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A comparison of contingent valuation method and random utility model estimates of the value of avoiding reductions in king mackerel bag limits

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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 is $2.24 per trip and $7.71 for a two-month time period. Considering several methodological issues, the difference in willingness to pay between the stated and revealed preference methods is in the expected direction.

I. 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., 1999b; Whitehead and Haab, 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 allow 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 (e.g. Loomis et al., 1991; Wu and Huang, 2001). In the case here, equality of willingness to pay estimates from the CVM and RUM would provide policymakers with confidence about using the results from either method when making policy decisions. Without convergent validity policymakers may 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 (e.g. RUM).

Relative to the value of catch rate changes, the value of bag limit changes has been estimated in only a few studies. Carson et al. (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 increases in the salmon bag limit is diminishing. McConnell et al. (1995) estimate harvest rates from a household production model to use as independent variables in a site-selection RUM. The data are 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. 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 and none that compare the value of bag limit changes.

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. Total 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.

II. THEORY

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

[u.sub.i] = u([x.sub.ij], [q.sub.ij]) (1)

where u(*) is the utility function for i=l, ..., m anglers, [x.sub.ij] is king mackerel targeted recreational fishing trips at j = 1, ..., n sites, and [q.sub.ij] is expected king mackerel harvest rates. Utility is increasing in trips and harvest.

The expected harvest rate depends on inputs in a household production function

[q.sub.ij] = q(k[.sub.i], [l.sub.i], [s.sub.j], [b.sub.j]) + [e.sub.ij] (2)

where q(*) is the household production function, [k.sub.i] is the capital input (e.g. fishing mode such as boat or pier fishing), [l.sub.i] is the labour input (e.g. time spent fishing), [s.sub.j] is the stock size, [b.sub.j] is the daily bag limit, and [e.sub.ij] is a mean zero error term that represents individual and site-specific random shocks. The expected harvest is increasing in capital and labour inputs and stock size. Subscripts are dropped through the remainder of this section.

The marginal effect of the bag limit on expected harvest is

[MATHEMATICAL EXPRESSION NOT REPRODUCIBLE IN ASCII] (3)

For those anglers who expect to approach the daily bag limit, b - q < 1, a decrease in the bag limit by one fish will decrease expected harvest. For those anglers who do not expect to approach the bag limit, b - q > l, the daily bag limit is non-binding and will not affect expected harvest. Substitution of expected harvest into the utility function yields

u = u(x, q(k, g, s, b)) (4)

Anglers are constrained by the fishing budget, Yi = [[summation].sub.j][p.sub.ij][x.sub.ij], where y is the budget and p is the travel cost. Maximization of angler utility subject to the budget constraint yields the indirect utility function

v = v(p, q(k, l, s, b), y) (5)

where v(*) is decreasing in p, increasing in q, and increasing in y. The marginal utility of a change in the bag limit is the product of the marginal utility of expected harvest and the marginal effect of the bag limit on expected harvest

[partial derivative]v/[partial derivative]b = [partial derivative]v/[partial derivative]q [partial derivative]q/[partial derivative]b (6)

The bag limit only affects the utility of anglers for whom the marginal effect of the bag limit is positive.

In other words, if the bag limit is a non-binding constraint a decrease in the bag limit has no negative effect on utility.

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

[WTP.sub.H] = [partial derivative]v/[partial derivative]q/[partial derivative]v/[partial derivative]y (7)

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

[WTP.sub.B] = [partial derivative]v/[partial derivative]q [partial derivative]q/[partial derivative]b/[partial derivative]v/[partial derivative]y (8)

Rearranging Equation 8 shows that the willingness to pay for a change in the bag limit is equal to the product of the willingness to pay for a change in the expected harvest the marginal effect of the bag limit

[WTP.sub.B] = [WTPH.sub.H] [partial derivative]q/[partial derivative]b (9)

Since the marginal effect of the bag limit may be zero the willingness to pay for a change in the bag limit is less than or equal to the willingness to pay for a change in expected harvest, [WTP.sub.B] [less than or equal to] [WTP.sub.H]. For those anglers for whom the bag limit is non-binding, willingness to pay for a change in the bag limit is equal to zero even if willingness to pay for harvest is positive.

