EXAMINING TARGET SPECIES SUBSTITUTION IN THE FACE OF CHANGING RECREATIONAL FISHING POLICIES.

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ABSTRACT

The National Marine Fisheries Service (NMFS) is mandated by law to analyze the benefits, costs, and economic impacts of the recreational fisheries policies it promulgates. NMFS has developed single species models that predict welfare and effort changes stemming from changes in various recreational regulations. Little is known, however, about angler switching behavior between species in the face of these same policy changes. That is, as regulations are tightened for one species do those anglers quit fishing entirely or switch to a substitute species with less stringent regulations? Estimating these relationships requires specialized data collections involving long-term panel studies to gauge revealed preferences or the presentation of hypothetical scenarios to elicit stated preferences. NMFS is currently pursuing the latter; conducting a stated preference mail survey that presents anglers a series of choice scenarios that vary in quality, policy, and species target attributes, and asks them to choose a preferred trip. Species included in the scenarios include grouper, red snapper, king mackerel, and dolphin fish. This data collection will field surveys monthly through August 2004 using anglers sampled during the Marine Recreational Fisheries Statistical Survey (MRFSS) creel survey and the MRFSS random digit dial survey of coastal households in the South Atlantic and Gulf Coast states of the US. This paper presents the preliminary results of the stated preference survey, including a random utility model that examines the substitution of target species under different policy scenarios.

Keywords: recreational fishing, random utility models, stated preference choice experiment

INTRODUCTION

The National Marine Fisheries Service (NMFS) has periodically collected travel cost demand model data since 1994 using the Marine Recreational Fishing Statistical Survey (MRFSS). This data has been used to estimate site choice random utility models (RUM) to examine the value of site access and the value of catch rate changes in the North Atlantic, Mid Atlantic, South Atlantic, and Gulf Coasts [1, 2, 3]. These analyses have been very useful in determining the value of access to saltwater recreational fishing and analyzing the value of changes to the catch and/or keep rate across broad species groups. Unfortunately, due to the nature of the MRFSS, species-specific valuation models have proven difficult to estimate for all but the most popular species. Also, due to the lack of adequate variation in fisheries regulations across the years NMFS has collected this data, it has been impossible to model welfare changes stemming from policies, even across species with adequate sample. Additionally, because the MRFSS is an intercept survey, only anglers that have already decided to take a recreational fishing trip are interviewed, therefore it will never be possible to estimate entry and exit. This leaves these RUM models very useful for environmental damage assessment and regional or national total value estimates, but of very little use for analyzing typical recreational policies like bag limits, minimum size limits, and seasonal closures [4].

To address these shortfalls in the site choice models, NMFS turned to stated preference choice experiments (SPCE) in 2000 with the launch of a single species SPCE covering summer flounder in the Northeast. This survey worked quite well, allowing NMFS to examine changes in welfare and effort resulting from changes in bag limits, size limits, and season lengths [4]. Additionally, SPCE's have also been utilized in Alaska for halibut and salmon fishing trips [5]. The most recent effort in Alaska used a catch attribute containing a mix of halibut and various species of salmon catch. This was not a branded SPCE design but did allow substitution of different species targets when the regulations for another species changed. This paper focuses on NMFS' efforts to incorporate the successes with these previous efforts and expand the agency's focus regarding species substitution. These SPCE surveys involve extensive qualitative research to develop, taking considerable time and money. By including multiple species, it is hoped that cost and time outlays can also be reduced while improving policy analysis through the explicit inclusion of species substitution. The current effort focuses on four species or species groups; Epinephelus and Mycteroperca species group, Lutjanus Campechanus, Scomberomorus Cavalla, and Coryphaena species group (hereinafter grouper, red snapper, king mackerel, and dolphin respectively). Groupers were aggregated because they are regulated together and anglers, during the qualitative phase of this survey, were rarely able to distinguish individual species. The two dolphin species were aggregated because they are not differentiated by anglers or in the regulations.

