MID-ATLANTIC

FISHERY MANAGEMENT COUNCIL

EAFM Summer Flounder Management Strategy Evaluation

Project Overview and Model Development

Mid-Atlantic Council Meeting

June 7, 2022

Riverhead , NY

Summer Flounder MSE Background

- **MSE Goals:** 1) Evaluate biological and economic benefits of minimizing rec discards (live and dead) and convert to landings and 2) identify management strategies to realize benefits
- Part of Council's continued development & implementation of the EAFM Guidance Document
  - Structured decision framework: risk assessment → conceptual model → **MSE** → implement/monitor
- MSE is a tool to test different strategies and their ability to achieve specified management objectives before implementation

MSE process and development

PHASE 1:

Public Scoping & Stakeholder Engagement

- **AP Kick Webinar**
  - 55 participants from Council and ASMFC APs
- **Scoping Feedback Form**
  - 818 unique responses
- **Regional Workshops**
  - 3 regions: MA-CT, NY-DE, MD-NC
- **Core Stakeholder Group**
  - 13 individuals representing all regions and stakeholder groups

<u>Early and continued engagement</u>

May 2020 – May 2021

AP Kick-Off Webinar –
Introduction to MSE process

↓

Scoping Feedback Form -
Broad input on variety of topics

↓

Regional Workshops –
Targeted, focused input

↓

Core Stakeholder Group –
Direct input and feedback to technical team

MSE process and development

PHASE 2: Management Considerations and Model Development

June 2021 – June 2022

Model Development

Model Refinement

- **Core Group Workshop #1** (June/July 2021)
  - Problem statement, draft management considerations
- **Workshop #2** (November 2021)
  - Refined goals and objectives, draft metrics & alternatives
- **Workshop #3** (March 2022)
  - Review draft model, refined metrics & alternatives
- **Workshop #4** (May 2022)
  - Review updated model, final metrics & alts, draft trade-offs
- **Workshop #5** (June 21st)
  - Review model outputs, final trade-offs & recommendations

MSE Model Framework

- **Management Objectives**
  - 4 Objectives: Angler Experience, Equity, Biological Sustainability, and Social/Economic Sustainability
- **Performance Metrics**
  - 17 Metrics: to evaluate performance in meeting objectives and trade-off considerations. At
- **Management Scenarios**
  - 7 Scenarios: different spatial scales (coastwide, regions, states) and range of size, season, and possession limits
- **Operating Model Configurations**
  - 3 Configurations: Baseline, MRIP bias, and stock distribution shift

Meeting Goals

- No specific decisions today
- Overview of MSE simulation model process and details on model(s) framework, data, assumptions, performance etc.
  - Introduce models and types of outputs and information provided
- Final core stakeholder group workshop on June 21st
- Present final results and recommendations at joint Council/Board meeting in August

https://www.mafmc.org/actions/summer-flounder-mse

07 June 2022

Gavin Fay
(gfay@umassd.edu)

EAFM summer flounder recreational discards Management Strategy Evaluation:
Simulation modeling overview

Why do Management Strategy Evaluations?

MSEs are a process that helps us:

- **Compare relative effectiveness of management alternatives for achieving multiple management objectives**
- Examine impacts, tradeoffs, & robustness of management strategies
- Identify sensitivity of management performance to system drivers and key uncertainty

"If we manage the system like X, what are the likely consequences compared to doing Y?"

Goals for our summer flounder MSE

- Understand consequences of alternatives for managing recreational fishery

- Can alternatives for recreational fishing regulations reduce discarding, increase harvest, maintain stock performance, & improve angler welfare & satisfaction?

- Modeling to support this work needs to be able to address these goals

Desired modeling features

- Represent plausible scenarios for our fishery system, including stock population dynamics
- Model impacts of fishing on the summer flounder population
- Effects of recreational fishing regulations on recreational harvest and discards (magnitude and size structure)
- Recognize geographic differences in recreational fishing dynamics
- Project population size through time in response to management and fishing
- Represent management actions & multiple alternatives
- Compute performance metrics relevant to multiple objectives

Coupled modeling approach

- Link extant ecological, fishery, & economic models
  - Less time on development & testing, more time on ensuring representation of working group needs
- Population dynamics & fishery model
  - Population size, status, multiple fishing fleets
- Emulate scientific assessment & management advice
- Length structure of population available to recreational fishery
- Simulate response of recreational fishery to both stock availability and regulations (at various scales).
- Feedback effect of recreational fishing response to regulations into the stock dynamics.

Modeling overview

Simulation experiment design

- 3 fishery & population dynamics model scenarios
- 7 management alternatives
- 17 performance metrics

Model components

- Fishery & Population dynamics model
- Management model
- Recreational demand model
- MSE projection loop

Fishery & Population dynamics model

- Age + sex-structured model, length structured mortality & fish growth
- Four fleets, commercial and recreational landings & discards
- Conditioned on results of 2021 Management Track Stock Assessment
- Emulating what we think the population is doing
  - stock status, productivity, etc.
- Includes assessment uncertainty in population age structure
- Validate model predictions to recent available data

Bottom line: Population model is similar to our stock assessment BUT allows us to directly include implications of changes in size structure of the removals (say due to changes in size limits)

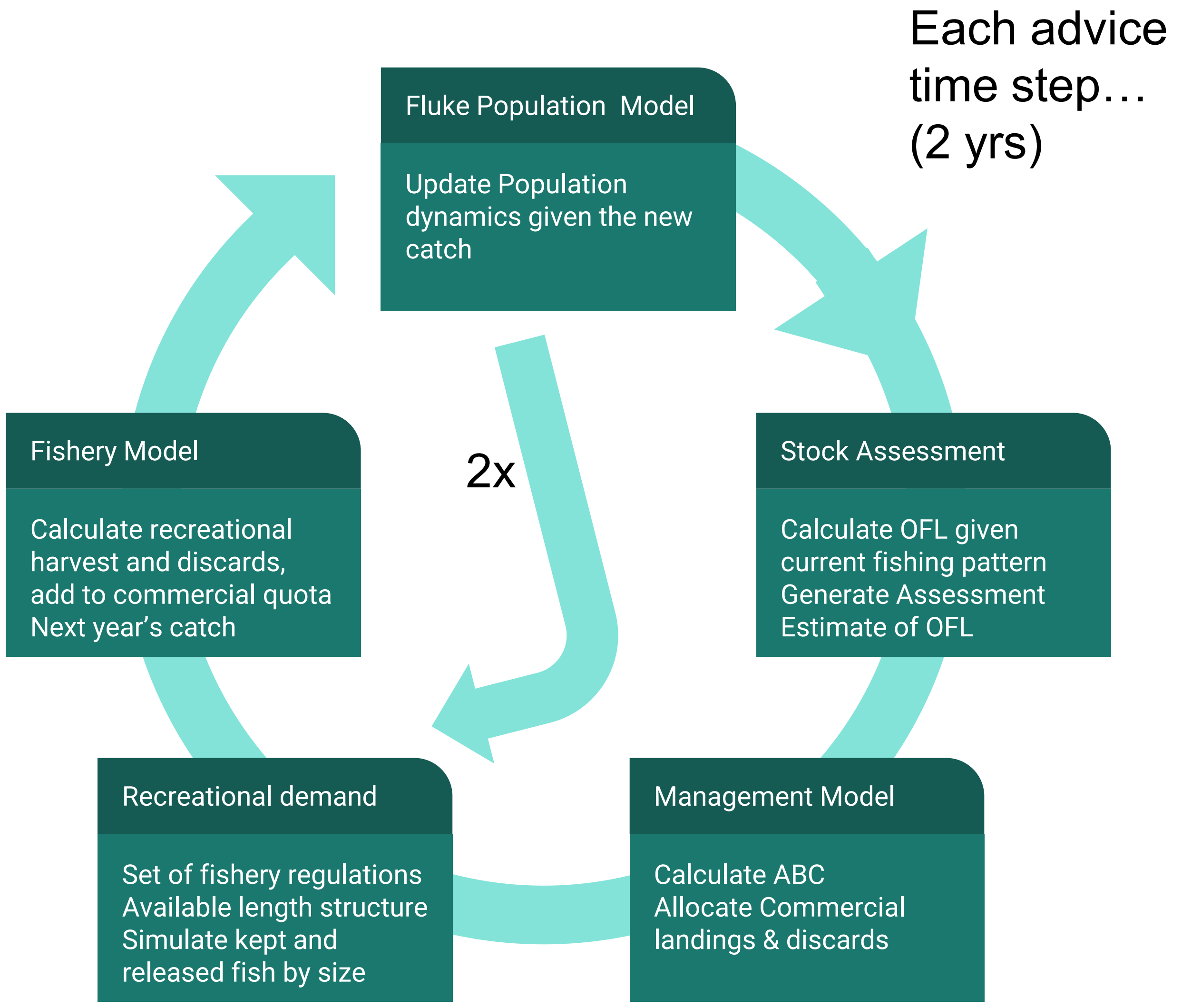
Management Model

- Streamlined to maintain focus on recreational fishery dynamics
- Approximate results of monitoring & assessment
  - Determine true OFL
  - Obtain estimate of OFL from the true value, given SSC's estimate of uncertainty in OFL
- ABC calculation via MAFMC risk policy
- Allocation of ABC to commercial & recreational
  - Commercial quota allocated to landings & discards, commercial fishery assumed to catch its quota
- Each management alternative represents a given set of recreational management regulations

