figure 4).
- All management procedures, except for one, reduce the proportion of females in the recreational harvest when compared to the status quo. However, reducing the harvest of females does not appear to result in increases to the overall population spawning stock biomass (Figure 5a-b)
- All management procedures, except for one, resulted in higher levels of angler welfare relative to the status quo. Angler welfare is measured by changes in consumer surplus, or the amount of money anglers would be willing to pay for a fishing trip under a given management procedure (Figure 6).
- According to trade-off analysis, relative to the performance of the status quo, the overall satisfaction provided by the fishery is expected to increase by 4 to 106% by implementing MP #2-8, respectively (Figures 7a-b).
    - This result is highly robust to both the range of weightings provided by stakeholders and the set of scenarios evaluated.
- The relative performance of a management procedure, particularly when comparing to the status quo, is highly variable at the state or regional level.
- Management procedures assessed season length, bag limit, and size limit; size and bag limit were most influential on performance.

- Due to priorities, data availability, and time constraints, not all areas of interest raised by stakeholders were able to be considered in the project.
- Overall, the core stakeholder group found the process to be very informative, appreciated their ability to participate and contribute, and believe the results and outcomes will be useful for management. They also identified and suggested a number of areas of improvement for any future MSE project.

Results from the MSE suggest there are opportunities to make management adjustments that can reduce the overall number of recreational discards, increase recreational opportunities, minimize risk to the stock, and provide for greater equity and access across states and likely fishing modes. The technical work group does note that there are a range of uncertainties and variabilities in the modeling framework that could have an affect the model outputs. In addition, some management procedures considered here have never been implemented, or there is limited experience with their implementation, and our understanding of how the stock, reference points, or angler behavior may change in response to new management measures is uncertain. However, the incorporation of the recreational demand model to capture angler behavior in response to changing regulations and stock conditions should help account for these changes and reduce uncertainty.

Future Direction and Meeting Goals

Potential Application of MSE Process and Results

As mentioned earlier, this MSE is designed to provide strategic advice to the Council and Board regarding a range of management procedures and their overall performance relative to priority management objectives intended to address discards in the recreational summer flounder fishery. Through a very collaborative process, driven both by stakeholder input and scientific rigor, this MSE has developed a novel, forward-thinking, and robust modeling framework unique to the Mid-Atlantic region that integrates a full summer flounder population dynamics model with an angler economic behavior model to understand how recreational behavior responds to changing regulations and stock availability. Results from the MSE demonstrate that there are different management procedures and management procedure categories, particularly when compared to status quo regulations, that achieve the overall management goals of reducing discards and converting discards to increased harvest opportunities, while maintaining stock biomass above the threshold and limiting risk to overfishing. In addition, the results suggest these same management procedures also increase angler welfare, result in more fishing trips and higher expenditures on fishing, reduce female harvest and keep total catch (commercial and recreational) relatively constant. However, as the trade-off analysis indicates, no management procedure achieves all of the management goals and procedures are likely to have differential effects across regions, states, and modes. The MSE is a different approach that has provided the Council and Board with a comprehensive understanding of how traditional management tools (e.g., size, season, and possession limits), within an ecosystem context, may perform over the long term and what the potential implications and associated trade-offs might be for the stock and fishery.

In addition, the MSE successfully developed new tools that can also provide tactical

advice to management. While the MSE developed a simulation framework designed at evaluating the long-term performance of different management procedures relative to B_{MSY} and F_{MSY}, the quantitative models developed within the framework can provide short-term (annual) recreational catch and harvest estimates for a given stock size and length structure. These estimates could then be compared to recreational catch (ACL) or harvest limits (RHL) and we can evaluate the overall effectiveness and response to different management measures. While the simulation framework and specific models are currently built for summer flounder, the overall application and approach could be applied to other recreational species.

