A Comparison of Contingent Valuation Method and Random Utility Model Estimates of the Value of Avoiding Reductions in King Mackerel Bag Limits[1]

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Abstract

This paper estimates the value of king mackerel bag limit changes with both stated and revealed preference methods. The 1997 Marine Recreational Fishery Statistical Survey allows estimation of the value of avoiding bag limit reductions with the random utility model and the contingent valuation method. Using the contingent valuation method, the willingness to pay to avoid a one fish reduction in the bag limit is $2.45 per year. Using the random utility model, the willingness to pay to avoid a one fish reduction in the bag limit for a two-month time period is $10.83. Considering several methodological issues, the difference in willingness to pay between the stated and revealed preference methods is in the expected direction.

Introduction

The purpose of this paper is to estimate the value of king mackerel bag limit changes. The data are from the 1997 Marine Recreational Fishery Statistical Survey (MRFSS) and the Add-On MRFSS Economic Study (AMES) (see Hicks et al., 1999). The AMES contains a series of contingent valuation method (CVM) questions that directly elicit the willingness to pay for reductions in bag limits. The MRFSS intercept data allows the estimation of random utility models (RUMs) that can be used to estimate the value of bag limit changes using revealed preference data. These data allow a direct comparison of stated and revealed preference estimates of willingness to pay.

One goal of using multiple valuation methods is the convergent validity of the estimates. Convergent validity results when estimates derived from different methods are equal. In the case here, equality of willingness to pay estimates from the CVM and RUM would provide policy makers with confidence about using the results from either method when making important decisions. Without convergent validity policy makers will be undecided whether to use the CVM or RUM estimates of value.

Carson et al. (1996) compare stated and revealed preference estimates from 83 studies conducted from 1966 to 1994. In general, they find that CVM estimates are lower than their revealed preference counterparts. In particular, the CVM estimates are about 30% lower than the estimates from multi-site travel cost models. Freeman (1995) finds several CVM studies that estimate the value of changes in catch and several revealed preference studies that do likewise but none that provide a direct comparison.

Relative to the value of catch rate changes, the value of bag limit changes has been estimated in few studies. Carson, Hanemann, and Steinberg (1990) estimate the value of increases and decreases in the bag limits for Kenai king salmon using the CVM. They ask anglers to choose their preferred salmon stamp and bag limit combination. They find that the value for the first salmon is about $28, $18 for the second, and $9 for the third salmon harvested. McConnell, Strand, and Blake-Hedges (1995) estimate harvest rates from a household production model to use as independent variables in a site-selection RUM. The data is for small game anglers in the Atlantic Ocean. They find that the willingness to pay to avoid a small game bag limit of four fish is almost $17. The average willingness to pay is influenced by a few expert anglers who have large willingness to pay estimates.

The application in this paper is to king mackerel (*Scomberomorus cavalla*), an important gamefish in the southeastern United States. King mackerel prefer waters between 68 and 78 degrees and migrate from south Florida waters in winter to more northerly waters in spring. The king mackerel season varies from state to state. King mackerel are found both inshore and offshore. They are usually caught from boats but can be caught from piers running into deep water. Many piers have designated “kingfish” zones at their tips, with special rules and fees. Recreational king mackerel landings are largest in Florida. North and South Carolina also have significant landings. Since 1986 anglers have faced a daily bag limit of two fish per person from Florida through Texas. The daily bag limit for Georgia, North Carolina and South Carolina has been three fish per day except from 1991 through 1995 when it was increased to five fish per day. The minimum size limit is 24 inches.

The rest of this paper is organized as follows. First we sketch a theory of the value of changes in bag limits. Next we describe the AMES data. The application of the CVM and RUM are then presented. Finally, we compare the estimates of the value of changes in bag limits and offer some conclusions.

