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Southeast Marine Recreational Fishery Statistical Survey: Distance and Catch Based Choice Sets

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Abstract *In this paper we estimate the economic value associated with marine recreational fishing in the southeast United States using the random utility model. The data used is the Southeast (North Carolina to Louisiana) Marine Recreational Fishery Statistics Survey (SE MRFSS). The geographic extent of the market and potential catch are used to determine the effect of choice set definition on random utility model parameter and welfare estimates. We find that choice sets based on distance or catch do not lead to large differences in the compensating variation of a fishing trip. Defining choice sets based on catch does lead to insignificant estimates of the effect of one measure of site quality on site selection. We also find differences in the value of an additional fish when comparing alternative measures of site quality.*

Key words Choice sets, MRFSS, Random Utility Model, recreational fishing.

Introduction

The National Marine Fisheries Service has established the random utility model as their standard for evaluating the economic value of recreational fishing. In this paper we provide estimates of the economic value associated with marine recreational fishing in the southeast United States using a random utility model of recreational site choice based on the 1997 Marine Recreational Fishing Statistical Survey (MRFSS) from the National Marine Fisheries Service. In addition to the myriad other issues associated with modeling recreational site choice (see Haab and Hicks, this issue), the recent literature has blossomed with attempts to narrow the dimensionality of large choice structures by narrowing the set of alternatives (choice set) assumed available to the recreator. In similar research Parsons and Hauber (1998) have shown that the number of sites to be considered by each angler can be limited geographically. Beyond a distance threshold, consideration of additional sites has little impact on welfare measures. Haab and Hicks (1998) and Hicks and Strand (forthcoming) have shown that further narrowing of the choice set based on a combination of individual and site-specific attributes can improve the accuracy of welfare estimates. However, the welfare estimates are often sensitive to the definition of the choice set.

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We contribute to this literature by considering the effect of distance and quality based choice set reductions on welfare measures derived from the 1997 Southeast MRFSS. To maintain attention on the effects of choice set definition, we narrowly focus on the value of site access and additional catch to day-trip anglers who target small game using private or rental boats. Various definitions for the geographic extent of the market are used to determine the effect of distance based choice set definitions on random utility model parameter estimates and welfare estimates. Quality based choice sets are defined using two different site quality measures: five-year average historic catch and keep rates at a site, and individual specific predicted catch rates at each site (Smith, Liu, and Palmquist 1993; McConnell, Strand, and Blake-Hedges 1995). The welfare effects of distance and quality based choice sets are considered independently and jointly. We find that distance based choice sets have very little effect on the value of access to a site, or the value of additional catch at a site. Quality based choice sets have little effect on the value of site access, but can lead to large variations in the value of additional catch depending on the catch definition used. Interestingly, for this example, it appears that the effects of distance and quality based choice sets are independent and as such mingling distance and quality based choice set definitions does not appear to confound the effects on welfare measures.

The rest of this paper is organized as follows. First, we describe the data and the sub-sample used in estimation. Next, we describe the alternative measures of site quality and the alternative choice sets. Random utility model estimation results and welfare estimates follow. We conclude with a discussion of our results, including potential policy implications, and our plans for future research.

The Southeast MRFSS Data

The data used for this study are from the National Marine Fisheries Service's Marine Recreational Fishery Statistics Survey (MRFSS) in the Southeastern (SE) United States. The MRFSS consists of two parts, an intercept survey and a telephone survey. We primarily use data from the intercept survey that gathers catch and demographic information. Sampling in the intercept survey is stratified by state, mode (party/charter boat, private/rental boat, shore), and wave and allocated according to fishing pressure. Sampling sites are randomly selected from an updated list of access sites. The MRFSS data is prone to avidity bias where the probability of being interviewed increases with the number of fishing trips (Thomson 1991). Over 57,000 intercept surveys of recreational anglers were conducted at over 1,000 fishing sites from North Carolina to Louisiana in 1997.

The NMFS also conducts a telephone survey of coastal residents to determine marine recreational fishing participation. Catch and effort estimates are made using the MRFSS telephone and intercept surveys, combined with Census and historical data (National Marine Fisheries Service 1999). We use the unweighted SE MRFSS data, not correcting for stratification or avidity. Therefore, our models are not necessarily representative of the population and should be viewed as exploratory.

During 1997 (Wave 2 through Wave 6)[1], approximately 10,000 Add-On MRFSS Economic Survey (AMES) telephone interviews were conducted with MRFSS intercept respondents who agreed to be interviewed (QuanTech 1998). The AMES survey collects economic information about the intercepted fishing trip including expenditure and travel cost information. Combining the MRFSS and AMES data and, omit-

[1] Wave 1 (January and February) interviews are not collected in North Carolina, South Carolina, and Georgia.

ting observations with missing data on key variables, results in 8,865 useable cases.

