The NEFSC's Recreation Demand Model and Development of a Decision Support Tool

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Outline of presentation

- Overview of the recreation demand model (RDM)
  - Discrete choice model of anglers' fishing decisions
  - Fishery simulation
- Developing the decision support tool
  - Using the online interface and example results
  - Collaborating with stakeholders

Components of the RDM

1. Discrete choice model of fishing decisions
   - Use angler survey data to estimate structural behavioral parameters representing the importance of trip attributes (e.g., harvest, trip cost) on anglers' decisions to fish
   - Allows us to compute the expected "utility" an angler would get from a fishing trip with specified attributes, as well as several other important trip-level outcomes
2. Fishery simulation
   - Use structural parameters + available fishery data to simulate trips under current conditions and alternative conditions in which some aspects are manipulated (e.g., regulations, length dist'n of the stock)
   - Compute trip-level outcomes under both scenarios and aggregate over all trips

What is a discrete choice?

- Any situation in which a decision-maker must choose between a discrete number of options, e.g.:
  - Which mode of travel a commuter takes to get to work
  - Which car to buy
  - Which job to take
  - Whether to recreational fish or not
- Discrete choice methods are designed to model these types of choices and help to understand why choices were made
- Results can be used to evaluate or predict market behavior

Random utility theory (RUT)

Under RUT[1], discrete choices are modeled under the assumption of utility-maximizing behavior

- A decision-maker receives some "utility" from each of the options
- The amount of utility can depend of characteristics of the options, characteristics of the decision-maker, and unobserved characteristics
- The decision-maker chooses the option that provides the greatest overall utility

[1] More details on random utility theory and modeling can be found in Train (2003) - *Discrete Choice Methods with Simulation*. Available free at https://eml.berkeley.edu/books/choice2.html

Discrete choice model specification

With data on:

- Anglers' choices among a set of options
  - Did they choose to fish when presented with the opportunity?
- Some characteristics about the options
  - e.g., how much fish was caught, how expensive was the trip?
- Some characteristics about the anglers themselves
  - e.g., how avid of angler are they?

...we can estimate the relative importance of each characteristic on angler choice and satisfaction

Angler survey and discrete choice experiment (DCE)

- Mail/web survey conducted in 2022 with rec. fishing licensees from MA-VA
- 2,317 completed surveys returned (RR = 38.7%)
- 30 versions of the survey, each containing a different set of 6 choice questions
- Final sample included responses from 1,437 eligible anglers who answered 8,522 choice questions

SECTION B: SALTWATER FISHING TRIPS

Suppose that you have the choice between two recreational saltwater fishing trips (**Trip A** or **Trip B**) and not going recreational saltwater fishing (**Trip C**). Below the table, indicate which of these three options would be your first choice.

REGULATIONS
You are legally allowed to keep: 2 Fluke, 18" or longer 22 Black Sea Bass, 12.5" or longer 20 scup, 9" or longer

	TRIP FEATURES	Trip A	Trip B	Trip C
CATCH	TOTAL NUMBER OF FISH YOU CATCH This number includes both undersized and legal size fish.	6 Fluke	1 Fluke	Do something other than saltwater fishing.
	NUMBER OF LEGAL-SIZE FISH YOU CAN KEEP These fish are at least legal minimum size.	2 Fluke	1 Fluke	
	TOTAL NUMBER OF OTHER FISH YOU CATCH Other fish you catch.	30 Black Sea Bass 0 scup	0 Black Sea Bass 60 scup	
	NUMBER OF OTHER LEGAL-SIZE FISH YOU CAN KEEP Other fish you catch on this trip that can be legally kept.	22 Black Sea Bass 0 scup	0 Black Sea Bass 10 scup	
TRIP DETAILS	TOTAL TRIP COST Your share of the fishing-related, transportation, and other expenses. This cost would not cover anyone else on the trip.	$160	$10	

If you were presented with these three options, which one would you choose? → **(Choose only one option.)**	Trip A	Trip B	Trip C
	○	○	○

Example choice question

Summary of discrete choice model results

- Of the three species, harvesting fluke contributes most to angler satisfaction:

$$\begin{aligned} \text{Value of one harvested fluke} &\approx 12.7 \text{ released fluke} \\ &\approx 2.3 \text{ harvested black sea bass} \\ &\approx 11.2 \text{ released black sea bass} \\ &\approx 45.9 \text{ caught scup} \end{aligned}$$

