Interim Report to the Mid Atlantic Fishery Management Council on the Project:
Evaluation of F-Based Management for the Recreational Summer Flounder Fishery

Principal Investigators:
Dr. Gavin Fay
Department of Fisheries Oceanography
School for Marine Science and Technology
University of Massachusetts Dartmouth

Dr. Jason E. McNamee
Chief, Division of Marine Fisheries
Rhode Island Department of Environmental Management (RIDEM)

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Introduction

This project uses a Management Strategy Evaluation (MSE, c.f. Bunnefeld et al. 2009) framework to conduct a set of management model forecast simulations of alternative management options for the recreational summer flounder fishery and their associated plausible uncertainties to compare the expected performance of these alternatives. The management alternatives are constructed in the context of their eventual application to the specification setting process for summer flounder. The project is informed by extending work by Dr. John Ward (Ward 2015) on quantifying the historical effects of changes in management measures on catch and harvest as well as the previous MSE done by Wiedenmann et al. (2013), both sponsored by the MAFMC. These management effects will be integrated into the MSE simulations as a way of emulating behavioral responses (and their uncertainty) to summer flounder management measures, to demonstrate the implications for achieving management objectives and to understand the relative value of management options.

Background

Given the current use of conservation equivalency (CE) and regional approaches in summer flounder management, which allow states or groups of states the ability to use differing recreational management measures, provided that state specific harvest falls within pre-specified harvest targets, it is important to investigate the efficacy of this yearly and somewhat ad hoc approach to management versus alternative recreational management strategies. Underlying the current process are the assumptions of similarity between years in the fishery for both fishing behavior and in the population dynamics of summer flounder. The process ignores many dynamic factors including implementation error in the new management procedure, changes to discard rates based on the new management regime, growth in the population, and inter-annual changes in availability of the resource to anglers. It was noted during the process for Addendum XXVIII that current methods for developing CE measures each year are subject to variability and uncertainty, and the performance of this strategy has not been good historically. This project was designed to develop a new methodology that can perform better over time by accounting for more of the known population dynamics, allow for fairness, equity, and clarity in the specification setting process, and can allow for more stability through time in the management program.

One of the ways this project will progress from the current specification setting procedures used to try and meet management objectives is to demonstrate the relative value of the current procedures and alternatives using an F-based approach for recreational management of summer flounder. Moving from a harvest-based approach to an F-based approach may allow for more inter-annual stability in recreational management by not being directly subject to the substantial between-year variability in MRIP harvest estimates. The F-based approach may also better account for important population dynamics that are currently being ignored, such as recreational discards, growth, and future changes in availability due to cohort strength. Proposed advantages of an F-based approach are that performance of projections will be enhanced as stability will be increased in specification-setting thus improving buy-in and knowledge of regulations by the fishing public, and because more factors are being accounted for in the population projections that have the potential to impact future performance.

In addition to the F-based strategies, tradeoffs that exist in the current management approach will also be investigated. These investigations will offer value to managers by providing context of existing versus new approaches to managing the recreational summer flounder fishery, thus allowing them to optimize the eventual management regime they select. The various options will be reviewed at different regional configurations to provide trade-off information with regard to the choice of management unit.

We are using a forecasting simulation modeling framework, using MSE, to test the performance of the current and potential alternative F-based management approaches for the recreational summer flounder fishery. Simulation testing and MSE are powerful frameworks for testing the expected performance of decision-making tools with respect to management objectives and robustness to uncertainty scenarios (e.g. Smith et al. 1999, Bunnefeld et al. 2009, Punt et al. 2016). Critically, MSE can allow for error associated with the implementation of management actions, associated with uncertain or unforeseen responses by resource users to changes in management measures. Additionally, our proposed work will seek to match the current spatial (regional) management set up to the extent that data allows, thus facilitating easier transition from the simulation results to applied use by fisheries managers and technical working bodies.