A majority of the 8,865 interviewed anglers (60%) fish from either a private or a rental boat (table 1). Approximately 30% fish from the shore with the remaining 10% fishing from a party or charter boat. The method of fishing will be referred to as the mode. In addition to the mode of fishing, the MRFSS contains information on the specific species targeted on the current trip. Of the reported target species, 32% of anglers target one of thirty-seven small game species such as red drum (table 2). Five percent, 7%, and 3% of the anglers target big game (*e.g.*, cobia), bottom fish (*e.g.*, grouper), and flat fish (*e.g.*, flounder) species. Over 50% of Southeast anglers do not target species (*e.g.*, "fishing for whatever is biting") or other target species (*e.g.*, eel).

Cross tabulations of mode and species choice indicate that private/rental boat anglers who target small game (24%) or other species (26%) are most common in these data (table 3). Other combinations of mode/species choice are big game (3.8%), bottom fish (4%), and flat fish (2.3%) anglers who fish from private/rental boats, small game (6.2%) and bottom fish (2.3%) shore anglers. The other species/mode choices include less than 200 anglers. No one in the sample targets flat fish from a party/charter boat. Only 22 anglers target big game fish from the shore.

For tractability, the National Marine Fisheries Service defined intercept sites are aggregated into seventy county level fishing sites. The MRFSS sampling scheme is designed to provide a random sample of recreational fishing trips in the Southeast. Given this objective, less than 5% of the anglers interviewed were intercepted in Alabama, Georgia, and Mississippi. Over 50% of the anglers interviewed were intercepted in Florida. Eleven, 17%, and 8% were intercepted in Louisiana, North Carolina, and South Carolina. Sites with more than two hundred interviews include Brevard, Hillsborough, Monroe, Palm Beach, Pasco, and Pinellas Counties in Florida. Pinellas County alone accounted for 7% of the sample. Two hundred sixty-five anglers fished in Plaquemines County in Louisiana. Five percent and 11% fished in Carteret and Dare Counties in North Carolina. In South Carolina, 222 and 248 anglers were intercepted in Georgetown and Horry Counties. The most popular site in Alabama is Baldwin County (n = 185). The most popular site in Georgia is Chatham County (n = 163).

Table 1
SE MRFSS-AMES Fishing Mode Choice

Mode	Frequency	Percent
Party/charter	906	10.1
Private/rental	5,370	60.1
Shore	2,652	29.7

Table 2
SE MRFSS-AMES Species Group Choice

Species	Frequency	Percent
Big	444	5
Small	2,882	32.3
Bottom	657	7.4
Flat	293	3.3
Other	4,652	52.1

Table 3
SE MRFSS-AMES Species/Mode Choices

Species	Mode	Frequency	Percent
Big	party/charter	85	1
Big	private/rental	337	3.8
Big	shore	22	0.2
Small	party/charter	154	1.7
Small	private/rental	2,175	24.4
Small	shore	553	6.2
Flat	party/charter	0	0
Flat	private/rental	205	2.3
Flat	shore	88	1
Bottom	party/charter	100	1.1
Bottom	private/rental	353	4
Bottom	shore	204	2.3
Other	party/charter	567	6.4
Other	private/rental	2,300	25.8
Other	shore	1,785	20

Small Game-Private/Rental Boat Anglers

The small game target and private/rental boat mode is the most popular species-mode choice in the data (n = 1,914). Because we want to focus on the effects of choice set definition and avoid complications introduced by nesting structure and modeling assumptions in more complete models of SE recreational site choice, we conduct our comparisons of choice set definitions and site quality variables with this sub-sample.[2] The average angler in this sub-sample has fished over 23 years and over 20 years in the state of intercept. Eighty percent of the anglers own their own boat. This sub-sample is 93% male and 95% white. The average age is 44 and average household income is $56,480 ($n$ = 1,397). A log-linear ordinary least squares regression model is used to impute missing income values. The resulting income imputation equation is:

$$\begin{aligned}\ln(\text{HHINC}) = &-0.64 + 0.28*\text{WHITE} + 0.07*\text{MALE} + 0.11*\text{AGE} \\ &- 0.0018*\text{AGE}^2 + 0.0000087*\text{AGE}^3 + 0.45*\text{EMPLOYED} \\ &+ 0.15*\text{BOATOWN} + 0.81*\ln(\text{STINC})\end{aligned}$$

where HHINC is the reported household income, WHITE = 1 if the respondent reports being white, MALE = 1 for males, AGE = age in years, EMPLOYED = 1 if the respondent is currently employed, BOATOWN = 1 if the respondent owns a boat, and STINC is the average income of residents in the respondent's home state. Each of the independent variables is statistically significant at the 0.01 level. The R^2 for the model is 0.16. The average imputed household income is almost $52,000.