While the MSE was not able to address all stakeholder and management interests raised throughout the process, the foundation and modeling framework is set up to investigate these other issues should there be interest from management and given there are appropriate data sources and resources that are made available to conduct the necessary analyses. Topics such as alternative recreational management strategies (e.g., education, terminal tackle, changes in discard mortality, compliance, and enforcement), allocations, the interaction between commercial and recreational harvest strategies, mode specific considerations, habitat management, and additional uncertainties (e.g., changes in stock productivity, environmental drivers) were all identified as other areas of interest. Some core group members also expressed interest in conducting a similar MSE for other recreational species like scup and black sea bass. Lastly, there may also be a need/interest to update the analysis with the results of the 2022 discrete choice experiment survey. The 2010 survey served as the foundation to developing the angler preferences used in the recreational demand model. It is anticipated the results and information from the 2022 survey will be available this fall and evaluating and comparing how potential changes in angler preferences for popular recreational species may affect the results of this MSE is likely worth considering.

Council and Board Direction in August

The Council and Board were very supportive and encouraged by the results of the MSE. They agreed to use the outcomes from the MSE to help inform potential recreational management options for summer flounder in 2023. In addition, they supported the use of the modeling approaches developed as part of the MSE (e.g., recreational demand model) to estimate recreational catch and harvest of summer flounder and other recreational species, such as black sea bass. The Council and Board agreed that these modeling approaches could be used to help evaluate and identify recreational management measures in 2023 under the recently approved recreational harvest control rule.

Given the positive outcomes and feedback from members of the core stakeholder group, the Council and Board also expressed interested in additional/future MSE projects for other recreational species and other Council priorities.

Table 1. Members of the Mid-Atlantic Council's EAFM management strategy evaluation technical work group. * Denotes members that were independent contract facilitators to help support core group work and decision analysis.

Name	Affiliation	Name	Affiliation
Andrew (Lou) Carr-Harris	NEFSC	Jorge Holzer	SSC/Univ. of Maryland
Dustin Colson-Leaning	ASMFC	Emily Keiley	GARFO
Jonathan Cummings*	UMass Dartmouth/USFWS	Jeff Kipp	ASMFC
Kiley Dancy	MAFMC staff	Doug Lipton	NOAA Fisheries
Geret DePiper	SSC/NEFSC	Brandon Muffley	MAFMC staff
Jon Deroba	NEFSC	Annabelle Stanley*	Cornell Univ.
Gavin Fay	SSC/UMass Dartmouth	Mark Terceiro	NEFSC
Sarah Gaichas	SSC/NEFSC	Mike Wilberg	SSC/Univ. of Maryland
Kaili Gregory*	Cornell Univ.	Greg Wojcik	CT DEEP/ASMFC TC chair

Table 2. Summary of model outputs for select performance metrics across the seven different management procedures under the baselines operating model configuration. MP#1 – 2019 regs; MP#2 – 2019 regs with 1 inch decrease in minimum size; MP#3 – 2019 regs with a standard season of April 1- Oct 31; MP#4 – new regional configuration; MP#6 – coastwide measures; MP#7 – modified slot; MP#8 – true slot.

Performance Metric	MP#1	MP#2	MP#3	MP#4	MP#6	MP#7	MP#8
Percent of trips that harvest one fish	0.193	0.284	0.197	0.279	0.301	0.350	0.357
Average number of harvested fish per trip	0.274	0.471	0.279	0.478	0.504	0.458	0.642
Harvest:Discards	0.102	0.207	0.104	0.202	0.240	0.189	0.390
Average number of discards per trip	2.91	2.45	2.89	2.55	2.29	2.58	1.84
Consumer surplus (angler satisfaction) per trip	3.703	12.896	4.001	13.100	13.502	14.352	19.873
Total recreational expenses (millions of $)	470.9	492.3	474.5	492.6	495.7	499.3	513.0
Total Spawning Stock Biomass (mature male & female) in metric tons	67,514	60,504	67,291	59,795	59,372	61,088	56,554
Percent of female harvest	0.676	0.607	0.677	0.608	0.591	0.602	0.49
Total catch (recreational+commercial) in metric tons	15,935	16,468	15,986	16,526	16,460	16,031	15,834
Total recreational removals (harvest+dead discards) in metric tons	6,331	8,157	6,498	8,337	8,263	7,685	8,085
Total number of recreational trips (millions)	11.22	11.72	11.31	11.74	11.82	11.91	12.22
Percent of trips harvesting a trophy fish (>28 inches)	0.017	0.008	0.018	0.008	0.007	0.008	0.000