Recreational Demand Model

- Predicts state-specific numbers of kept and released fish at length given
  - Population abundance availability
  - Population model size structure
  - Management alternative settings for
    - Season length
    - Bag limit
    - Size limits
- Computes number of trips, catch per trip, costs, consumer surplus, etc.
- Outputs are summed over states to obtain numbers at size kept and released for input to population model

MSE projection sequence



MSE projection sequence

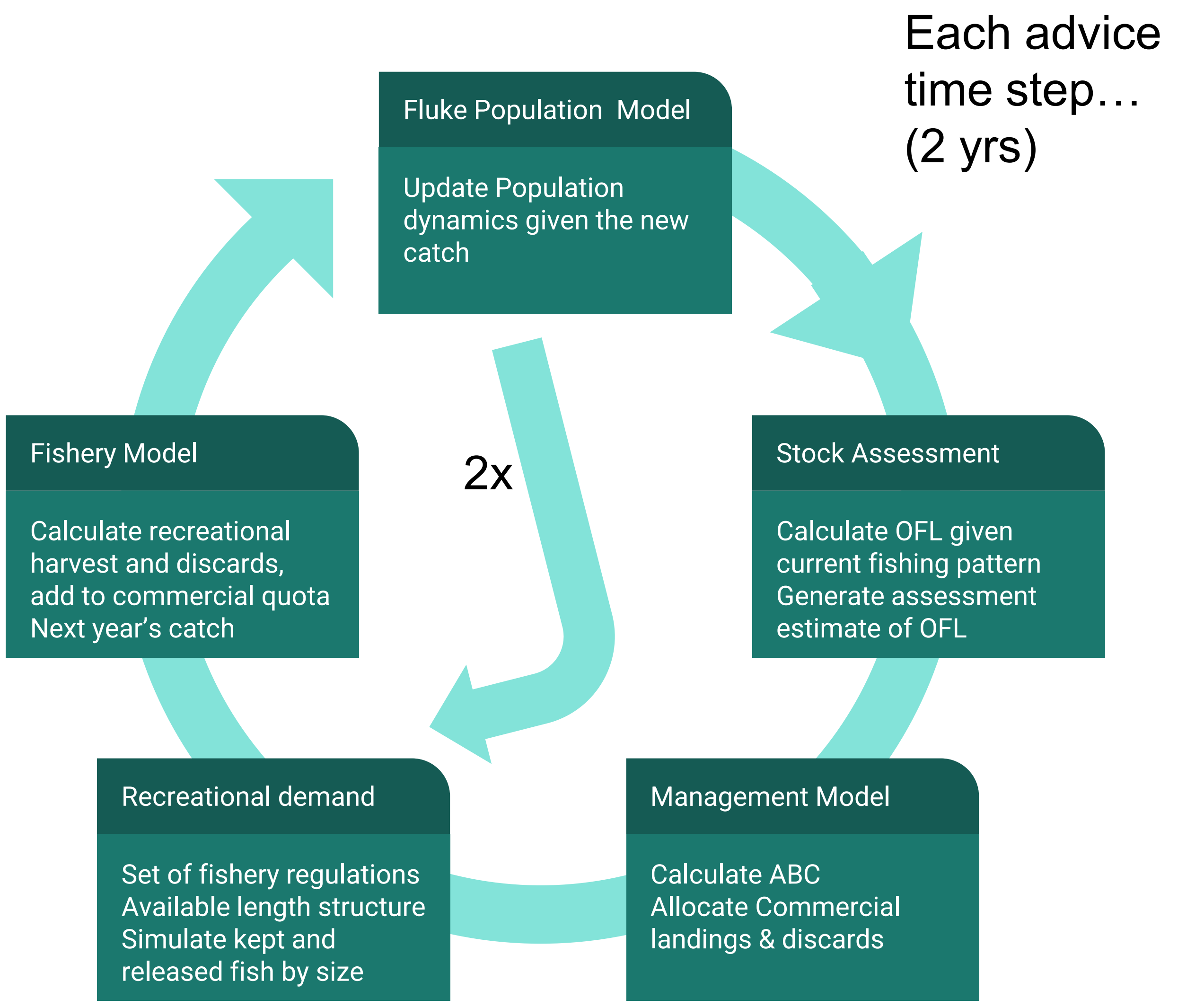
Modeling loop applied over a 26 year projection period

Management advice (ABC) updated every two years

Recreational fishing dynamics updated each year as the summer flounder population responds to recruitment and imposed fishing

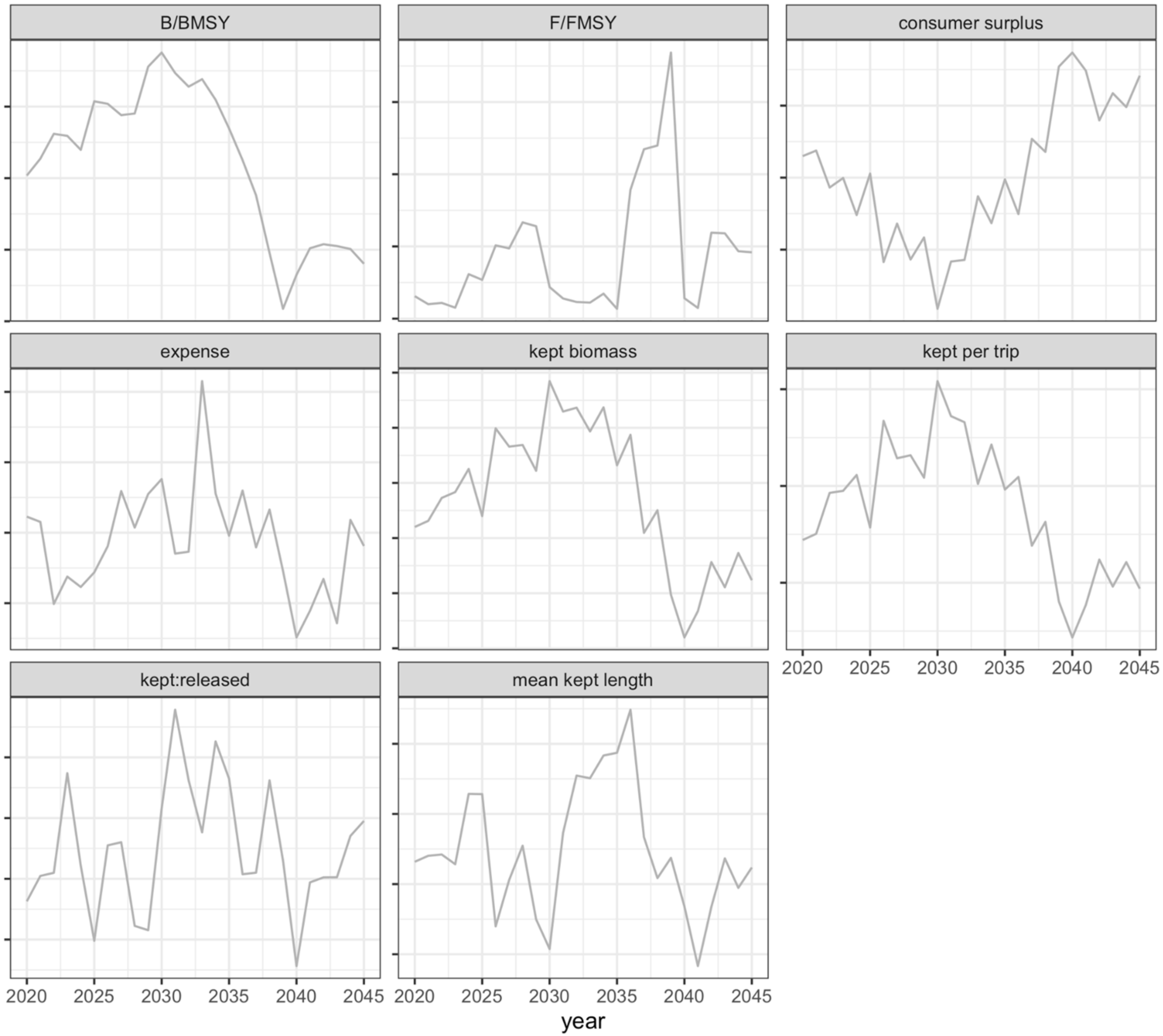
100 simulations for each combination of management alternative and operating model scenario

Compute and save performance metrics corresponding to ecological, economic, and social management objectives, as well as diagnostics.

