"A la carte" management of recreational resources: Evidence from the US Gulf of Mexico

Brenna Jungers [1] Joshua K. Abbott [1]
Patrick Lloyd-Smith [2] Wiktor Adamowicz [3]
Daniel Willard [4]

[1]Arizona State University

[2]University of Saskatchewan

[3]University of Alberta

[4]Environmental Defense Fund

Introduction

- Management tools traditionally used in recreational (regulated open access) fisheries are inefficient (Homans and Wilen, 1997; Holzer and McConnell, 2014)
- In a perfect economic world, we would charge one price that perfectly captures intertemporal stock externalities (McConnell and Sutinen, 1979; Anderson, 1993)
- We live in a second-best world, and so need tools like differentiated pricing instruments to reach "closer to optimal" outcomes (Lipsey and Lancaster, 1956; Fenichel and Abbott, 2014)

Introduction

We use choice experiment data from a survey of anglers who took deep sea fishing trips aboard headboats in the U.S. Gulf of Mexico to estimate structural models of trip-taking and red snapper retention.

Using those behavioral models, we produce *ex ante* simulations of differentiated pricing instruments in the recreational red snapper fishery and assess those policy counterfactuals according to a suite of management objectives (e.g., economic efficiency, harvest or biomass goals, revenue generation)

Gulf of Mexico Red Snapper

- Accessed by commercial and private (private boat, headboat) anglers
- Stock was declared overfished and subject to overfishing in 1988
- A successful recovery program lead to a stock of more and larger fish
- Even as stock recovered, federal recreational seasons continued to get shorter

The Gulf Headboat Collaborative

- A rights-based management pilot program (2014-2015)
- Participants (27 of 72 vessels) were exempt from season closures
- Tradable quota was assigned according to 2011 landings

https://www.joshuakabbott.com/research.html

Data

Onboard Survey

- All GHC passengers were asked to fill out a 20-question survey
- Data Collected:
  - Feedback on the trip experience
  - Sociodemographic data
  - Email address if they were willing to participate in a follow-up survey[1]
- 10,719 responses, 5,330 valid email addresses

[1] Anglers who provided their email were entered into a drawing for a free fishing trip.

Data

Follow-Up Survey

- Sent in both 2015 (12/2 - 12/22) and 2016 (2/11 - 3/7) waves
- Both waves had 15% response rates (823 complete surveys)
- Ten surveys dropped for missing or unreasonable recall data
- We use the 537 surveys that focus on red snapper (not gag grouper)

Data

Follow-Up Survey

Survey Sections:

- Vacation & recreation behaviors. Familiarity with GOM.
- Trip recall from the past year
- Contingent Behavior[2]
- Leisure Time Valuation[3]
- **Choice Experiment**

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[2] Abbott, J. K., Lloyd-Smith, P., Willard, D., & Adamowicz, W. (2018). Status-quo management of marine recreational fisheries undermines angler welfare. *Proceedings of the National Academy of Sciences*, *115*(36), 8948–8953.

[3] Lloyd-Smith, P., Abbott, J. K., Adamowicz, W., & Willard, D. (2019). Decoupling the value of leisure time from labor market returns in travel cost models [ISBN: 2333-5955 Publisher: University of Chicago Press Chicago, IL]. *Journal of the Association of Environmental and Resource Economists*, *6*(2), 215–242.

Data

Follow-Up Survey

Many recreational fisheries, including red snapper, are managed through bag limits to help ensure the fishery is not depleted. An alternative management option used in some fisheries is where fishermen pay a fee per fish they retain. For the next two choices, assume that there is an alternative fishery management in place where there are no limits on the number of red snapper you can retain (i.e. no bag limits), but rather a fee for each red snapper retained.

The fee would be collected by the headboat operators as people leave the vessel at port. The money collected by the headboat operators would be used to fund habitat enhancement projects in the Gulf of Mexico and Gulf of Mexico fishery research.

How acceptable do you find the fishery management option where there are no limits on the number of red snapper you can retain (i.e. no bag limits), but rather a fee for each red snapper retained?

	Definitely Acceptable	Somewhat Acceptable	Neither Acceptable nor Unacceptable	Somewhat Unacceptable	Definitely Unacceptable
Management option with a fee for each red snapper retained	○	○	○	○	○

Data

Follow-Up Survey

Features	Trip 1	Trip 2	No trip
Total expected number of red snapper caught per trip	7 red snapper	7 red snapper	Do something else, but do not go saltwater fishing on a headboat
Bag limit	3	1	
Number of other species caught per trip	8 fish	2 fish	
Congestion	Spacious	Crowded	
Price for full day trip	$250	$80	

Follow up: How many red snapper would they retain?