Theory

The utility of each angler depends on fishing trips targeting king mackerel and king mackerel harvest

(1) $$u = u(x, q)$$

where *u(.)* is the utility function, *x* is a vector of recreational fishing trips at *n* sites, and *q* is a vector of *n* harvest rates. Utility is increasing in trips and harvest. The king mackerel harvest rate depends on inputs in a household production function

(2) $$q = q(k, \ell, b)$$

where *q(.)* is the household production function, *k* is a vector of capital inputs, ℓ is a vector of labor inputs including time spent fishing and experience, and *b* is a vector of daily bag limits at *n* sites. The harvest is increasing in capital and labor inputs. The marginal product of the bag limit on harvest is,

(3) $$\frac{\partial q}{\partial b} = \begin{cases} 0 & \text{if } q < b \\ 0 < \frac{\partial q}{\partial b} \le 1 & \text{if } q \ge b \end{cases}$$

For those anglers who reach the daily bag limit an increase in the bag limit will increase harvest. For those anglers who harvest one fish less than their daily limit a decrease in the bag limit by two fish will decrease harvest. For all other anglers, $q < b$, the daily bag limit is non-binding and will not affect harvest. Substitution of the household production function into the utility function yields

(4) $$u = u(x, q(k, \ell, b)).$$

Anglers are constrained by the fishing budget, $y = p'x$, where y is the budget and p is a vector of n travel costs. Maximization of angler utility subject to the budget constraint yields the indirect utility function

(5) $$v = v(p, q(k, \ell, b), y)$$

where *v(.)* is the indirect utility function which is decreasing in p, increasing in q, and increasing in y. The marginal utility of a change in the bag limit is equal to the marginal utility of harvest multiplied by the marginal product of the bag limit

(6) $$\frac{\partial v}{\partial b} = \frac{\partial v}{\partial q}\frac{\partial q}{\partial b}$$

The bag limit only affects the utility of anglers for whom the marginal product of the bag limit is positive. In other words, if the bag limit is a non-binding constraint an increase in the bag limit yields no additional utility. Similarly, reductions in the bag limit may not be binding and may have no effect on angler utility.

Dividing the marginal utility of harvest by the marginal utility of income yields the willingness to pay for harvest

(7) $$WTP_H = \frac{\frac{\partial v}{\partial q}}{\frac{\partial v}{\partial y}}.$$

The willingness to pay for a change in the bag limit is equal to the marginal utility of a change in the bag limit divided by the marginal utility of income

(8) $$WTP_B = \frac{\frac{\partial v}{\partial q}\frac{\partial q}{\partial b}}{\frac{\partial v}{\partial y}}$$

Rearranging (8) shows that the willingness to pay for a change in the bag limit is equal to the willingness to pay for a change in the harvest multiplied by the marginal product of the bag limit

(9) $$WTP_B = WTP_H \frac{\partial q}{\partial b}.$$

Since the marginal product of the bag limit may be zero the willingness to pay for a change in the bag limit is less than the willingness to pay for a change in harvest. For those anglers for whom the bag limit is non-binding, willingness to pay is equal to zero.

Data

We use data from the MRFSS intercept survey that gathers trip, catch and demographic information. Sampling is stratified by state, mode (party/charter boat, private/rental boat, shore), and two-month survey waves and allocated according to fishing pressure. Sampling sites are randomly selected from a list of access sites. Over

57,000 intercept interviews of recreational anglers were conducted at over 1,000 fishing sites from North Carolina to Louisiana in 1997. Texas is not part of the MRFSS. Wave 1 (January, February) interviews are not collected in Georgia, North Carolina, and South Carolina and are not included in our analysis.

During 1997 approximately 10,000 AMES telephone interviews were conducted with MRFSS intercept respondents (QuanTech, 1998). The AMES collected economic information about the intercepted fishing trip including expenditure and travel costs. Merging the intercept and telephone survey data and omitting observations with missing data on key variables, results in 8865 useable cases.

In order to make the contingent valuation method and random utility models as comparable as possible 268 anglers who were either primarily or secondarily targeting king mackerel from all modes are included (Table 1). Only a few of the anglers interviewed were intercepted in Alabama, Georgia, Louisiana, and Mississippi. Almost two-thirds of the anglers interviewed were intercepted in Florida. Thirteen and 15 percent were intercepted in North Carolina and South Carolina. The percentage of intercept interviews range from 15% to 25% across wave. A majority of the 268 interviewed anglers (71%) fish from either a private or a rental boat. Approximately 9% fish from the shore with the remaining 20% fishing from a party or charter boat.

CVM Model

The AMES interview leads the respondent through a series of questions related to king mackerel (Quantech, 1998). The willingness to pay question is open-ended:

> "The current bag limit for king mackerel is [STLIMIT] fish per day. It may be necessary in the future to reduce the bag limit to [VER_KM] fish. Suppose you could purchase a special annual permit that would allow you to keep [STLIMIT] fish per day while all anglers who did not purchase the permit would only be allowed to keep [VER_KM] fish per day. The [VER_KM] fish bag limit would be your daily limit for the year. How much would you be willing to pay for this special permit?"

