Summer Flounder Quota Allocation Analysis

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Recreational Analysis

Study Outline

Goal of Recreational Component:
Measure the benefits (or costs) to recreational anglers from a change in the summer flounder quota.

Key Steps:

- Develop a model of individual angler behavior *using data from new MRIP methodology*
- Develop a measure of the costs or benefits from quota changes
- Aggregate results to population
- Using aggregate results, develop marginal analysis for allocation recommendations
- Recognize limitations of model

What is the recreation data telling us about Summer Flounder?

1. Focus on NC to MA
2. Drop waves 1 (Jan-Feb) and 6 (Nov-Dec)
3. Summer Flounder is heavily caught and targeted
4. Even non-targeted trips might catch summer flounder

Details

The Econometric Model

Our work follows previous work by McConnell and Strand, and Hicks et al.

Key Insight:
The summary data suggests that even those not directly targeting SF may catch SF and therefore, we need a model that allows trip values to be influenced by a broad range of species.

The Econometric Model: Choice Structure

Choice structure:

- We model the choice of mode [shore, private/rental, party/charter], species group [small game, bottom fish, summer flounder][1], and fishing site (at the county level).
- **80 x 3 x 3** potential choice alternatives per observed trip in the data.
- We have approximately 26,000 trips (in NC-MA in 2018) $\times$ 720 choice alternatives $=$ 21.6 million rows of data for modeling!

[1] Other species groups such as big game, other flat-fish, non-specific targets are ommitted from our analysis.

McConnell/Strand Species Groupings

Small Game		
Striped Bass	Bluefish	Jack
Pompano	Seatrout	Bonefish
Bonito	Snook	Red Drum
Barracuda	Mackerel	
Bottom Fish		
Sandbar Shark	Dogfish Shark	Cat Shark
Sand Tiger Shark	Smooth Dog Shark	Carp
Catfish	Toadfish	Cod/Codfish
Pollack	Hake	Sea Robin
Sea Bass	Sawfish	Grunt
Kingfish	Mullett	Tautog
Butterfish	Nurse Shark	Brown Cat Shark
Porgy/Scup	Sheepshead	Pinfish
Snapper	Grouper	Perch
Black Drum		
Flat Fish		
Summer Flounder	Winter Flounder	Southern Flounder
Sole	Founders	
Big Game		
Blue Shark	Tuna	Marlin
Thresher Shark	Great Hammerhead	Swordfish
Shortfin Mako Shark	Tiger Shark	White Shark
Smooth Hammerhead	Scalloped Hammer	Tarpon
Billfish	Sailfish	Dolphin
Cobia	Wahoo	
Other Fish		
Herring	Eel	Skate
Puffer	Blacktip Shark	Requiem Shark
Dusky Shark	Atlantic Sharpnose	Bull Shark
Smalltail Shark		

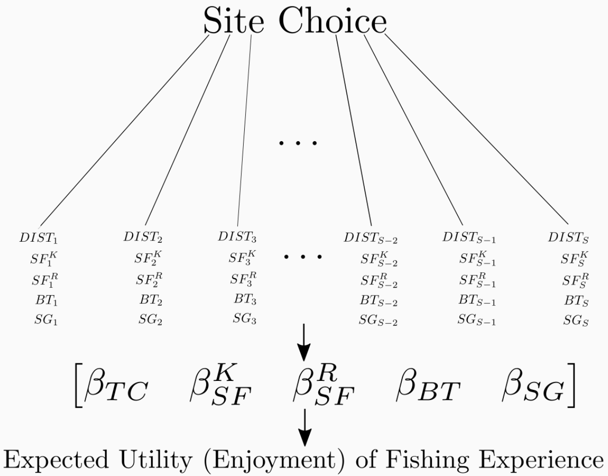
Reducing size of Choice Structure
Using the NOAA Fisheries S&T distance files, we limit the choice structure to those sites within 150 miles of the respondents home.

Note: This necessarily eliminates all persons in the MRIP sample living far away ($>$150 miles) from their chosen site.

Correcting for MRIPS Sampling Intensity

Since strata are over (under) sampled in MRIPS, we use the supplied sample weights for calculating **any** summary statistic (e.g. average per site catch for summer flounder) in this study.