[2] The use of the small game—boat mode potentially limits our results. The probability of travel to distant sites is lower for boaters and site selection is limited by the existence of boat ramps and marinas. Our conditional logit models do not allow substitution across species or mode as in a nested RUM. More general models of recreational species-mode and site selection that incorporate the preliminary results presented here are currently being considered. See Haab and Whitehead (1999) for preliminary results and future plans.

Over 50% of the small game-private/rental boat anglers reside in Florida and fished in Florida. Louisiana is home to almost 23% of the anglers and 24% of the day trips. North and South Carolina account for about 14% of the residents and 15% of the day trips. Mississippi and Alabama combined account for less than 5% of the residents and day trip destinations. Residents of Virginia (12), New Jersey (5), and Texas (5) are also represented in the sample. Other states accounted for 33 of the anglers.

The small game-private/rental boat anglers fished on average over 41 days during the 12 months prior to the intercepted trip. During the 2-month wave of the interview these anglers fished over 7 days. More than 4 of these fishing days were at the intercepted site and mode (private/rental boat). About 3.5 days were spent fishing from the intercepted site, targeting small game, and using a private/rental boat. This last quantity measure is most relevant for the welfare analysis conducted later.

Other characteristics of the trip include an average one-way travel distance of 70 miles to the intercepted site.[3] Only 8% of the sample lost wages during their trip. The average number of hours fished and number of people in the boat fishing party are 4.5 and 2.3. The average angler spent $10 on lodging, $13 on travel, and $19 on bait, equipment and other expenses on the trip. Twelve percent of the trips were multi-day trips.

Definition of Quality Measures: Catch and Keep Rates

Two measures of fishing quality are used to explain fishing site choice: historic average catch and keep and predicted catch and keep. Five-year average historic catch and keep rates were calculated from the 1992–96 MRFSS. Catch of the targeted species groups for each wave and mode were aggregated at the county level. For small game-private/rental mode trips the average county level catch rate per trip is 3.47 fish. The minimum catch is 0 and the maximum catch is 9.11. The average catch and keep rate is 1.57 with a minimum of 0 and maximum of 6.57. Since fish caught and kept are viewed and counted by the interviewer, while fish caught and released are self-reported by the interviewee, historical catch and keep is a more conservative and accurate measure of fishing quality.

Since fish catch is a count variable we estimate Poisson household production catch and keep rate models with an overdispersion correction (Cameron and Trivedi 1986; McConnell, Strand, and Blake-Hedges 1995). Model estimates appear in table 4.[4] The dependent variable is the number of fish caught and kept per trip, and since we estimate the model for the full MRFSS-AMES sample, the number of fish caught and kept is conditioned on a set of dummy variables describing the particular type of trip. Anglers who target big game (BIG), small game (SMALL), bottom fish (BOTTOM), and flat fish (FLAT) catch more than anglers who do not target fish (OTHER is the excluded variable). More fish are caught during May and June (WAVE3), July and August (WAVE4), September and October (WAVE5), and November and De-

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[3] Travel distances are calculated as the travel distance from the angler's zip code to the zip code of the intercepted site using PC*Miler.

[4] We considered several potential functional forms and specifications for the catch models. In preliminary modeling efforts we found that catch rate models for individual species groups do not perform particularly well, especially for the flat, bottom, and big game species (Wang 1999). We also conducted numerous specification tests to determine the best combination of variables in the catch rate models. For example, a specific measure of fishing experience, visits to the site/mode/species during the past 2 months, only marginally helped explain the actual catch and keep. Li (1999) determined that there is considerable noise in the catch rates, relative to the catch and keep rates, limiting our ability to model catch rates (fish are either kept, released, or used for bait). Li also finds that catch and keep rate models pooled over species groups and with five year historic average catch rates (as opposed to individual year average rates) perform best.

Table 4
Poisson Catch and Keep Rate Model

Variable	Beta	Standard Error	t-statistic	Variable Mean
INTERCEPT	–2.039	0.275	–7.42	
BIG	1.141	0.273	4.18	0.05
BOTTOM	2.057	0.216	9.53	0.07
SMALL	2.001	0.182	11.01	0.32
FLAT	1.834	0.309	5.93	0.03
WAVE3	0.430	0.182	2.37	0.23
WAVE4	0.490	0.189	2.59	0.18
WAVE5	0.624	0.173	3.60	0.22
WAVE6	0.290	0.182	1.59	0.21
MODE2	–0.987	0.135	–7.34	0.60
MODE3	–1.673	0.173	–9.67	0.30
HCKR	0.191	0.017	10.98	0.98
HRSF	0.104	0.023	4.53	4.37
MULTI	0.227	0.113	2.01	0.28
YRFISHST	0.026	0.006	4.08	17.88
YRFISHST Squared	–0.000	0.000	–2.00	593.64
BOATOWN	–0.116	0.106	–1.10	0.57
SCALE	4.598			

Note: Sample size = 8,865. Dependent variable = catch and keep per trip.

cember (WAVE6) relative to March and April (WAVE2 is the excluded variable). Fewer fish are kept on private/rental boat (MODE2) and shore trips (MODE3) relative to party/charter trips (MODE1 is the excluded variable).