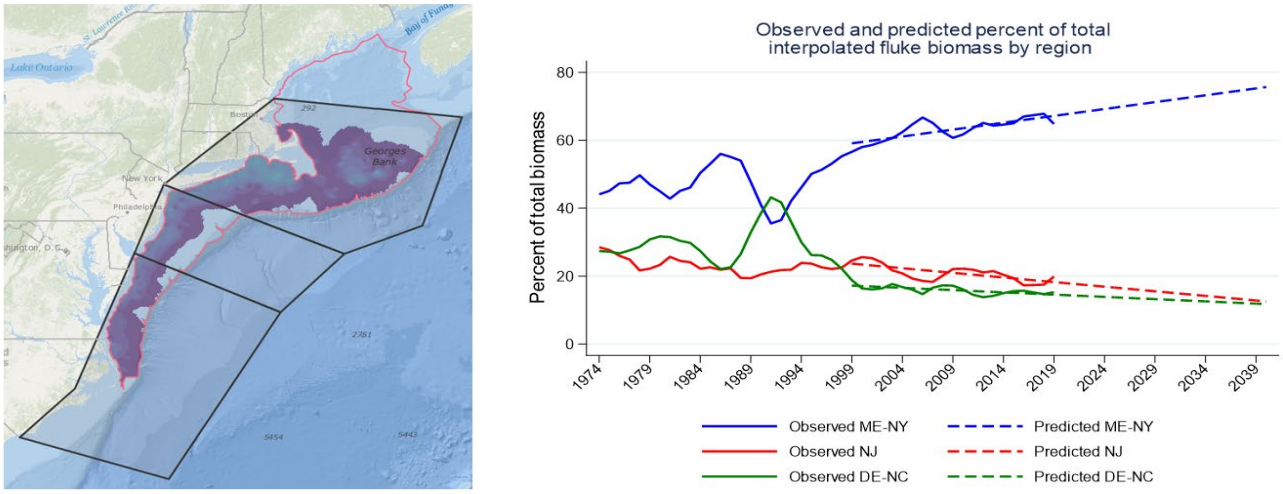

Figure 2. Proportion of observed and projected summer flounder stock biomass by region (ME-NY, NJ, DE-NC) based on the NEFSC fall bottom trawl survey used for an alternative MSE operating model to reflect potential changes in future stock distribution and availability to recreational anglers. Source: NOAA Fisheries. 2022. DisMAP data records. Retrieved from apps-st.fisheries.noaa.gov/dismap/DisMAP.html. Accessed 7/14/2022.