Models

Our objective is to tie together extensive and intensive margin *behavioral* models to generate *ex ante*, population level policy prescriptions.

Extensive margin: Mixed Logit

- Models trip choice in response to trip- and individual-specific characteristics
- Allows for heterogeneity

Intensive margin: Top-Censored Poisson

- Count model of red snapper retention per (fee governed) trip
- Top-censored by total expected catch of red snapper

$\Rightarrow$ Both models are weighted to allow for population-level recommendations. Supplemental Information

Results: Extensive Margin

			estimates
3	price	μ	-4.49913*** (0.24597)
		σ	1.06657*** (0.13825)
1	other	μ	0.14822*** (0.04478)
		σ	0.16368* (0.0638)
	congest	μ	-1.49132*** (0.28366)
		σ	1.14397** (0.35745)
2	optout	μ	-2.82661* (1.3825)
		σ	2.81591*** (0.52788)
	gomresident		-0.2129 (2.58804)
	income		0.00065 (0.00361)
Bag Limit Version	retain	μ	0.73978** (0.25241)
		σ	0.64788 (0.39382)
	discard	μ	0.10376 (0.0582)
		σ	0.1598 (0.35309)

- 0.01964 (0.0033)

0.02859 (0.0069)

			estimates
Fee Version	target	μ	0.09356* (0.04159)
		σ	0.17906 (0.11073)
	fee	μ	-0.04446** (0.01497)
		σ	0.01356 (0.03694)
	optout		-0.04209 (1.04215)
	gomresident		0.9431 (1.12054)
	income		-0.00167 (0.00553)
	unacceptable		-0.08957 (0.58371)
	acceptable		-2.76009*** (0.67615)
N			2148
LL			-1778.609
Pseudo R2			0.2365

Cluster robust standard errors in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Results: Extensive Margin

	(1)	(2)
price	-0.00655***	-0.00677***
	(0.00183)	(0.00182)
other	0.0420	0.0294
	(0.0275)	(0.0264)
congest	-0.826***	-0.741***
	(0.192)	(0.183)
target	0.0333	0.186***
	(0.0277)	(0.0530)
fee	-0.0227***	
	(0.00502)	
fee × target		-0.00541***
		(0.00126)
N	1486	1486
LL	-386.56691	-384.10395
$Pseudo\ R^2$	0.0896	0.0954

