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Abstract

In this paper we measure the recreational economic benefits of the for-hire recreational fishery in the coastal region of North Carolina. We estimate a single trip random utility model for primary purpose and secondary purpose anglers with data from a field survey of charter and head-boat passengers. We find that primary and secondary purpose anglers exhibit significantly different behavior with regards to cost. However, once costs are weighted for secondary purpose anglers the value of catch is not statistically different across groups. For primary purpose anglers, the willingness to pay per trip is between $1800 and $2000 for one additional billfish (per angler), between $55 and $65 for one additional coastal migratory pelagic fish, $39 for one additional mackerel, and the willingness to pay per trip for an additional snapper-grouper is between $61 and $94. The net economic value for a charter boat trip averages $624 per angler per trip, and net economic value for a head boat trip is $102 per angler per trip.

Introduction

The North Carolina for-hire recreational fishery consists of approximately 750 charter boat vessels and head boat vessels operating year-round and targeting a succession of fish species depending on seasonal fish abundances and economic conditions. For-hire vessels charge recreational anglers a fee to take them fishing on half-day or full-day saltwater fishing trips from estuarine waters to 50 miles offshore. The vessels supply expertise and experience in finding and catching saltwater sport fish. The vessels also typically supply the fishing rods, reels and bait. Charter boats are generally smaller vessels (less than 70 feet in length), carry six or fewer passengers, and operate on a reservation basis. Head boats (also known as party boats) are larger (often more than 70 feet in length), carry more passengers (30 or more), and operate on a posted schedule.

There is a large marine recreational demand literature. However, most of this literature uses data from for fishing modes other than the for-hire mode (e.g., Massey, Newbold and Gentner, 2006), focuses on economic impacts and not economic benefits (Bohnsack et al., 2002), or employs bioeconomic models (Abbott and Wilen, 2009, Abbott, Maharaj and Wilen, 2009). In contrast, the objective of this paper is to measure the recreational economic benefits of the for-hire recreational fishery in the coastal region of North Carolina.

The data for this study come from a field survey of charter and head-boat passengers used to obtain information about the current fishing trip. Whitehead et al. (2011) use data from a follow-up telephone survey of a subsample of these charter

anglers to estimate demand models to value snapper-grouper and king mackerel bag limits in the North Carolina for-hire fishery. Carter and Liese (2010) estimate a hedonic model using charter fees as the price per trip to estimate the value of recreational catch. In contrast, we estimate a single trip random utility model for primary purpose and secondary purpose anglers based on the dockside interview. We find significant differences in the behavior of those anglers for which fishing is the primary purpose of their trip and those for which fishing is a secondary trip purpose, but the value per catch is not statistically different across these groups.

Data

During 2007 surveyors approached passengers at the end of a fishing trip and interviewed them (while fish were being cleaned) at marinas and fishing centers from Dare County, NC, to Brunswick County, NC. The dockside field survey of passengers produced 1,317 usable surveys. After deleting observations with missing values on key variables, we consider a sample of 1,204 anglers who took charter and headboat fishing trips in 2007.

Based on empirical analysis and knowledge of the North Carolina recreational fishery, we consider fifteen fishing alternatives. The choice alternatives are federal waters (more than 3 miles from the shore) vs. state waters (i.e., offshore and inshore trips), charter vs. headboat trips, location and whether fishing is the primary or secondary purpose of the trip. Interviews occurred at 14 locations which were grouped into five aggregate sites. For the purpose of this analysis the sites are labeled as Roanoke Island

(Manteo and Wanchese based trips), Outer Banks (Oregon Inlet, Hatteras and Ocracoke), Central Coast (Morehead City, Atlantic Beach and Topsail Island), New Hanover County (Wrightsville Beach and Carolina Beach) and Brunswick County (Oak Island, Ocean Isle, Southport, Calabash).

Five hundred ninety seven (49.6%) of the anglers state that fishing is their primary purpose for taking a trip to the North Carolina coast (Table 1). Six hundred and seven (51.4%) of the anglers state that fishing is a secondary purpose. Twenty percent of all charter and headboat trips originate at the Roanoke Island site, 29% originate on the Outer Banks, 7% originate on the Central Coast, 31% originate in New Hanover County and 14% originate in Brunswick County. Eighty-four percent of all trips are charter trips while 16% are headboat trips. Seventy-one percent of all charter trips have a federal waters destination.