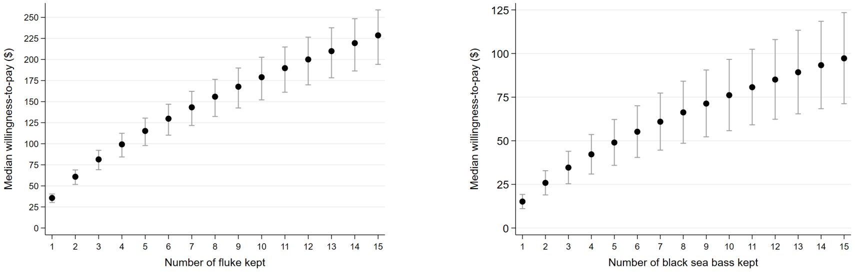
- Fluke and black sea bass are substitutes species
  - Increase in harvest of one species reduces the value of harvest of the other species, holding all else constant

- Increases in trip costs reduces angler satisfaction

- Angler satisfaction from *not fishing* increases with age, decreases with angler avidity

Economic values

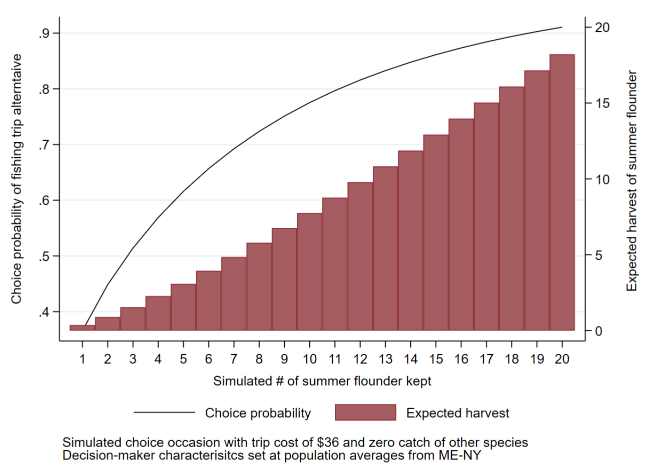
- What can we do with discrete choice model estimates?
- For one, we can compute the monetary value anglers place on keeping/releasing fish



Median willingness-to-pay for increases in harvest of fluke only (left) and black sea bass only (right)

Choice probabilities

- We can also estimate the probability an angler would take a trip, and the expected harvest of that trip, based on different trip outcomes



Counterfactual simulation

- A more practical benefit of the discrete choice modeling approach is that it allows us to conduct counterfactual simulations and assess their effect on overall angler satisfaction ($) and other trip attributes (e.g., harvest)

- We ask: what would choices be under alternative fishery scenarios?

Components of the RDM

Now for Part 2:

1. Discrete choice model of fishing decisions
   - Use angler survey data to estimate structural behavioral parameters representing the importance of trip attributes (e.g., harvest, trip cost) on anglers' decisions to fish
   - Allows us to compute the expected "utility" an angler would get from a fishing trip with specified attributes, as well as several other important trip-level outcomes
2. Fishery simulation
   - Use structural parameters + available fishery data to simulate trips under current conditions and alternative conditions in which some aspects are manipulated (e.g., regulations, length dist'n of the stock)
   - Compute trip-level outcomes under both scenarios and aggregate over all trips