RUM Choice Model for Recreation Demand



Model Details   Result Details

Policy Analysis: CV for Keep versus Release of SF

For the policy analysis data will remain as observed in the data, except for landings and released historical catch averages for summer flounder. Note that the allocation policy

- Doesn't alter total catch (combined keep and release)
- Does alter the distribution of total catch between keep and release categories.

Example: a +10% Increase in Summer Flounder Allocations to the Recreational Sector

Table 1: Example Policy Impacts on Catch and Keep Rates

Policy	Total Catch	Landings	Release
0	5	3	2
1	5	3.3	1.7

Details

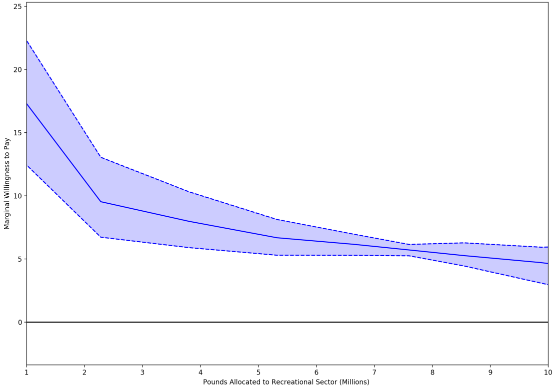
Policy Analysis: Compensating Variation

The standard welfare calculation for angler i at time t (defined as compensating variation (CV)) for a change in policy affecting site-specific variables from $\mathbf{x}$ by altering recreational allocation and hence site specific summer flounder catch rates is defined as:

$$CV_{it}(\Delta) = \frac{log\left(\sum_{i \in S} e^{\mathbf{x}^0_{ist}\beta}\right) - log\left(\sum_{i \in S} e^{\mathbf{x}^1_{ist}\beta}\right)}{\beta_{tc}}$$

For total willingness to pay (across the population), we calculate the sample weighted average compensating variation ($\overline{CV}$) and multiply times total number of trips.

Marginal Willingness to Pay Recreational Sector (Time Cost Excluded)

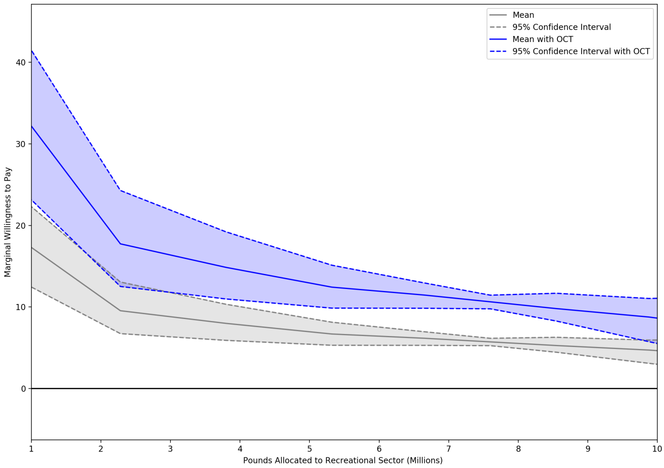


Details Compare to 2014 Estimates

Table 2: A comparison of Summer Flounder Marginal Willingness to Pay Estimates

Study	Mean Value per Pound	Opportunity Cost of Time	Weighting	Nested
Current Study	\$18.75 - \$2.11	Not Included	Yes	No
Hicks et al. 2017	\$9.86 - \$2.07	Not Included	Yes	No
Gentner et al.	\$3.48	Included	No	Yes
	\$2.38	Not Included	No	Yes
	\$1.45	Included	No	No
	\$0.80	Not Included	No	No
	\$0.99	Included	Yes	No
	\$0.53	Not Included	Yes	No
Massey et al.	\$1.59	Unknown	Unknown	No

Policy Simulations: Marginal Willingness to Pay [including opportunity cost of time]



Discussion

Observed differences with our earlier 2017 study might be due to

- Behavioral differences in conditions: quotas have been tightening and each landed fish is more valuable for anglers. This may change behaviour and hence estimated model parameters.
- Biological differences in abundance of summer flounder and substitute species
- The new data collection methodology is very different and there is little evidence apart from this study on how the methodology impacts willingness to pay for recreational fishing.
- Recreational policy measures for 2018 were not successful in meeting target quota (since MRIPS estimated catch exceeds 40% allocation).

