

Mid-Atlantic Fishery Management Council

## **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 836 South  
Rodney French Boulevard  
New Bedford, MA 02744  
gfay@umassd.edu, 508-910-6363

Jason E. McNamee

Chief, Marine Resource Management  
Division of Fish and Wildlife, Marine Fisheries  
Rhode Island Department of Environmental Management (RIDEM) 3  
Ft. Wetherill Rd.  
Jamestown, RI 02835  
jason.mcnamee@dem.ri.gov, 401-423-1943

Institutional Representative:

Michelle Plaud

Manager, Pre & Post Award Administration  
University of Massachusetts Dartmouth  
Sponsored Projects Administration  
North Dartmouth, MA 02747  
mplaud@umassd.edu, 508-999-8509

Project Term: April 1, 2018 to March 31, 2019

### **Executive Summary**

We propose to use a Management Strategy Evaluation (MSE) framework to test the performance of the current and potential alternative F-based management approaches for the recreational summer flounder fishery. Our intent is to show the relative value of both current and potential management actions for satisfying management objectives. The F-based management alternatives will be constructed in the context of application to the specification setting process for summer flounder. We will construct an age-structured operating model of summer flounder population and fishery dynamics that explicitly includes implementation uncertainty associated with application of management measures in the recreational fishery. We will synthesize available data on the responses of recreational fishers to summer flounder management measures to construct a set of plausible alternatives for these fleet dynamics and their associated uncertainty. As an extension of work performed by Dr. John Ward for the MAFMC (Ward 2015), we will investigate the historical effects of various management measures on harvest and catch at various levels of refinement (e.g. state, wave, mode) based on MRIP data to quantify the most appropriate levels of effect and uncertainty to associate with the management choices made in the MSE analysis.

The management approaches tested within the MSE will replicate the steps associated with data collection, interpretation, and decisions about whether and how to adjust recreational fishing measures. With our work we seek to match as much as possible the current regional management to permit an easier transition from the MSE results to applied use by fisheries managers and technical working groups. Our simulations will consider several broad sets of alternative management approaches including: 1) Status quo, where recreational harvest limits are compared to estimates of current recreational harvest based on the MRIP statistical sampling program, with adjustment measures to include: season length, minimum size, bag limits, and combinations thereof; 2) Risk-based status quo, where a percentile of the estimated uncertainty is used rather than point estimates of recreational harvest; 3) F-based management, where the stock assessment estimate of the current fishing mortality is compared to the target F, with one or more of the management measures described above being adjusted accordingly, alternatives within this approach will include incremental adjustments to encourage stability in advice and overfishing threshold projections based on expected probabilities of overfishing given different management measures; 4) Risk-based F-based management where similar approaches as for 3. are applied but percentiles of uncertainty estimates are used to determine appropriate adjustments instead of point estimates. The performance of the various management 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.

Finally, we will review the project in the context of the MAFMC's risk policy, annual catch limit setting procedure, and accountability mandates, and provide an analysis of how to modify the Summer Flounder Fishery Management Plan to accommodate procedures as developed for this project. Our analyses will explicitly consider how the performance of management options is likely to change based on how fast an individual (or portfolio of) management measures are allowed (or able) to change over time. Though designed to be characteristic of and applied to summer flounder, our modeling framework will be sufficiently general that it could be readily modified to facilitate analyses of other species and fisheries. We plan to make code and model software available via an open source online repository to enable reproducibility and reuse of the technical tools developed during the project.

The project team will consist of Dr. Gavin Fay, assistant professor of Fisheries Oceanography at the University of Massachusetts Dartmouth, and Dr. Jason McNamee, Chief of Marine Resource Management for the state of Rhode Island. A graduate student at the University of Massachusetts Dartmouth School for Marine Science and Technology, supervised by Dr. Fay and co-advised by Dr. McNamee, will perform the bulk of the analyses. Our team combines expertise in fisheries population modeling and Management Strategy Evaluation with applied experience in the management of the summer flounder fishery. Our proposed budget for this project totals \$57,400 with the bulk of these funds being used to support the graduate student's time on the project. Our budget and work plan includes regular meetings and progress updates with Council staff and relevant sub-groups (MC) to assist in scoping and evaluating the range of alternative management measures being considered and to advise on performance metrics to best ensure the results will align with Council and Management Plan objectives.