Several decisions that led to the angler alternatives in Table 1 deserve comment. First, Oregon Inlet origination trips and Roanoke Island trips both reach the Atlantic Ocean via Oregon Inlet and are logically the same type of trips. However, based upon our preliminary empirical analysis Oregon Inlet trips are closer substitutes to Outer Banks trips than Roanoke Island trips. In the same way, econometric analysis indicates that grouping Topsail Island trips in the same aggregate site as New Hanover County trips is fruitless. Second, there are too few headboat trips to differentiate between federal and state waters so these trips are aggregated by origin site.

Angler characteristics sorted by purpose and fishing mode are presented in Table 2. Individual charter fees are about four and five times greater for charter boat anglers relative to headboat anglers (variable name is FEE). Most anglers are male (MALE) with

an average age of forty years (AGE). Average household income (INCOME) is between $72 thousand and $76 thousand except for primary headboat anglers with income of $79 thousand. The average number of charter boat anglers per trip is about five while the average number of headboat anglers per trip is 43 for primary anglers and 27 for secondary anglers. Primary purpose anglers spend an average of 3 nights away from home (NIGHTS) on their fishing trip while secondary purpose anglers spend 6 to 7 nights away from home. Very few anglers take day trips (DAYTRIP) where they return home on the same day they leave home. Primary and secondary purpose charter boat anglers took 3 and 2 charter boat trips (CB_TRIPS) during the past year, respectively. Headboat anglers took an average of 2 headboat trips (HB_TRIPS) during the past year. Few charter boat anglers took headboat trips and few headboat anglers took charter boat trips.

Charter boat anglers specifically target an average of one fish species (Table 3). The most popular primary purpose charter boat target species are tuna (22%), wahoo (17%) and dolphin (34%). The most popular secondary purpose charter boat species are billfish and tuna (13% each), Spanish mackerel (20%) and dolphinfish (34%). Only 25% and 50% of primary and secondary purpose headboat anglers target fish species, respectively. The most popular headboat trip target species for primary purpose anglers are snapper (7%) and grouper (6%). The most popular headboat trip target species for secondary purpose anglers are bluefish (13%), grouper (8%), dolphin (7%) and snapper (5%).

Model

We estimate nested logit recreation demand models for primary and secondary purpose anglers. We specify the angler choice in two stages. First, anglers choose amongst three mode/waters combinations: offshore charter, inshore charter and offshore or inshore headboat trip. Then, anglers choose one of five aggregate recreation sites. These choices depend on the cost and benefits of the choices. Costs include travel costs and individual charter/headboat fees per mode and site. Trip benefits are catch rates. We also include site specific constants to capture any other site specific costs or benefits.

Suppose an angler considers a number of recreation sites on each choice occasion. The individual utility from the trip is decreasing in trip cost and increasing in trip quality:

(1) $$u_i = v_i(y - tc_i - fee, q_i) + \varepsilon_i$$

where u is the individual utility function, v is the nonstochastic portion of the utility function, y is income, tc is the trip cost, fee is the charter/headboat fee, q is site quality (i.e., catch rate), ε is the error term, and i is a member of s recreation sites, $j = 1, \ldots, i, \ldots J$. The individual chooses the site that gives the highest utility:

(2) $$\pi_i = \Pr(v_i + \varepsilon_i > v_s + \varepsilon_s \quad \forall\, s \neq i)$$

where π is the probability that site i is chosen. If the error terms are independent and identically distributed extreme value variates then the conditional logit model results. The conditional logit model restricts the choices according to the assumption of the independence of irrelevant alternatives (IIA). The IIA restriction forces the relative probabilities of any two choices to be independent of other changes in the choice set. For example, if a quality characteristic at site i causes a 5% decrease in the probability of

visiting site *i* then the probability of visiting each of the other *j* sites must increase equally to sum to a 5% increase. This assumption is unrealistic if any of the *j* sites are better substitutes for site *i* than the others.