METHODOLOGY

Random utility theory underpins the analysis of SPCE data. An angler chooses a fishing trip from the set of all trips in the experimental design X if the utility of taking that trip is greater than the utility of taking any other trip in his or her choice set. The indirect utility of taking trip j is

$$U_j\left(X_j, \varepsilon_j\right) = V_j\left(X_j\right) + \varepsilon_j \qquad \text{(Eq. 1)}$$

where V_j is the deterministic portion of utility, X contains trip cost, total catch of target species, target species catch of legal size, target species keep, catch of non-target species, target specific recreational fisheries policies, and ε_j is the unobservable portion of indirect utility. Including a policy, as a direct utility argument, can be very convenient as the outcome, expressed as a change in catch and keep, of any recreational fisheries policy is not always readily available or even known. Denoting the set of all alternatives faced by an angler by S = {1,…,N} as the global choice set, an angler will choose trip j from S if

$$V_j\left(X_j\right) + \varepsilon_j \geq V_k\left(X_k\right) + \varepsilon_k,\ j \in S, \forall k \in S_i, S_i \subset S \qquad \text{(Eq. 2)}$$

the indirect utility of taking trip j is greater than the indirect utility of taking trip k for all trips in the individual's choice set. In this experimental design, anglers were presented eight paired comparisons using species target to define the type of trip taken. Since the experimental design contained four species, not all species were available in each choice experiment, and, therefore, each angler faced their own choice set, S_i. The random portion of the random utility model stems from the unobservable portion of indirect utility, captured here in the error term ε_j. If this error term is assumed be distributed in a type I extreme value distribution, the above trip choice framework can be modeled with the conditional logit model. S.Maddala [6] gives a complete derivation of the conditional logit model. Within this framework the probability that i takes trip j is given by

$$P_i(j) = P(j \mid j \in S) = \frac{e^{V_j\left(X_j\right)}}{\sum_{k \in S_i} e^{V_k\left(X_k\right)}} \qquad \text{(Eq. 3)}$$

Because the goal of this paper is to examine the impacts of policies on anglers, compensating variation (CV) for a hypothetical policy change will be calculated. This expression for CV is taken from Haab and McConnell's book [7] examining the value of quality improvements in the demand for recreation.

$$CV = \frac{\ln\left(\sum_{k \in S_i} e^{\left(-\beta_y TC_k + q_k^1 \beta_k\right)}\right) - \ln\left(\sum_{k \in S_i} e^{\left(-\beta_y TC_k + q_k^0 \beta_k\right)}\right)}{\beta_y} \quad \text{(Eq. 4)}$$

where trip cost for the k^{th} trip is represented by TC_k and all other trip quality attributes from X are included in q_k, with the superscript 0 denoting the initial condition and the superscript 1 denoting the condition after the change in one or more of the quality attributes. In this case, the total number of attributes in X is seven. The researcher controls the attribute levels in X and these attribute levels were assigned based on conversations with fishery managers, analysis of MRFSS catch data, analysis of MRFSS expenditure data, and through the qualitative phase of the project. It was decided to present anglers with paired trips and a no trip option to choose from in each choice experiment. Incorporating the seven attributes from both trips into the sample design results in 14 factors, four with three levels and 10 with four levels, creating a full factorial of around 85 million possible combinations. Obviously, it would be impossible to present any sample the full factorial. Some subset of the factorial must be selected and a fractional factorial maintains the same statistical properties of the full factorial if it is balanced and orthogonal. When each level of each factor occurs with the same frequency, a design is balanced and, when all parameters to be estimated are uncorrelated, a design is orthogonal [8]. For large designs with restrictions on the combinations of levels that can occur simultaneously, perfect balance and orthogonality, jointly defined as design efficiency, are difficult to achieve. Instead, efficiency can be measured relative to perfect balance and orthogonality and a design selected based on optimization of an efficiency criterion. One such criteria that was used for this design is D-efficiency. This criterion sets out to minimize estimate variance resulting from the fractional factorial selected. Since the estimable effects of concern here all stem from the conditional logit model described above, D-efficiency is a function of the covariance matrix Γ, as taken from Kuhfeld [8]:

$$\Sigma = \left(Z' P Z\right)^{-1} = \left[\sum_{j=1}^{S} \sum_{k=1}^{S_i} z'_{kj} P_{kj} z_{kj}\right] \quad \text{(Eq. 5)}$$