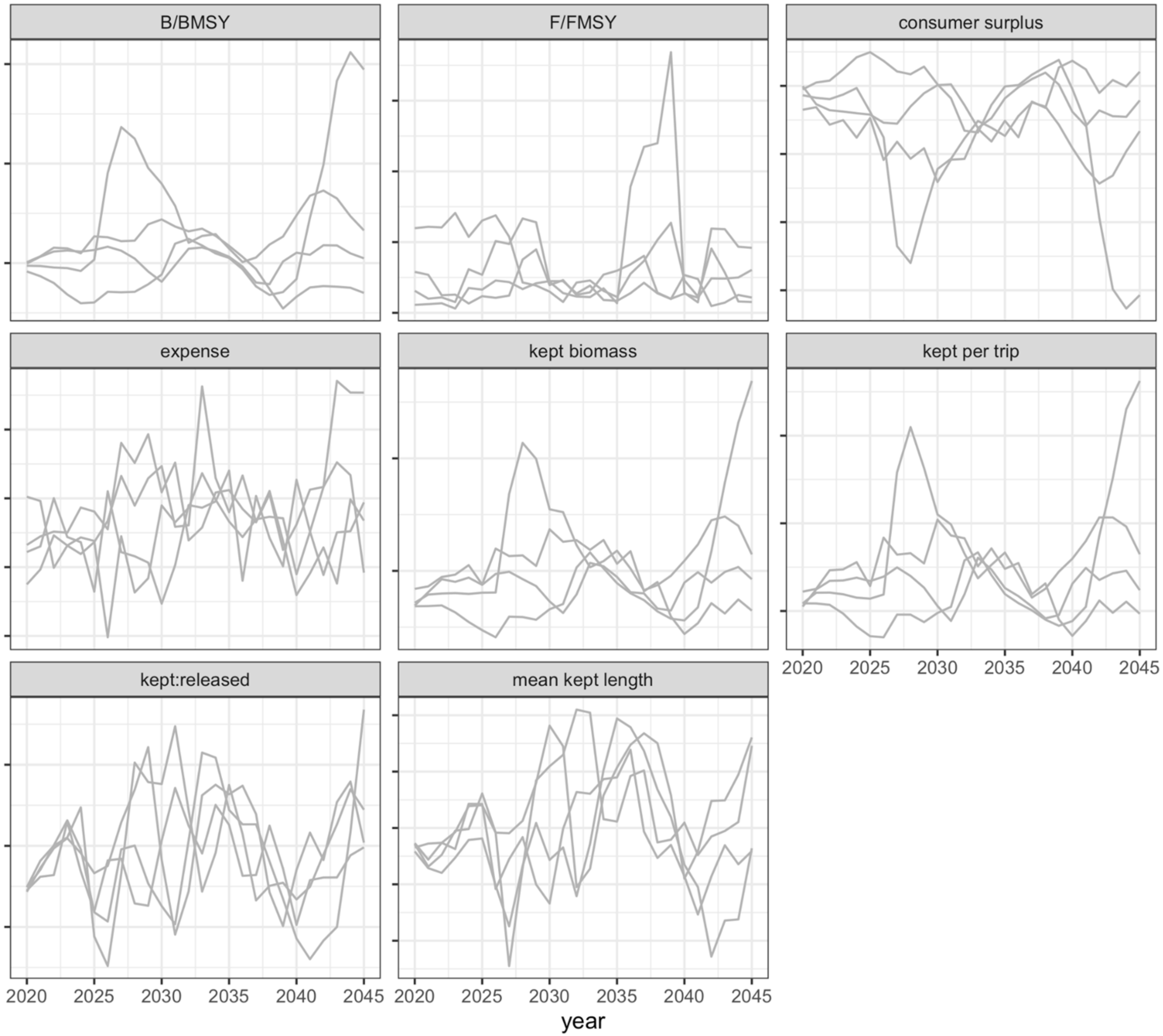


What will the results look like?

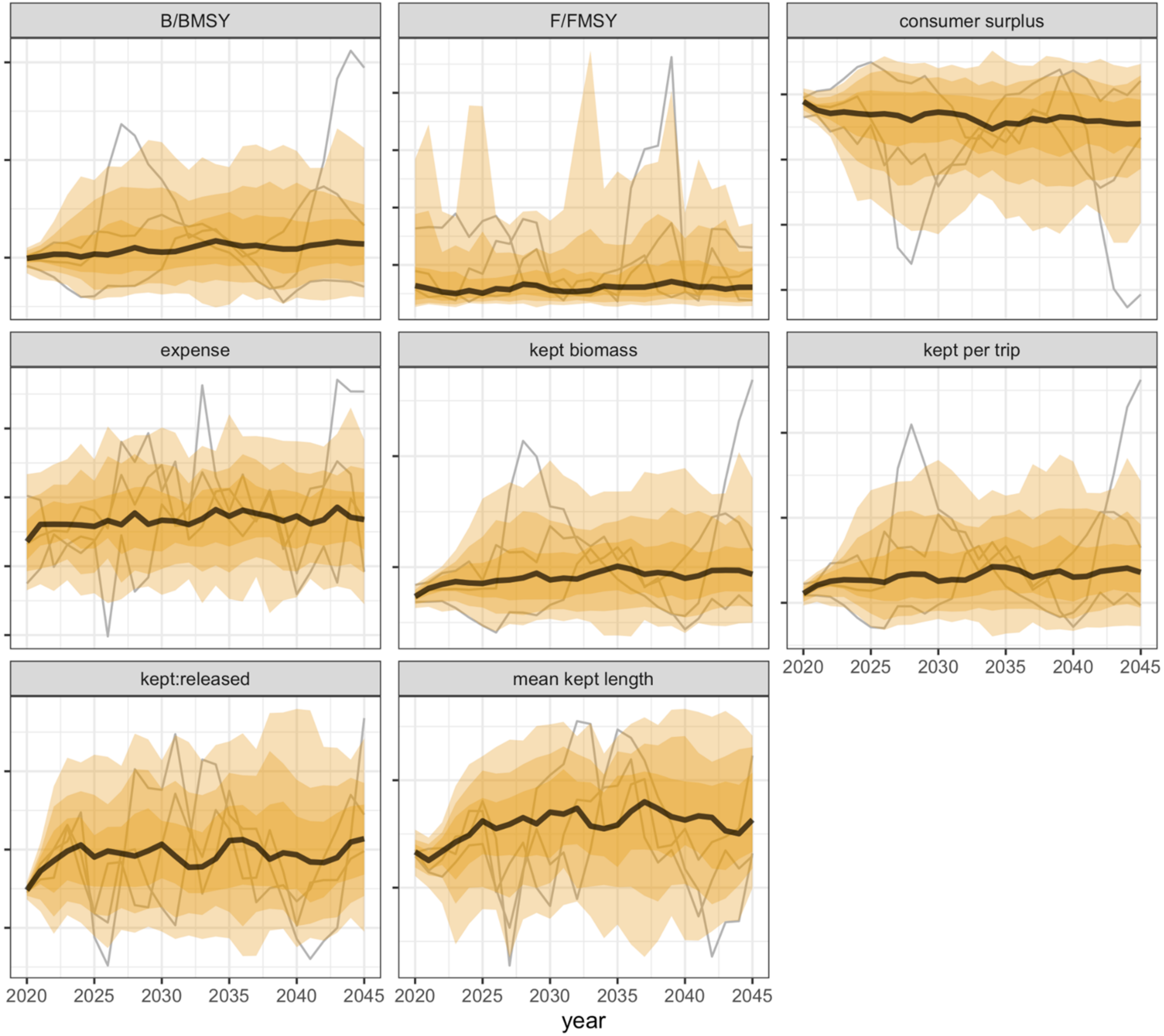
- Set of 17 performance metrics reflecting 4 management objectives.
- Summarize metrics over simulations for each alternative and scenario.
- Compare metrics among alternatives and scenarios.
- Rank comparison of alternatives based on stakeholder weighting of objectives.