The variable STLIMIT is equal to 3 for anglers that were intercepted in Georgia, North Carolina, and South Carolina and 2 for anglers intercepted in Florida, Mississippi, Alabama, and Louisiana. The variable VER_KM is randomly assigned and can take on values of 0, 1, or 2 when STLIMIT = 3 and 0 or 1 when STLIMIT = 2. The difference between STLIMIT and VER_KM is used to construct the change in bag limit variable: Δb = STLIMIT – VER_KM.

The next question asks those who state that they are not willing to pay anything: "Why wouldn't you pay any money for this special permit?" The most popular reason is that they don't agree with the special permit idea or they perceive it as unfair (Table 2). A related reason is that they don't want to pay any more to fish. Other popular reasons are related to the non-binding nature of the bag limit. These reasons are that they don't fish for king mackerel, they practice catch and release, the lower limit is sufficient or they do not fish for king mackerel often enough. Only 2.5% admitted that they don't usually catch their daily bag limit.

A related question about a zero bag limit was then asked:

> "If it was decided that king mackerel would have a zero bag limit due to seasonal or quota closure, meaning that you had to release all king mackerel you caught regardless of size, how would this affect your fishing?"

Almost 30% of the anglers would stop fishing for king mackerel and fish for other species (Table 3). Almost 24% say that they would continue fishing for king mackerel because they practice catch and release. About 19% indicate that the regulation would not affect them because they seldom fish for king mackerel. Other responses are that the bag limit does not matter, they would stop fishing, or they fish less for king mackerel.

Since many of the willingness to pay responses are zero, the Tobit model for censored data is appropriate

$$WTP^* = \alpha' X_1 + e \tag{10}$$

where

$$WTP = \begin{cases} 0 & \text{if } WTP^* \leq 0 \\ WTP^* & \text{if } WTP^* > 0 \end{cases} \tag{11}$$

where WTP^* is an unobserved variable, α is a vector of coefficients, X_1 is a vector of independent variables including the change in the bag limit, Δb, and e is a normally distributed error term (Greene, 1997). The expected value of WTP is

$$E[WTP] = \Phi Z\left(\alpha' X_1 + \sigma\left(\frac{\phi Z}{\Phi Z}\right)\right) \tag{12}$$

where Φ is the cumulative distribution function, ϕ is the probability density function,

$Z = \frac{\alpha' X_1}{\sigma}$ and σ is the standard deviation of the regression. The marginal effect of the change in the bag limit on the dependent variable is

(13) $$\frac{\partial E[WTP]}{\partial \Delta b} = \alpha_{\Delta b} \Phi Z \ .$$

The marginal effect of the change in the bag limit is a measure of the willingness to pay to avoid a change in the bag limit.

RUM

Following the standard derivation of the conditional logit RUM, we assume that the angler will choose to visit the site that provides the maximum utility of all the available alternatives. The choice between alternatives is viewed as random since only the angler knows the ranking of site-specific utility levels. The individual, *i*, and site, *j*, specific indirect utility function is additively separable with a Type-I extreme value distributed random error term

(14) $$u_{ij} = v_{ij} + \varepsilon_{ij}$$

where v_{ij} is the deterministic portion of the indirect utility function and ε_{ij} is the random error term. The conditional logit model is

(15) $$\pi_{ij} = \frac{e^{v_{ij}}}{\sum_{j=1}^{n} e^{v_{ij}}}$$

where π_{ij} is the probability of individual *i* selecting site *j*.

The deterministic part of the indirect utility function is linear

$$(16)\qquad v_{ij} = \gamma_1 tc_{ij} + \gamma_2 tt_{ij} + \gamma_3 m_j + \gamma_4 \hat{q}_{ij} + \gamma_5 b_j$$

where tc_{ij} is the travel cost, tt_{ij} is the travel time, m_j is the log of the number of sites aggregated to the county level (see Parsons and Needleman, 1992), $\hat{q}_{ij}$ is the expected harvest rate, and b_j is the bag limit.