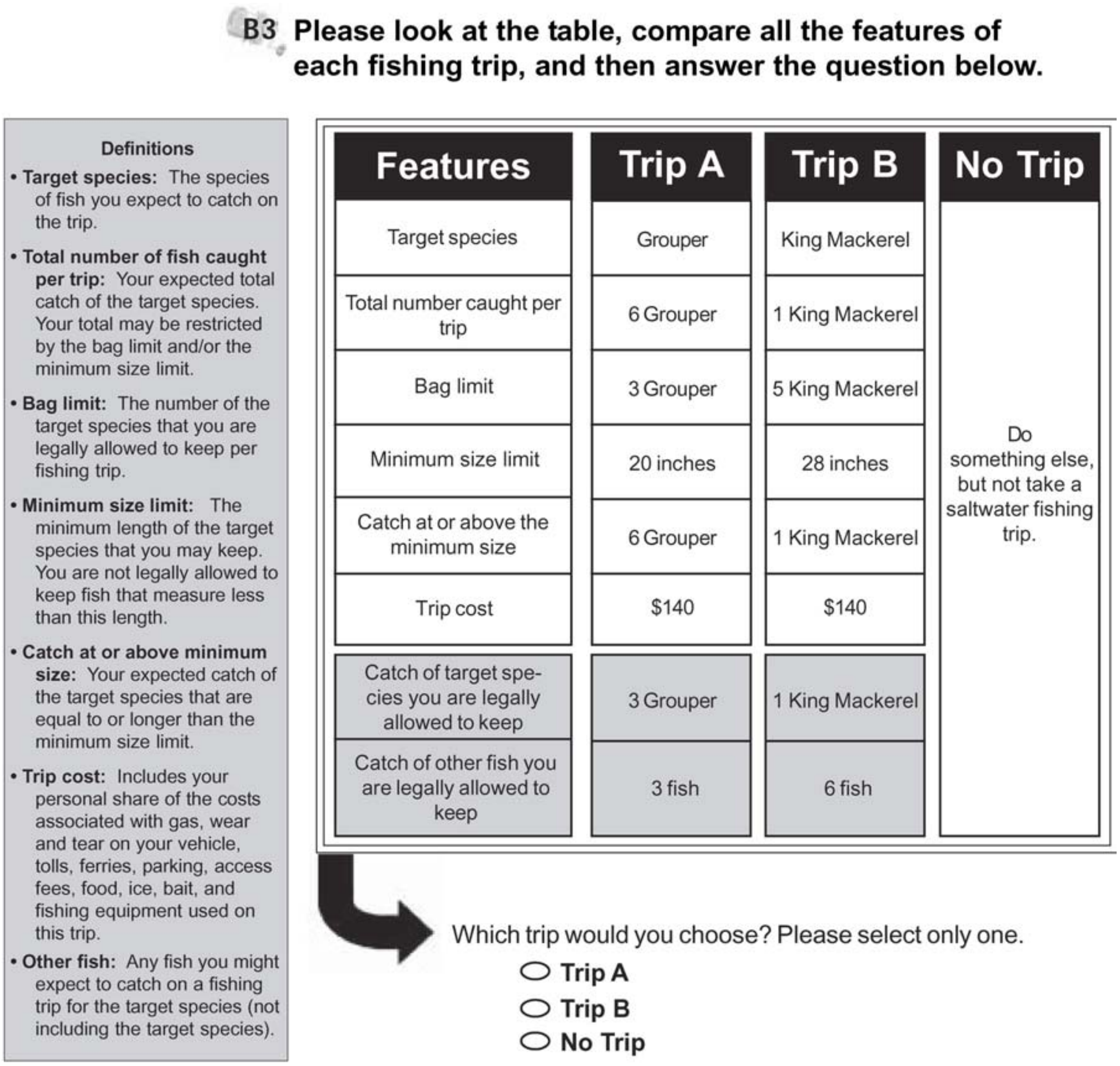
$$\text{where } z_{kj} = x_{kj} - \sum_{i=1}^{S_i} x_{ij} P_{ij}$$

$$\text{D-efficiency} = 100 \times \frac{1}{|\Sigma|^{\frac{1}{G}}} \quad \text{(Eq. 6)}$$

Where G is the number of parameters in P_{ij}. From these equations, one can see that the covariance and therefore the efficiency criterion are functions of the parameters that are to be estimated using the survey data to be generated by this experimental design. As a result, a linear form of the efficiency criterion was used here rather than making restrictive assumptions regarding the value of unknown parameters.

$$\text{Linear D-efficiency} = 100 \times \frac{1}{K \left|\left(X' X\right)^{-1}\right|^{\frac{1}{G}}} \quad \text{(Eq. 7)}$$