## **Proposed Scope of Work**

We propose to use 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 will be constructed in the context of their eventual application to the specification setting process for summer flounder. The project will also be extended in to a discussion of this project in the context of the existing Summer Flounder Fishery Management Plan, suggesting changes to the existing mandates to allow for the techniques in this project to be used for management moving forward. Our MSE scenarios will be informed by extending work by Dr. John Ward (Ward 2015) on quantifying the historical effects of changes in management measures on catch and harvest. These 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*

The recreational summer flounder fishery is jointly managed by the Atlantic States Marine Fisheries Commission (ASMFC) and the Mid-Atlantic Fishery Management Council (Council) in accordance with the original fishery management plan (FMP) adopted in 1988 (MAFMC 1988). The original FMP has been modified by numerous amendments, framework actions, and addenda. Actions that have significance to this proposal are Framework Adjustment 2, Addendum XVII, Framework Adjustment 6, and Addendum XXVIII.

Framework Adjustment 2, adopted in 2001, authorizes the use of conservation equivalency (CE), allowing states the ability to use state specific recreational management measures, provided that state specific harvests fall within pre-specified harvest targets. To define the process for developing these CE proposals, states will generally view the most recent year's harvest estimates, including wave specific harvest, fish caught per angler, and wave specific harvest rates, and then use this information to either liberalize or restrict harvest in the following year. What triggers the need to act (reduce or increase harvest) is fishery performance relative to an overall recreational harvest limit (RHL) set for the coast; this RHL is parsed in to state or region specific targets. Targets are based on harvest performance in a single year (1998). At the conclusion of each year, the state's harvest according to the Marine Recreational Information Program (MRIP) is evaluated relative to the state or region specific RHL, and it is determined as to whether that state or region came in under or above their RHL in that year. If the RHL was not met, action can be taken to adjust management in the current year to better achieve the RHL. Underlying this 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.

Addendum XVII, adopted in 2005, and Framework Adjustment 6, adopted in 2006, authorized the formation of CE regions as an alternative to state-based CE. A series of regions were set up along the Atlantic coast following this action. Initially, five regions were established – MA; RI; CT/NY/NJ; DE/MD/VA; and NC. NJ was later allowed to become its own management region to allow for management measure differences to be implemented in Delaware Bay, thus creating six regions. Under this regional modification, measures for each region were developed by the technical committee (TC) which, when combined, were proposed to constrain the coastwide recreational harvest to the RHL. All three addenda were adopted under the long-standing CE standards and procedures established by Framework Adjustment 2.

The most recent action, Addendum XXVIII, adopted in February 2017, continues the adaptive regional management approach, involving the same six management regions. This latest action aimed to address the issue of fair and equitable access to the resource in the context of a historically low RHL in 2017. 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 precipitated the MAFMC to develop the request for proposals that this proposed project is answering, in essence 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 single year swings in MRIP harvest estimates. The F-based approach may also better account for important population dynamics that are currently being ignored, such as accounting for 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, trade-offs 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. All of the various options will be reviewed at different regional configurations to provide trade-off information with regard to the management unit chosen.

Here we propose to use 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. Wiedenmann et al. (2013) applied MSE to summer flounder to evaluate management and regulatory options for the recreational fishery. Our proposed work differs from that by Wiedenmann et al. (2013) by considering F-based methods for adjusting recreational fishing measures in addition to status quo approaches, using the estimated uncertainty in recreational fisheries data within management procedure, inclusion of season length as an adjustment measure, bias and imprecision in the stock assessment estimate of fishing mortality rate and the MRIP recreational harvest estimate, and by extending work by Dr. John Ward (Ward 2015) to formally quantify the uncertainty in recreational fisher's responses to changes in management measures from available data. 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: The RHL is compared to an (uncertain and possibly biased) estimate of current recreational harvest based on the MRIP statistical sampling program. Management measures are then adjusted based on proportional scaling between the point estimate of current harvest and the RHL. Within this approach, the following options will be tested:
  - a. No implementation error – the catch in the projection model is adjusted correctly based on the scaling between the current mean harvest estimate such that the harvest equals the RHL (note that the estimate of current harvest is still uncertain as it is based on a statistical sampling program so the applied catch may not be 'correct').
  - b. Season length can be adjusted proportionally – affects catch by directly affecting magnitude of effort. Effort is not necessarily related to catch in a 1:1 ratio as changes in season length can affect fisher behavior (increase effort during open periods) and discarding (fishers still fish for other species during closed periods therefore continue to catch and discard even though the season is closed).
  - c. Minimum size: adjusted based on expected relative change in catch based on the current proportions of the population in the new versus the old size range. The status quo procedure does not account for differences in weight and growth that occur when fishing effort focuses on a new portion of the population (noted also by Wiedenmann et al. 2013), nor does it account for new cohorts coming in to the population and growing in to the new harvestable size range. Additionally, accounting for the newly discarded undersized fish is not accounted for.
  - d. Bag limit can be adjusted proportionally based on the MRIP estimates of fish caught per angler. It is assumed that the number of fish caught per angler is largely based on information coming from party and charter vessels, and is potentially biased relative to the general fishing community. Another assumption is that the number of fish caught per angler is static year to year, and does not account for potential changes in availability inter-annually.
  - e. Finally, states or regions often combine methods b, c, and d above to meet management goals, by using a rudimentary calculation to account for the interaction between these different procedures.
2. Risk-based status quo: Same as (1), except the estimated uncertainty in the recreational harvest estimate is considered when compared to the RHL by using a percentile of the

