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Abstract: We use telephone survey data on charter boat anglers to estimate demand models to value snapper-grouper and king mackerel bag limits in the North Carolina for-hire fishery. The telephone survey presents respondents with hypothetical situations about higher charter fees and lower snapper-grouper and king mackerel bag limits and asks about the number of trips they would take in each situation. Stated preference trip responses are used in a jointly estimated revealed and stated preference demand model. We find that reduction in the snapper-grouper bag limit from 15 fish to 7 fish would reduce the annual aggregate value of charter boat fishing by 29% due to quality effects. The reduction in the snapper-grouper bag limit would reduce the number of charter boat fishing trips by 25% and aggregate economic value an additional 25% million.

Key words: recreation demand, revealed preference, stated preference, charter fishing

JEL Classification Codes: Q22, Q26, Q51

Introduction

Policies that are used to address recreational overfishing are quotas, bag and size limits, area closures and, in extreme cases, fishery closures. Each of the policies can change the behavior of anglers and have beneficial impacts on fish populations. Benefits can be assessed by analyzing the effect of fishing restrictions on the biomass and distribution of fish species and how that affects recreational fishing (e.g., Massey, Newbold, and Gentner 2006). The costs of the policies can include lost use value for recreational anglers, lost income for commercial fishing boats and charter/head boat captains, and lost expenditures for the supporting tourism industry. Economic analysis of recreational fishing demand can be used to estimate costs of these management options on anglers, and any expected changes in their behavior can be used to further assess the impact on the charter boat sector and the local tourist economy.

Literature

While there is a large marine recreational demand literature, most of the research is focused on fishing modes other than the charter boat sector and those studies focusing on the charter boat sector consider economic impacts (*e.g.* Bohnsack *et al*. 2002) or employ bioeconomic models (Abbott and Wilen 2009; Abbott, Maharaj, and Wilen 2009). We know of only one previous study that considers the recreation value of charter boat anglers. Poor and Breece (2006) use the travel cost method with revealed and stated preference data to estimate the value of water quality improvements to Chesapeake Bay anglers. One limitation of using the travel cost method with charter boat trips is that many of these are overnight trips. Overnight trips typically have multiple purposes so that a standard travel cost method demand model likely overstates the value of the fishing experience (Parsons 2003).

There is a relatively large literature that values catch rate changes. For example, Gillig, Ozuna, and Griffin (2000) and Gillig *et al*. (2003) use data from the Gulf of Mexico red snapper fishery. In the first paper the authors use the travel cost method and estimate the effects of increasing catch rates on trip behavior. Gillig *et al*. (2003) use contingent valuation and single-site travel cost methods to estimate the value of red snapper catch rates. Schuhmann (1998) and Whitehead and Haab (1999) use the random utility model to estimate the value of catch rates for species aggregates in the southeastern U.S. Numerous other studies in the gray literature have measured the value of catch rate changes (McConnell and Strand 1994; Hicks *et al*. 1999; Haab, Whitehead, and McConnell, 2001).

Using the value of catch rate changes to proxy for the value of bag limit changes is problematic because, while all anglers can be affected by catch rate changes, only expert (or lucky) anglers are affected by bag limit changes. An increase in stock size that makes it more likely to catch a fish would affect all anglers almost equally. But, since a bag limit constrains the upper limit of the number of fish caught and kept, only those anglers who reach the upper limit are affected. While it is relatively straightforward to estimate the value of catch rates, it is much more difficult to estimate the value of bag limits. As such, the value of bag limit changes has been estimated in only a few studies.

Using the travel cost method, McConnell, Strand, and Blake-Hedges (1995) estimate harvest rates from a household production model to use as independent variables in a random utility model. The effect of bag limits are simulated by capping expected catch rates at the limit. Economic values are obtained by comparing the value of utility with and without bag limits. One difficulty with this approach is that the data may not support reliable estimation of the model. First, historical catch rates must be statistically related to individual catch rates. Second, the predicted catch rate for each angler at each site must be statistically related to angler site selection. Whitehead *et al*. (2010) find that only one of four single species models supported by the Marine Recreational Fishery Statistical Survey can be used to value bag limits.