Recreational Model Caveats

- Uses historical data on recreational catch (2014-2018) to characterize current conditions in the fishery.
- Due to data limitations, ignore changes in trips that might occur due to quota changes
- Ignore losses/gains in profits at charter operations, bait shops, and boating repair and supply businesses.
- Due to data limitations (no economic add-on), the preferred estimate of MWTP uses benefits transfer methods.
- This method scales our estimated marginal willingness to pay to account for time costs in the model using two parameters estimated in Gentner et al. 2010, neither of which are significantly different from zero at the 5% level.

Commercial Analysis

Overview

- Our analysis differs from the prior work on sector allocation (Gentner et al. 2010; Carter et al. 2008), but follows the methods used in our 2017 work
- Our analysis uses the Random Utility Model (McFadden 1978) framework
- We use the model as a predictive model of commercial fishermen behavior

Model Overview

Steps:

1. Estimate trip-level costs
2. Estimate a site choice model for commercial fishermen
3. Combine (1) and (2) into a fleet simulation
4. Use (1) - (3) to estimate marginal values per a pound

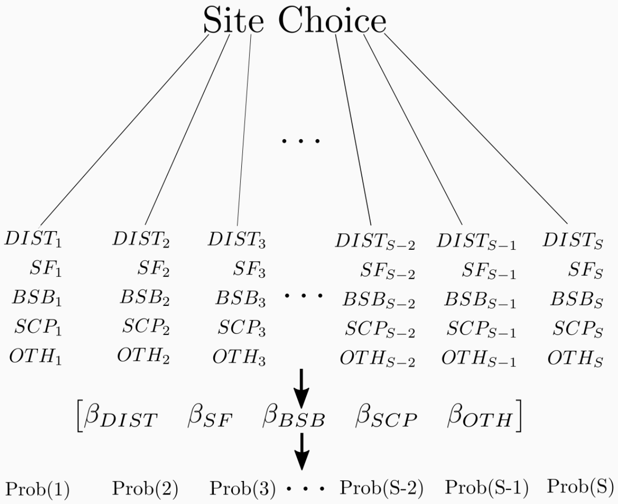
Step 1: Estimating Trip Level Costs - Outline

- We use trip-level cost data from 2000 through 2018 (updated from our prior work through 2014)
- Data was obtained from the Social Science Branch of the NMFS Northeast Fisheries Science Center
- Part of the annual data collection of the Northeast Fishery Observer Program (NEFOP)
- We focus on all vessels who landed summer flounder (analysis done at the trip level)
- Estimate a log-log trip level cost function (cost imputed for years beyond 2014)

Step 2: Modeling Discrete Choices

- Modeling builds on an extensive literature of spatial choice modeling in fisheries (Curtis and Hicks 2000); (Hicks and Schnier 2008); (Haynie et al. 2009); (Holland and Sutinen 1999,2000); (Smith and Wilen 2003)
- Based on the estimation of a random utility model (RUM) (McFadden 1978). Same model used in recreational section.
- We incorporate alternative specific constants (Timmins and Murdock 2007); (Smith 2005); (Hicks et al. 2012)
- Use 60-day lags to calculate the variables
- 12,778 unique trips between 2000-2018
  - 6,982 unique trips with at least 10% summer flounder
  - 4,656 unique trips with at least 33% summer flounder

The Commercial Choice Model



Model Details

Step 3: Policy Simulation

The simulation model uses the parameter estimates from Steps (1) and (2) to simulate fleet behavior

- Step 1: Initialize the TAC in the commercial sector (1,000 metric ton increment up to 24,000 metric tons)
- Step 2: Take a random draw from the parameter distribution
- Step 3: Randomly draw fishing trip from data and calculate probabilities:

  $$P(i,t) = \frac{e^{U(i,t)}}{\sum_{j \in N} e^{U(j,t)}}$$

  and multiply the probability by the expected catch rates and calculate expected catch for each species. E.g. summer flounder:

  $$E[Catch_{SF,t}] = \sum_{j \in N} P(j,t) * SFExp_{j,t}$$

Step 3: Policy Simulation, cont.