where K is the total number of trip combinations in the global choice set, S. Kuhfeld's [8] SAS experimental design macros were used as a framework for constructing the experimental design used for this survey. Kuhfeld's procedure involves four basic steps. The first involves recommending the optimal factorial size taking into account the number of attributes, number of attribute levels and the number of choices each angler will be expected to make. During the qualitative phase it was determined that anglers could handle as many as 8 choices per instrument and this phase recommend a design with 384 runs using 48 blocks, or different survey instruments. The next phase involve selecting a design based on the D-efficiency criteria while accounting for any restrictions that need to be imposed on the design. Three basic restrictions were imposed here; no strictly dominated trips could be allowed, legal catch could not be larger than total catch, and, for comparisons between trips with the same target, if the minimum size in trip one was less than the minimum size in trip two, the proportion of legal sized fish to total catch in trip one must be greater than that ratio in trip two and vice versa. All second order effects were included and one third level effect, species x legal catch x minimum size, was included. The third phase involved evaluating the design and several iterations were made to find a design that maximized D-efficiency while controlling the correlation between attributes. The final design, while not perfectly balanced or orthogonal, had very low levels of correlation between attributes with only legal catch and total catch slightly correlated. In reality these factors are correlated, but the correlation here stems from the restriction that total catch must always exceed legal catch. Finally, the design was blocked into 48 blocks by assigning a blocking factor that was totally uncorrelated with any other factor in the design.



B3 Please look at the table, compare all the features of each fishing trip, and then answer the question below.

Definitions

- **Target species:** The species of fish you expect to catch on the trip.
- **Total number of fish caught per trip:** Your expected total catch of the target species. Your total may be restricted by the bag limit and/or the minimum size limit.
- **Bag limit:** The number of the target species that you are legally allowed to keep per fishing trip.
- **Minimum size limit:** The minimum length of the target species that you may keep. You are not legally allowed to keep fish that measure less than this length.
- **Catch at or above minimum size:** Your expected catch of the target species that are equal to or longer than the minimum size limit.
- **Trip cost:** Includes your personal share of the costs associated with gas, wear and tear on your vehicle, tolls, ferries, parking, access fees, food, ice, bait, and fishing equipment used on this trip.
- **Other fish:** Any fish you might expect to catch on a fishing trip for the target species (not including the target species).

Features	Trip A	Trip B	No Trip
Target species	Grouper	King Mackerel	Do something else, but not take a saltwater fishing trip.
Total number caught per trip	6 Grouper	1 King Mackerel	
Bag limit	3 Grouper	5 King Mackerel	
Minimum size limit	20 inches	28 inches	
Catch at or above the minimum size	6 Grouper	1 King Mackerel	
Trip cost	$140	$140	
Catch of target species you are legally allowed to keep	3 Grouper	1 King Mackerel	
Catch of other fish you are legally allowed to keep	3 fish	6 fish	

Which trip would you choose? Please select only one.

○ **Trip A**
○ **Trip B**
○ **No Trip**

Figure 1. Sample choice experiment from survey.

As mentioned previously, qualitative development work involved 12 focus groups in three different locations in the study area, Charleston, South Carolina, Miami, Florida (FL), and Tampa, FL, and 20 cognitive interviews conducted in Miami, FL. Input from this qualitative work informed both the construction of the experimental design and the layout of the choice experiment itself. Figure 1 contains a shot of the choice experiment as presented to the anglers. Names and addresses for this survey were sourced from both the MRFSS intercept creel survey and the telephone survey of coastal households. The MRFSS survey is conducted throughout the year stratified by two-month waves and the mail survey mirrored this wave stratification. The mail survey followed a modified Dillman method [9], with the initial field or telephone contact substituting for the first mailing in the Dillman series. This methodology has resulted in a 48% response rate across the first two waves of mailing. The analysis below utilizes 8,010 responses from 1,436 anglers.

RESULTS

The model was estimated in LIMDEP using full information maximum likelihood techniques. Because of current debate centering around the inclusion of policies as direct arguments in utility functions, two models were estimated; one containing only policy attributes and one containing only catch and keep attributes. Initially both models performed poorly across the whole sample. The survey was sent to all anglers agreeing to participate regardless of their targeting preference from their most recent saltwater fishing trip. This was done for three reasons; one, to insure adequate sample size, two, to capture entry behavior from anglers not currently participating in these fisheries, and, three, targeting behavior on the most recent trip might not be indicative of usual targeting behavior. The mail survey included a question