Catch and keep rates increase with the average historic catch and keep rate at the site (HCKR) and the number of hours fished (HRSF).[5] Fishing experience, measured by the number of years fished in the state of the interview, increases catch and keep rates (YRFISHST) at a diminishing rate. Anglers who fish multiple days per trip (MULTI) catch more fish per day. Boat ownership (BOATOWN) does not increase the number of fish caught and kept. The Poisson model is used to predict catch and keep rates at each site.

We use measures of fishing quality in the conditional logit models to explain site choice. The quality variables used are the mean historic and predicted small game catch and keep rates. The predicted catch and keep rates are measured with the specific variables for each angler (see McConnell, Strand, and Blake-Hedges 1995). For example, the individual specific dummy variables for wave and mode and the historic catch and keep rate at each site are used to predict catch and keep rates for each angler at each site. Therefore, each quality measure is specific to the mode and wave for which the individual fished.[6]

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[5] We attempted to test for the endogeneity of hours fished using an instrumental variable approach (Smith, Liu, and Palmquist 1993; Schuhmann 1998). We are unable to explain more than 1–2% of the variation in hours fished so we abandoned our efforts.

[6] An alternative approach, as suggested by a referee, would be to include both historic average catch and keep rate and predicted catch and keep rate in the site selection model. The historic average catch and keep rate would measure stock effects. The predicted catch and keep rate would measure the effects of angler skill and other site-specific variables. This approach would require eliminating the historic average catch and keep rate from the Poisson model and including other site-specific variables that would affect catch, such as pollution, as in Smith, Liu, and Palmquist (1993).

Table 5
Number of Sites in Each Choice Set

Choice Set	Maximum Distance	Minimum Historic Catch and Keep Rate	Mean	SD	MIN	MAX
1			70.00			
2	360		27.91	7.10	2	43
3	300		23.95	5.79	3	35
4	240		19.15	4.20	3	28
5	180		13.50	2.73	2	19
6		0.25	60.71	3.26	55	68
7		0.33	57.50	2.85	53	64
8		0.5	51.81	4.28	45	61
9	300	0.25	21.40	5.31	2	33
10	180	0.25	12.37	2.83	2	19

Choice Sets

To examine the effects of choice set definition on the site choice, ten choice sets based on distance and historic catch and keep rates were constructed. Table 5 enumerates the set of choice sets. The first choice set includes the full set of potential fishing sites (all 70 counties). The second through fifth choice sets reduce the set of alternative sites available to the recreator based on distance. The second choice set includes the actual site chosen and eliminates any site beyond 360 miles of the one-way travel distance. If this choice set only contains one site, then the closest site to the angler's residence is also included. If the closest site is the actual site chosen then the next closest site is included. The third through fifth choice set reduces the maximum travel distance allowed by 60-mile increments. For choice set 5 only sites within 180 one-way miles are considered. It is worth noting that while 180 miles still represents a significant distance for a day-trip, the least restrictive distance-based choice set eliminates on average over 60% of the candidate sites from the respondents' choice set.

The sixth, seventh, and eighth choice sets are based on average historic catch and keep rates. The sixth choice set eliminates all sites for which the average historic catch and keep per trip is less than 0.25 fish. The seventh and eighth choice set eliminates all sites for which the average catch and keep per trip is less than 0.33 and 0.50 fish.

The ninth and tenth choice sets combine distance and catch criteria. The ninth choice set excludes sites beyond 300 miles and with average catch and keep less than 0.25 fish. The tenth choice set excludes sites beyond 180 miles and with average catch and keep less than 0.25 fish.[7]

Given the definitions in table 5, anglers are assumed to consider an average of almost 28 sites in the second choice set. The minimum number of sites considered by an angler are 2 and the maximum are 43. The average number of sites in the third through fifth choice sets is 24, 19, and 13.5. The catch and keep criteria eliminate fewer sites than the distance based choice sets. The average number of sites for

[7] Numerous other combinations of distance and catch thresholds are possible. We limit our comparisons for brevity.

choice sets 6, 7, and 8 are 61, 57.5, and 52. The range of sites considered in the catch-based choice sets is also narrower than the distance based choice sets. The minimum number of sites in these choice sets is 55, 53, and 45. In the combined distance and catch based choice sets the average number of sites included is 21 and 12 for choice sets 9 and 10.