When the deterministic indirect utility increases the probability that the site is selected increases. We expect travel cost and travel time to have negative effects on the probability. We expect site aggregation to have a positive effect on site selection. The more interview sites in the county zone, the more likely anglers will visit the county site. As the expected number of fish harvested at the site increases the probability of a site visit will be higher. Finally, a higher bag limit should attract more anglers. Thus the first two coefficients should be negative and the rest positive.

The Poisson count data model is used to estimate expected harvest rates at each site for each angler (McConnell, Strand, and Blake-Hedges, 1995; Schuhmann, 1999). We use a generalization of the standard Poisson model that relaxes the restrictive equal mean/variance assumption (Cameron and Trivedi, 1986). Predicted harvest is calculated as in McConnell, Strand and Blake-Hedges (1995). The probability of catching q fish is

$$(17)\qquad \pi(q) = \frac{e^{-\bar{q}}\bar{q}^{q}}{q!} \text{ for } q = 0, 1, 2, \ldots$$

where $E[q] = \bar{q}$ is the mean total catch. The probability is conditioned on measures of fishing characteristics through the conditional mean

(18) $E[q] = e^{\beta' X_2}$

where $E[q]$ is the expected catch rate, β is a vector of coefficients and X_2 is a vector of independent variables.

Willingness to pay is based on the difference in the indirect utility from a change in the bag limit divided by the marginal utility of income. The coefficient on the travel cost variable is an estimate of the marginal utility of income. For those anglers who are expected to catch more fish than the restricted bag limit, $\hat{q} > b - \Delta b$, the expected catch rate is truncated at $\tilde{q} = b - \Delta b$, $\Delta b = 1, 2$. Otherwise, $\tilde{q} = \hat{q}$.The willingness to pay to avoid a reduction in the bag limit measured from the RUM is

(19) $$WTP_B = -\frac{v(tc_{ij}, tt_{ij}, \tilde{q}, m_j, b_j) - v(tc_{ij}, tt_{ij}, \hat{q}, m_j, b_j)}{\gamma_1}.$$

CVM Data and Results

Almost 60% of the anglers who targeted king mackerel on the intercepted trip stated that they would be willing to pay zero for the king mackerel stamp (Table 3). Eight percent of the anglers are willing to pay $5 and 10% are willing to pay $10. Several anglers are willing to pay $2, $20, and $25. The rest of the willingness to pay distribution is spread evenly from $1 to $100. The average willingness to pay for the king mackerel stamp is $6.34.

Independent variables in the willingness to pay model are the change in the bag limit, income, a dummy variable for whether the angler generally targets king mackerel, fishing experience, and whether the angler owns a boat (Table 4). The average change in the bag limit is 1.62. The average household income is $58,130. Forty-eight percent of the sample generally targets king mackerel. The average number of years of fishing experience in the state of intercept is 16.55. Seventy percent of king mackerel anglers own their boat.

Two of the five coefficients on the independent variables are statistically significant (Table 4). The coefficient on the change in the bag limit is positive as expected. This indicates that anglers are willing to pay more money to avoid larger reductions in the bag limit. The coefficient on the number of years fished in the state is negative. More experienced anglers are willing to pay less. The variables that measure income, if the angler generally targets king mackerel, and boat ownership do not affect willingness to pay.

The willingness to pay to avoid a one fish decrease in the bag limit is $2.45 with a 95% confidence interval of [$0.51, $4.38]. Doubling the marginal effect of the bag limit change can roughly approximate a two-fish change in the bag limit. However, this estimate should be used with caution due to the non-linearity of the marginal effects equation.

RUM Data

For tractability, the NMFS intercept sites are aggregated into seventy-seven county level fishing sites (Table 5). King mackerel anglers visited thirty-five of these counties in 1997. The choice among the thirty-five sites serves as the dependent variable in the site selection random utility models. Pinellas County in Florida is the most popular fishing site in this sample. Ten or fewer of the trips were located in Alabama, Georgia, Louisiana, and Mississippi.

Expected harvest rates are estimated with a Poisson household production model. Dependent variables are the historic harvest rate, boat ownership, fishing experience, hours fished per trip, the state bag limit, and dummy variables for whether the angler generally targets king mackerel, took a multi-day trip, and was intercepted during wave 5 (Table 6). Five year mean historic king mackerel per trip harvest rates were calculated from the 1992 through1996 MRFSS and aggregated at the county level. The five-year average historic harvest rate is 0.21 fish. The average number of hours fished on the trip was 4.83. Twenty-five percent of the trips are multi-day trips.