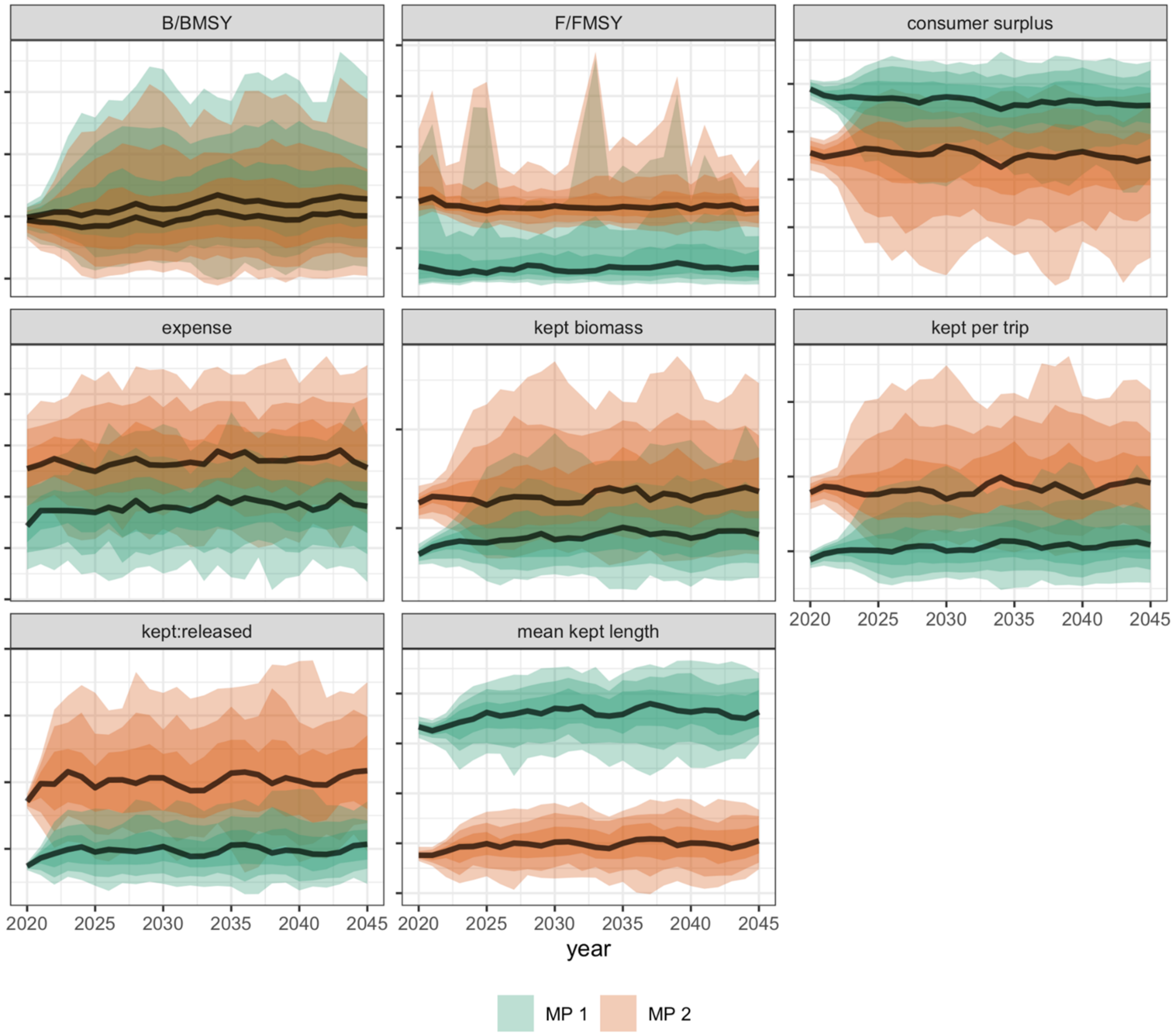
Time trajectory of projections for one complete simulation for a scenario