- Step 4: Reduce the TAC's by the expected catch
- Step 5: Calculate the expected profits from each trip

$$\sum_{i \in N} P(i,t)[SFRev_{i,t} + BSBRev_{i,t} + SCUPRev_{i,t} + OtherRev_{i,t} - TripCosts_{i,t}] \tag{1}$$

- Step 6: Determine if the current catch exceeds the allocation and if TAC not exceeded return to step 2
- We increase commercial TAC up by 1,000 and then re-run and store results

Simulation Models

- All models use state allocations for summer flounder, black sea bass and scup
- All models utilize seasonal fishing patterns to distribute summer flounder trip effort
- Model 1: All trips that from vessels that landed summer flounder (12, 778 trips)
- Model 2: Only trips with at least 10% of revenues from summer flounder (6,982 trips) Preferred Model
- Model 3: Only trips with at least 33% of revenues from summer flounder (4,656 trips)

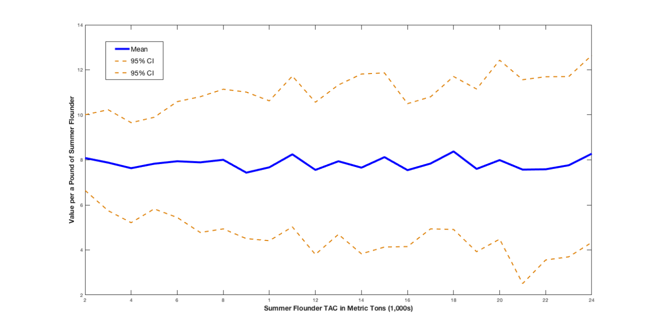
Marginal Values

- Construction of Marginal Values:

$$\text{Marginal Value}_k = \frac{Profit_k - Profit_{k-1}}{1000 * \text{Metric Ton}}$$

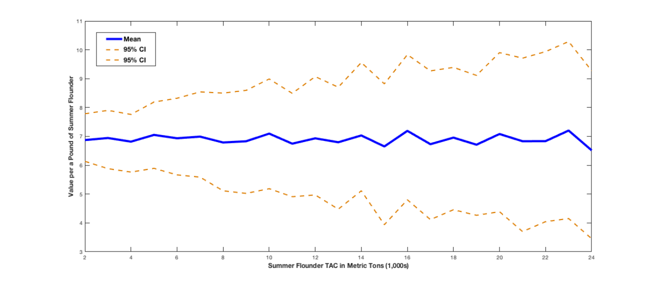
- We simulate each quota change 40 times and use the convolution method to generate 1,600 simulated outcomes
- Construct 95% confidence intervals
- Profits are based on the catch of all species

Commercial Marginal Values for Model 1

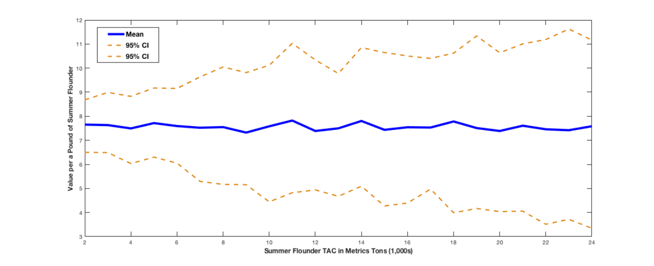


Commercial Marginal Values for Model 2

(Preferred Model)



Commercial Marginal Values for Model 3



Differences Between Prior Model

- The marginal value per a pound of summer flounder is higher than in our prior model
- Difference is attributable to the growth in average price:
  - Summer Flounder: $2.64 to $3.25
  - Black Sea Bass: $3.26 to $3.53
  - Scup: $1.11 to $0.99 (small decrease)
  - "Other": $1.29 to $1.49

Commercial Model Caveats

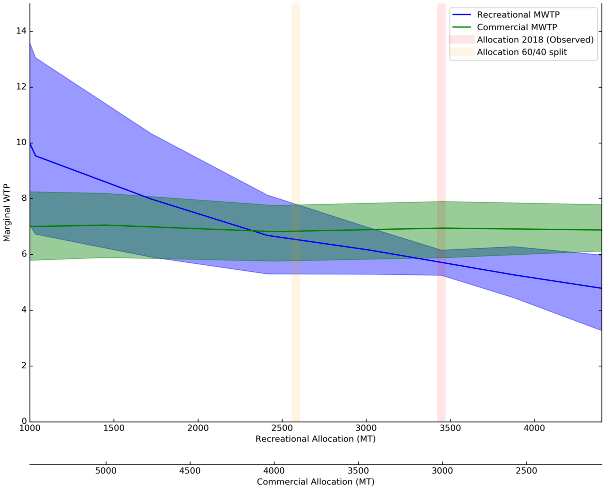
- Data relies on observer data so it is not a complete data set of all activity
- Short run analysis - prices are not endogeneous, exit/entry
- Model does not account for localized depletion of the resource
- Relies on historical data to characterize current conditions in fishery
- Focus on at-sea commercial behavior and ignores any changes in consumer and produce surplus in the commerical sector *solely due to quota changes* such as boating and dock services, and losses in consumer surplus for consumers of summer flounder.