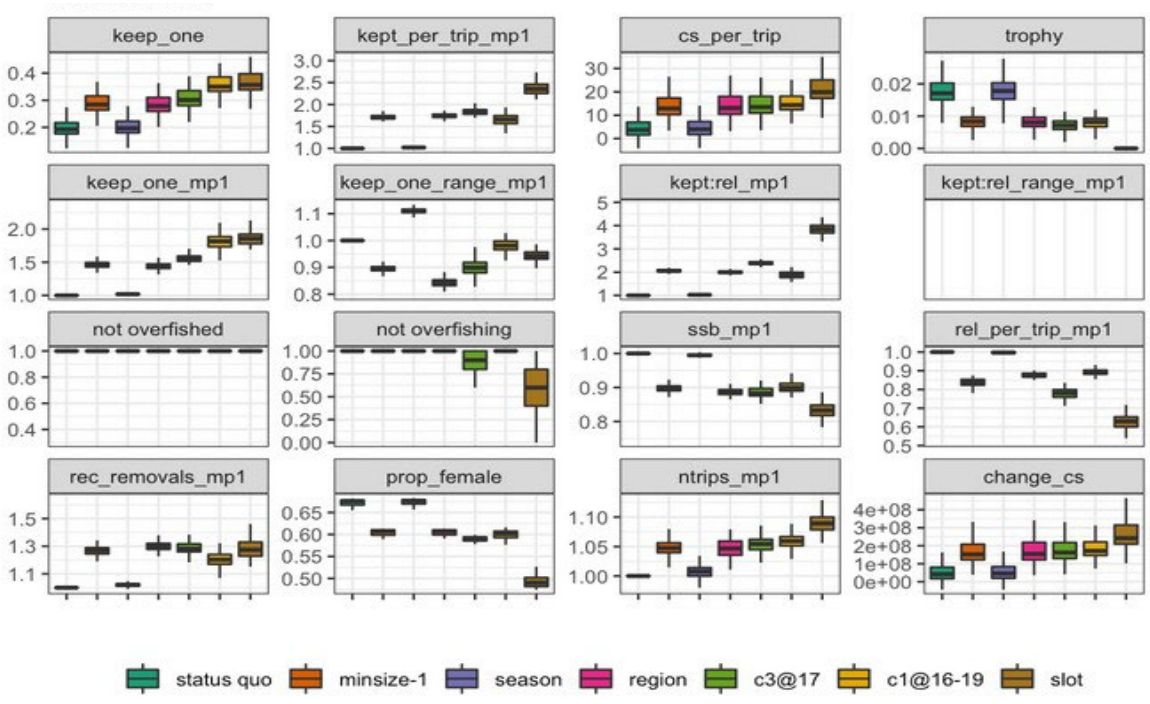

Figure 3. Coastwide results for a suite of biological, social, and economic performance metrics for seven different management procedures under the baseline operating model configuration.