Fishery simulation

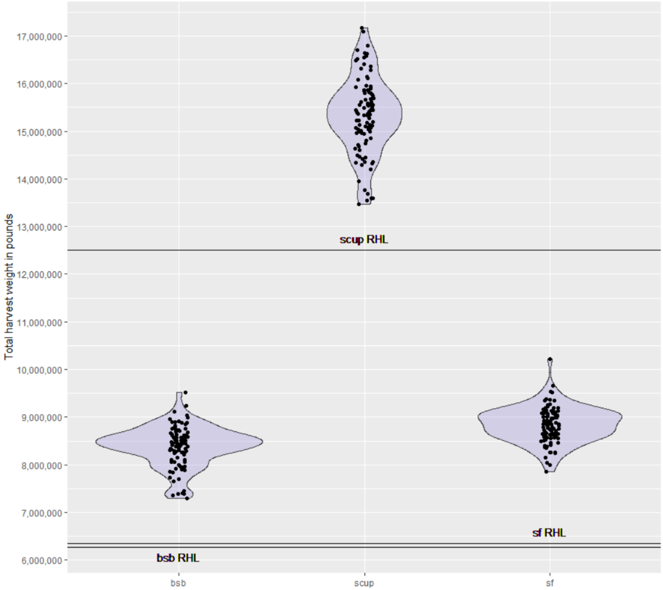
- Multi-part algorithm with three main components:
  1. Simulate "choice occasions" under baseline (2022) fishery conditions
  2. Calibration: determine how many choice occasions to simulate, ensure their outcomes are similar to observed trip outcomes in 2022
  3. Simulate choice occasions under alternative (2024) fishery conditions
- The entire algorithm is repeated 100 times, each time generating new data to account for statistical uncertainty in the input data
- Output includes predicted total harvest/discards in numbers and pounds, angler satisfaction ($), and number of fishing trips. We compute the median value of the 100 iterations as the relevant summary statistic

Incorporating statistical uncertainty

- We bake into the model any uncertainty that is exploitable in the input data

- The model is run one 100 times, each time drawing new values from the estimated distribution of:
  - Directed trips (MRIP)
  - Catch-per-trip (MRIP)
  - Projected 2024 population numbers-at-length for fluke and scup (NEFSC's stock assessment program) and subsequent 2024 recreational catch-at-length
  - Mean weight per harvested fish in 2024 (MRIP)
  - Angler behavioral parameters (discrete choice model)

Projected total harvest weight under SQ measures



Key improvements from last year

- Incorporation of MRIP statistical uncertainty in input data

- Model is run at the state, fishing mode, and daily level $\rightarrow$ enables single-day adjustments to open season and projections by fishing mode
  - In contrast, 2023 model was run at the state and bi-monthly level with post-estimation adjustments used to curtail/lengthen season by single days or weeks and provide estimates by fishing mode

- Accounts for population demographics (age and avidity) when predicting total demand for recreational fishing

Summary

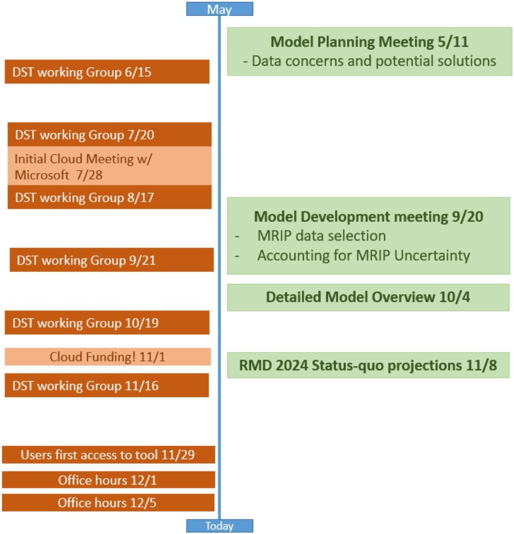
- The structural econometric model (i) provides key information about what drives anglers to fish and (ii) enables a tractable analysis on the effect of counterfactual regulations on fishery outcomes
- Unlike previous approaches for predicting harvest, the RDM accounts for angler behavioral responses to management and the projected length distribution of the stock
- Predicts changes in angler satisfaction ($) and fishing trips under proposed regulations, thus allowing for consideration of socio-economic outcomes in management decisions