Results

Site Selection Models

Some characteristics of the day-trip sample are presented in table 6. We have data on 1,914 anglers. Most of the trips are to the Gulf Coast of Florida (43%), Louisiana (22%) and the Atlantic Coast of Florida (15%). The average number of trips across each 2-month wave is 3.66. The average historic catch and keep rate at the chosen site is 1.51. The predicted catch and keep rate at the chosen site is 1.78 with much more variability across sites relative to the historic rate. The standard deviation of the predicted catch and keep rate is almost four times greater than for the historic catch and keep rate.

Conditional logit random utility site-choice models are estimated using both historic catch and keep and predicted catch and keep rates as site quality measures. Following the standard derivation of the conditional-logit RUM, we assume that the individual will choose to visit the site that provides the maximum utility of all the available alternatives. Because this utility ranking is known to the recreator but unobservable to the researcher, the choice between alternatives can be viewed as random. Given an individual (i) and site specific (j) indirect utility function (V_{ij}) that is additively separable in a Type-I extreme value distributed random error term (ε_{ij}): $V_{ij} = v_{ij} + \varepsilon_{ij}$, the conditional logit model emerges such that the probability of individual i selecting site j (P_{ij}) becomes:

$$P_{ij} = \frac{e^{v_{ij}}}{\sum_j e^{v_{ij}}} \tag{1}$$

Table 6
Characteristics of Small Game, Boat Fishing, Day Trippers

Variable	Mean	SD
Intercept site:		
Alabama	0.02	0.14
Florida—Atlantic coast	0.15	0.36
Florida—Gulf coast	0.43	0.5
Georgia	0.01	0.12
Louisiana	0.22	0.42
Mississippi	0.02	0.15
North Carolina	0.06	0.23
South Carolina	0.08	0.27
Visits to site/mode/species	3.66	4.48
Years fished in state	20.63	16.28
Household income (in thousands)	50.73	29.4
Historic Catch and Keep Rate (HCKR)	1.51	1.64
Predicted Catch and Keep Rate (PCKR)	1.78	5.96

Sample size = 1,914

For our purposes, the indirect utility function is assumed to be a linear function of the individual and site-specific travel cost to each site (TC_{ij}), and the associated expected catch and keep rate variable (Q_{ij}):

$$v_{ij} = \beta_y TC_{ij} + \beta_Q Q_{ij} \tag{2}$$

where β_y is the negative of the marginal utility of income, and β_Q is the parameter on expected catch. Travel costs are calculated at $0.20 per mile traveled and time costs are calculated using estimated travel times (40 mph) and wage rate estimates from the imputed income data. The full wage is used as the opportunity cost of travel time as in Hicks, *et al.*, (1999).

Table 7 presents the results from twenty random utility models for small game-private/rental boat anglers. Prior expectations dictate the trip cost parameter to be negative and the site quality parameter to be positive. All of the parameter estimates have the expected sign except one and all but three of the parameter estimates are statistically significant at the 0.10 level. The insignificant coefficients are for the historic catch and keep rate variable in choice sets 6, 7, and 8. When the choice set is restricted by historic catch and keep rate, the lack of variability in quality for the sites remaining leads to insignificant effects of site quality on site choice. The most restrictive catch rate based choice set (8) has a negative coefficient on site quality.[8]

The most striking result from table 7 is that choice set definition has very little effect on the trip cost coefficients which range from –0.053 to –0.057 even though the choice set definitions in table 2 eliminate an average minimum of 13% and maximum of 82% of the available sites. The change in the trip cost parameter is largest (relative to the full-reference set) when the choice set is restricted to only sites with at least a 0.50 historic catch and keep rate. The quality coefficients for the predicted catch and keep rate models are always at least 2.5 times greater than for the historic catch and keep rate models. For distance based choice sets, the quality coefficients do not change in magnitude. When the distance-based choice sets are narrowed by catch rates (sets 9 and 10) the effect of site quality on site selection is smaller.

We find more variability in the quality coefficients across choice set when using the predicted catch and keep rate variable. Again, however, the distance based choice sets have little effect on the quality coefficients. When the number of sites in the choice set are restricted based on historic catch and keep rates the size of the quality coefficient falls by about 20%, 25%, and almost 50% when comparing sets 6, 7, and 8 to the base case (choice set 1). When eliminating some sites from the catch based choice sets combined with distance thresholds (choice sets 9 and 10) the coefficients on site quality fall between the strictly distance based and catch based choice sets quality coefficients.[9]

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[8] This result is amplified in models that restrict the catch rate based choice sets even further (Haab and Whitehead 1999).