A number of other studies have estimated the value of bag limits with stated preference methods. Carson, Hanemann, and Steinberg (1990) estimate the value of a stamp that allows increases in the bag limits for king salmon using the contingent valuation method. Oh *et al*. (2005) use a choice experiment to value increases in red drum bag limits in Texas. Stoll and Ditton (2006) use the contingent valuation method to value bluefin tuna bag limits in North Carolina. Whitehead (2006) compares a random utility model using the McConnell, Strand, and Blake-Hedges method with a contingent valuation method estimate of the willingness-to-pay to avoid king mackerel bag limits.

In contrast to previous research, we estimate a joint revealed and stated preference trip taking model and use the results to value the economic costs of bag limits incurred by anglers on charter boat trips. Since there are no existing data that would describe how anglers might respond to reductions in bag limits, stated preference data are necessary to help develop estimates of the benefits and costs of alternative fishery policies. The stated preference data are combined with revealed preference data to assess behavior beyond the range of historical experience while attenuating bias associated with behavioral intentions data (Whitehead et al. 2008). We avoid the problem of multiple purpose and overnight trips by asking respondents how many charter boat trips they would take with an increase in the charter boat fee. Since the increased fee is an increase in the marginal cost, the willingness to pay for the charter trips is a marginal willingness to pay.

Data

During the 2007 fishing season surveyors approached charter boat and head boat passengers at the end of a fishing trip and interviewed them at marinas and fishing centers from Dare County, NC, to Brunswick County, NC. At the conclusion of the peak fishing season a follow-up telephone survey was conducted of passengers to collect information on all for-hire and other saltwater fishing trips taken that season and the geographic distribution of trips. The dockside field survey of passengers produced 1317 usable surveys, and the telephone follow-up survey of passengers produced 296 completed surveys (Dumas *et al*. 2009).

Relative to the full sample, phone survey respondents are more likely to have been on a trip with the primary purpose of fishing when intercepted and are more avid in terms of the number of annual trips as reported on the intercept survey. Sixty percent of phone survey respondents were on a trip for the primary purpose of fishing, while only 46% of nonrespondents were on a primary purpose trip. Phone survey respondents took an average of 4 charter and head boat trips during the past 12 months, while nonrespondents took an average of 3 trips. We constructed weights with the trips and purpose variables so that the phone survey sub-sample reflects the avidity of the onsite sample. Eighty-eight percent of the phone sample is male and 96% are white. The average age is 46 and average income is $76 thousand. We discard anglers who do not plan to take charter trips during the 12 months following the phone survey. We adjust the weights for this subsample so that the sum of the weights is equal to the sample size. Of the 296 anglers from the on-site survey who participated in the phone survey, 244 provided enough information to estimate recreation demand models.

During the phone survey respondents are asked about the number of marine recreational fishing trips taken during the past 12 months with 5 modes of fishing (charter boat, head boat, private boat, pier and beach) across 8 coastal counties. The average number of trips across all modes is 7.55. The average number of charter boat trips is 1.93, head boat trips is 0.11, private boat trips is 1.64, pier trips is 0.84, and beach fishing trips is 3.04. Dare County beach (1.68) and charter (1.52) trips are the most common in the sample. A few respondents reported a large number of fishing trips. In order to reduce the influence of outliers, we top-code each mode/county trip variable at 30.

We ask respondents hypothetical questions about charter trips that they expect to take during the next 12 months (denoted the SP0 trip), charter trips during the next 12 months with either a $50 or $100 increase in the charter fee, charter trips during the next 12 months with an 8 fish decrease in the snapper-grouper bag limit (SP2), and charter and other fishing trips during the next 12 months with a 2 fish decrease in the king mackerel bag limit (SP3) (see appendix for the text of these questions).

In table 1 we summarize the responses. During the past 12 months respondents took 1.93 charter boat trips. Respondents state that they will take 1.99 charter trips during the next 12 months. With higher charter fees, 78 respondents state that they will take fewer charter trips. Of these 78 respondents, 48 report that they would take zero charter boat trips, and the mean trips for this group falls from 2.29 to 0.85. The average number of trips for the full sample of 244 falls to 1.52. Charter trips decrease with the eight fish reduction in snapper-grouper bag limits. All of the 60 anglers who state that they target snapper-grouper state that they will take 0 trips in the future with the bag limit reduction. The average number of trips for the full sample falls to 1.45. Charter trips also decrease with lower king mackerel bag limits, but the effect is slight. The average number of trips for the full sample of 244 falls to 1.86, only a 6% change from the status quo. Of the 96 anglers who state that they target king mackerel, 24 state that they will take fewer charter trips, with 12 stating their charter trips will be 0. The average number of trips for the 96 targeting anglers falls from 2.02 to 1.70, a 16% change.