Management alternatives to be tested:

1. Status quo
2. Risk-based status quo
3. F-based management
4. Risk-based F-based management
5. Spatial management scale, from coast-wide to state specific

Recreational fishery fleet dynamics model

The first iteration of the project investigates the performance of management alternatives 1 versus 3 from the list above. Crucial to short-term fishery forecasts of these two approaches is a consideration of how changes to recreational management measures such as minimum size, bag limits, season length, etc. affect recreational harvest and discarding rates. To allow for management effects to feed back in to the operating model, a recreational fishery fleet dynamics model was developed that predicts both harvest and catch (harvest + discards) using the historical MRIP dataset. This dataset was overlaid with state specific historical management measures dating back to 1993, the year that coastwide recreational management measures were put in to place. From this empirical catch information, and the knowledge of the management structure in place in each state, a series of Generalized Additive Models (GAMs) were built to model the effects of management on harvest and catch. By using available information on recreational fishing to evaluate plausible alternatives for these relationships, we can account for uncertainty in the management responses of recreational fishery fleet dynamics. The estimated uncertainty from these analyses will be used to describe alternate states of nature in the recreational fleet dynamics model within our MSE simulations.

The general form of the management model is:

$$\begin{aligned} Log(Harvest\ or\ Catch\ at\ length) \\ &= s(Length, MinLength) + factor(Year) + State + s(Wave) + s(Season) \\ &+ s(Bag) \end{aligned}$$

Where a s indicates variables in the GAM that are smoothed, $Length, MinLength$ is an interaction term between the length of the fish caught and the regulatory minimum size, $Year$ is the calendar year in which the catch occurred, $State$ is the state in which the harvest occurred (states of MA – NC used in the analysis), $Wave$ is the two month period in which the catch occurred, $Season$ is the length of the season in the specific wave, and Bag is the regulatory bag limit in the given state and year.

This general model was applied to the coast, can be run with state used as a factor in the model, can be run as a stand-alone state specific model, and can be run as two regional configurations (Table 1).

Output from the management model shows logical outcomes from the historical dataset. Output from the coastwide model with state as a factor for harvest is presented. Keeping in mind that the data is plotted in log-space and that we have initialized this model with the old MRIP estimates (to be updated soon to the calibrated estimates), we see that the bag limit is statistically significant, but has only minor effects on harvest (Figure 1). Season length has a positive effect on harvest, meaning as season length increases, so does harvest (Figure 2). Wave has a parabolic effect on harvest, matching with the fact that the majority of the harvest is occurring during the spring, summer, and fall times of year (Figure 3). The interaction between minimum size and length of harvest shows an increase in harvest as length increases, peaking at around 14 – 18 inches, and then declines as size gets larger (Figure 4). For the state effects, NY and NJ have the strongest positive effect on harvest (harvest in these states is higher than average), while the states of MD and DE have the strongest negative effect on harvest (harvest in these states is lower than average, Table 2). States having a positive or negative effect is made in reference to the reference state in the model, in this case the state of CT.

Forecasting model

We conditioned an age-structured operating model to reflect the life history and dynamics of summer flounder. Parameter values and initial conditions are taken from estimates from recent stock assessments for summer flounder (NEFSC 2013, Terceiro 2015). This will be updated with the most recent benchmark assessment when available. The operating model will project numbers at age, subject to recruitment variability, forward in time given removals (or F rates) from commercial and recreational fishing. An observation model generates data from the operating model to represent a simplified result from a summer flounder stock assessment (biomass estimates and fishing mortality relative to targets), and an estimate of recreational catch/harvest. These observations are subject to autocorrelated bias and imprecision. The observations are then used by one of the alternative management procedures described above to provide a new F or catch level to update the dynamics of the operating model. As noted, the initial runs will use management alternatives 1 and 3.

The modeling is conducted using the 'sinatra' software (Fay et al. 2009), which is implemented in R and FORTRAN, and is a general age-structured modeling platform for Management Strategy Evaluation and stock assessment performance testing. Aside from providing parameter values appropriate for summer flounder, modifications to the software have been made to include the recreational fishery fleet dynamics model that links changes in recreational management measures to changes in fishing mortality and harvest.

Evaluating performance

The performance of the options will be evaluated by comparing the projections of recreational harvest to prescribed limits (for options that retain RHLs), as well as projected stock biomass and fishing mortality rates relative to reference points and risk tolerances. The forecast simulations will also allow tradeoffs in the ability to meet objectives while maintaining recreational opportunities to be explored. A preliminary evaluation will be presented to the MAFMC at their December 2018 meeting.