The nested logit model relaxes the IIA assumption. The nested logit site selection model assumes that recreation sites in the same nest are better substitutes than recreation sites in other nests. Choice probabilities for recreation sites within the same nest are still governed by the IIA assumption. Consider a two-level nested model. The site choice involves a choice among M groups of sites or nests, $m = 1, \ldots, M$. Within each nest is a set of J_m modes, $j = 1, \ldots, J_m$. When the site chosen, n, is an element in M, the mode choice, i, is an element in J_m and the error term is distributed as generalized extreme value the site selection probability in a two-level nested logit model is:

$$(3) \qquad \pi_{ni} = \frac{e^{v_{ni}/\theta}\left[\sum_{j=1}^{J_n} e^{v_{nj}/\theta}\right]^{\theta-1}}{\sum_{m=1}^{M}\left[\sum_{j=1}^{J_m} e^{v_{mj}/\theta}\right]^{\theta}}$$

where the numerator of the probability is the product of the utility resulting from the choice of site n and mode i and the summation of the utilities over modes within the chosen site nest n. The denominator of the probability is the product of the summation over the utilities of all modes within each site nest summed over all nests. The dissimilarity parameter, $0 \leq \theta \leq 1$, measures the degree of similarity of the modes within the site nest. As the dissimilarity parameter approaches zero the alternatives within each nest become less similar to each other when compared to modes in other nests. If the dissimilarity parameter is equal to one, the nested logit model collapses to the conditional logit model.

Welfare analysis is conducted with the nested logit model by, first, specifying a

functional form for the site utilities. It is typical to specify the utility function as linear:

$$
\begin{aligned}
v_{ni}(y - tc_{ni} - fee_{ni}, q_{ni}) &= \alpha(y - tc_{ni} - fee_{ni}) + \beta q_{ni} \\
&= \alpha y - \alpha tc_{ni} - \alpha fee_{ni} + \beta q_{ni} \\
&= -\alpha tc_{ni} - \alpha fee_{ni} + \beta q_{ni}
\end{aligned} \tag{4}
$$

where α is the marginal utility of income. Since αy is a constant it will not affect the probabilities of site choice and can be dropped from the utility function. Theory suggests that the marginal utility of income is constant on trip cost and fee, but empirical results may indicate that these differ:

$$v_{ni}(y - tc_{ni} - fee_{ni}, q_{ni}) = -\alpha_{tc} tc_{ni} - \alpha_{fee} fee_{ni} + \beta q_n \tag{5}$$

Haab and McConnell show that the willingness-to-pay for a quality change (e.g., changes in catch rates) can be measured as

$$WTP(\Delta q \mid ni) = \frac{\beta \Delta q_{ni}}{\alpha} \tag{6}$$

If the coefficients on trip cost and fee differ then we estimate willingness-to-pay with the weighted average of the marginal utility of income:

$$WTP(\Delta q \mid ni) = \frac{\beta \Delta q_{ni}}{\gamma_{tc}\alpha_{tc} + \gamma_{fee}\alpha_{fee}} \tag{7}$$

where $\gamma_{tc} = tc/(tc + fee)$ and $\gamma_{fee} = fee/(tc + fee)$. Willingness to pay for the elimination of a recreation site from the choice set (e.g., due to shoaling of an inlet) is

$$WTP(i \mid n) = \frac{\ln\left[\left(1 - \Pr(i \mid n)\right)^{\theta} \Pr(n) + \left(1 - \Pr(n)\right)\right]}{\gamma_{tc}\alpha_{tc} + \gamma_{fee}\alpha_{fee}} \tag{8}$$

where $\Pr(i \mid n)$ is the unconditional probability of choosing mode *i* given that site nest *n* is chosen and $\Pr(n)$ is the unconditional probability of choosing site nest *n*. These welfare measures apply for each choice occasion, in other words, trips taken by the

individuals in the sample.