Table I. Descriptive Statistics

Variable	Levels Used in Experimental Design	Mean	Standard Error
K_BAG	**1, 2, 3, 5**	2.70	0.0227
D_BAG	**6, 10, 15, 20**	12.98	0.0857
G_BAG	**1, 2, 3, 6**	3.00	0.0295
R_BAG	**1, 2, 3, 5**	2.86	0.0238
TC	**$45, $70, $105, $140**	59.92	0.3324
OTHER	**1, 3, 6**	2.22	0.0148
K_KEEP	**1, 2, 3, 5**	1.76	0.0153
D_KEEP	**1, 3, 6, 10, 15, 20**	6.70	0.0851
G_KEEP	**1, 2, 3, 5, 6**	1.97	0.0211
R_KEEP	**1, 2, 3, 5**	1.90	0.0173
K_TOTAL	**1, 2, 3, 5**	3.43	0.0230
D_TOTAL	**1, 3, 6, 10**	6.69	0.0541
G_TOTAL	**1, 2, 5, 6**	4.42	0.0302
R_TOTAL	**1, 2, 3, 5**	3.47	0.0240
K_SIZE	**20", 24", 28"**	24.00	0.0504
D_SIZE	**18", 20", 24"**	20.69	0.0403
G_SIZE	**18", 20", 24"**	20.71	0.0395
R_SIZE	**16", 18", 22"**	18.65	0.0400
K_LEGAL	**1, 2, 3, 5**	2.42	0.0217
G_LEGAL	**1, 2, 3, 6**	3.12	0.0319
D_LEGAL	**1, 3, 6, 10**	4.37	0.0522
R_LEGAL	**1, 2, 3, 5**	2.55	0.0235

that asked anglers to rank their preference for targeting the species included here and that question was used to subset this data. If an angler responded that they always, frequently, or sometimes targeted one or both of the species in the paired comparison, that comparison was retained. This sub setting significantly improved model fit, and Table I contains descriptive statistics for the attributes used in the model within this subset. The first initial of each target species is used to label the target species-specific attribute (i.e. k = king mackerel, d = dolphin, g = grouper, and r = red snapper).

It is difficult to test the appropriateness of such a subset, but a likelihood ratio test indicates the parameters generated using the whole data set and the data set containing only targeters were statistically different. Preliminary estimation of a parsimonious model nested along stated targeting preference indicates that the sub setting is appropriate. In this model, all species-specific constants for the non-targeters were insignificant indicating that anglers inexperienced with the target species included in the study did not consider target species, but instead focused on other attributes. Hereinafter, non-nested results after sub setting the data will be reported, with Table II containing the results from policy attribute model and Table III containing the results of the catch and keep model.

These two different models were estimated to demonstrate the difficulty in analyzing policy based strictly on angler's preferences for keep. Keep is function of the stock, size distributions within the stock, angler experience, and regulations; items difficult to know with certainty. Also, just because a there is a bag limit of two fish does not mean that an angler will always catch enough to fill his bag or even desire to fill his bag. Because experienced anglers have the ability to target larger sizes of fish, minimum size limits may not directly bind keep. Additionally, regulations have a stock effect so this relationship between keep and policies is inherently a dynamic one. As a result, there are no direct relationships between these policies and keep. Therefore, including policy attributes directly allows policy impacts to be simulated directly without the additional information required for keep. Finally, even if perfect information about size distributions and individual catch rates existed; anglers may also have separate preferences for the policy mechanism itself, which can only be incorporated by including policy attributes directly.

Not much can be drawn from the parameters of a conditional logit model directly. Instead the focus is on sign, significance and model fit. All variables in both models were significant, with the exception of king mackerel bag limit, which also has an unexpected sign. Both models are significant, with all parameters significantly different from zero using a likelihood ratio test. Additionally, the fit of both models, as measured by adjusted R-squared, is excellent. A Hausman test was conducted for every trip option included in both models. The Hausman test's maintained hypothesis states that the error distributional assumptions for the conditional logit model hold; that is there is no violation of the independence of irrelevant alternatives property. All trips in both models fail to reject the null at any reasonable level of significance.

All initial policy attribute models that included minimum size exhibited an unexpected positive sign. On would expect that a tightening of regulations would reduce utility. From the qualitative work, anglers view minimum size limits very differently and those varying preferences are perhaps reflected in the initial positive sign on this policy attribute. The same result was obtained in [4] and Hicks dealt with this apparent conflict by crossing minimum size with the number of legal sized fish to achieve a measure of the total inches of fish caught. In this analysis, this relationship was modeled as a quadratic, and those results are reported in Table II.

To further examine this quadratic relationship, Figure 2 plots angler utility as a function of the minimum size for the four target species. In this figure, the dotted vertical lines represent the minimum and maximum levels of minimum size included in the experimental design. All graphs show a preference for larger minimum sizes to some maximum level, at which point larger minimum sizes decreases utility.

Table II. Policy Attribute Model Results.