Developing the RDM and decision support tool

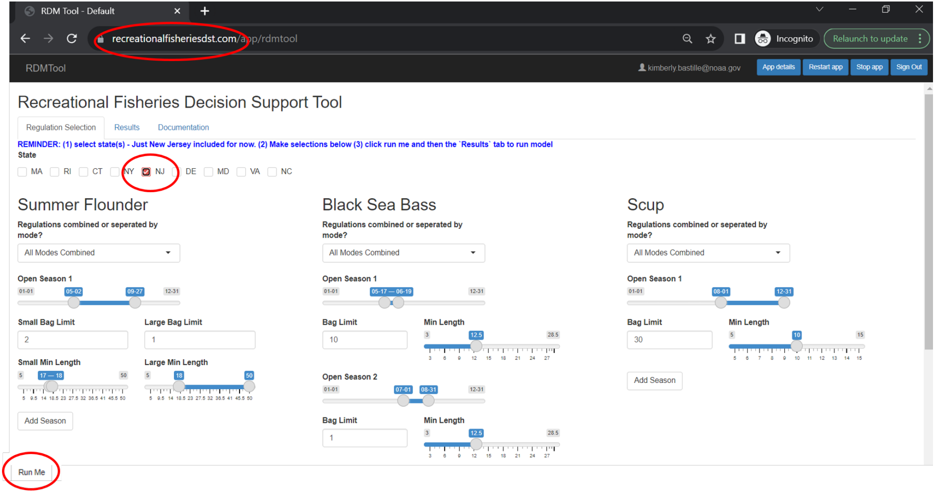
- Collaborative process with stakeholders to ensure transparency and arrive at solutions to important data challenges
- Developed first R-shiny app in NOAA cloud
  - Cloud processing reduced model run time from $\sim$6 hours to $\sim$15 minutes
- Plan to continue collaborating to improve decision support tool

Development timeline

- Monthly meetings with DST working group where we garnered and incorporated feedback about the graphic user interface
- Three meetings devoted to finding solutions to data concerns, and to provide technical overview about the model



Online user interface



Online user interface

RDM Tool - Default

recreationalfisheriesdst.com/app/rdmtool

RDMTool

kimberly.bastille@noaa.gov | App details | Restart app | Stop app | Sign Out

Recreational Fisheries Decision Support Tool

Regulation Selection | Results | Documentation

REMINDER: (1) Do not click any buttons in this tool once while it says 'Calculating'! (2) Be sure to download data (3) When finished with tool, click 'Stop App' and close out of the window.

Download

State	Species	Mode	Season	Bag Limit	Length
NJ	Summer Flounder	All	05-02 - 09-27	3 , 0	18 - 50 , 50 - 50
NJ	Black Sea Bass	All	05-17 - 06-19	10	12.5
NJ	Black Sea Bass	All	07-01 - 08-31	1	12.5
NJ	Black Sea Bass	All	10-01 - 10-31	10	12.5
NJ	Black Sea Bass	All	11-01 - 12-31	15	12.5
NJ	Scup	All	08-01 - 12-31	30	11

State	Statistic	Mode	Species	Difference relative to status-quo 2024 (median)
NJ	Change in angler satisfaction ($)	all modes	all species	-36,130,828
NJ	Change in angler satisfaction ($)	For Hire	all species	-1,120,134
NJ	Change in angler satisfaction ($)	Private	all species	-28,717,404
NJ	Change in angler satisfaction ($)	Shore	all species	-6,335,977

State	Statistic	Mode	Species	Status-quo value (median)	Alternative option value	% difference from status-quo outcome (median)	% under harvest target (out of 100 simulations)
NJ	harvest pounds	all modes	Black Sea Bass	2,337,478	2,304,987	-1.39	No harvest target
NJ	harvest pounds	all modes	Scup	238,111	185,083	-22.27	100
NJ	harvest pounds	all modes	Summer Flounder	3,619,192	2,627,171	-27.41	32
NJ	harvest pounds	For Hire	Black Sea Bass	162,829	160,859	-1.21	No harvest target
NJ	harvest pounds	Private	Black Sea Bass	2,150,512	2,120,405	-1.4	No harvest target
NJ	harvest pounds	Shore	Black Sea Bass	0	0	0	No harvest target
NJ	harvest pounds	For Hire	Scup	49,954	38,745	-22.44	100
NJ	harvest pounds	Private	Scup	188,749	146,903	-22.17	100
NJ	harvest pounds	Shore	Scup	0	0	0	Not Applicable
NJ	harvest pounds	For Hire	Summer Flounder	140,405	104,897	-25.29	7
NJ	harvest pounds	Private	Summer Flounder	3,004,631	2,205,098	-26.61	26
NJ	harvest pounds	Shore	Summer Flounder	456,044	304,318	-33.27	100
NJ	harvest numbers	For Hire	Black Sea Bass	118,164	116,746	-1.2	No harvest target
NJ	harvest numbers	Private	Black Sea Bass	1,583,878	1,560,278	-1.49	No harvest target
NJ	harvest numbers	Shore	Black Sea Bass	48,160	47,698	-0.96	No harvest target
NJ	harvest numbers	For Hire	Scup	36,679	23,284	-36.52	No harvest target

