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Welfare Economics of the Allocation of Fishery Harvests

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Abstract

This project employs economic models of fisheries harvest for commercial and recreational sectors in order to assess the efficiency of current catch allocations. We focus on catch of dolphin, king mackerel, red snapper, and a "grouper" species collection in the South Atlantic and Gulf of Mexico fisheries using commercial catch and recreational survey data. We utilize marginal values in each sector to identify allocations that maximize net economic benefits with consideration of biological and other constraints imposed by fishery management plans.

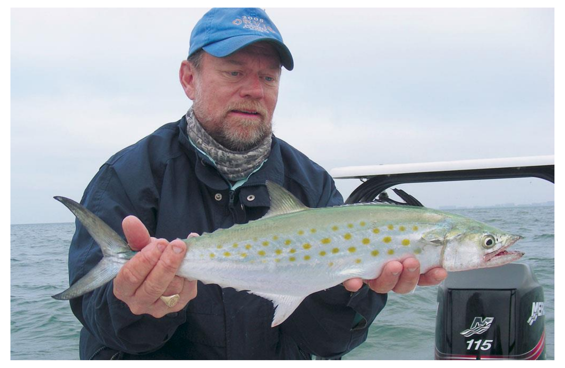

Figure 1. Spanish Mackerel.

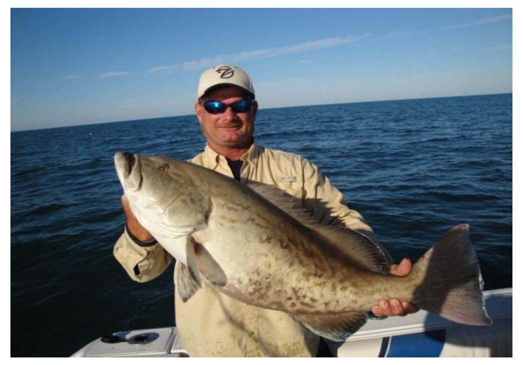

Figure 2. GAG Grouper.

Introduction

In this project we evaluate the economic effects of the allocation of fishery harvest among competing agents by estimating the net economic value to the commercial and recreational sectors. We employ the equimarginal principle to compare the desirability of alternative quota allocation scenarios for key species – dolphin, king mackerel, red snapper, and a "grouper" species collection – in the South Atlantic and Gulf of Mexico (Plummer, Morrison, and Steiner 2012). To implement the equimarginal principle, the marginal value-per-unit (i.e., pound) of landings is estimated for commercial and recreational sectors.

We use revealed preference (RP) recreation survey (intercept and telephone) data from NOAA for the South Atlantic and the Gulf of Mexico collected in 2003 and 2009 (Haab, et al. 2009) in conjunction with stated preference (SP) data collected in 2003 and 2009 (Wallmo and Gentner 2008). For RP analysis we use site -specific historic catch rates and expected catch rates (conditioning on anglers' characteristics) within common Random Utility Model (RUM) formulations to evaluate factors influencing site choice, while mitigating onsite sampling biases using weights (Hindsley, et al. 2011; Kuriyama, et al. 2013). The SP analysis employs choice experiments to assess the influence of catch rates (and other factors) on site choice. The recreational analysis is tailored to permit joint estimation with RP and SP data. Lastly, multi-species profit functions are estimated using cost and earnings data for commercial fishers (Gentner 2012). Evaluation of the commercial sector includes analysis by gear type and fishing location, incorporating any fishery management plans relevant to the location or season.

Methods

RECREATION: Random utility theory is the basis for recreational fishing models:

$$U_{ij}=V_{ij}+\varepsilon_{ij},$$

where U_{ij} is the utility angler i receives from fishing alternative j, i = 1, …, I, j = 1, …, J, $V_{ij}=\beta' x_{ij}$ is the systematic portion of utility, β is a vector of parameters, x_{ij} is a vector of variables specific to choice, and ε is the random error. Given the unobserved elements of utility, estimation is based on the probability of individual i choosing alternative j:

$$\pi_{ij}=\Pr[V_{ij}+\varepsilon_{ij}>V_{ik}+\varepsilon_{ik}];\forall k\in J.$$

The econometric specification depends upon the distribution of the error term and other elements of the choice model. Marginal values of recreational catch are calculated as MWTP = β_{catch}/β_{tc} and confidence intervals are generated by Krinksy-Robb. Combining RP and SP data permits additional variation in catch & travel cost.