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]
K_BAG	-0.0059	0.0215	-0.2750	0.7829
D_BAG	0.0208	0.0068	3.0570	0.0022
G_BAG	0.1079	0.0177	6.0910	0.0000
R_BAG	0.1450	0.0227	6.3920	0.0000
TC	-0.0053	0.0005	-11.5250	0.0000
OTHER	0.0617	0.0083	7.4620	0.0000
K_SIZE^2	-0.0027	0.0005	-5.8320	0.0000
D_SIZE^2	-0.0017	0.0008	-2.2980	0.0216
G_SIZE^2	-0.0026	0.0007	-4.0110	0.0001
R_SIZE^2	-0.0020	0.0008	-2.6300	0.0085
K_SIZE	0.1223	0.0134	9.1020	0.0000
D_SIZE	0.0685	0.0191	3.5880	0.0003
G_SIZE	0.1189	0.0161	7.3670	0.0000
R_SIZE	0.0816	0.0177	4.6040	0.0000
K_LEGAL	0.2923	0.0241	12.1450	0.0000
G_LEGAL	0.1280	0.0161	7.9350	0.0000
D_LEGAL	0.0491	0.0111	4.4160	0.0000
R_LEGAL	0.1876	0.0229	8.2060	0.0000
Log-Likelihood			-7129.98	
Log-Likelihood no coefficients			-17601.97	
Log-Likelihood constants only			-22945.64	
Adjusted R-squared			0.59448	

Table III. Policy Outcome Model Results.

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]
TC	-0.0023	0.0004	-5.8300	0.0000
OTHER	0.1108	0.0076	14.5240	0.0000
K_TOTAL	0.2745	0.0189	14.5000	0.0000
G_TOTAL	0.1785	0.0141	12.6560	0.0000
D_TOTAL	0.0495	0.0091	5.4200	0.0000
R_TOTAL	0.1429	0.0194	7.3640	0.0000
K_KEEP	0.2589	0.0348	7.4330	0.0000
G_KEEP	0.2851	0.0276	10.3430	0.0000
D_KEEP	0.0201	0.0076	2.6560	0.0079
R_KEEP	0.2893	0.0327	8.8520	0.0000
K_LEGAL	0.2923	0.0241	12.1450	0.0000
G_LEGAL	0.1280	0.0161	7.9350	0.0000
D_LEGAL	0.0491	0.0111	4.4160	0.0000
R_LEGAL	0.1876	0.0229	8.2060	0.0000
Log-Likelihood			-7223.69	
Log-Likelihood no coefficients			-17601.97	
Log-Likelihood constants only			-22945.64	
Adjusted R-squared			0.58935	

In this case, the maximums occur approximately at 20 inches for red snapper and dolphin, 22 inches for grouper, and 23 inches for king mackerel. Currently, the minimum size limit is 16 inches, 20 inches, 24 inches, and 24 inches for red snapper, dolphin, grouper and king mackerel respectively[a].