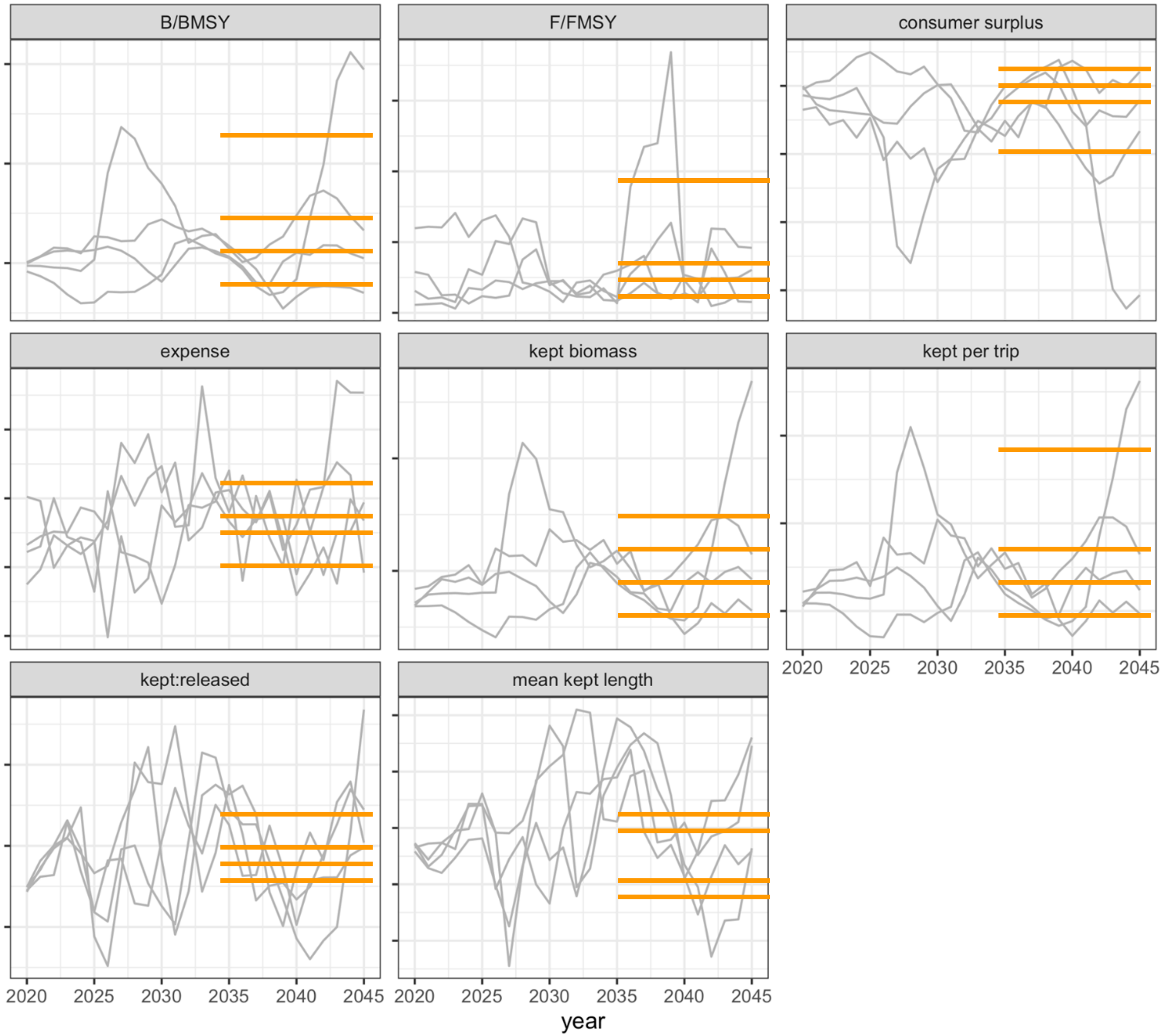
Add multiple simulations



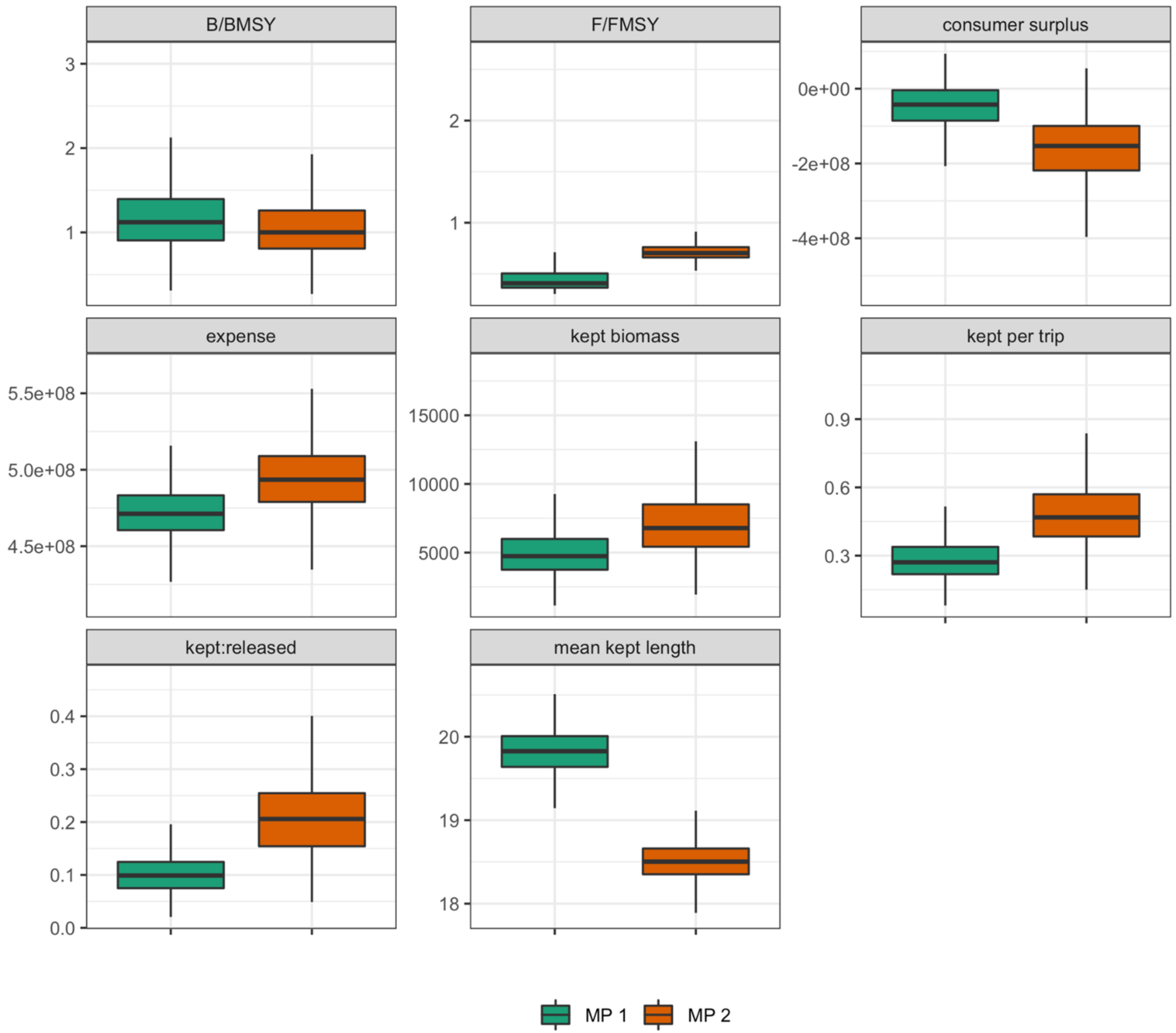
Summary distribution of the set of simulations for a scenario



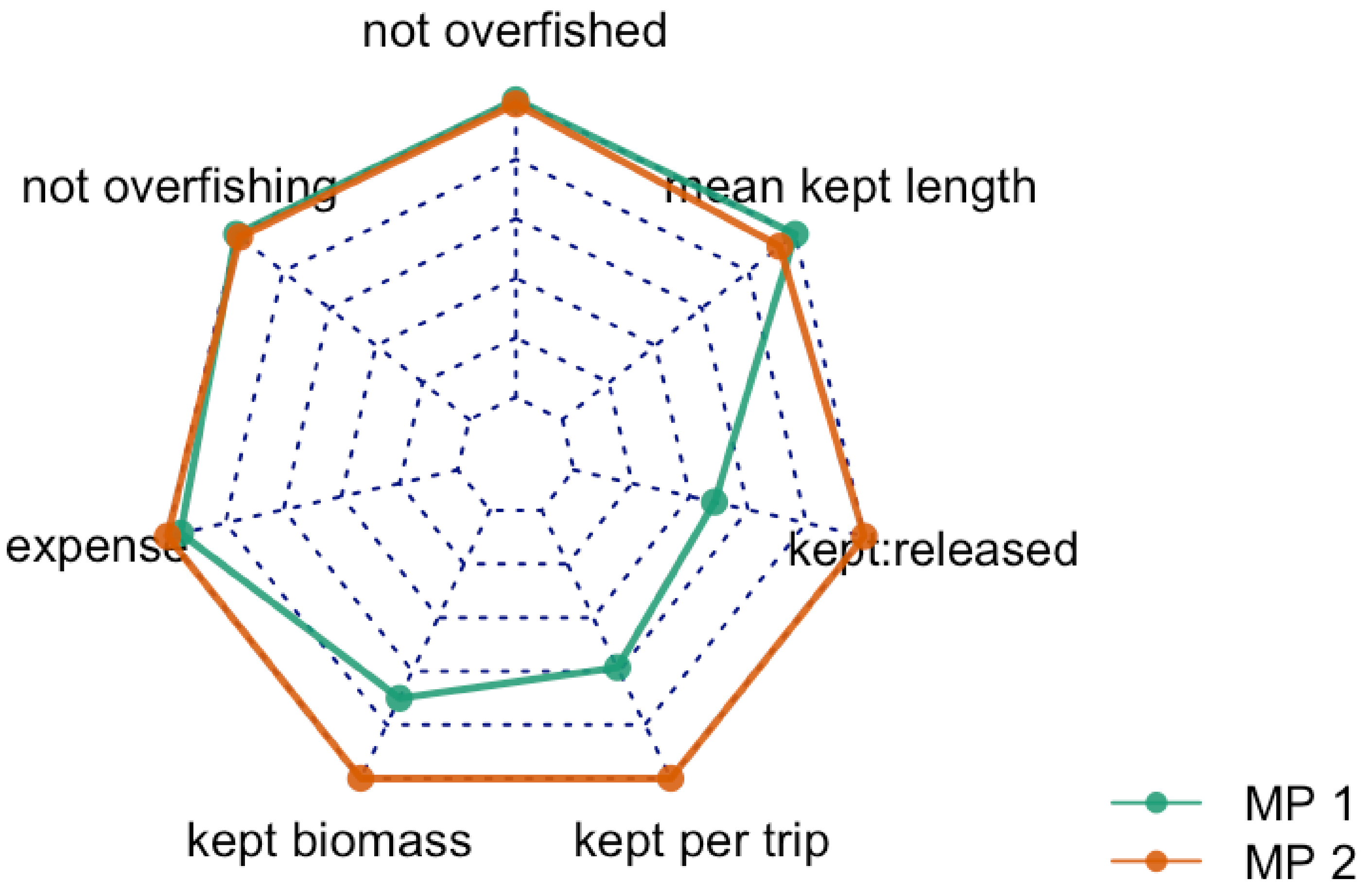
Compare among scenarios



Developing metrics
Calculate metrics by summarizing information from each simulation, e.g. here the average over time.



Developing metrics
We can show the distribution of these summary statistics over simulations for each scenario



Visualizing multiple measures together to view tradeoffs

Here a single value for each performance metric is plotted for both scenarios.

The farther out the point from the center the better the performance.

What will the results look like?

- Set of 17 performance metrics reflecting 4 management objectives.
- Summarize metrics over simulations for each alternative and scenario.
- Compare metrics among alternatives and scenarios.
- Rank comparison of alternatives based on stakeholder weighting of objectives.