Allocation Analysis

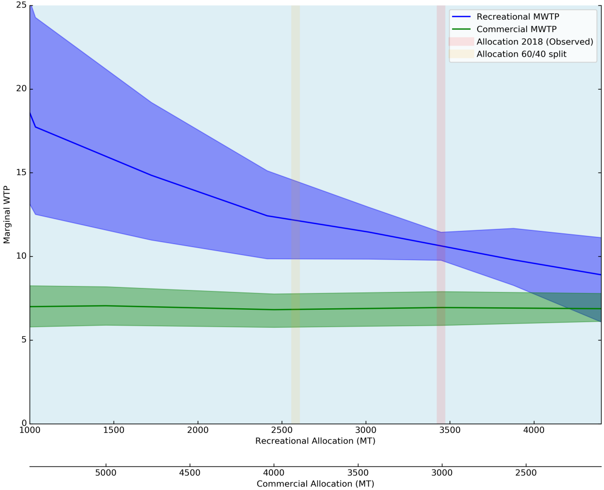
Equimarginal Principle

If the value of the last pound of fish allocated to the commercial sector is equal to the value of the last pound allocated to the recreational sector, we have maximized benefits to the nation from the fishery.

Marginal Analysis for the Preferred Models



Marginal Analysis for the Preferred Models



Recommendations

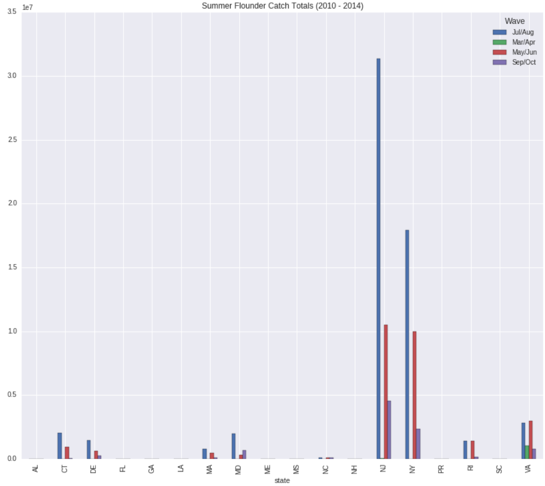
- The current analysis supports changes in allocations between sectors in either direction. It is likely (but not statistically significant) that increasing the recreational allocation from 60/40 would increase benefits from the fishery.
- With perfect data collected using the new MRIPS methodology allowing for a model including the opportunity cost of time, our opinion is that truth lies somewhere between what is plotted in the preceding two slides but with larger confidence intervals in the recreation MWTP.