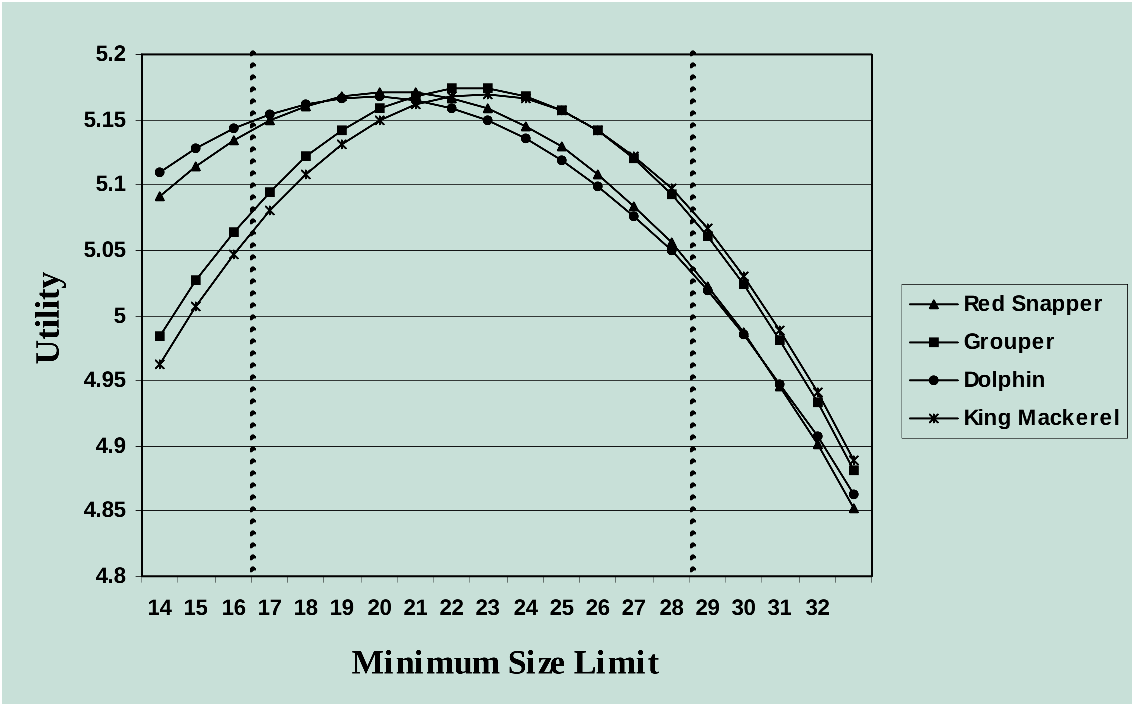


Figure 2. Utility as a function of size limit.

Tables IV and V detail the substitution elasticities for both a bag limit policy and for catch and keep respectively. The elasticities reflect the percentage change in the probability of selecting a given targeted trip relative to a one unit change in either the bag limit or the catch and keep rate. This result shows that anglers are definitely substituting away from one fishery and into another as regulations are tightened. This has implications for policy analysis. NFMS is required to examine the economic impacts of regulations and this substitution tends to dampen those impacts. Anglers are a dedicated group and unlikely to quit fishing altogether when regulations are tightened. Instead, their effort will shift to other species.

To examine changes in effort, welfare, and economic impacts across both models, a policy simulation was conducted. All four of these species were included in this SPCE because of upcoming changes in their respective management plans. Table VI details the changes in effort, welfare loss, and economic impacts stemming from a 2 fish decrease in the red snapper bag limit[b]. Bag limit was the focus here as it has the most direct connection to keep. Size limit, on the other hand, would require the incorporation of extensive size frequency data in order to simulate the effect of change size limits on catch and keep composition. The first scenario in Table VI uses the policy attribute model, first setting the current regulations across all species and then reducing the bag limit by two red snapper. Table VI indicates that this 50% reduction will reduce grouper trips by 1.05% and red snapper trips 5.18%, increase king mackerel and dolphin trips by 1.83% and 2.51% respectively, and 1.90% would not take any trip. Compensating variation per trip lost under this option is $27.99 (US dollars) and when applied to current red snapper effort yields a welfare loss of $528,759. Net effort lost under this scenario is 581 trips, and when applied to US national average trip expenditure of $49.12, as calculated from [11], there is a loss of $28,545.90 in trip expenditures[c]. Using multipliers from [12], these lost expenditures generate losses in sales impacts of $64,028.39, a $21,716.61 loss of income, and the loss of about three quarters of one full time job[d].

Table IV. Bag Limit Elasticities.

Species Target	Bag Limit Elasticities			
	King Mackerel	Dolphin	Grouper	Red Snapper
GROUPER	0.004	-0.037	0.069	-0.094
RED SNAPPER	0.004	-0.037	-0.085	0.101
DOLPHIN	0.004	0.088	-0.085	-0.094
KING MACKEREL	-0.004	-0.037	-0.085	-0.094

Table V. Catch and Keep Elasticities.

Species Target	Catch and Keep Elasticities			
	King Mackerel	Dolphin	Grouper	Red Snapper
GROUPER	-0.123	-0.02	0.114	-0.127
RED SNAPPER	-0.123	-0.02	-0.151	0.131
DOLPHIN	-0.123	0.043	-0.151	-0.127
KING MACKEREL	0.102	-0.02	-0.151	-0.127

It is much more difficult to analyze this policy change in the catch and keep model so three different approaches are used, all more illustrative than comparable to the bag limit change due to lack of information regarding how these policies impact keep. The second scenario sets keep at the current bag limit of four fish and examines the reduction to two fish. This scenario produces a total welfare loss of nearly $2.5 million. The third scenario does not fix initial conditions but allows them to vary as presented in the choice experiment and compares that to a model with keep fixed at two red snapper. This scenario produces a total welfare loss of over $1.3 million. These two scenarios were more to demonstrate the difference between using a direct policy attribute than an accurate measure of the welfare effect of these scenarios because, in reality, average catch rates for red snapper are quite low. Averaged across 10 years of MRFSS data and across all anglers catching a red snapper, the average harvest of red snapper is 0.929 fish per trip. The fourth policy scenario fixes this value as the base keep and simulates a 50% reduction is this value. Clearly this isn't correct either as the average catch and keep rate is lower than the proposed policy, further illustrating the difficulty of using a catch and keep model without more information regarding stock composition. The most correct way to simulate this policy using the catch and keep model would be to estimate some sort of count data expected catch and keep model and use the predicted values of catch and keep for each individual as the base case in the simulation. This technique is currently being pursued.