Travel distances and time between each survey respondent's home zip code and the zip code of the most frequented fishing site within each site nest are calculated using the ZIPFIP correction for "great circle" distances. Travel time is calculated by dividing round trip distance by 50 miles per hour. The cost per mile used is $0.37, the national average automobile driving cost including only variable costs and no fixed costs as reported by the American Automobile Association (AAA). Thirty-three percent of the wage rate is used to value leisure time for each respondent. The round-trip travel cost is $p_{ij} = (c \times d_{ij}) + (\theta w_i \times \lfloor d_{ij} / mph \rfloor)$ where c is cost per mile, d is round trip distance, θ is the fraction of the wage rate, w, mph is miles per hour, i is the subscript for individual i = 1, …, 1024 and j is the subscript for sites j = 1, …, 5. We top-code each of the travel cost variables at the 90th percentile to reduce the influence of outliers.

The benefits of the trip are measured as the average self-reported catch and keep rates of one specie (billfish) and species groups at each site for each mode. The species groups are mackerel (king and Spanish), coastal migratory pelagic (tuna, dolphin, wahoo), snapper-grouper and other species (e.g., cobia, striper, red drum, bluefish).

Results

The average sum of the travel cost and charter fee over all primary purpose anglers and alternatives (n = 8955) is $630 (Table 4). Only trip cost varies across anglers. The other variables reflect characteristics of the choice alternatives and are equal for each angler to the site/mode specific mean for each of the alternatives. The average charter fee

is $253. We top-code the charter fee variable at the 99th percentile to reduce the influence of outliers. The average catch rates are 0.02 for billfish caught and kept per trip, 2 coastal migratory pelagic fish per trip, 1 mackerel per trip, 1 snapper-grouper per trip, and 4 other fish per trip.

Our demand models find that primary purpose anglers are less likely to choose an alternative as the trip cost and fee rises and more likely to choose a site with greater billfish, coastal migratory pelagic, mackerel and snapper-grouper catch (Table 4). Other fish caught does not influence primary purpose anglers. Primary purpose anglers are more like to visit Outer Banks, Central Coast and New Hanover sites relative to Roanoke Island and Brunswick County sites. The coefficient on the inclusive value is between zero and one which indicates the mode-waters/site nesting structure is appropriate. Other nesting structures were attempted but each alternative led to poor statistical fit.

The average sum of the travel cost over all secondary purpose anglers and alternatives (n = 9105) is $527 (Table 5). The average charter fee and catch rates are the same as in the primary purpose model. The qualitative results are similar to the primary purpose model. Secondary purpose anglers are less likely to choose an alternative as the trip cost increases and as the charter fee increases. Anglers are more likely to choose an alternative with greater billfish, coastal migratory pelagic, mackerel and snapper-grouper catch. Other fish caught does not influence secondary purpose anglers. Secondary purpose anglers are less likely to visit Central Coast, New Hanover County and Brunswick County sites relative to Roanoke Island and Outer Banks sites. The coefficient on the inclusive value is between zero and one indicating the mode-waters/site nesting

structure is appropriate. Other nesting structures were attempted but each alternative led to poor statistical fit.

The major difference between the primary purpose and secondary purpose models is the influence of travel cost and charter fees on choices. A likelihood ratio test indicates that primary purpose anglers are influenced equally by travel cost and fees. Secondary purpose anglers are influenced more by charter fees than trip costs so each variable enters the model separately. The split sample modeling approach is appropriate according to a likelihood ratio test.

The economic value per fish per trip (i.e., willingness-to-pay to catch and keep one more fish) is estimated according to equation (7) (Table 6). While primary and secondary purpose anglers exhibit significantly different behavior with regards to cost, once costs are weighted for secondary purpose anglers the value of catch is not statistically different across groups. For primary purpose anglers, one additional billfish per trip (per angler) is worth over $2000 for primary purpose anglers and $1800 for secondary purpose anglers. One additional coastal migratory pelagic fish is worth $55 and $65 for primary purpose and second purpose anglers, respectively. One additional mackerel is worth $39 for both types of anglers. An additional snapper-grouper is worth between $94 and $61, respectively.