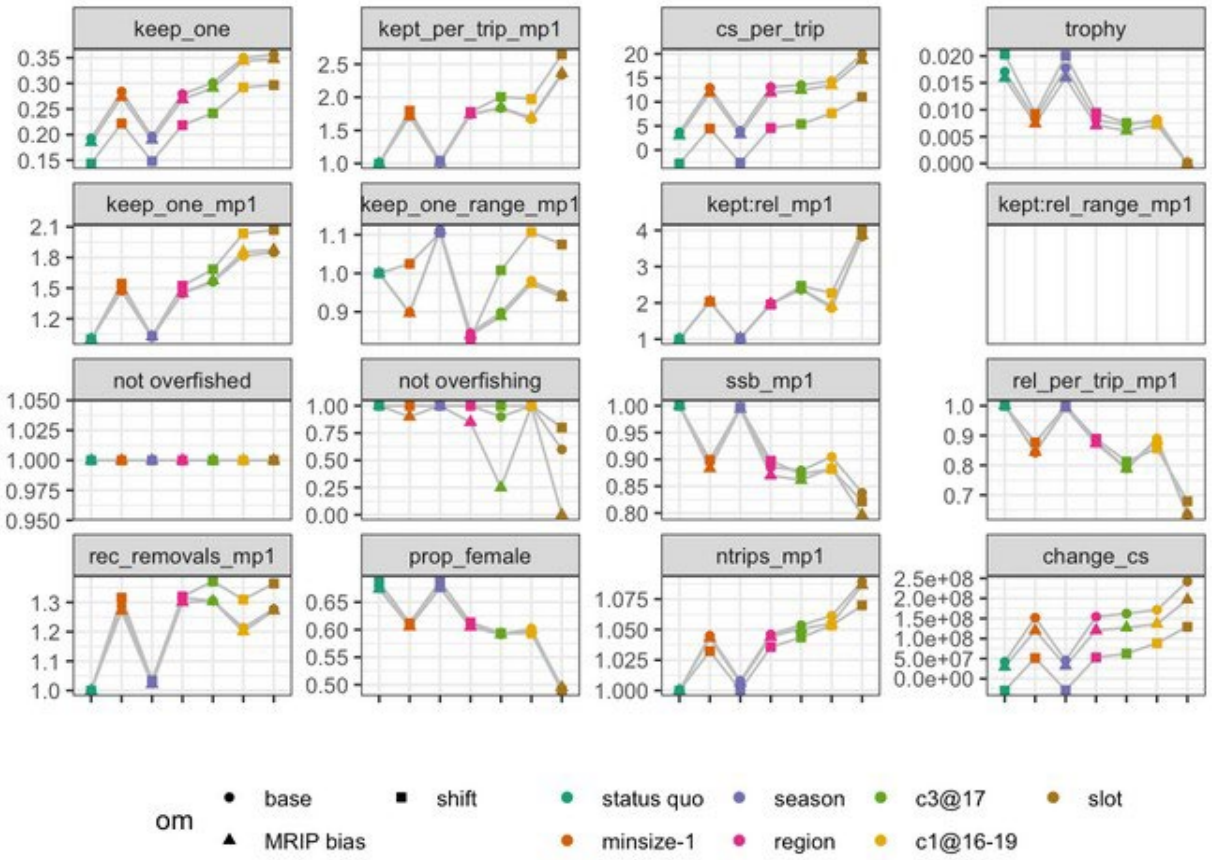

Figure 4. Comparison of the relative performance of seven different management procedures across a suite of biological, social, and economic performance metrics and three different operating model scenarios (baseline, MRIP bias, and stock distribution shift).

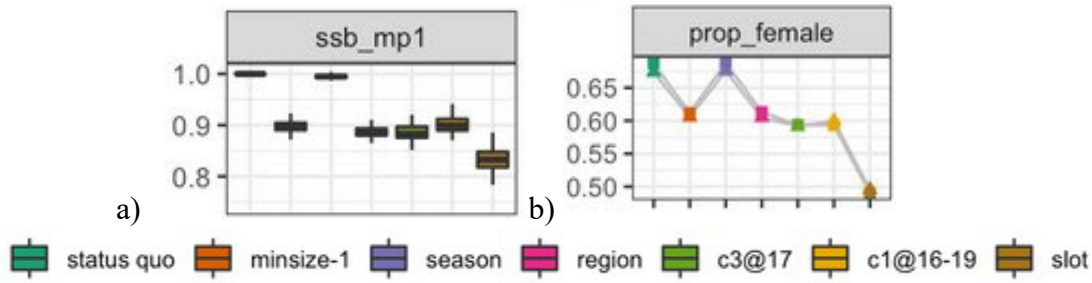

Figure 5 a) The relative difference in total spawning stock biomass (SSB) for the different management procedures compared to the status quo. SSB includes both mature male and female summer flounder. **b)** The average percentage of the recreational summer flounder harvest is female across the seven different management procedures.

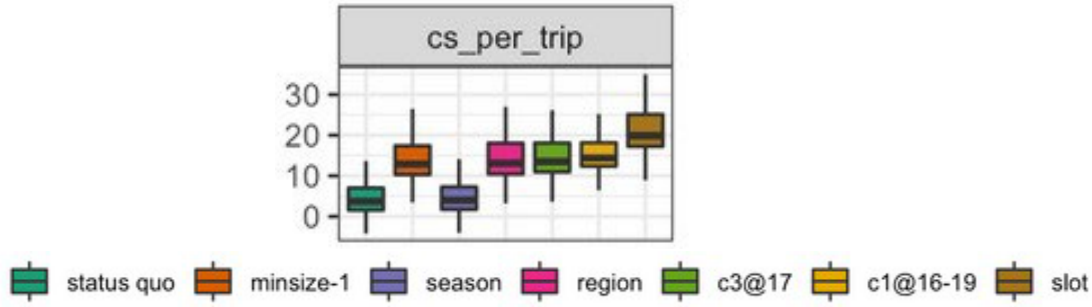

Figure 6. The differences in angler welfare measured by changes in consumer surplus, or the amount of money anglers would be willing to pay for a fishing trip under a given management procedure.