DISCUSSION

To date, this ongoing data collection has been successful. Two models are presented here, one based on the inclusion of the policy attribute directly and the other based on catch and keep. While the policy attribute model is more expedient for policy analysis, the positive sign on the minimum size limit attribute deserves further attention. These are preliminary results based on a small fraction, less than 12%, of the data from early returns. Perhaps these coefficients will swing negative as the sample increases. Perhaps spatial or temporal factors will improve the performance of this attribute as the availability of these species varies with region and time of the year. Regional dummies crossed with the species-specific minimum size limit attribute showed promise, but were not reported here. Additionally there is just not enough seasonal variation in this preliminary data to examine any sort of seasonal effect. Finally, further examination of the transcripts from the qualitative work may shed light on anglers' preferences for this type of regulation that may impact the way the attribute is modeled. At the very least one can model welfare effects of size limit policy using a cross of minimum size and the total keep, which is a measure of inches of fish landed as in Hicks [4].

Table VI. Effort Loss, Welfare Loss, and Economic Impacts of the 50% Reduction in the Red Snapper Bag Limit.

		1: 50% Reduction in Bag		2: Reduction in Keep from 4 to 2 Fish		3: Reduction in Keep from Sample Values to 2 Fish		4: 50% Reduction in MRFSS Average Keep	
Target Species	**2003 Effort**	**Share Change**	**Effort Change**	**Share Change**	**Effort Change**	**Share Change**	**Effort Change**	**Share Change**	**Effort Change**
Grouper	32,418	-1.05%	-340	2.78%	900	1.50%	485	0.59%	191
Red Snapper	18,891	-5.18%	-979	-11.66%	-2,203	-5.64%	-1,066	-2.65%	-500
King Mackerel	35,851	1.83%	656	2.90%	1,038	1.16%	417	0.59%	211
Dolphin	17,556	2.51%	441	2.84%	499	1.39%	244	0.68%	119
No Trip		1.90%	-359	3.39%	-640	1.59%	-300	0.79%	-150
Net Effort Loss			-581		-405		-220		-129
Welfare Effects									
CV per Trip			$27.99		$132.28		$69.66		$25.86
Welfare Loss			$528,759		$2,498,901		$1,315,947		$488,521
Expenditures and Impacts									
Average Trip Cost			$49.12		$49.12		$49.12		$49.12
Loss of Trip Expenditures			-$28,545.90		-$19,898.60		-$10,786.37		-$6,345.78
Sales Impacts			-$64,028.39		-$44,572.87		-$24,161.48		-$14,214.55
Income Impacts			-$21,716.61		-$15,122.94		-$8,197.64		-$4,822.79
Job Losses			-0.74		-0.52		-0.28		-0.16

Clearly anglers substitute into other fisheries when regulations are tightened and this paper quantifies that substitution in real terms. This substitution has the effect of softening the economic impacts by allowing some effort to shift into other fisheries. This is a far more realistic assumption than assuming that some ad hoc proportion of effort leaves fishing entirely with no considerations of angler's ability to shift their effort into other fisheries. Finally, this is only the beginning of the analysis of this data. The short list of further explorations includes the development of expected catch and keep models that incorporate size distributions and various nesting structures. Preliminary nesting was done using the stated preference for targeting and that model shows promise. Additionally the no trip option and the target species could be nested.

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ENDNOTES

[a] These regulations are simplification of the current regulations. Currently there is no minimum size for dolphin in federal waters, but the state of Georgia has a 20-inch minimum in its state waters. Also,

there are multiple species of grouper in the grouper target species group all with slightly different minimum size limits. The two most popular groupers, black and gag grouper, have a 24-inch minimum size, so that was used here.

[b] This reduction in the red snapper bag limit is strictly a creation of the author and by no means is it meant to represent an actual policy under consideration by either the South Atlantic or Gulf Fisheries Management Council.

[c] This is a simple average across resident status and trip mode including shore mode, boat mode, and the for-hire mode. The majority of red snapper trips are taken in the boat or for hire mode, which both have significantly higher trip expenditures than the shore mode. As a result this is likely a lower bound on trip costs.

[d] Economic impact multipliers were calculated at the national level, which might slightly overstate impacts over multipliers developed for the South Atlantic and Gulf Coast regions. Unfortunately, [12] did not calculate multipliers across the South Atlantic and Gulf Coast regions. US level multipliers were deemed much more suitable than state level multipliers because imports are far less a factor as geographic scope increases.