distribution of the estimate of harvest or calculating the expected harvest using a simple time series model or other harvest smoothing approach (i.e. identifying outliers with Thompson's Tau method and altering using windsorization) and assuming probability distributions around the estimates of other metrics (e.g. for bag limit analyses).

3. F-based management: The stock assessment produces an estimate of the current fishing mortality rate. This can be compared to the target  $F$ , and then this is used to apply a rule to give an adjustment ratio (the rule constitutes what the adjustment ratio should be dependent on the estimate of  $F$  relative to the target, similar to the approach applied by Fay et al. 2011 and Klaer et al. 2012). This ratio can then be applied to the recreational measures described in 1b-d. Alternatives of this approach could include:
  - a. Annual adjustments implemented over several years to achieve the target  $F$  by a specific window.
  - b. An overfishing threshold projection approach, where a stochastic projection is conducted within the decision process to select a set of measures that meets a given overfishing criteria (i.e. an expected tolerance of overfishing).
4. Risk-based F-based management: as for 3, but percentile of the current  $F$  estimate is used to define the value used to determine the adjustment ratio.
5. Spatial management scale: Analyses using the above alternatives (status quo and F-based) will be conducted assuming management operates at different regional scales, to examine likely performance against objectives associated with managing at different stratification units, from coast-wide to state specific.
6. Frequency of regulatory changes: Stability in management measures has been identified as a metric of importance by the MAFMC research steering committee. The degree to which the above management measures are allowed (or can) change over time will also be investigated (number of changes and number of measures changed) to explore how the flexibility or stability of management influences the ability to meet objectives.

Approach 3 is similar to that used in the Australian Southern and Eastern Scalefish and Shark fishery for stocks where an estimate of  $F$  is available but there is no abundance information (e.g. Smith et al. 2008, Fay et al. 2011a). However, the proposed approach in this project differs from the Australian application because the adjusted  $F$  there is applied to an estimate of current catch to obtain a recommended catch level. As the purpose of this exercise is to potentially avoid relying on an uncertain and biased estimate of catch, the method proposed here will not follow the procedure in the Australian application exactly.

Crucial to the short term forecasts is a consideration of how changes to recreational management measures such as minimum size, bag limits, season length, etc. affect recreational effort and discarding rates. We aim to take an empirical approach and to extend analyses by Ward (2015) to use the available historical data on changes in catch and effort in the recreational fishery associated with changes in management measures. By using available information on fishing effort 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. Our intent is to describe general relationships that capture the characteristics of the recreational fishery dynamics and relate these to known quantities,

rather than construct a detailed mechanistic model of recreational fishing behavior and entry (e.g. Little et al. 2014).

Our analyses will focus on comparing scenarios where one of the above alternative management approaches is used. However, the framework we will develop could be extended to allow for an adaptive management approach where a decision with regard to which recreational measures to use at each time step is modeled as part of the management process, based on the currently perceived stock and fishery status, and the expected performance of the alternatives. This approach would require a pre-defined set of discrete management options.

The specifications for the management alternatives will be developed with consultation of members of the Monitoring Committee and members of other relevant bodies to ensure that the range of options explored during the analyses are plausible, and to possibly identify candidates that have not yet been identified. The intent of the analyses is to show the likely relative value of the approaches, to provide decision-makers with a means to formally weigh the benefits and costs of the alternatives.

#### *Forecasting model*

We will condition an age-structured operating model to reflect the life history and dynamics of summer flounder. Parameter values and initial conditions will be taken from estimates from recent stock assessments for summer flounder (NEFSC 2013, Terceiro 2015). 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 will generate 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 will be subject to autocorrelated bias and imprecision. The observations will then be 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.

The modeling will be 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. This software has been used to evaluate: the performance of fisheries assessments and management strategies in Southeast Australia (Fay et al. 2011); monitoring and management for Patagonian toothfish (Fay and Tuck 2011); use of environmental derivatives in fish conservation (Little et al. 2014); and the performance of assessments and management procedures when recreational fisheries data are included or not (Griffiths and Fay 2015). Aside from providing parameter values appropriate for summer flounder, modifications to the software will be made to include the recreational fishery fleet dynamics model that links changes in recreational management measures to changes in fishing mortality and harvest.