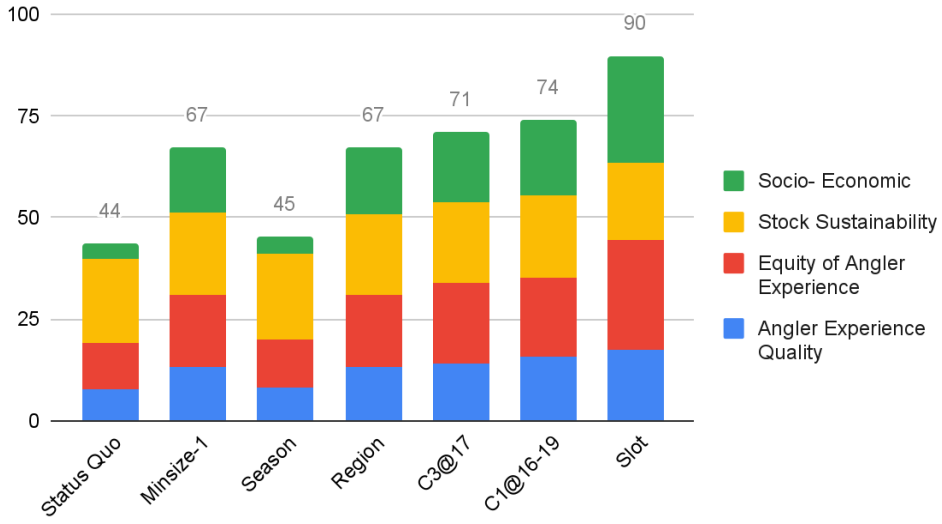

Figure 7a. Total Performance of each management procedure. Management procedures are listed across the bottom axis and the total performance score is displayed by the height of the stacked bar on the vertical axis. Scores reflect the expected degree of satisfaction provided by a management procedure, such that a doubling of the score indicates the average stakeholder expects to be twice as satisfied by the change in management procedure. The four colored regions of each bar show the degree of contribution each management objective provides to the total score.

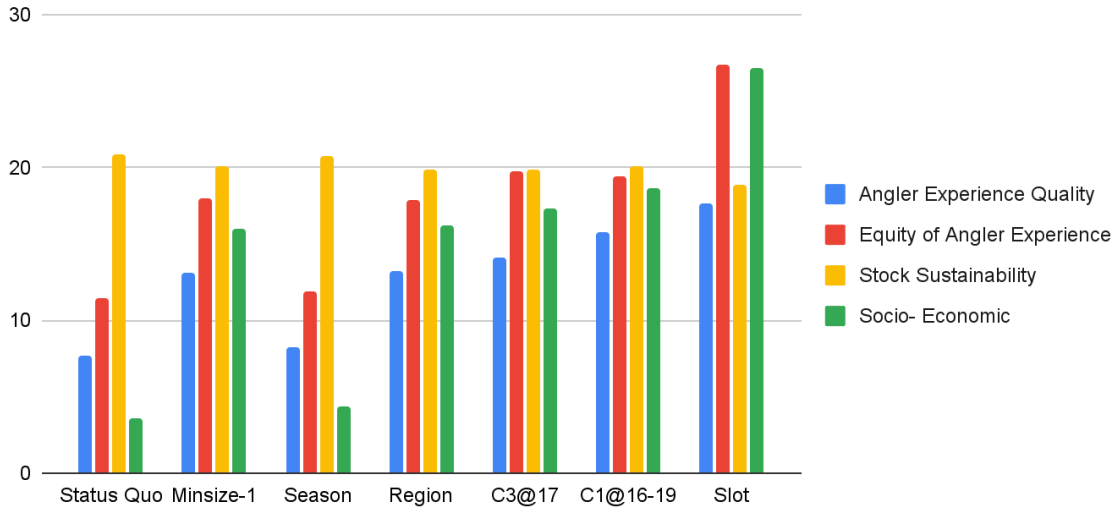

Figure 7b. Performance of each management procedure by management objective. Management procedures (MP) are listed across the bottom axis and the total performance score is displayed by the height of the stacked bar on the vertical axis. Looking only at a single color bar shows the relative performance of a MP for that objective (e.g., the blue bars display the relative performance of the MP for the Angler Experience Quality objective).