We asked several debriefing questions. The first was “Now that the hypothetical questions are over, how sure are you about your answers? Are you very sure, somewhat sure, or not sure at all?” Ninety percent of all respondents stated that they were very sure about their answers. We next asked, “When you answered the hypothetical trip questions, did you tell us the number of trips that you would hope to take in the future or the number of trips that you really think you will be able to take in the future?” Eighty percent stated that the stated preference trips were those that they really thought they would take. Finally, “Do you think your answers to the hypothetical questions are good enough for scientists to use to provide good information for fishery management decisions?” Ninety percent thought that their answers were good enough for supporting fishery management decisions.

Empirical Model and Results

Consider a choice situation where y is the number of charter boat trips and x is a vector of independent variables. Separate revealed and stated preference models would involve two equations:

$$y_r = \alpha_r + \beta_r^{'} x_r + \varepsilon_r$$
$$y_s = \alpha_s + \beta_s^{'} x_s + \varepsilon_s \text{ ,} \qquad (1)$$

where α and β are coefficients to be estimated, ε is the error term, and r, s indicate revealed and stated preference data.

When jointly estimating the revealed and stated preference data, it is stacked and combined into a single equation. If the revealed and stated preference data coefficients are constrained to be equal, then the basic model is estimated:

$$y_{r,s} = \alpha_{r,s} + \beta_{r,s}^{'} x_{r,s} + \varepsilon_{r,s} \text{ .} \qquad (2)$$

This framework is typically naïve in that revealed and stated preference data diverge for various reasons. The first-order test for divergence is to allow the intercepts to vary:

$$y_{r,s} = \alpha + \gamma SP + \beta ' x_{r,s} + \varepsilon_{r,s} \text{ .} \qquad (3)$$

The γ regression coefficient allows a test for compatibility between the data formats. If γ is statistically insignificant, then the model collapses to the basic model in equation (2), and the revealed and stated preference data are compatible. If γ is statistically significant, then the revealed and stated preference intercepts are $\alpha_r = \alpha$ and $\alpha_s = \alpha + \gamma$, respectively.

Since recreation trips are count data consisting of non-negative integers, we use a fixed effects Poisson panel data model that was first used in this context by Englin and Cameron (1996):

$$y_{it} = \alpha_i + \beta' x_t + \varepsilon_{it} \ . \tag{4}$$

The fixed effects model employs an implicit individual-specific constant term, α_i, $i = 1, \ldots, n$. The independent variables are those that change across time for each individual, x_t. In contrast, the more commonly used random effects model includes a common constant term, α, and allows estimation of the individual specific variables, z_i (see Landry and Liu 2011). If individual specific variables are correlated with the variables that are time specific then the coefficients on the random effects model coefficients may be inconsistent. An advantage of the fixed effects model is that it avoids this inconsistency. An advantage of the random effects model is that it allows estimation of the effects of individual specific variables. Random effects models can also be more efficient. In the current application we employ the fixed effects model because the coefficients of the typical individual specific variables employed in this type of model;

i.e., travel cost and income, are not significantly different from zero. All other results are similar across models.

The fixed effects demand model is presented in table 2. The dependent variable is the number of charter boat fishing trips. The independent variables are the increased charter boat fishing fee, the reductions in bag limits, and a stated preference dummy variable. We find that higher fees and the reduction in snapper grouper bag limits will reduce charter boat fishing trips. The reduced king mackerel bag limit does not significantly reduce the number of trips in this model or in one that includes only those anglers who target king mackerel. The revealed and stated preference intercept variables are not significantly different indicated that the revealed and stated preference data do not diverge.

The willingness-to-pay value (WTP) per trip is estimated as the negative inverse of the coefficient on the higher fee variable:

$$WTP \mid trip = -\frac{1}{\beta_{fee}} \quad . \tag{5}$$

The WTP value per trip for a one-fish reduction in the bag limit is the negative of the coefficient on the bag limit divided by the coefficient on the higher fee variable:

$$WTP(\Delta bag) \mid trip = -\frac{\beta_{\Delta bag}}{\beta_{fee}} \quad . \tag{6}$$

The WTP estimates are presented in table 3. The WTP per angler per trip is $273. The WTP per angler per trip to avoid a one fish reduction in the snapper-grouper bag limit is

$10. Anglers would be willing to pay $80 to avoid the reduction in the snapper-grouper bag limit from 15 fish to 7 fish.