Harvest rates increase with the average historic harvest rate at the site (Table 6). Those on multi-day trips and those who fish longer hours tend to harvest more fish per day. Anglers intercepted during wave 5 catch more fish. Anglers fishing in states with a 3 fish per day bag limit, relative to a 2 fish limit, caught fewer fish. Anglers who own a boat and those who generally target king mackerel do not harvest more fish. The scale parameter is much larger than one, which indicates that the Poisson model without the overdispersion correction would be inappropriate.

The predicted harvest rates are measured with the values for each angler from the Poisson household production model with one exception. The exception is that the value for the multi-day trips is set equal to zero to simulate catch per day trip. For example, individual specific dummy variables and the historic harvest rate at each site are used to predict harvest rates for each angler at each site for a single day trip.

Distances from the household zip code to the zip code at the center of the county are calculated using PC*Miler. Travel costs, including transportation and time costs, are measured as in Hicks et al. (1999) and Haab, Whitehead, and McConnell (2001). Time costs are calculated using estimated travel times (assuming an average speed of 40 miles per hour) and the wage rate. Transportation costs are calculated at $.30 per mile traveled. The household wage rate is used as the opportunity cost of travel time. Only those respondents who reported that they lost income during the trip (LOSEINC = 1) are assigned a time cost in the travel cost variable

$$(20) \qquad tc_{ij} = \begin{cases} \$.30 \times d_{ij} + w_i \times \dfrac{d_{ij}}{40} & \text{if LOSEINC} = 1 \\ \$.30 \times d_{ij} & \text{otherwise} \end{cases}$$

where d_{ij} is the round trip distance for individual *i* to site *j*. The wage, w_i, is measured as household income (in thousands) divided by 2.08 (the number of fulltime hours potentially worked annually in thousands). Wage rates are estimated for those respondents who did not report income. A log-linear ordinary least squares regression model is used to impute missing income values (see Haab, Whitehead, and McConnell, 2000).

For those respondents who do not lose income on the trip, the time cost is accounted for with an additional variable equal to the amount of time spent in travel. This is estimated as the round trip distance divided by 40 mph

$$(21) \qquad tt_{ij} = \begin{cases} 0 & \text{if LOSEINC} = 1 \\ \dfrac{d_{ij}}{40} & \text{otherwise} \end{cases} .$$

The average one-way distance to the actual county visited is 159 miles. The median one-way distance to the county is 49 miles. The average travel cost to the visited county is $282 and the median is $67. Once aggregated over all sites, the average travel cost is $377 and the average travel time is 20.45 hours (Table 7). The average expected harvest rate is .41 fish. The average log of the number of sites in the county is 2.93. The state bag limit is recoded from 3 fish and 2 fish to a dummy variable ($b_j - 2$). Twenty-nine percent of the individual and site combinations (n = 9380) have a daily bag limit of 3 fish.

RUM Results

The signs of all coefficients in the RUM site selection model are in the expected direction with one exception (Table 7). The travel cost and travel time coefficient estimates are negative and statistically significant. The coefficient on the predicted harvest variable is positive and statistically significant. The coefficient on the number of interview sites in each county site is positive and statistically significant. The coefficient on the state bag limit is negative and statistically significant. The expected sign of this coefficient, positive, would indicate that sites that allow a larger bag are more attractive. However, this coefficient may be picking up the attractiveness of the more southern states for king mackerel fishing throughout the year.

For each of the willingness to pay estimates the change in indirect utility is calculated over a subset of sites. We consider each state an aggregate site except for Florida, which is divided into South Atlantic (SA) and Gulf of Mexico (Gulf) sites. The per trip willingness to pay to avoid a one fish reduction in the bag limit ranges from zero for several states to $1.47 for the Florida Gulf (Table 8). A willingness to pay of zero indicates that a reduction in the bag limit is not a binding constraint. In other words, very few anglers are expected to harvest more fish than the reduced bag limit in that state. The willingness to pay for the entire southeastern U.S. is $3.13 per trip.

The per trip willingness to pay estimates can be aggregated up to the two-month wave or approximate king mackerel season level. Detailed fishing days and trip per wave information were collected in the MRFSS and AMES interviews. During the intercept interview, each king mackerel angler fished an average of almost 8 days during the 2-month wave. Four of these days were spent fishing primarily for king mackerel. During the telephone interview, each angler reported an average of 4.63 fishing trips during the 2-month wave. An average of less than one of these trips were overnight trips. About three and one-half of the total trips were spent primarily targeting king mackerel.