- Summary of regulations selected
- Angler Satisfaction ($)
- Harvest (Pounds, Numbers)
- Release (Pounds, Numbers)
- Dead Discard (Pounds, Numbers)
- Number of Trips

Status-quo = estimates under no change in regulations
Alternative = estimates under alternative regulations
% difference = difference between status-quo and alternative
% under harvest target = How many times does the alternative regulation meet the harvest target?

Many helping hands

Big thanks to all who provided feedback on the model and input data:

- RDM DST Working Group members
- Geret DePiper (NEFSC)
- Min-Yang Lee (NEFSC)
- Jorge Holzer (UMD)
- Sabrina Lovell (NOAA OST)
- Kurt Gottschall (CT DEEP)
- Mike Celestino (NJ DEP)
- Nicole Lengyel Costa (RI DEM)

Questions?

Back-up slides (not presented)

Similar recreational demand model applications

- 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.
- 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.
- 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.

Utility parameter estimates from mixed logit model

Attribute	Mean parameter	St. dev. parameter
$\sqrt{\text{SF kept}}$	0.827***	1.267***
	(0.070)	(0.057)
$\sqrt{\text{BSB kept}}$	0.353***	0.129**
	(0.048)	(0.071)
$\sqrt{\text{SF kept}} \times \sqrt{\text{BSB kept}}$	−0.056*	0.196***
	(0.031)	(0.024)
$\sqrt{\text{SF released}}$	0.065***	0.325***
	(0.022)	(0.050)
$\sqrt{\text{BSB released}}$	0.074***	0.055
	(0.013)	(0.034)
$\sqrt{\text{scup catch}}$	0.018*	0.024
	(0.009)	(0.025)
cost	−0.012***	
	(0.000)	
opt-out alternative:		
constant	−2.056***	1.977***
	(0.297)	(0.109)
avidity	−0.010**	
	(0.005)	
age	0.010**	
	(0.005)	
No. anglers	1,437	
No. choices	8,522	
LL	-7297	
McFadden's pseudo R^2	0.221	
AIC	14,629	

Note: Standard errors in parentheses. Variables under the opt-alternative are interacted with a dummy variable that takes the value of one if the "Do something other than fishing" alternative is chosen and zero otherwise. "Avidity" is the number of fishing trips taken in the past year.
* $p<0.10$, ** $p<0.05$, *** $p<0.010$.

Fishery simulation data

- **Angler behavioral parameters** come from the discrete choice model results
- **Total trip costs** by state and fishing mode come from NOAA's 2016-2017 National Marine Recreational Fishing Expenditures on Fishing Trips Survey, adjusted for inflation
- **Angler ages and avidities** come from unpublished survey-weighted data from NOAA's 2019-2020 National Marine Recreational Fishing Expenditures on Durable Goods Survey

Fishery simulation data

- **Directed trips data** (baseline-year 2022) from MRIP estimates at the state, month, mode, and kind-of-day level
- **Catch-per-trip data** from MRIP estimates at the state, wave, mode level using the most recent two years of data available
- **Catch-at-length data** from 2022 MRIP and volunteer angler survey data, aggregated to the region level and for all modes combined and adjusted to account for the projected length distribution of the stock in 2024

Fishery simulation data

- **Projected 2024 population numbers-at-length** from NEFSC's stock assessment program
  - Used to adjust 2024 recreational catch-at-length based on the size of fish anglers are expected to encounter

- **Mean weight per harvested fish in 2024** (under status-quo management measures) comes from 2023 MRIP data at the state and model level

- **Mean weight per discarded fish in 2024** (under status-quo management measures) comes NEFSC's final estimates of discards in weight in 2022

- **Percent changes in harvest/discard weights** between status-quo and alternative measures based on L-W equations from NEFSC stock assessment scientists

More about the model

- RDM technical overview presentation slides from Summer Flounder, Scup, and Black Sea Bass Monitoring Committee Meeting on October 6th, 2023: https://www.mafmc.org/council-events/2023/oct-06/sfsbsb-mon-com