Summer Flounder MSE Update: Recreational Demand Model

Andrew (Lou) Carr-Harris
Social Sciences Branch, NEFSC

Recreational Demand Model (RDM): Overview

The RDM predicts the impact of changes in stock structures and alternative regulations on:

- recreational catch (harvest and discards)
- angler satisfaction/welfare
- # fishing trips
- local economy (sales, GDP, income, jobs)

RDM Overview

Model input:

- Fluke stock structure (numbers-at-age)
- Information about angler behavior
- Set of management measures (bag, size, season limits)

Model output:

- Expected recreational catch → feeds back into the operating model
- Metrics related to angler satisfaction and success

RDM Overview

The RDM links stock structures and regulations to recreational catch through changes in **angler effort**

We model **angler effort** as a function of trip costs and expected harvest and discards

RDM predecessors

- Carr-Harris and Steinback (2020)[1]: similar model for striped bass in MA, RI, and CT
- Holzer and McConnel (2017)[2]: similar model for summer flounder in MA-VA
- Lee and Steinback (2017)[3]: similar model for GoM cod and haddock, currently provides policy-relevant advice to managers

RDM improvements from predecessors

- Incorporates correlated catch data
  - i.e., changes in expected fluke catch-per-trip affect black sea bass catch-per-trip

- Relates fluke stock structure to *both* the size and number of fish caught by recreational anglers

- Incorporates regional biomass availability
  - Allows us to predict the impact of a northward shifting biomass distribution on state-level catch

Approach

Angler behavioral model

Estimate angler preferences for harvesting and discarding fluke and other primary species

Calibration sub-model

-Simulates trip-level fishing activity under baseline-year stock conditions and mgt. measures

-Sets the number of simulated trips (choice occasions) used in projections

Projection sub-model

-Re-simulates trip-level fishing activity and predicts expected coast-wide outcomes of alternative stock conditions and mgt. measures

Approach

Angler behavioral model

Estimate angler preferences for harvesting and discarding fluke and other primary species

Angler behavioral model – data

- 2010 saltwater fishing survey
- Administered in conjunction with MRIP intercepts
- Four regional sub-versions (ME-NY, NJ, DE/MD, VA/NC)
- 10,244 surveys distributed, 3,234 returned (RR=31.5%)

SECTION B: SALTWATER FISHING TRIPS

The following questions help us understand tradeoffs made by anglers when they go fishing.
Compare Trip A, Trip B, and Trip C in the table below, then **answer** questions **2A** and **2B**.
Compare only the trips on this page. Do **not** compare these trips to trips on other pages in this survey.

	Trip Features	Trip A	Trip B	Trip C
Summer Flounder (Fluke)	Regulations	2 Fluke, 20" or larger	5 Fluke, 21" or larger	Go fishing for striped bass or bluefish
	Fish Caught	0 to 4 Fluke, 25" TL	8 Fluke, 12" TL	
	Fish Kept	0 to 2 Fluke	0 Fluke	
Black Sea Bass	Regulations	10 Bl. Sea Bass, 12.5" or larger	15 Bl. Sea Bass, 10" or larger	
	Fish Caught	15 Bl. Sea Bass, 9" TL	20 Bl. Sea Bass, 12" TL	
	Fish Kept	0 Black Sea Bass	15 Black Sea Bass	
Scup (Porgy)	Regulations	15 Scup, 11.5" or larger	20 Scup, 11" or larger	
	Fish Caught	80 Scup, 13" TL	60 Scup, 10" TL	
	Fish Kept	15 Scup	0 Scup	
Total Trip Cost		$90	$105	$160

<u>Definitions</u>:
- **Regulations:** The legal minimum size restriction and bag limit for this trip.
- **Fish caught:** The number of fish caught on this trip and the total length (TL) of those fish.
- **Fish kept:** The number of fish you can legally keep on this trip.
- **Total trip cost:** ***Your portion*** of the costs associated with this trip, including bait, ice, fishing equipment purchase or rental, daily license fees, boat rental fees, boat fuel, trip fees, and round trip transportation costs associated with traveling to and from the fishing location. Travel costs may include vehicle fuel, car rental, tolls, airfare, and parking.

2A Choose your favorite trip. (Please mark only **one** trip with a ☑ or a ☒.)

Trip A ☐
Trip B ☐
Trip C ☐
I would not go saltwater fishing ☐

Angler behavioral model – results

Table 2. Estimated utility parameters from panel mixed logit models.

	ME-NY		NJ		DE/MD		VA/NC	
Mean parameters	*Estimate*	*St. Error*	*Estimate*	*St. Error*	*Estimate*	*St. Error*	*Estimate*	*St. Error*
trip cost	-0.012***	0.000	-0.009***	0.000	-0.009***	0.000	-0.008***	0.000
$\sqrt{\text{SF kept}}$	0.559***	0.063	0.762***	0.067	0.807***	0.051	0.521***	0.033
$\sqrt{\text{SF released}}$	-0.061	0.046	0.013	0.043	0.040	0.034	0.108***	0.022
$\sqrt{\text{BSB kept}}$	0.275***	0.034	0.174***	0.034	0.239***	0.027	0.192***	0.019
$\sqrt{\text{BSB released}}$	-0.021	0.024	0.015	0.025	-0.011	0.020	0.020	0.013
$\sqrt{\text{scup kept}}$	0.075***	0.021	0.097***	0.021				
$\sqrt{\text{scup released}}$	-0.010	0.015	-0.039**	0.016				
$\sqrt{\text{WF kept}}$			0.394***	0.056	0.379***	0.045	0.231***	0.032
$\sqrt{\text{WF released}}$			0.093**	0.044	0.064*	0.036	0.030	0.024
$\sqrt{\text{RD kept}}$							0.454***	0.040
$\sqrt{\text{RD released}}$							0.081***	0.025
do not fish	-2.641***	0.252	-2.095***	0.288	-2.963***	0.259	-3.908***	0.259
fish for other species	1.429***	0.181	1.139***	0.208	0.645***	0.159	0.454***	0.121
No. choices	3460		2768		4514		8340	
No. anglers	449		359		594		1072	
Pseudo R^2	0.332		0.274		0.323		0.307	
LL	-3203.6		-2785.2		-4236.5		-8010.3	
LL(0)	-4796.6		-3837.3		-6257.7		-11561.7	
AIC	6441.1		5612.3		8506.9		16062.6	
BIC	6569.2		5765.9		8639.6		16239.4	

Notes: *,**, and *** represent significance at the 10%, 5%, and 1% level of significance, respectively. SF = summer flounder, BSB = black sea bass, WF = weakfish, RD = red drum.

Approach

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Projection sub-model

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Approach

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Calibration sub-model algorithm

Replicates 2019 fishing activity by simulating choice occasions, each consisting of:

a) Harvest and discards of summer flounder and other primary species
   - MRIP-based catch-per-trip distributions

b) Trip costs
   - 2017 angler expenditure data

c) A draw from the distribution of estimated utility parameters
   - Angler behavioral model

Calibration sub-model algorithm

Using the simulated trip attributes and utility parameters, the RDM calculates

a) the probability of taking a summer flounder fishing trip conditional on expected harvest, discards, and costs

b) dollar value of satisfaction (welfare) from that trip,

c) expected harvest and release on that trip

Simulates *N* trips such that the sum of the trip probabilities equals the MRIP point estimate of 2019 directed trips

- *N* held constant for projections

Calibration sub-model output

State	Calibration sub-model	MRIP 2019
	Summer flounder harvest	
Massachusetts	54,896 [54615, 55177]	55,386 [23325, 87447]
Rhode Island	220,799 [219764, 221834]	213,592 [51594, 375590]
Connecticut	92,581 [91951, 93211]	89,843 [54911, 124776]
New York	563,376 [559579, 567173]	561,173 [318178, 804167]
New Jersey	1,075,530 [1069815, 1081245]	1,108,158 [736178, 1480138]
Delaware	89,045 [88593, 89497]	91,025 [56129, 125921]
Maryland	77,650 [77195, 78105]	79,371 [25346, 133396]
Virginia	150,361 [149794, 150928]	149,785 [66148, 233423]
North Carolina	33,391 [33280, 33502]	34,895 [13536, 56253]
	Black sea bass harvest	
Massachusetts	52,917 [52587, 53247]	54,178 [20329, 88028]
Rhode Island	207,900 [206767, 209032]	214,471 [118736, 310206]
Connecticut	157,294 [156091, 15849]	153,564 [84144, 222985]
New York	567,622 [562454, 572790]	556,955 [349796, 764115]
New Jersey	123,443 [121616, 125270]	123,860 [65887, 181833]
Delaware	13,672 [13469, 13875]	14,348 [4518, 24178]
Maryland	12,515 [12311, 12718]	13,272 [2407, 24136]
Virginia	32,112 [31675, 32549]	31,597 [-11867, 75062]
North Carolina	0	0

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Approach

Projection sub-model

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Projection sub-model algorithm

1. Create population-adjusted catch-per-trip and catch-at-length distributions for fluke and black sea bass
   - Projected numbers-at-age from operating model
   - Harvest- and discards-at length data from MRIP and volunteer angler logbooks