The sample includes both overnight trips and anglers secondarily targeting king mackerel. The inclusion of overnight trips suggests that the quantity based on trips, and not days, is most appropriate. Inclusion of the secondary king mackerel trips will bias the wave or season estimates upwards if secondary king mackerel trips are fewer than primary king mackerel trips. Based on an average of 3.46 king mackerel trips per wave, the willingness to pay to avoid the one fish reduction in the bag limit for a two-month period in the entire southeastern U.S. is $10.83. Assuming the king mackerel season is roughly four months in each state, the annual willingness to pay to avoid a one fish reduction in the bag limit in the entire southeast is close to $22.

The willingness to pay to avoid a two fish reduction in the bag limit ranges from zero in Georgia to $16.72 for the Florida Gulf (Table 8). The willingness to pay for a two fish reduction is more than two times greater than the willingness to pay for a one fish reduction because more anglers are affected by the change. The willingness to pay for the entire southeastern U.S. is $29.09 per trip. The willingness to pay to avoid the two fish change in the bag limit for a two-month period is $100.65.

Most of the individual angler willingness to pay estimates are equal to zero. For North Carolina 98% of the one fish reduction willingness to pay values are equal to zero. The Florida Gulf has 86% zero values. Therefore, as in McConnell, Strand and Blake-Hedges (1995), outliers strongly influence the size of the WTP estimates. The outliers are the few anglers who expect to catch more fish than the restricted bag limit allows. The maximum willingness to pay ranges from zero (Georgia) to $51 in South Carolina and $63 in the Florida Gulf for a one fish reduction and $.10 (Georgia) to between $50 and $60 in South Carolina, Alabama, and the Florida Atlantic and $105 in the Florida Gulf.

Comparing Willingness to Pay Estimates

The willingness to pay to avoid a reduction in the bag limit is lower when estimated using the CVM relative to estimates from the RUM. The annual CVM willingness to pay estimate is $2.45 for each fish reduced from the bag limit. While it is not made explicit in the willingness to pay question, it can be assumed that respondents assumed that the hypothetical bag change would cover the entire southeastern U.S. or either the South Atlantic or Gulf of Mexico.

The two-month wave RUM estimate ranges from $0 to $5.09 across states and $10.83 for the southeastern U.S. The sum of the Gulf of Mexico individual site per wave willingness to pay estimate ($1.91) compares closest to the corresponding CVM estimate.

If the RUM estimates are aggregated across the king mackerel season (roughly two waves) then the RUM estimates are even greater than the CVM estimates. Also, comparison of the two fish reduction in the bag limit results in an even larger difference between CVM and RUM estimates.

The divergence of willingness to pay estimates is not surprising for several reasons. In this application the CVM estimates will tend to be biased downward and the RUM estimates will tend to be biased upward. First, open-ended CVM questions tend to generate lower estimates of willingness to pay than the preferred dichotomous choice question format (Boyle et al., 1996). Hoehn and Randall (1987) provide a theory for this result based on time-constrained willingness to pay formation. They argue that in an effort to avoid valuation mistakes (e.g., stating willingness to pay greater than true willingness to pay) respondents will underbid in open-ended questions.

Carson, Groves, and Machina (1999) also provide several theoretical reasons why open-ended willingness to pay estimates will be less than dichotomous choice estimates. One is that the cost of the policy is not revealed to respondents with open-ended questions, creating cost uncertainty. Respondents may respond to cost uncertainty by stating a "protest zero" willingness to pay. A protest response is one in which respondents who may have a positive willingness to pay value for the good will respond with a zero willingness to pay. Over 30% of the zero willingness to pay values were stated by those who rejected the scenario or considered it unfair.

The RUM estimates will be biased upward for two reasons. The conditional logit model for an individual species does not allow the substitution among species that would naturally occur when conditions change across species. With the single species RUM the number of substitutes is constrained to be equal to the number of alternative sites. An angler who wishes to stop fishing for the targeted species is technically not allowed. In a nested RUM, anglers faced with reductions in bag limits for king mackerel might switch to targeting another species. This lack of substitution opportunities will upwardly bias the willingness to pay for bag limit and harvest reductions. This will lead to overestimates of losses from reductions in bag limits and catch rates and underestimates of gains from increases in bag limits and catch rates.