COMMERCIAL: A generalized Leontief dual revenue model is used for commercial analysis (Squires and Kirkley 1991).

$$\pi(p;K)=\sum_i \gamma_i p_i K^2+\sum_i\sum_j \phi_{ij}\,(p_i p_j)^{0.5}\,K+\sum_i\sum_j \mu_{ij}\,t_j p_i+\sum_i\sum_j \omega_{ij} l_j p_i K+\sum_i\sum_j \delta_{ij} c_j p_i K$$

where *p* are ex-vessel prices, *K* is fixed capital, and *t*, *l*, and *c* are dummy variables capturing time, location, and other control effects, respectively. From this specification, input-compensated supply equations can be derived for each species and the virtual prices for a pre-specified level of quota can be defined (Gentner 2012).

ALLOCATION: *Recreational benefit*: B=f[q, d(q)] where q is catch per day and d(q) is the trip-response function for days fished. Allocation analysis employs this function to assess welfare change under binding quota constraints, bag limits, or site closures. *Commercial benefits* are simulated using the virtual price framework of Fulginiti and Perrin (1993).

Results and Discussion

__Recreation Values__: RP estimates using VC of travel range from several dollars to under $10, but increase 74 – 86% when using full cost travel; SP estimates using full cost are multiples of $10 to well over $100. Combined RP-SP model permits flexible scale parameter across respondents & allows for random parameters, producing values between RP and SP (ranging from $4.50 (Dolphin) to $48 (King Mackerel). These can be adjusted downward to account for only VC.
__Commercial Values__: Marginal profits calculated for 2016 allocations range from $2 to $4 (2016$)
__Allocation Analysis__: Economic efficiency may be enhanced through reallocations from commercial to recreational sector. The complete analysis, however, requires analyzing changes in surplus from additional recreation catch and loss of producer surplus down the supply chain and reduced supply of seafood for consumption. This is the current focus of our project.

Conclusions

We will consider behavioral responses in targeting and effort redirection in response to allocation changes through trip response models that utilize inclusive values from the RP-SP model as the dependent variable (Parsons, et al. 1999). Changes in days fished will be simulated by calculations of the inclusive value stemming from policy changes (i.e. recreational quota).

Lastly, consumer surplus of seafood consumers arising from seafood purchases in markets and restaurants will be estimated utilizing the synthetic inverse demand system (SIDS) model (Park, et al. 2004) as described in Gentner, et al. (2010, 2012). These techniques allow estimation of consumer demand functions from landings and ex-vessel value data available from NOAA. The methods support calculation of the marginal and non-marginal value (compensating variation) of commercial landings to seafood consumers.

Table 1. Margainl Catch Values for Recreation [CL = Conditional Logit; NL=Nested Logit; MXL = Mixed Logit; GMXL = Generalized mixed Logit; C.I. = Confidence Interval; % Δ = Percentage Change in Marginal Catch Values from using cost of driving to full cost.

	RP 2003	RP 2004 Variable cost (0.13c)				RP 2004 Full cost (0.50c)				% Δ	SP		RPSP	Commercial
	CL	CL	C.I.	NL	C.I.	CL	C.I.	NL	C.I.		CL	MXL	GMXL	
Dolphin	$7.84	$3.68	$2.72-$4.65	$6.21	$4.91-$7.68	$27.8	$20.2-$38.1	$23.9	$18.9-$29.5	%86	$30.39	$1.90	$4.44	$2.04
Grouper	$1.94	$1.81	$1.32-$2.36	$0.93	$0.60-$1.31	$6.95	$5.07-$9.09	$3.56	$2.31-$5.04	%74	$104.79	$55.64	$43.94	$3.45
Red snapper	$5.65	$1.05	$0.20-$1.99	-$0.45	-$0.98-$0.15	$4.05	$0.77-$7.67	-$1.72	-$3.78-$0.57	%74	$83.31	$43.13	$30.94	$3.79
King mackerel	$0.27	$1.20	-$0.95-$3.01	$2.17	$1.68-$2.69	$4.62	-$3.67-$11.6	$8.36	$6.45-$10.4	%74	$143.78	$69.67	$47.86	$1.98

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