Appendix

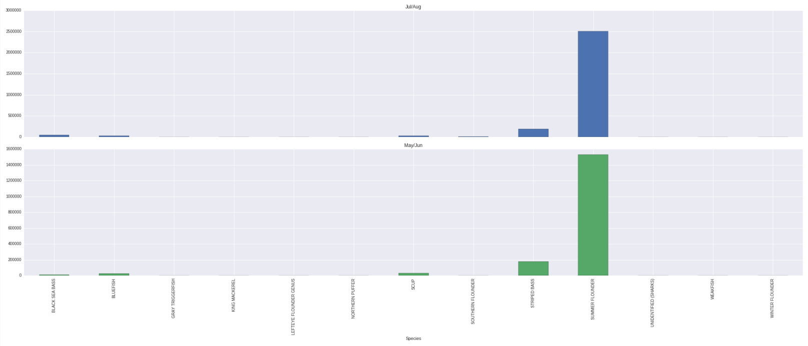
IT Infrastructure

	Recreational			Commercial		
	MySQL	Python	R	MySQL	Python	Matlab
Data Acquisition						
Clean Raw Data for DB storage		x		x	x	x
Store in Database	x	x		x	x	
Data Assembly						
Retrieve from DB	x	x		x	x	
Reshape for Econometric Model		x			x	x
Merge and combine		x				x
Survey adjusted Means and Totals		x	x	N/A	N/A	N/A
Store analysis data in DB	x	x				x
Econometric Model						
Retrieve from DB	x	x				x
Final Assembly		x				x
Model Estimation		x				x
Store parameters in DB	x	x				x
Policy Analysis						
Retrieve data and parameters from DB	x	x				x
Simulate Behavior		x				x
Calculate Policy Means and Totals		x	x			x

Summer Flounder Recreational Total Catch by State

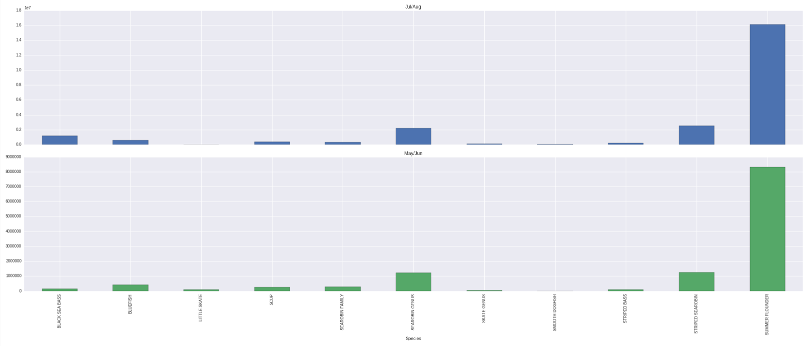


Summer Flounder in Context: Species Caught in NY



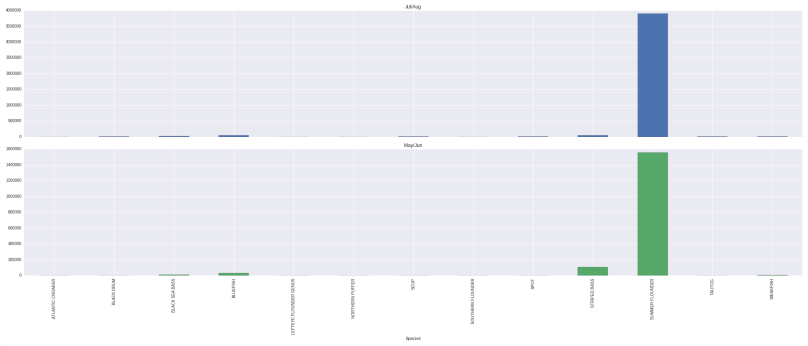
Note: this is based on 2017 study data.

Summer Flounder in Context: Species Targeted in NY



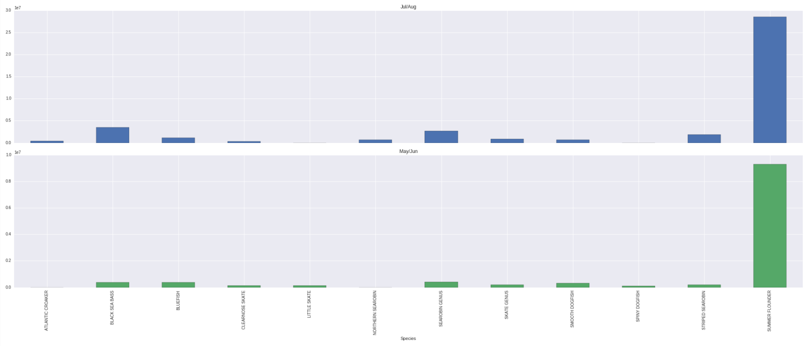
Note: this is based on 2017 study data.

Summer Flounder in Context: Species Caught in NJ



Note: this is based on 2017 study data.

Summer Flounder in Context: Species Targeted in NJ



Back to Back to Presentation Note: this is based on 2017 study data.