2. Impose alternative fluke mgt. measures (bag, size, season limits)

3. Re-simulate trip-level outcomes for the *N* choice occasions

Projection sub-model output

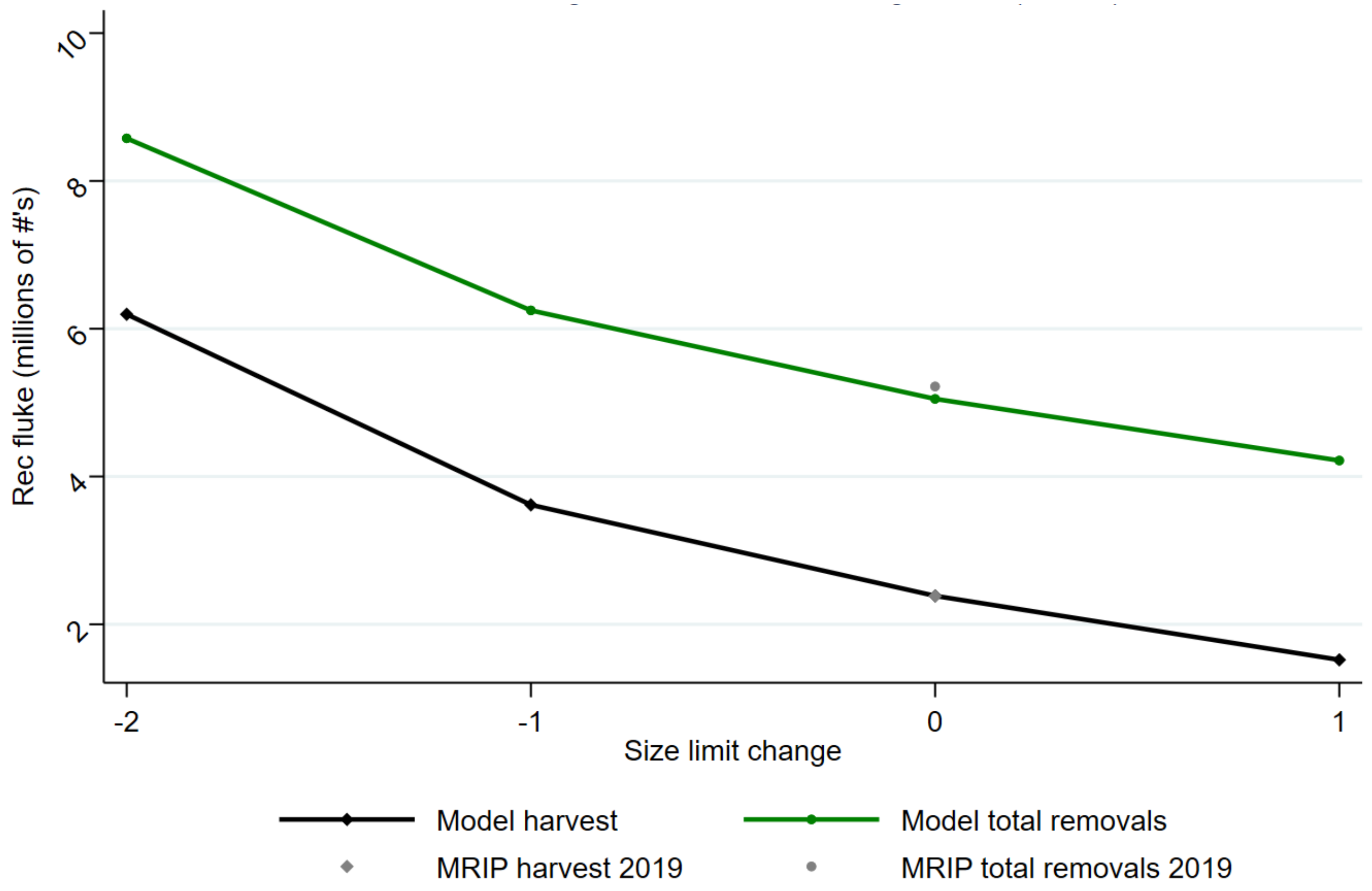
1. Recreational harvest- and discards-at-length
   - Feeds back into the operating model

2. Angler welfare change from baseline year

3. Number of directed fluke fishing trips
   - Used in conjunction with NEFSC input-output model of marine angler expenditures to calculate expected impacts to local economy

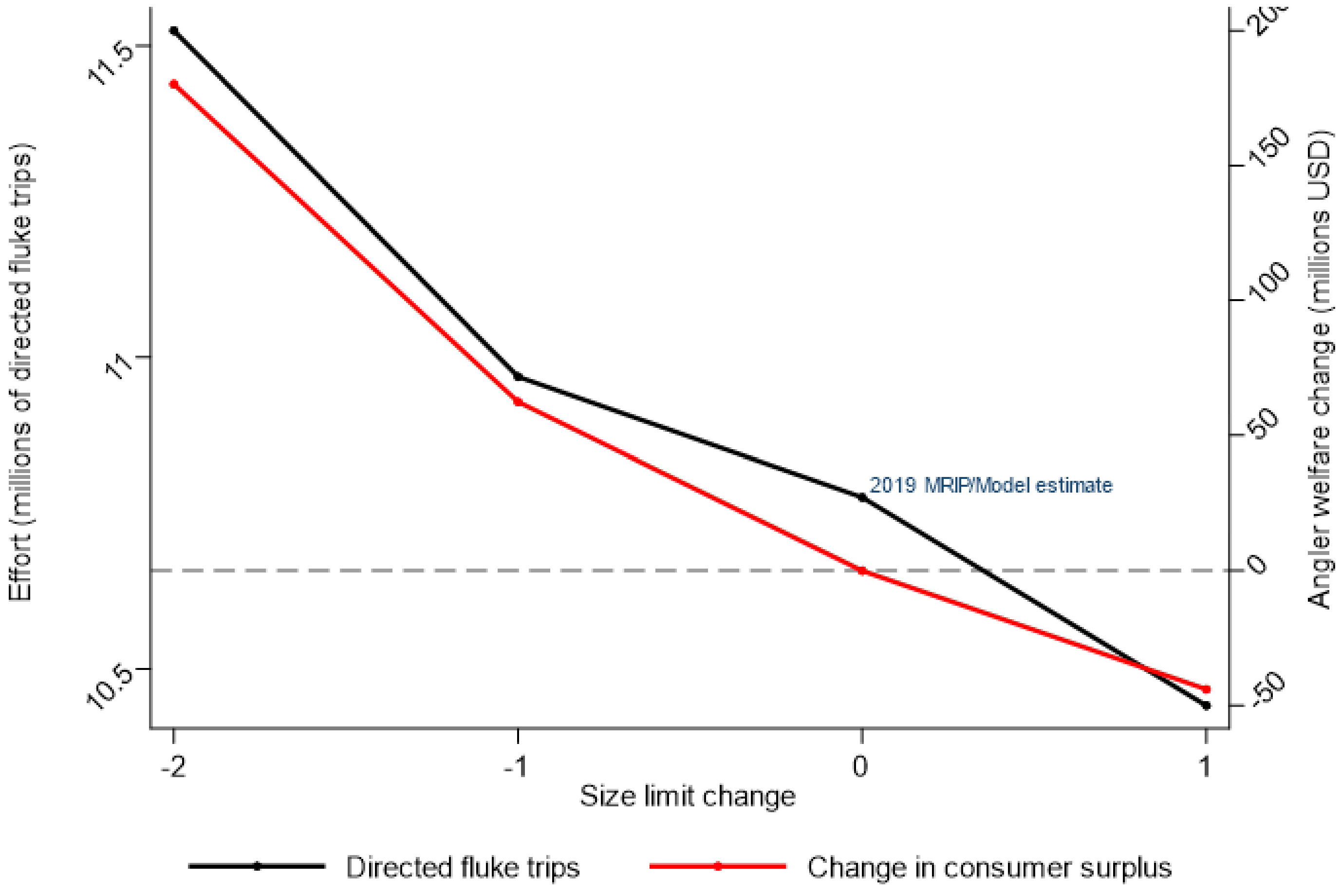
Projection sub-model example

Expected fluke catch based on universal size limit changes relative to 2019 regulations (population held constant)