Another reason for the upward bias in the RUM estimates is the estimate of trips across the two-month wave. The trip estimate is based on anglers who primarily target king mackerel. To the extent that anglers who secondarily target king mackerel take fewer king mackerel target trips, this trip estimate will be biased upward.

Conclusions

Differences in willingness to pay between the CVM and RUM are in the expected direction for theoretical reasons and are generally consistent with the summary of other stated and revealed preference comparison studies by Carson et al. (1996). While an explanation of the divergence may be comforting to RUM and CVM researchers, it does not answer the question about how best to value changes in bag limits for important recreational fisheries.

The benefit of the CVM is that it is flexible and estimating willingness to pay is relatively straightforward. The problem with the CVM in the MRFSS context is that anglers target a multitude of species. Willingness to pay questions focused on individual species will inevitably lead to reliable samples that are small. While all anglers in the AMES telephone survey were asked the king mackerel questions, the validity of these data is questionable since only a few of the anglers have experience with king mackerel fishing (see Whitehead and Haab, 2001).

The benefits of the RUM are that it can be used to value a host of policy proposals. With the simple model presented here the value of bag limit changes, harvest changes, and site access can be estimated. The cost of the RUM with the MRFSS data is the time required to manipulate the data and estimate the models. Estimation of the preferred nested RUM is even more of a time burden. However, estimation of individual species nested RUMs with the MRFSS data is difficult, if not impossible, for most species due to the low sample size of anglers who target individual species (see Haab, Whitehead, and McConnell, 2001). Even so, the RUM appears to be the most effective valuation method for the MRFSS data.

With the current application, the open-ended form of the willingness to pay question led to a large number of protest responses. Plus, some of the protest responses may be due to the lack of specificity of the willingness to pay question. For example, it is not clear whether the change in the bag limit is for a single state or the entire southeastern U.S. If the CVM is to be used in future applications with the MRFSS, the incentive compatible dichotomous choice form of the willingness to pay question should be employed and more effort should be devoted to describing the institutions of the hypothetical scenario. Use of the dichotomous choice question could produce willingness to pay estimates that are convergent valid with their RUM counterparts.

Table 1. Sample Properties

Intercept Site/Wave/Mode	Percent
Alabama	3.7
Florida (Atlantic)	21
Florida (Gulf of Mexico)	45
Georgia	1.5
Louisiana	0.4
Mississippi	0.4
North Carolina	13
South Carolina	15
Wave 2	23
Wave 3	19
Wave 4	25
Wave 5	18
Wave 6	15
Party/Charter	20
Boat	71
Shore	9
Cases	268

Table 2. Follow-up Willingness to Pay Questions

Why wouldn't you pay for this special permit?	Frequency	Percent
Don't fish for king mackerel	21	13.2
You practice catch and release	16	10.1
You don't usually catch the current limit	4	2.5
Limits do not restrict your catch	4	2.5
The lower limit is sufficient/don't fish for them often enough	12	7.5
You don't want to pay any more to fish than you do now	19	11.9
You don't know how much the change is worth to you	4	2.5
You don't understand how the permit would work	4	2.5
Don't agree with the special permit idea/"unfair"	50	31.4
Don't believe in restrictions or regulations	2	1.3
Other	23	14.5

How would a zero bag limit affect your fishing?		
Keep fishing because you don't fish for king mackerel or seldom do	50	19.2
Keep fishing for king mackerel because you practice catch and release	62	23.8
Keep fishing for king mackerel because the bag limit doesn't matter	24	9.2
Stop fishing for king mackerel and fish for other species	77	29.6
Stop fishing altogether	21	8.1
Fish less for king mackerel	22	8.5
Other	4	1.5

Table 3. Willingness to Pay Frequencies

WTP	Frequency	Percent
0	160	59.7
1	1	0.4
2	10	3.7
3	1	0.4
4	1	0.4
5	21	7.8
9	3	1.1
10	27	10.1
13	1	0.4
15	6	2.2
20	14	5.2
25	12	4.5
30	1	0.4
35	1	0.4
40	3	1.1
50	4	1.5
100	2	0.7