Cluster robust standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

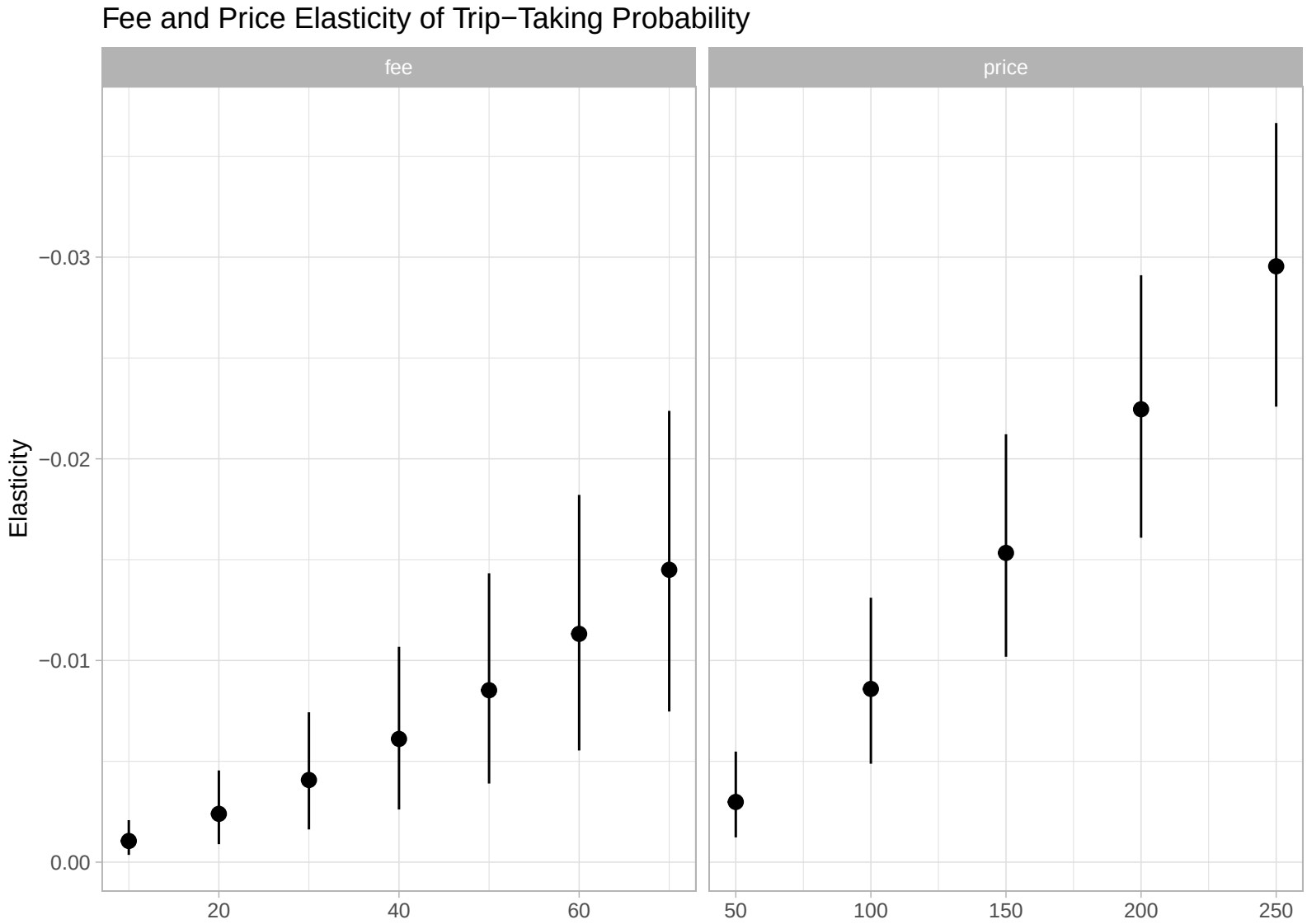


Figure: Estimated mean elasticities (with 95% error bars) across relevant fee and price levels.

Results: Intensive Margin

		cPoisson
congest		0.0649
		(0.0962)
other		-0.00900
		(0.0185)
target		0.183***
		(0.0242)
price		-0.000108
		(0.000705)
gom_resident		-0.0355
		(0.0932)
gomfishing_years		0.0869*
		(0.0352)
income		0.000972
		(0.000627)
Vfeetoboat		0.0902
		(0.0882)
unacceptable		-0.106
		(0.220)
acceptable		0.401**
		(0.154)
fee		-0.0231***
		(0.00502)
	× unacceptable	0.00308
		(0.00695)
	× acceptable	0.00125
		(0.00618)
_cons		0.348
		(0.233)
N		736
LL		-643.79706

Cluster robust standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Results: Intensive Margin