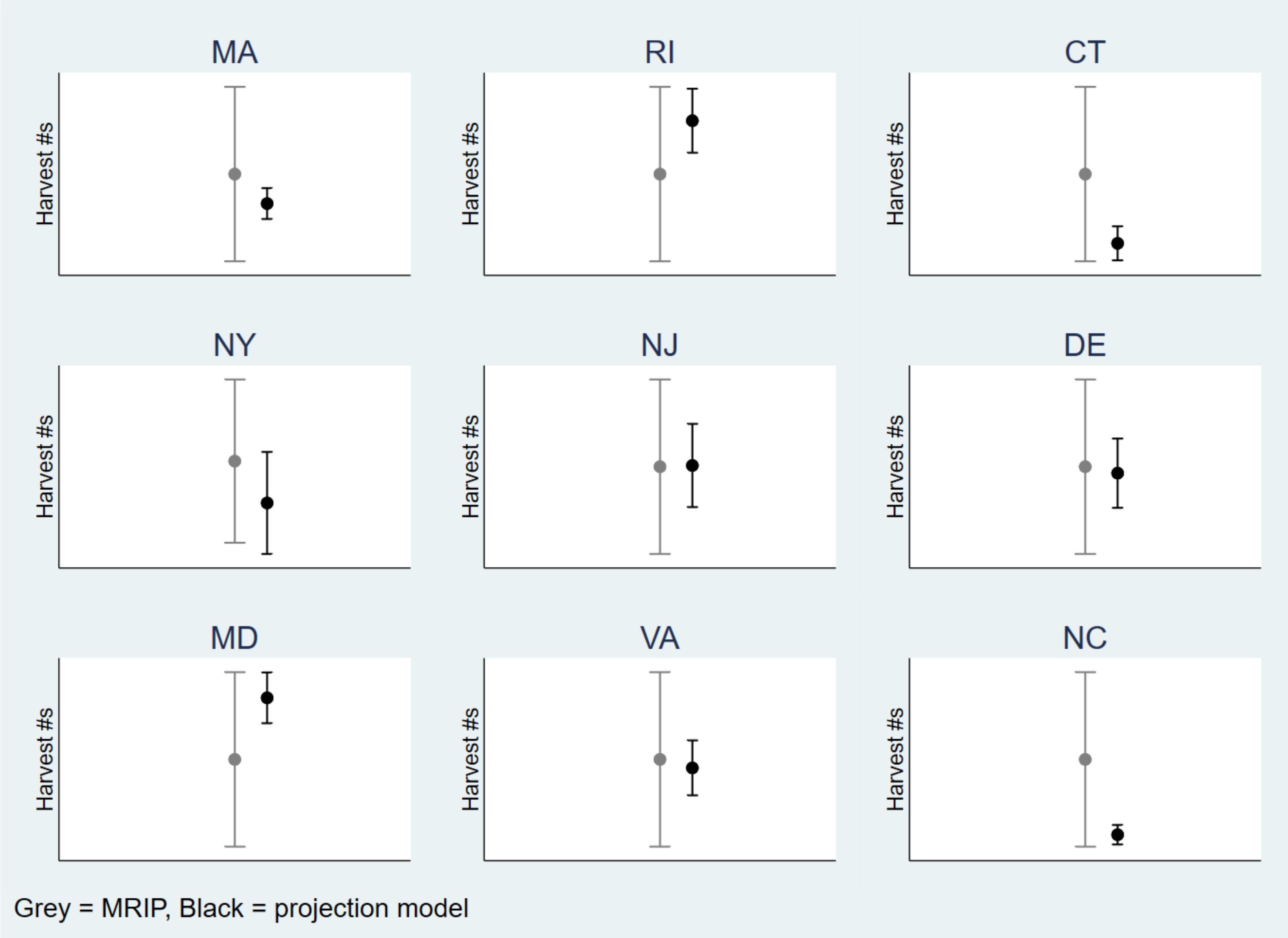
Projection sub-model example

Expected trips and consumer welfare based on universal size limit changes relative to 2019 regulations (population held constant)



Projection sub-model – out-of-sample predictions

Projection model vs. MRIP 2018 **harvest (numbers of fish)**



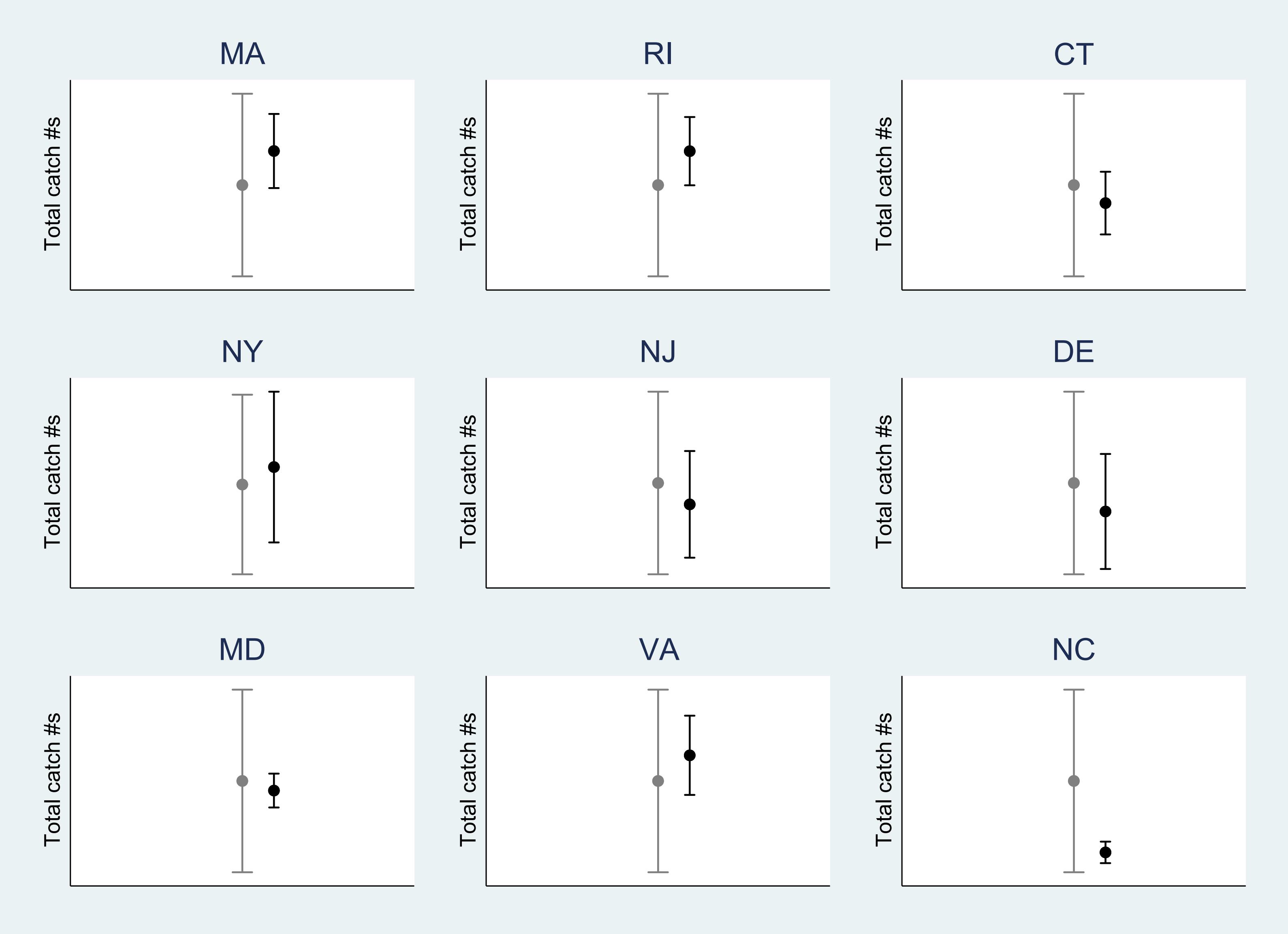
Projection sub-model – out-of-sample predictions

Projection model vs. MRIP 2018 **total catch (numbers of fish)**

Projection fluke populations
- 2018: 135M
- 2019: 154M
- ratio 2018/2019: 0.87

Simulated total catch
- 2018: 23.3M
- 2019: 29M
- ratio 2018/2019: 0.80

Actual MRIP total catch
- 2018: 23.5M
- 2019: 30.7M
- ratio 2018/2019: 0.77



Thank you!

References

[1]Carr-Harris, Andrew, and Scott Steinback. 2020. “Expected Economic and Biological Impacts of Recreational Atlantic Striped Bass Fishing Policy.” *Frontiers in Marine Science* 6 (January): 1–20

[2]Holzer, J., and K. McConnell. 2017. “Risk Preferences and Compliance in Recreational Fisheries.” *Journal of the Association of Environmental and Resource Economists* 4 (S1): S1–43.

[3]Lee, M., S. Steinback, and K. Wallmo. 2017. “Applying a Bioeconomic Model to Recreational Fisheries Management: Groundfish in the Northeast United States.” *Marine Resource Economics* 32 (2): 191–216.