Results: RUM Model

	Mean	Std Dev	Min	2.5%	50%	97.5%	Max
β_{tc}	-0.1049	0.0007	-0.1072	-0.1062	-0.1049	-0.1036	-0.1027
β_{lnm}	1.3504	0.0126	1.3137	1.3255	1.3504	1.3758	1.3939
β_{bt}	0.0745	0.0090	0.0425	0.0573	0.0744	0.0920	0.1064
β_{sg}	0.4796	0.0086	0.4497	0.4630	0.4796	0.4960	0.5066
$\beta_{sf,land}$	1.5421	0.0633	1.3720	1.4314	1.5379	1.6703	1.7335
$\beta_{sf,release}$	0.4645	0.0232	0.3938	0.4169	0.4652	0.5058	0.5255
β_{pr}	2.7471	0.0331	2.6595	2.6901	2.7416	2.8188	2.8521
β_{sh}	3.4908	0.0325	3.4125	3.4396	3.4863	3.5597	3.5975

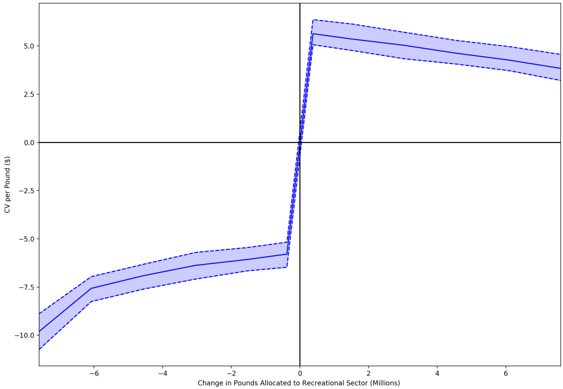
Back to Recreational Model Summary

Table 3: Marginal Willingness to Pay by Quota Allocation

Pounds	Metric Tons	Lower 95% CI	Mean MWTP	Upper 95% CI
759,965	345	13.51	18.75	24.03
2,279,894	1,034	6.73	9.54	13.05
3,799,823	1,724	5.90	7.98	10.32
5,319,752	2,413	5.30	6.68	8.13
6,649,690	3,016	5.29	6.16	6.96
7,599,646	3,447	5.25	5.71	6.15
8,549,602	3,878	4.44	5.27	6.28
9,879,540	4,481	3.09	4.71	5.93
11,399,469	5,171	1.58	3.80	6.09
12,919,398	5,860	-0.46	3.22	6.11
14,439,327	6,550	-2.08	2.11	6.75

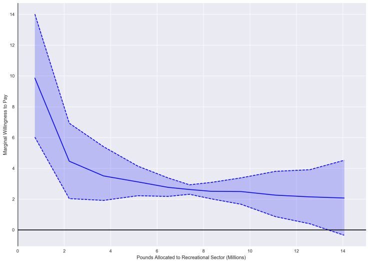
Back to marginal value plot

Policy Simulations: CV per Pound

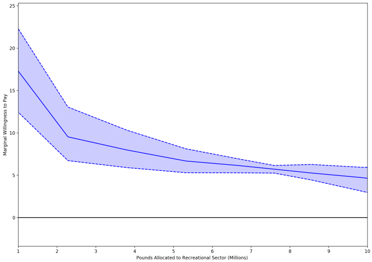


Back to Total CV

Comparison of MWTP estimates



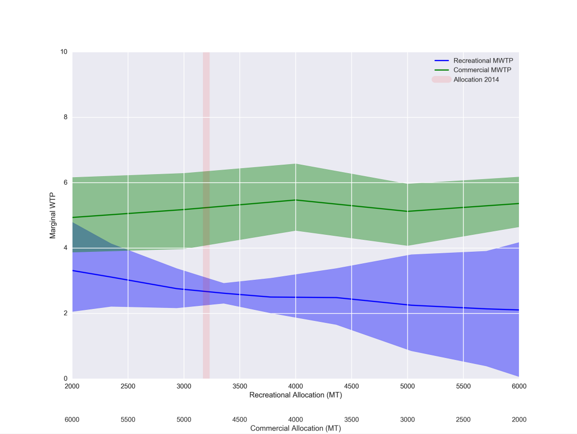
(a) 2014



(b) 2018

Back to Back to MWTP Estimates

2017 Allocation Figure [No OCT]



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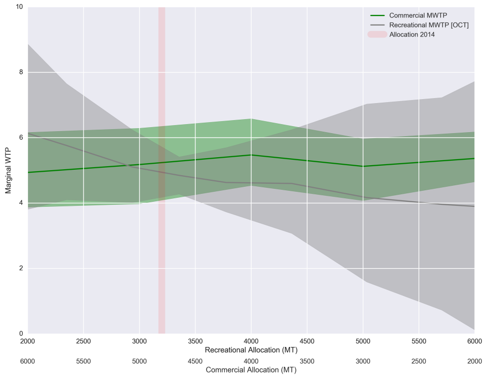
2017 Allocation Figure [OCT]



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The Econometric Model: Expected Catch, Release, and Keep, cont.