Table 4. Tobit Willingness to Pay Model

Variable	Mean	StdDev	Coeff.	t-ratio
Constant			-9.15	-1.48
Change in Bag Limit	1.62	0.66	6.41	2.48
Income	58.13	35.09	-0.01	-0.21
Generally Target	0.48	0.50	0.89	0.26
Years Fished in State	16.55	13.36	-0.31	-2.17
Boat ownership	0.70	0.46	-4.49	-1.18
Sigma			24.04	13.21
Log-Likelihood			-586.26	
Cases			268	

Table 6. Household Production Model

Variable	Mean	StdDev	Coeff	t-ratio
Intercept			1.39	1.82
Mean Historic Harvest	0.21	0.41	0.83	3.91
Own a boat	0.70	0.46	-0.37	-1.53
Years fished in State	16.55	13.36	0.00	0.27
Hours Fished	4.83	1.88	0.14	1.98
Generally Target	0.48	0.50	0.07	0.31
Multi-Day Trip	0.25	0.43	1.65	5.45
Wave 5	0.18	0.39	0.73	2.96
State bag limit	2.29	0.46	-1.42	-4.07
SCALE			2.03	
Cases			268	

Table 5. County Sites

State	County	Frequency	Percent
Alabama	Baldwin	7	2.6
Alabama	Mobile	3	1.1
Florida	Bay	12	4.5
Florida	Brevard	13	4.9
Florida	Broward	3	1.1
Florida	Charlotte	1	0.4
Florida	Collier	1	0.4
Florida	Dade	2	0.7
Florida	Duval	5	1.9
Florida	Hernando	3	1.1
Florida	Hillsborough	4	1.5
Florida	Indian River	2	0.7
Florida	Manatee	2	0.7
Florida	Martin	4	1.5
Florida	Monroe	8	3
Florida	Okaloosa	13	4.9
Florida	Palm Beach	11	4.1
Florida	Pasco	11	4.1
Florida	Pinellas	62	23.1
Florida	St. Johns	9	3.4
Florida	St. Lucie	8	3
Florida	Santa Rosa	1	0.4
Florida	Sarasota	3	1.1
Georgia	Chatham	4	1.5
Louisiana	Plaquemines	1	0.4
Mississippi	Jackson	1	0.4
North Carolina	Carteret	26	9.7
North Carolina	Dare	7	2.6
North Carolina	Onslow	2	0.7
South Carolina	Beaufort	1	0.4
South Carolina	Berkeley	1	0.4

South Carolina	Charleston	11	4.1
South Carolina	Colleton	1	0.4
South Carolina	Georgetown	15	5.6
South Carolina	Horry	10	3.7

Table 7. Random Utility Model

Variable	Mean	StdDev	Coeff.	t-ratio
Travel Cost (tc)	376.55	402.01	-0.0083	-6.99
Travel Time (tt)	20.45	16.88	-0.1836	-8.62
Expected Harvest (q)	0.41	0.45	0.6559	4.60
Log(Sites) (m)	2.93	0.79	1.0395	10.62
State Bag Limit (b-2)	0.29	0.45	-2.6254	-6.94
Chi-squared			820.61	
Sample size	9380			
Cases	268			
Sites	35			

Table 8. Willingness to Pay to Avoid Bag Limit Change

	One Fish ($\Delta b = 1$)			
	Mean	StdDev	Maximum	Per Wave*
Alabama	0.35	1.80	17.46	1.21
Florida (SA)	0.18	1.35	18.10	0.62
Florida (Gulf)	1.47	7.05	62.95	5.09
Georgia	0.00	0.00	0.00	0.00
Louisiana	0.00	0.02	0.28	0.00
Mississippi	0.01	0.17	2.65	0.03
North Carolina	0.00	0.01	0.08	0.00
South Carolina	0.78	4.89	50.98	2.70
Southeastern US	3.13	13.42	124.52	10.83
	Two Fish ($\Delta b = 2$)			
Bag Limit (k = 2)	Mean	StdDev	Maximum	Per Wave*
Alabama	2.48	6.97	52.44	8.58
Florida (SA)	5.51	8.44	56.47	19.06
Florida (Gulf)	16.72	18.54	105.36	57.85
Georgia	0.00	0.01	0.10	0.00
Louisiana	0.14	1.03	12.72	0.48
Mississippi	0.40	1.36	11.18	1.38
North Carolina	0.05	0.75	12.25	0.17
South Carolina	0.92	5.06	51.89	3.18
Southeastern US	29.09	30.41	199.03	100.65

*Based on 3.46 king mackerel trips.

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