#### *Forecast Simulations*

Each of the above management alternatives will be implemented in the projection models for a large number (1,000) of Monte Carlo simulations. Each of these simulations will vary with

regard to process error (variation in year class strength), estimation uncertainty (correlated error in the estimate of current biomass and fishing mortality rate to replicate a stock assessment, as well as bias and error in the recreational catch level), application of the control rule itself, and implementation uncertainty (actual effect on recreational effort, mortality, and discards that occurs given adjustments to management measures). To compare the performance of alternatives with the maximum expected performance, simulations will also be conducted without estimation and implementation error, and when the population dynamics are deterministic (no recruitment variability). While these scenarios are not realistic in application and in practice, they will provide a baseline for the expected performance of the various approaches, given perfect information.

#### *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.

#### *Evaluating current management program in the context of this project*

As a final element of the project, we will provide suggestions on how the analyses conducted will dovetail with and help to better meet the MAFMC's current annual catch limit setting process and accountability mandates stemming from the Magnuson-Stevens Act. In doing so, we will illustrate how the procedures tested align with the MAFMC's Risk Policy in comparison with the current harvest focused management program. With an eye towards application of the simulation tested procedures and based on the procedure(s) that appear to offer the greatest benefit by way of conservation of the resource, yield to the fishery, and stability of management, we will offer language to modify the existing Summer Flounder Fishery Management Plan to allow the new processes and techniques developed in this proposed project to become a part of the recreational management process and will align with the requirements of the Greater Atlantic Regional Fisheries Office (GARFO). The proposal working group will make itself available to meet with a sub group of relevant scientists and managers, the most likely group would be a subset of the MAFMC and ASMFC's Monitoring Committee and Management Boards for summer flounder. Holding a meeting with this group early in the project will ensure successful transition from the proposed research to direct application of the deliverables to the management process.

#### Key components of the proposed work:

1. Assemble historical data on recreational management measures, catch history, recreational fishing effort, and assessment results. Use these data to estimate the parameters (and their uncertainty) of a set of relationships for the effects of recreational management measures on the recreational fishery (implementation model).
2. Present initial set of management alternatives to the appropriate MAFMC sub-group such as the Monitoring Committee (MC) and/or a subset of the ASMFC management board to solicit feedback about sets of management options, including spatial stratification of their implementation, and also on the defined plausible values for the recreational fleet dynamics models.



3. Update the management component of the 'sinatra' software to include the management alternatives described above, and condition the operating model to be characteristic of summer flounder using assessment results and other available information.
4. Conduct simulations, compare performance of current and alternative management approaches, present results to Council staff, GARFO staff, SSC, and MC for revisions.
5. Review the project in the context of the MAFMC's risk policy, annual catch limit setting procedure, and accountability mandates, and provide an analysis of how to modify the Summer Flounder Fishery Management Plan to accommodate procedures as developed for this project.

#### Deliverables:

1. Progress reports to the MAFMC at each of their scheduled August and October meeting weeks during the project period.
2. Presentation to appropriate MAFMC ASMFC sub-groups in mid 2018 to solicit feedback on range of approaches and modeling scenarios being tested.
3. Preliminary results presented to Council staff / GARFO staff / MC / SSC (possibly via webinar) around November 2018.
4. Draft final report to Council December 2018.
5. Final results presented to Council early winter 2019.
6. An R package for implementation of the analyses, that can be used to investigate other stocks and fisheries given inputs for scenarios and parameter values.
7. An additional R package that replicates the analyses in the project/paper.
8. A peer-reviewed journal paper on the analyses, to be incorporated in to the graduate student's thesis.
9. This approach will provide a new mechanism for quantifying management uncertainty for use by the MC.
10. The project will provide text on how the analysis conducted will dovetail with and help to better meet the MAFMC's current annual catch limit and accountability mandates stemming from the Magnuson-Stevens Act, and additionally will offer suggestions on how to modify the Summer Flounder Fishery Management Plan to allow for the process as developed in this proposed project.

#### **Qualifications of Applicant**

Dr. Gavin Fay, assistant professor of Fisheries Oceanography at the University of Massachusetts Dartmouth, has been conducting stock assessments and management strategy evaluations for exploited marine fish populations since 2005. Dr. Fay has 15 years experience fitting population dynamics models and comparing the performance of alternative management strategies. Dr. Fay teaches graduate courses in advanced population modeling, and modeling for ecosystem-based management and structured decision making.

Dr. Jason McNamee, Chief of Marine Resource Management for the state of RI, is a long serving member of the ASMFC summer flounder, scup, and black sea bass technical committee, a member of the MAFMC summer flounder, scup, and black sea bass Monitoring Committee, and has been a participant in the summer flounder stock assessment process since 2005.