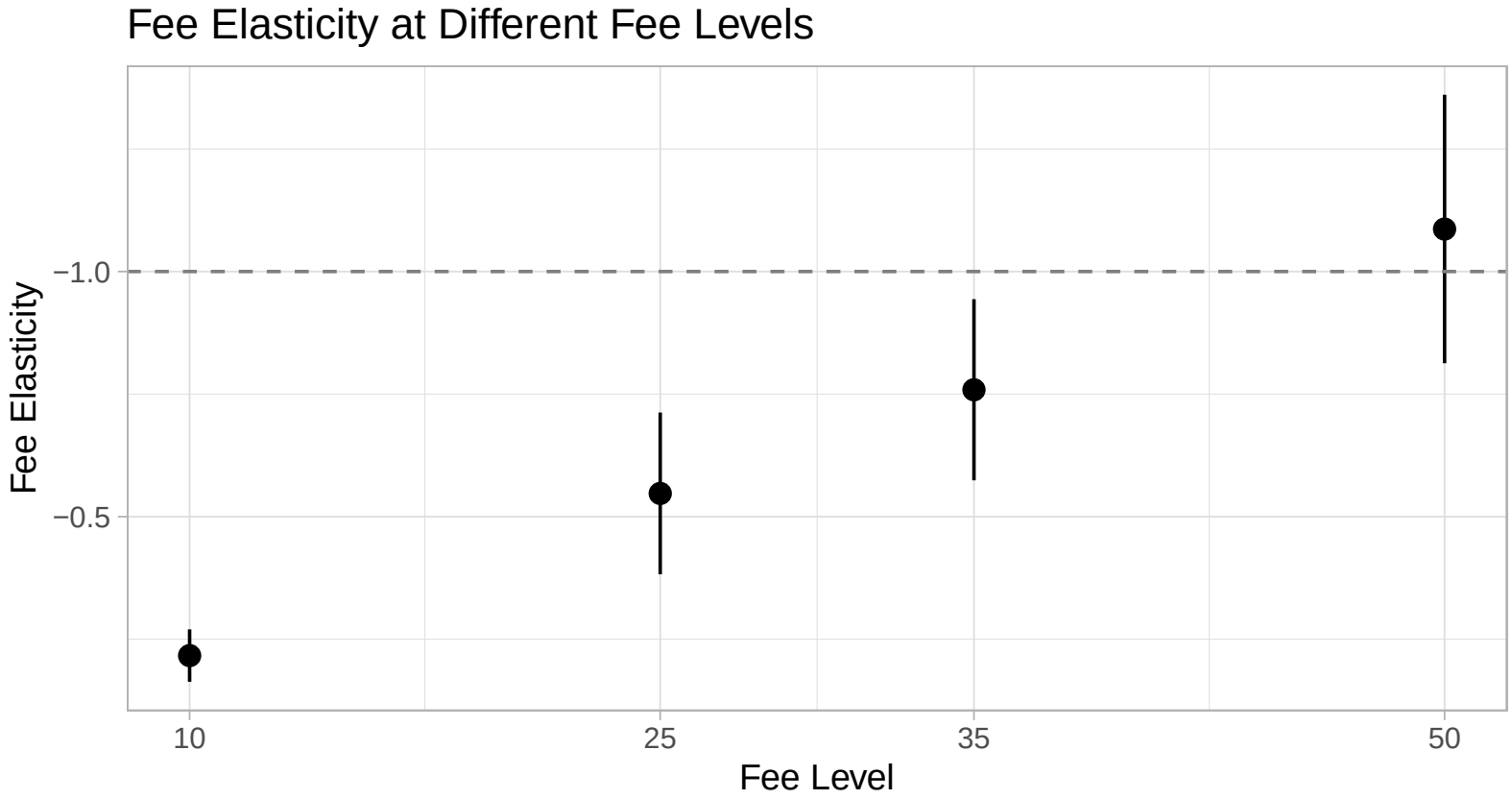
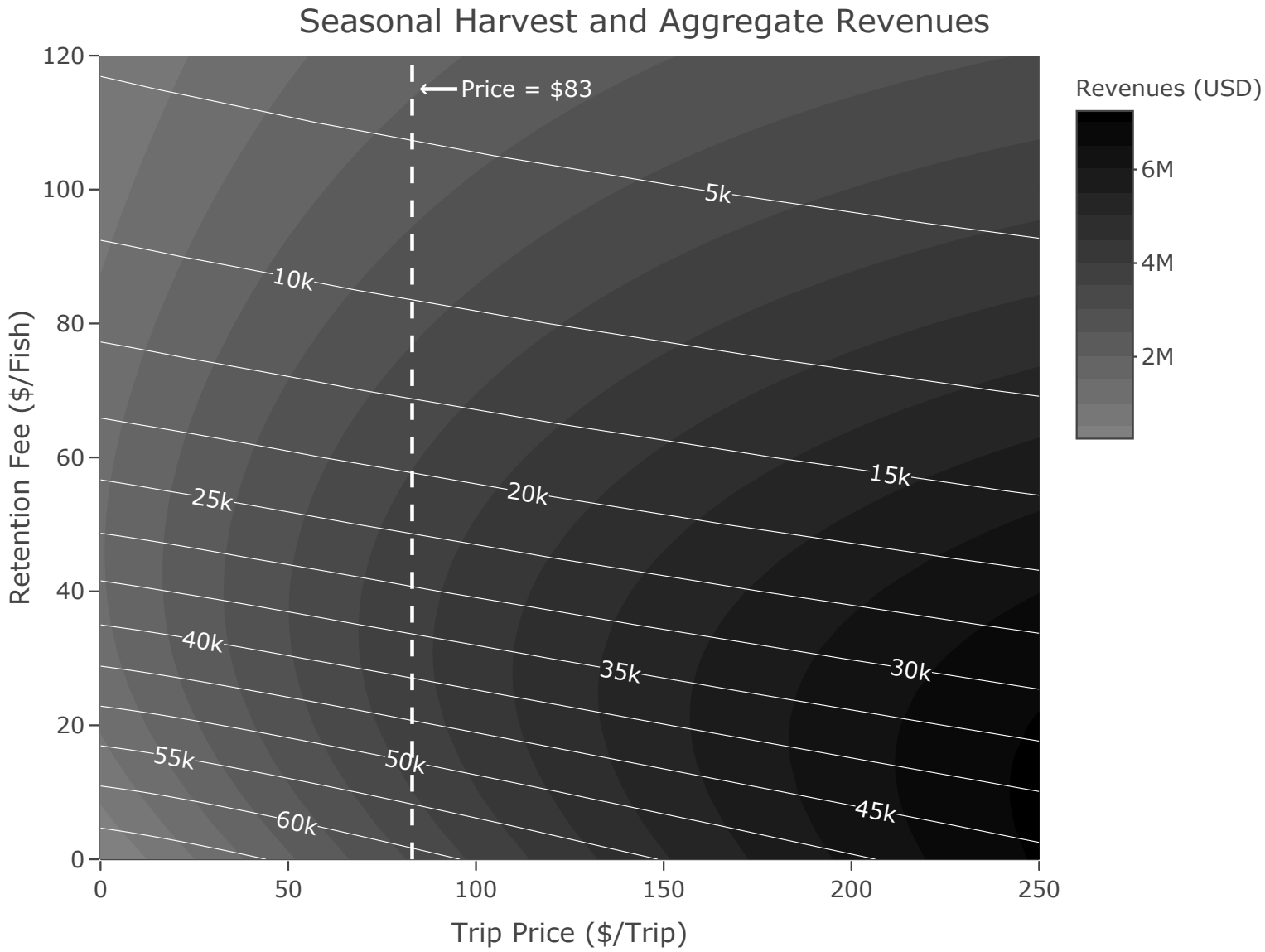