The economic value for access to each site per trip (i.e., willingness-to-pay to avoid loss of the site) is estimated according to equation (8) (Table 5). For primary purpose anglers, all offshore charter trip sites are worth $5 or more per trip. That is, if an angler were not able to fish from his most-preferred location (say, due to inlet closure, shoaling, etc.) but was instead forced to fish from his next-best substitute location, the

value of the fishing experience to him would be reduced by $5 or more. The Outer Banks offshore charter trip site is the most valuable at $27. New Hanover offshore and inshore charter trips are worth $11 and $10, respectively. The most valuable headboat trip sites for primary purpose anglers are located in New Hanover and Brunswick Counties.

For secondary purpose anglers, all offshore charter trip sites are worth $5 or more per trip except those from the Central Coast. The Outer Banks offshore charter trip site is the most valuable at $17 with the Roanoke Island site worth $11. The New Hanover County inshore charter trip site is worth $17 to secondary purpose anglers. The most valuable headboat trip sites for secondary purpose anglers are Roanoke Island and Brunswick County.

Conclusions

For-hire recreational fishing passengers receive economic value from the fishing experience. Economic value is estimated using data from an on-site survey of for-hire passengers. On average, economic value for a charter boat trip averages $624 per angler per trip, and consumer surplus for a head boat trip is $102 per angler per trip. Multiplying by the estimated annual numbers of North Carolina charter passengers (303,000) and head boat passengers (128,000) produces estimates of $189 million in charter boat passenger value and $13 million in head boat passenger value per year.

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Table 1. Angler Alternatives

			Primary Purpose		Secondary Purpose	
Waters	Mode	Site	Trips	%	Trips	%
Federal	Charter	Roanoke Island	47	7.87	84	13.84
Federal	Charter	Outer Banks	188	31.49	123	20.26
Federal	Charter	Central Coast	40	6.70	2	0.33
Federal	Charter	New Hanover	84	14.07	58	9.56
Federal	Charter	Brunswick	50	8.38	41	6.75
State	Charter	Roanoke Island	15	2.51	46	7.58
State	Charter	Outer Banks	6	1.01	15	2.47
State	Charter	Central Coast	7	1.17	1	0.16
State	Charter	New Hanover	71	11.89	120	19.77
State	Charter	Brunswick	3	0.50	8	1.32
Both	Headboat	Roanoke Island	5	0.84	38	6.26
Both	Headboat	Outer Banks	5	0.84	7	1.15
Both	Headboat	Central Coast	12	2.01	23	3.79
Both	Headboat	New Hanover	33	5.53	4	0.66
Both	Headboat	Brunswick	31	5.19	37	6.10
		Total	597		607	

Table 2. Angler Characteristics

	Charter				Headboat			
	Primary		Secondary		Primary		Secondary	
Variable	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
FEE	402.00	396.11	319.50	328.94	89.73	33.22	84.68	34.93
MALE (=1)	0.90	0.30	0.82	0.38	0.73	0.45	0.83	0.37
AGE	43.33	11.66	43.27	10.92	40.16	12.36	41.54	11.10
INCOME ($1000)	72.93	23.27	75.80	22.09	56.77	27.15	71.72	23.84
PASSENGERS	4.97	2.84	4.65	1.45	43.23	34.93	26.92	10.90
NIGHTS	3.23	2.54	6.48	4.51	3.06	3.49	6.78	3.89
DAYTRIP	0.10	0.31	0.03	0.18	0.45	0.50	0.05	0.21
CB_TRIPS	3.27	2.98	2.43	1.27	0.66	1.79	0.59	1.26
HB_TRIPS	0.17	0.74	0.12	0.56	2.24	1.45	2.71	3.19
Sample Size	511		498		86		96	

Note: The sample size for the fee variable is lower than other variables due to item nonreponse.