Conclusions

In addition to the economic impacts of for-hire passengers' expenditures on the coastal economy, passengers also enjoy economic value from the fishing experience. WTP is the economic value of the fishing experience to the passenger beyond the expenditures necessary to take the trip. We find that higher charter fees and lower snapper-grouper bag limits will reduce the quality of trips, the number of trips, and the economic value in the North Carolina charter boat fishery. With about 303,000 annual passenger trips in North Carolina (Dumas et al. 2009), the annual aggregate value of the North Carolina charter boat fishery is $83 million (with a 95% confidence interval of $44 and $122 million). The reduction in the snapper-grouper bag limit from 15 fish to 7 fish, a trip quality effect, would reduce the annual aggregate value by $24 million (the 95% confidence interval is $12 to $36 million), 29% of the total value. The reduction in the snapper-grouper bag limit would reduce charter boat fishing trips by 25% and aggregate economic value an additional $21 million, 25% of the total. The total reduction in annual aggregate value is $45 million, 54% of the total. Future research should compare estimates of the cost of bag limits estimated here to the economic benefits to determine if they are economically efficient.

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Table 1

Revealed and Stated Preference Charter Boat Trip Data

Trips Scenario	Mean	Standard Deviation
RP: Past 12 months	1.93	4.64
SP0: Status quo next 12 months	1.99	2.07
SP1: Increased charter fee	1.52	1.90
SP2: Decreased snapper-grouper bag limit	1.45	1.97
SP3: Decreased king mackerel bag limit	1.86	2.09

Table 2

Revealed and Stated Preference Fixed Effects Demand Model[a]

Independent Variables	Mean	Coefficient	t-ratio
Increase in the charter fee (=0, $50, $100)	14.91	-0.0037	-4.15
Snapper-grouper bag limit (=7, 15)	13.40	0.0367	4.27
King mackerel bag limit (=1, 3)	2.60	0.0275	0.85
Stated preference data (=0, 1)	0.80	0.009	0.147
LLF		-996.27	
AIC		1.64	
Cases		244	
Periods		5	

[a]Dependent variable: Charter boat fishing trips

Table 3

Willingness-to-Pay Estimates (per angler)

	WTP	t-ratio
Trip	$273.11	4.15
One fish change in snapper-grouper bag limit (per trip)	$10.03	3.85
One fish change in king mackerel bag limit (per trip)	$7.52	0.92

Appendix. Stated Preference Charter Boat Trip Questions

Now think about the saltwater fishing trips you might take next year in North Carolina. Please answer the following questions to the best of your ability.

About how many saltwater fishing trips do you think you will take during the next 12 months in North Carolina? About how many of these saltwater fishing trips would be charter boat trips?

Suppose the cost of your portion of the charter fee increases by ($50/$100) because of a fuel surcharge. For example, if you paid $250 for your portion of the charter fee during the past 12 months, during the next 12 months you would pay ($300/$350). If your charter fee was ($50/$100) higher, would you take more, fewer, or the same number of charter trips during the next 12 months? How many more/fewer charter trips would you take?

Many fish species in North Carolina are overfished for a variety of reasons. The South Atlantic Fishery Management Council, an agency that regulates North Carolina offshore fishing, is expected to consider tighter recreational bag limits in the future. For the next several questions, consider how tighter bag limits will affect you. Assume that the costs of charter fishing trips are not higher due to a fuel surcharge.

The current bag limit for many snapper species is 10 snapper per person per day. The current bag limit for many grouper species is 5 grouper per person per day. Suppose new bag limits of 5 snapper and 2 grouper per person per day are put into place before your next charter fishing trip. All other bag limits remain the same. Considering the new bag limits, would you take more, fewer, or the same number of charter fishing trips during the next 12 months? How many more/fewer charter trips would you take?

The current bag limit for king mackerel is 3 king mackerel per person per day. Suppose a new bag limit of 1 king mackerel per person per day is put into place before your next charter fishing trip. All other bag limits remain the same. Considering the new bag limit, would you take more, fewer or the same number of charter fishing trips during the next 12 months? How many more/fewer charter trips would you take?