Figure: Estimated mean fee elasticities (with 95% error bars) of retention across a range of fee levels.

Policy Simulations



Demand Curve

Abbott, J. K., Lloyd-Smith, P., Willard, D., & Adamowicz, W. (2018). Status-quo management of marine recreational fisheries undermines angler welfare. *Proceedings of the National Academy of Sciences*, *115*(36), 8948–8953.

Anderson, L. G. (1993). Toward a complete economic theory of the utilization and management of recreational fisheries. *Journal of Environmental Economics and Management*, *24*(3), 272–295.

Fenichel, E. P., & Abbott, J. K. (2014). Heterogeneity and the fragility of the first best: Putting the "micro" in bioeconomic models of recreational resources. *Resource and Energy Economics*, *36*(2), 351–369.

Holzer, J., & McConnell, K. (2014). Harvest allocation without property rights. *Journal of the Association of Environmental and Resource Economists*, *1*(1/2), 209–232.

Homans, F. R., & Wilen, J. E. (1997). A model of regulated open access resource use. *Journal of Environmental Economics and Management*, *32*(1), 1–21.

Lipsey, R. G., & Lancaster, K. (1956). The general theory of second best [ISBN: 0034-6527 Publisher: JSTOR]. *The review of economic studies*, *24*(1), 11–32.

Lloyd-Smith, P., Abbott, J. K., Adamowicz, W., & Willard, D. (2019). Decoupling the value of leisure time from labor market returns in travel cost models [ISBN: 2333-5955 Publisher: University of Chicago Press Chicago, IL]. *Journal of the Association of Environmental and Resource Economists*, *6*(2), 215–242.

McConnell, K., & Sutinen, J. G. (1979). Bioeconomic models of marine recreational fishing. *Journal of Environmental Economics and Management*, *6*(2), 127–139.

Extensive Margin Estimation Weights

1. **Survey Version: Reciprocal Probability**

$$Pr(RedSnapper) = \begin{cases} 0.80 & if\ TX,\ AL,\ NW\ FL \\ 0.20 & if\ SW\ FL \end{cases}$$

2. **Spatial-Temporal Post-Stratification Survey Weights**
   - Used logbook data from all GOM headboat vessels to calculate the percentage of total anglers in each of the four seasons and five GOM regions.

3. **Non-Response Bias: Inverse Propensity Scores**
   - Non-response = no email provided OR did not complete follow-up survey
   - Used logit of response on ISCs to estimate propensity scores.