[9] Other RUM results are presented in Haab and Whitehead (1999) for other SE MRFSS species/mode combinations that contained more than 200 cases. For all species models the trip cost coefficients are similar when comparing similar distance based choice sets. For private/rental boat trips, neither of the quality coefficients are significant for big game anglers and both of the quality coefficients are significant for bottom fish anglers. In contrast to small game, the coefficient on the mean historic catch and keep variable is much larger than the coefficient on the predicted catch and keep rate variable for bottom fish anglers. For flat fish anglers, only the historic catch and keep quality coefficient is significant. For shore anglers, none of the quality coefficients are significantly different from zero.

Welfare Measures

An upper bound on compensating variation due to loss of site access by state is reported in table 8. The upper bound is calculated from the expected compensating variation of a loss of site access to site *k* from the conditional logit model described in equations (1) and (2) (see McConnell, Bockstael, and Strand):

$$C_{ik} = \frac{\ln\left[\sum_{j} e^{v_{ij}}\right] - \ln\left[\sum_{j \neq k} e^{v_{ij}}\right]}{\beta_y}. \tag{3}$$

Rearranging, the compensating variation of the loss of site *k* can be written as:

$$C_{ik} = \frac{-\ln\left[1 - P_{ik}\right]}{\beta_y} \tag{4}$$

Table 7
Conditional Logit Regression Estimates

		Historic Catch and Keep			Predicted Catch and Keep		
Choice Set	Variables	Beta	Standard Error	t-statistic	Beta	Standard Error	t-statistic
1	Trip Cost	–0.057	0.001	–43.30	–0.057	0.001	–43.40
	Quality	0.083	0.025	3.30	0.211	0.043	4.97
	Log-Likelihood	–3,191.40			–3,185.4		
2	Trip Cost	–0.057	0.001	–43.30	–0.057	0.001	–43.40
	Quality	0.084	0.025	3.34	0.212	0.043	4.98
	Log-Likelihood	–3,186.1			–3,180.2		
3	Trip Cost	–0.057	0.001	–43.29	–0.057	0.001	–43.38
	Quality	0.084	0.025	3.34	0.212	0.043	4.97
	Log-Likelihood	–3,185.9			–3,180.0		
4	Trip Cost	–0.057	0.001	–43.17	–0.057	0.001	–42.93
	Quality	0.085	0.025	3.36	0.212	0.043	4.98
	Log-Likelihood	–3,183.1			–3,177.2		
5	Trip Cost	–0.056	0.001	–41.58	–0.056	0.001	–41.67
	Quality	0.085	0.025	3.35	0.211	0.042	4.96
	Log-Likelihood	–3,175.1			–3,169.3		
6	Trip Cost	–0.056	0.001	–42.81	–0.056	0.001	–42.97
	Quality	0.040	0.026	1.54	0.177	0.043	4.09
	Log-Likelihood	–3,052.4			–3,045.9		
7	Trip Cost	–0.055	0.001	–42.62	–0.055	0.001	–42.85
	Quality	0.007	0.027	0.28	0.153	0.044	3.47
	Log-Likelihood	–2,956.6			–2,951.1		
8	Trip Cost	–0.053	0.001	–41.69	–0.053	0.001	–42.09
	Quality	–0.036	0.028	–1.30	0.119	0.045	2.65
	Log-Likelihood	–2,951.1			–2,679.9		
9	Trip Cost	–0.054	0.001	–42.91	–0.055	0.001	–43.04
	Quality	0.049	0.026	1.89	0.182	0.043	4.23
	Log-Likelihood	–3,077.0			–3,070.4		
10	Trip Cost	–0.053	0.001	–40.77	–0.054	0.001	–40.91
	Quality	0.049	0.026	1.89	0.181	0.043	4.20
	Log-Likelihood	–3,063.5			–3,057.1		

Table 8
Compensating Variation per Trip for Site Access

	State							
	AL	FL_E	FL_W	GA	LA	MS	NC	SC
	Historic Catch and Keep Rate							
MIN	0.35	2.64	7.56	0.18	3.87	0.35	1.06	1.41
MED	0.36	2.69	7.72	0.18	3.95	0.36	1.08	1.44
MAX	0.38	2.83	8.12	0.19	4.16	0.38	1.13	1.51
	Predicted Catch and Keep Rate							
MIN	0.35	2.63	7.55	0.18	3.86	0.35	1.05	1.40
MED	0.36	2.69	7.70	0.18	3.94	0.36	1.07	1.43
MAX	0.37	2.81	8.04	0.19	4.12	0.37	1.12	1.50

where P_{ik} is defined in equation (1). As P_{ik} approaches zero, $-\ln[1 - P_{ik}]$ approaches P_{ik}. For larger P_{ik}, $-\ln[1 - P_{ik}] > P_{ik}$ and as such P_{ik} serves as a lower bound. Substituting into equation (4), and recognizing $\beta_y < 0$, that we find that:

$$C_{ik} \le \frac{P_{ik}}{\beta_y}. \tag{5}$$

For the population, the average compensating variation of loss of site access to k [summing equation (5) over the population and dividing by N] is bound from above by:

$$\overline{C}_k \le \frac{\overline{P}_k}{\beta_y} \tag{6}$$

$\overline{P}_k$ represents the population mean probability of visiting site k. As such, $\overline{P}_k$ can be consistently estimated using the observed sample frequency of visits to site k. In other words, the upper bound welfare loss due to elimination of a site described in equation (6) can be consistently estimated by dividing the observed sample frequency of visits to a site by the negative of the estimate of the marginal utility of income. A couple of caveats must be noted. The larger the frequency of visits to a site, the larger the divergence between the upper bound estimate in equation (6) and the actual expected welfare loss. Further, the welfare measure in equation (6) relies on the indirect utility function being additively linear in income. Despite these caveats, the lower bound welfare measure in equation (6) provides a quick (and for large site selection models, accurate) measure of the expected welfare loss of site elimination.

In addition to the welfare approximation for loss of site access presented above, a simple measure of welfare for an increase in expected catch (or quality) exists. Suppose instead of looking at percentage increases and decreases in the expected catch at all sites (as appears to be the standard policy measure in the literature) we instead look at the welfare effect of an absolute increase in catch at all sites. For simplicity we will assume that the measure of interest is an increase in expected catch of 1 fish at every site. For the linear conditional logit model, the welfare change of a 1 fish increase at all sites is:

$$C_{i(+1)} = \frac{\ln\left[\sum_j e^{\beta_y TC_{ij} + \beta_Q Q_{ij}}\right] - \ln\left[\sum_j e^{\beta_y TC_{ij} + \beta_Q \left(Q_{ij}+1\right)}\right]}{\beta_y}. \quad (7)$$

Upon simplification, equation (7) becomes:

$$C_{i(+1)} = -\frac{\beta_Q}{\beta_y}. \quad (8)$$

By simply dividing the catch coefficient by the marginal utility of income, we get an estimate of the welfare gain from an increase in expected catch of 1 fish.[10] While a one fish increase at every site is biologically infeasible for most species, scaling down the increase in expected catch by a constant (*e.g.* 0.01 additional fish at every site) or aggregating only over the affected population provides a quick and simple measure of welfare from the conditional logit model. The welfare measure in equation (8) can simply be multiplied by the expected increase in fish catch over the population to find the population welfare gain.[11]

The Effect of Choice Sets on Welfare Measures

Table 8 presents the minimum, median, and maximum welfare measures for loss of access to each state [equation (6)] across the ten choice sets for both measures of site quality. We find very little difference in these welfare measures indicating that our selection of choice sets does not affect the value of site access. Aggregated to the state level, we find differences in the value of a trip across site. For example, the lost compensating variation of a trip if access to the Gulf Coast of Florida (FL_W) is eliminated is about $8 but the value of a trip to Alabama is less than $1. These differences are driven by site selection patterns and not the model estimates. We find virtually no difference in the value of site access across the two measures of site quality.

The compensating variation per trip estimates are multiplied by the average number of trips taken during the 2 month wave targeting small game, and using private/rental boats (table 9).[12] This provides an estimate of the value of access over the 2 month time period. The pattern of results is similar as in table 8. The Gulf coast of Florida is the most valuable fishing site. Louisiana and the Atlantic coast of Florida have values of about $12.

In table 10 we present the compensating variation per trip of an increase in the catch and keep rate by one additional fish [equation (8)]. The value of an additional fish does not vary across distance based choice sets. The value of an additional fish

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[10] Note that this result holds for a change in any right hand side variable. For example, the welfare gain from a one unit increase in water quality at all sites can be found by dividing the coefficient on water quality by the marginal utility of income. The same holds for any other right hand side variable.

[11] In addition, if the researcher wants to introduce hypothetical changes in catch to stated preference interviewees, it is much easier to convey a 1 fish increase in expected catch than a 5% increase in catch.

[12] The average number of trips across wave are 2.32 (Alabama), 4.33 (Florida-Atlantic Coast), 3.91 (Florida-Gulf Coast), 3.37 (Georgia), 2.96 (Louisiana), 3.23 (Mississippi), 3.49 (North Carolina), and 3.55 (South Carolina).