In this study we need to analyze allocation policy which will alter landings (keep) of SF. So we calculate mean landings and release rates (numbers of fish) for each mode and site for summer flounder.

Choice Probability

Following normal conventions on assumptions about site, mode, and species specific errors (ϵ), we can model the probability that an individual chooses g (species), n (mode), and s (site) as

$$P(g, n, s) = \frac{e^{U(g,n,s)}}{\sum_{i \in G} \sum_{j \in M} \sum_{k \in S} e^{U(i,j,k)}}$$

Using likelihood contributions like this for each individual, we define the log-likelihood function.

Formal Recreational Choice Model

We assume an individual will choose species group g, mode n, and site s by comparing the alternative specific utilities if it is the best one:

$$U(g,n,s) + \epsilon_{g,n,s} > U(i,j,k) + \epsilon_{i,j,k} \forall i \in G, j \in M, k \in S$$

where all species groups are denoted by G, all modes M, and all sites S.

The Econometric Model: Site-Specific Utility Specification

Ignoring subscripts indexing individuals, we have for summer flounder the utility at each site k and mode j:

$$\begin{aligned} U(SF, j, k) = &\beta_{tc} TC_k + \beta_{lnm} log(M_k) \\ &+ \beta_{SH}(mode_j == SHORE) \\ &+ \beta_{PR}(mode_j == PRIVATE/RENTAL) \\ &+ \beta_{SF,K} Keep_{SF,j,k} + \beta_{SF,R} Release_{SF,j,k} \end{aligned} \tag{2}$$

The Econometric Model: Site-Specific Utility Specification,cont.

For the other two species, we have similar specifications. For example, for bottom fish the utility at each site k and mode j:

$$\begin{aligned} U(BT, j, k) = & \beta_{tc} TC_k + \beta_{lnm} log(M_k) \\ & + \beta_{SH}(mode_j == SHORE) \\ & + \beta_{PR}(mode_j == PRIVATE/RENTAL) \\ & + \beta_{BT} Catch_{BT,j,k} \end{aligned} \tag{3}$$

Back to Recreational Choice Model

Choice Model Details

Individual *i* will choose site *j* if it is the best site:

$$U_{ijt} + \epsilon_{ijt} > U_{ikt} + \epsilon_{ikt} \forall k \in S$$

For our application (subscripts for individual, site, and time dropped):

$$\begin{aligned} U = &\gamma_i + \beta_1 * Distance_{ijt} + \beta_2 * SF_{Revenues} + \beta_3 * BSB_{Revenues} + \\ &\beta_4 * SCUP_{Revenues} + \beta_5 * Other_{Revenues} + \beta + 6 * No_{Choice} \end{aligned} \tag{4}$$

Back to Commercial Choice Model Summary

Policy Analysis: CV for Keep versus Release of SF,cont.

Pre-policy Keep and Release rates at site k, mode j is $Keep^{0}_{SF,j,k}$ and $Release^{0}_{SF,j,k}$.

Following the policy change (for example giving more Keep to recreational anglers) Keep and Release change to

$$Keep^{1}_{SF,j,k} = Keep^{0}_{SF,j,k} \times (1 + \Delta) \tag{5}$$

$$Release^{1}_{SF,j,k} = Release^{0}_{SF,j,k} - \Delta \times Keep^{0}_{SF,j,k} \tag{6}$$

Note that: $Keep^{1}_{SF,j,k} + Release^{1}_{SF,j,k} = Keep^{0}_{SF,j,k} + Release^{0}_{SF,j,k}$

Policy Analysis: Quota Changes and Site Attributes

For a ΔQ pound change in the recreational quota from 2014 levels (Q_{2018}), we map quota changes to site specific catch changes by constructing Δ:

$$\Delta = \frac{\Delta Q}{Q_{2018}}$$

and apply the summer flounder catch rate formulas from the previous slide. Back to Policy Change Summary