Table 3. Target Species

	Charter				Headboat			
	Primary		Secondary		Primary		Secondary	
Variable	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
BILLFISH	0.10	0.29	0.14	0.35	0.00	0.00	0.00	0.00
TUNA	0.22	0.41	0.12	0.33	0.00	0.00	0.02	0.13
KING	0.11	0.32	0.09	0.29	0.05	0.21	0.02	0.13
SPANISH	0.10	0.30	0.21	0.41	0.00	0.00	0.05	0.21
WAHOO	0.17	0.38	0.12	0.32	0.00	0.00	0.01	0.10
DOLPHIN	0.34	0.47	0.34	0.47	0.02	0.15	0.07	0.26
GROUPER	0.06	0.24	0.02	0.15	0.06	0.24	0.08	0.28
SNAPPER	0.02	0.15	0.01	0.11	0.07	0.26	0.05	0.21
COBIA	0.02	0.15	0.03	0.17	0.01	0.11	0.03	0.16
STRIPER	0.01	0.09	0.01	0.09	0.00	0.00	0.03	0.16
DRUM	0.01	0.11	0.01	0.11	0.00	0.00	0.03	0.16
BLUEFISH	0.04	0.19	0.11	0.31	0.01	0.11	0.13	0.34
Sample Size	511		498		86		96	

Table 4. Nested Logit Models: Primary Purpose Anglers				
	Mean	S.D.	Coeff	t-stat
Trip cost + Fee	629.58	286.17	0.012	14.95
Billfish kept	0.02	0.04	26.798	7.75
CMG kept	2.35	4.17	0.662	12.31
Mackerel kept	1.79	1.84	0.470	4.70
Snapper-Grouper kept	1.07	1.25	1.117	7.25
Other fish kept	4.30	3.34	0.048	1.05
Outer Banks	0.07	0.25	1.177	2.11
Central Coast	0.07	0.25	1.501	3.14
New Hanover	0.07	0.25	2.060	4.52
Brunswick	0.07	0.25	0.016	0.04
Inclusive Value			0.840	6.28
$\chi 2$			852.82	
R2			0.26	
Anglers			597	
Alternatives			15	

Table 5. Nested Logit Models: Secondary Purpose Anglers				
	Mean	S.D.	Coeff	t-stat
Trip cost	526.78	237.71	-0.008	10.10
Fee	254.09	175.46	-0.021	12.07
Billfish kept	0.02	0.04	22.666	6.54
CMG kept	2.35	4.17	0.797	11.87
Mackerel kept	1.79	1.84	0.477	7.57
Snapper-Grouper kept	1.07	1.25	0.749	6.06
Other fish kept	4.30	3.34	-0.036	1.45
Outer Banks	0.07	0.25	-0.498	1.21
Central Coast	0.07	0.25	-2.058	6.11
New Hanover	0.07	0.25	-4.663	7.40
Brunswick	0.07	0.25	-1.361	4.70
Inclusive Value			0.890	3.72
$\chi 2$			662.76	
R2			0.20	
Anglers			607	
Alternatives			15	

Table 6. Economic Value of Additional Fish Caught and Kept per Trip

	Primary		Secondary	
	WTP	t-value	WTP	t-value
Billfish	2243.89	10.37	1839.89	7.35
Coastal Migratory Pelagic	55.42	20.26	64.73	18.79
Mackerel	39.39	4.82	38.69	8.98
Snapper-Grouper	93.51	8.62	60.79	7.14
Other	-3.99	1.04	2.94	1.41

Table 7. Economic Value per Site per Trip

			Primary Purpose		Secondary Purpose	
Waters	Mode	Site	WTP	t-value	WTP	t-value
Federal	Charter	Roanoke Island	5.77	5.13	10.86	3.69
Federal	Charter	Outer Banks	27.03	5.48	16.62	3.87
Federal	Charter	Central Coast	4.88	5.12	0.24	3.45
Federal	Charter	New Hanover County	10.70	5.20	7.30	3.60
Federal	Charter	Brunswick County	6.15	5.14	5.07	3.55
State	Charter	Roanoke Island	1.80	5.29	5.76	3.74
State	Charter	Outer Banks	0.71	5.15	1.81	3.53
State	Charter	Central Coast	0.83	5.17	0.12	3.45
State	Charter	New Hanover County	9.55	7.11	16.54	4.78
State	Charter	Brunswick County	0.35	5.11	0.96	3.49
Both	Headboat	Roanoke Island	0.59	5.15	4.76	4.00
Both	Headboat	Outer Banks	0.59	5.15	0.84	3.52
Both	Headboat	Central Coast	1.44	5.28	2.82	3.73
Both	Headboat	New Hanover County	4.12	5.82	0.48	3.49
Both	Headboat	Brunswick County	3.85	5.75	4.63	3.98