References

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Table 1 – Regional configurations tested. In each row, states with the same letter are in a region.

State	MA	RI	CT	NY	NJ	DE	MD	VA	NC
Region configuration 1	A	B	C	C	D	E	E	E	E
Region configuration 2	A	B	B	B	C	D	D	D	D

Table 2 – Estimated effects of state factor from the GAM.

State	Estimate	Std. Error	t value	Pr(>|t|)
DE	-0.77883	0.078612	-9.90725	5.64E-23
MA	-0.12007	0.090349	-1.32895	1.84E-01
MD	-0.87628	0.091785	-9.54719	1.85E-21
NC	-0.13158	0.092807	-1.41781	1.56E-01
NJ	1.758009	0.077714	22.62165	4.239264e-109
NY	1.30965	0.078907	16.5973	1.30E-60
RI	-0.32131	0.081169	-3.95857	7.62E-05
VA	0.866226	0.075822	11.42442	6.12E-30

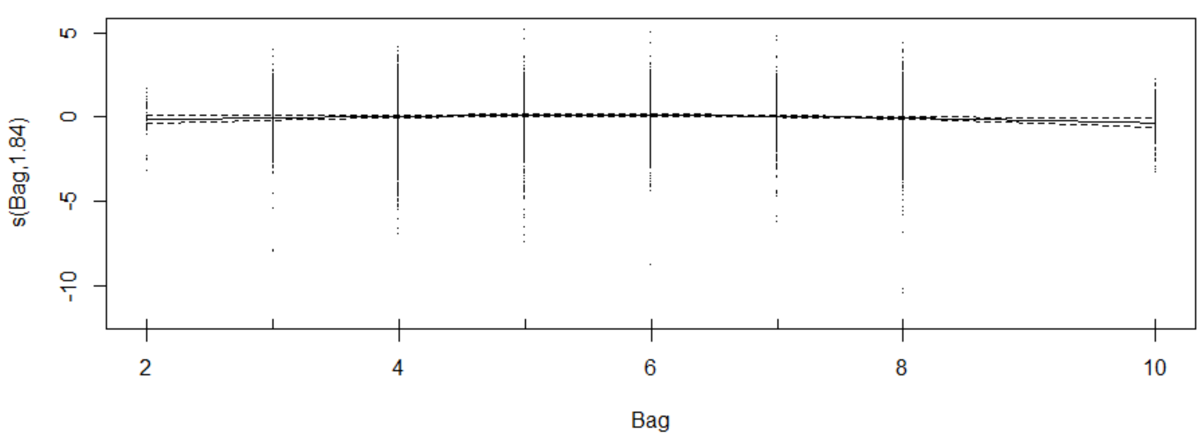

Figure 1 – Output on bag limit effects from the recreational fishery fleet dynamics GAM model.

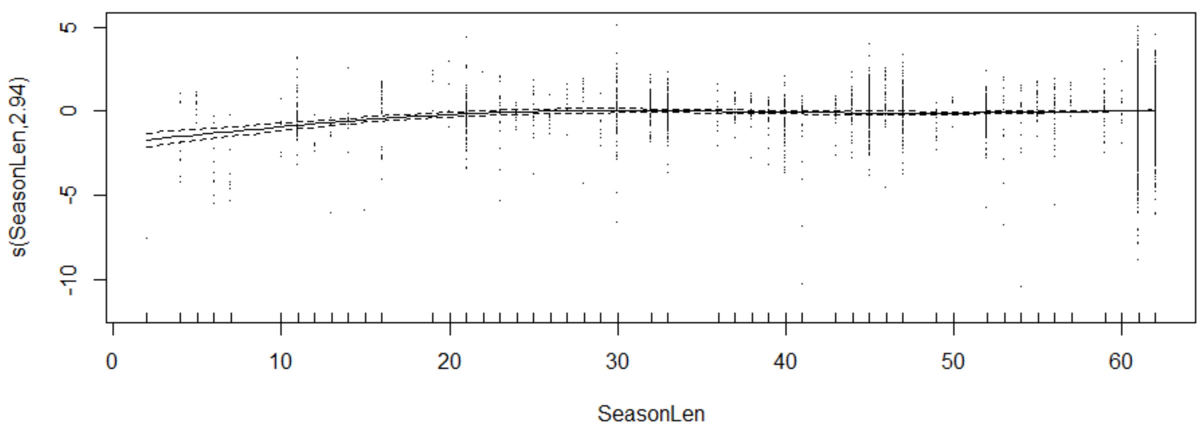

Figure 2 – Output on season length effects from the recreational fishery fleet dynamics GAM model.