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Intensive Margin Estimation Weights

$$w_i = \left[\underbrace{Pr(in\ EM)}_{extensive\ margin\ weights} \times \underbrace{Pr(take\ trip\ under\ fee\ version)}_{1-Pr(Optout)} \right]^{-1}$$

- $1 - Pr(Optout)$ was calculated using monte carlo sampling from our extensive margin βs (N=1000).

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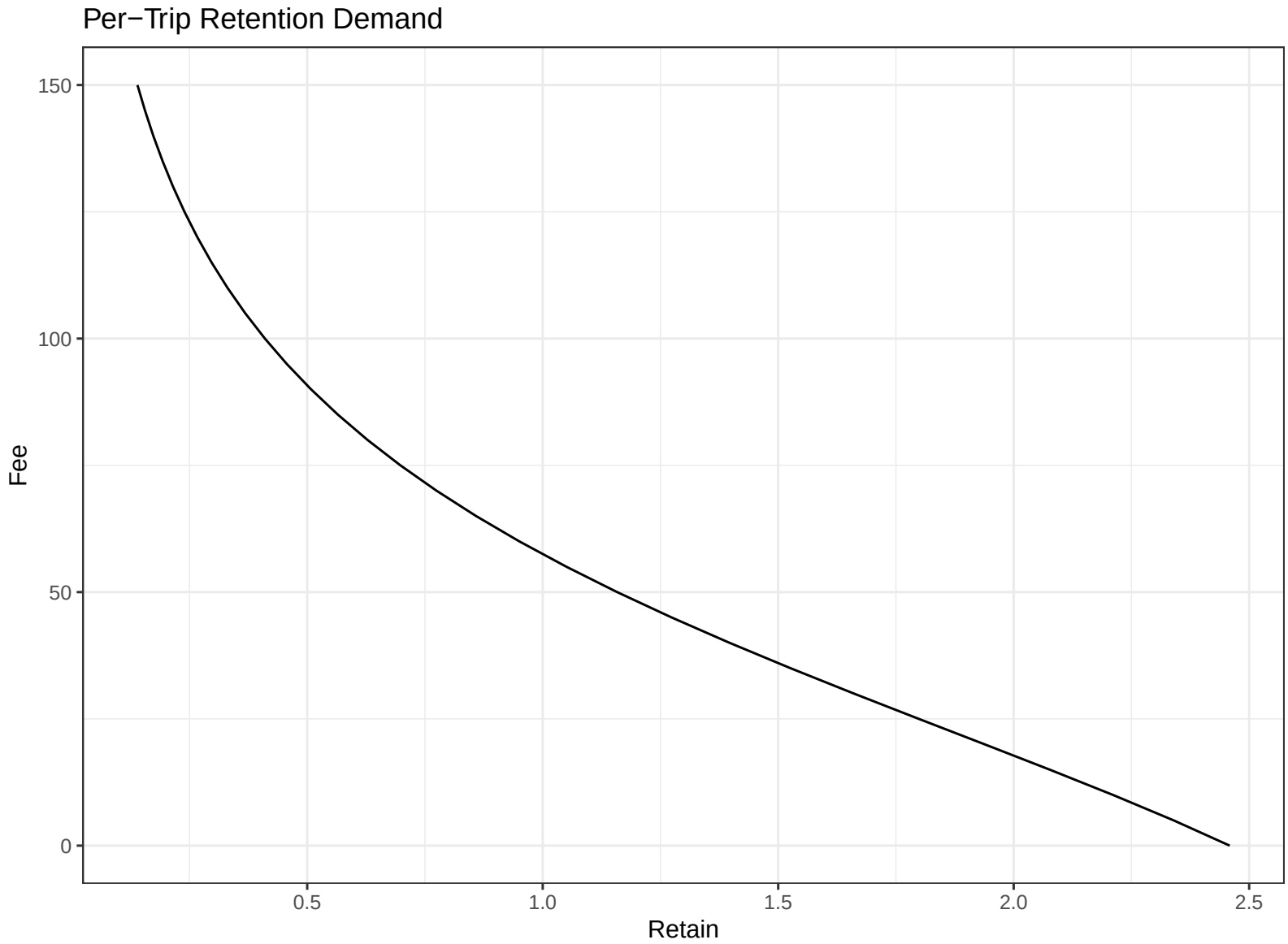
Policy Simulations



Price=$83, Target=3, Other=8, Congest=0

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