Table 9
Compensating Variation per Wave for Site Access

	State							
	AL	FL_E	FL_W	GA	LA	MS	NC	SC
	Historic Catch and Keep Rate							
MIN	0.82	11.42	29.57	0.59	11.45	1.14	3.68	4.99
MED	0.83	11.66	30.19	0.61	11.69	1.16	3.76	5.10
MAX	0.88	12.27	31.76	0.64	12.30	1.22	3.96	5.36
	Predicted Catch and Keep Rate							
MIN	0.81	11.40	29.51	0.59	11.43	1.13	3.67	4.98
MED	0.83	11.63	30.10	0.60	11.66	1.16	3.75	5.08
MAX	0.87	12.15	31.45	0.63	12.18	1.21	3.92	5.31

Table 10
Compensating Variation per Fish

Choice Set	Historic Catch and Keep Rate	Predicted Catch and Keep Rate
1	1.47	3.71
2	1.49	3.72
3	1.49	3.72
4	1.50	3.74
5	1.52	3.77
6	0.72	3.18
7	0.14	2.79
8	–0.68	2.22
9	0.90	3.34
10	0.92	3.38

is smaller when the choice set is limited by historic catch and keep rates, although this effect is slight when using the predicted catch and keep rate as the measure of site quality. The value of an additional fish is more than twice as large when using the predicted catch and keep rate as the measure of site quality.

Discussion

In this paper we find that choice sets based on distance do not lead to large differences in angler welfare. Our distance thresholds, more than 4.5 to 9 hour one-way drives (assuming 40 mph), may be beyond the realistic time constraints for day-tripping small game anglers. In this sense, our results support the findings of Parsons and Hauber (1998). Rejecting sites from the choice set that may be unrealistic substitutes does not affect the model. Rejecting additional sites from the choice set based on a further tightening of the distance threshold allows determination of the threshold at which differences in welfare measures arise. We find that a choice set that restricts substitute sites to those within 120 one-way miles (about a 3 hour drive) does not lead to significant parameter estimates in the random utility model. This result is not surprising since our most restrictive choice set includes an average of only 13.5 sites. The further narrowing of the choice set to 120 miles and an average of 6 sites does not represent angler behavior well.[13] These results suggest that sites with a 4.5 hour drive are reasonable substitutes.

Defining choice sets based on minimum historic catch and keep rates does not lead to large effects on the trip cost parameter estimates or per trip welfare measures. We do find, however, that the RUM parameter estimate for fishing quality is affected. When the historic catch and keep rate is used as the measure of fishing quality, the parameter estimate is insignificant and site quality does not seem to matter to anglers. When the predicted catch and keep rate is the measure of site quality the effect of site quality on site selection is smaller. When combining a distance threshold to the catch rate based choice sets we find results that are closer to the base case model. Both measures of site quality are significant predictors of site selection but their effects are smaller in comparison to the baseline model.

We find differences in RUM parameter estimates on site quality and the welfare measure of an additional fish when comparing alternative measures of site quality. The historic catch and keep rate is best considered as a proxy for the stock of fish at the site. Increases in the stock of fish at the site will potentially lead to increased catch rates. The predicted catch and keep rate varies according to the historic catch and keep rate and individual characteristics which measure the angler's ability to catch fish. The predicted catch and keep rate measure is the conceptually preferred measure of site quality. Using the historic catch and keep rate as the measure of site quality would lead to under-estimates of the value of catching fish.

These per trip and per fish value estimates can be used for recreational fishery policy analysis. For example, the economic cost of a two-month reduction in the season of a small game species could be estimated as the number of trips lost during the two-months multiplied by the compensating variation per trip. Using National Marine Fisheries Service estimates of the total number of recreational trips, a closure of the small game (all species) fishery in Louisiana during September and October would cost $584,308. A similar closure of the Atlantic coast of Florida during May and June would cost over $1 million. Extending this analysis to the entire southeast leads to an annual (waves 2 through wave 6) aggregate value of small game marine recreational fishing of $22.35 million in 1997.

Estimates of the value of additional caught and kept fish is also useful for policy analysis. For example, consider a regulation that would reduce the commercial quota of a small game fish so that about 10,000 additional small game fish would be available for recreational anglers. If 25% of these fish are caught and kept by recreational anglers the benefit of this regulation to recreational anglers would be 2,500 fish multiplied by the value of an additional fish. Using the value of an additional fish from the most restrictive distance based choice set with predicted catch and keep as the site quality measure ($3.77) yields an aggregate recreational benefit of $9,426.

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[13] These results are available upon request.

Future Research

Our site-selection models and welfare estimates are purposefully simple to allow us to focus on the effects of distance and catch based choice set on estimated welfare. Our choice sets do not include alternative species or modes. In future research it will be useful to extend our small game/boat analysis to all species/mode group choices represented in the SE MRFSS. Nested-Logit models of marine recreational fishing in which the two-level nested model involves the species/mode and site-selection choices should be estimated. The MRFSS-AMES data also allows for an investigation of the effects of choice set definition on single species participation/site selection models for important recreational species such as red drum.

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