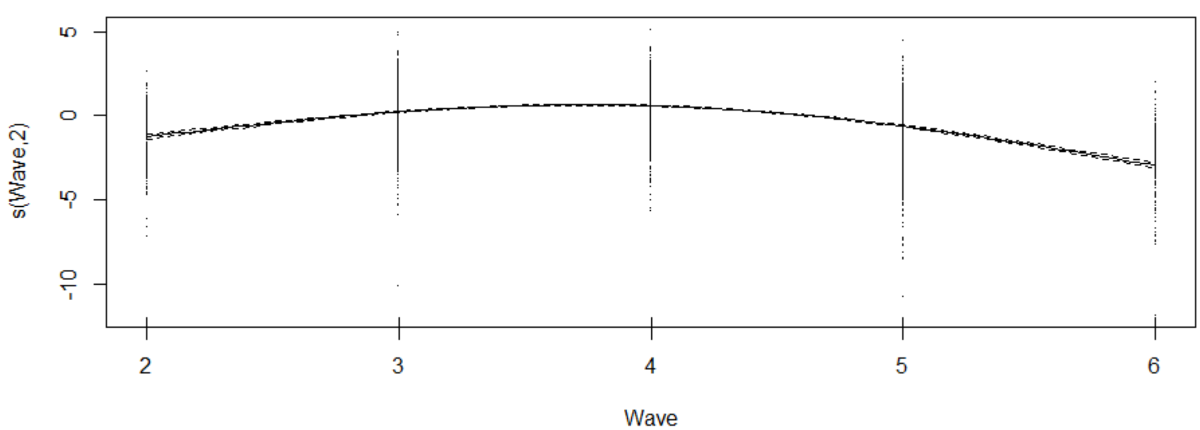

Figure 3 – Output on wave (2 month period) effects from the recreational fishery fleet dynamics GAM model.

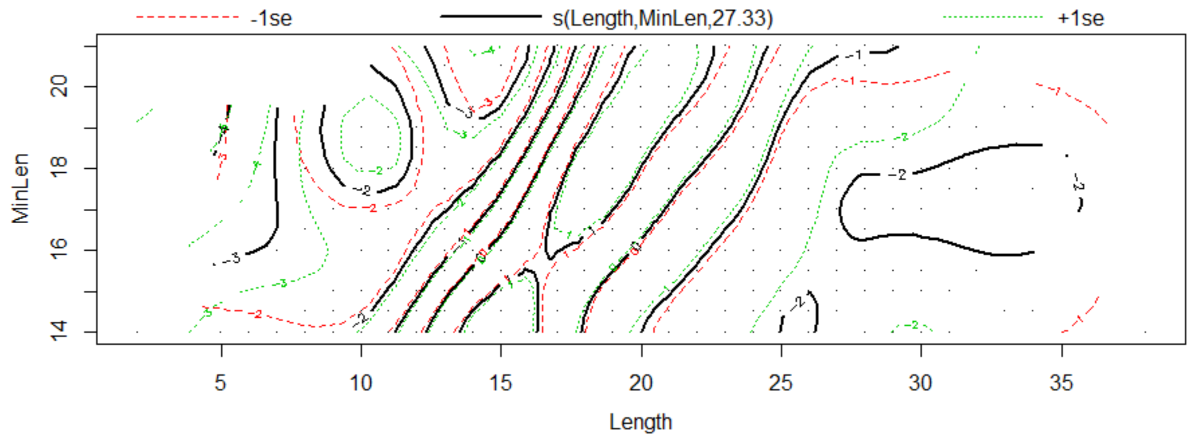

Figure 4 – Output on minimum length and length at harvest interaction effects from the recreational fishery fleet dynamics GAM model.