III. DATA

We use data from the MRFSS intercept survey that gathers trip, catch, harvest 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 57000 intercept interviews of recreational anglers were conducted at over 1000 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 10000 AMES telephone interviews were conducted with MRFSS intercept respondents (QuanTech, Survey Research Center, 1998). The AMES collected economic information about the intercepted fishing trip including expenditure and travel costs and willingness to pay for king mackerel, red snapper and gag grouper bag limits. (1) 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 CVM and RUM 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% were intercepted in North Carolina and South Carolina. The percentage of intercept interviews ranges 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

The AMES interview leads the respondent through a series of questions related to king mackerel (QuanTech, Survey Research Center, 1998).

The willingness to pay question is open-ended (Mitchell and Carson, 1989; Boyle et al., 1996):

> 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 STLIM1T and VER KM is used to construct the change in bag limit variable: [DELTA]b = 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. 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 practise 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.

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

[WTP.sup.*] = [alpha]' [X.sub.1] + [mu] (10)

where

[MATHEMATICAL EXPRESSION NOT REPRODUCIBLE IN ASCII] (11) where [WTP.sup.*] is an unobserved variable, [alpha] is a vector of coefficients, [X.sub.1] is a vector of independent variables including the change in the bag limit, [DELTA]b, and [mu] is a normally distributed error term (Halstead et al., 1991, Greene, 2003). The expected value of WTP is

E[WTP] = [PHI]Z ([alpha]' [X.sub.1] + [sigma] ([phi]Z/[PHI]Z)) (12)

where [PHI] is the cumulative distribution function, [phi] is the probability density function, Z = [alpha]' [X.sub.1]/[sigma] and [sigma] is the standard deviation of the regression. The marginal effect of the change in the bag limit on the dependent variable is

[partial derivative]E[WTP]/[partial derivative][DELTA]b = [[alpha].sub.[DELTA]b][PHI]Z (13)

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 (McConnell el al., 1995; Schuhmann, 1998; Haab and McConnell, 2002; Freeman, 2003). (2) 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

[u.sub.ij] = [v.sub.ij] + [[epsilon].sub.ij] (14)

where [v.sub.ij] is the deterministic portion of the indirect utility function and [[epsilon].sub.ij] is the random error term. The conditional logit model is

[MATHEMATICAL EXPRESSION NOT REPRODUCIBLE IN ASCII] (15)

where [[PI].sub.i](j) is the probability of individual i selecting site j.

The deterministic part of the indirect utility function is linear

[v.sub.ij] = [[gamma].sub.ij][p.sub.ij] + [[gamma].sub.2][t.sub.ij] + [[gamma].sub.3][m.sub.j] + [[gamma].sub.4][q.sub.ij] + [[gamma].sub.5][b.sub.j](16)

where [p.sub.ij] is the travel cost, [t.sub.ij] is the travel time, [m.sub.j] is the log of the number of sites aggregated to the county level (see Parsons and Needleman, 1992), [q.sub.ij] is the expected harvest rate, and [b.sub.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 harvest at the site increases the probability of a site visit should be higher. Finally, a higher bag limit should attract more anglers. Thus the first two coefficients in Equation 16 should be negative and the rest positive.

The Poisson count data model is used to estimate expected harvest at each site for each angler (Smith et al., 1993; McConnell et al., 1995; Schuhmann, 1998). We use a generalization of the standard Poisson model that relaxes the restrictive equal mean/variance assumption (Cameron and Trivedi, 1986). The probability of harvesting q fish is

[MATHEMATICAL EXPRESSION NOT REPRODUCIBLE IN ASCII] (17)

where [bar.q] is the mean total harvest. The probability of harvest is conditioned on measures of fishing characteristics through the conditional mean household production function

[MATHEMATICAL EXPRESSION NOT REPRODUCIBLE IN ASCII] (18)

where [beta] is a vector of coefficients and [X.sub.2] is a vector of independent variables. The independent variables include measures of stock size, fishing experience, individual characteristics and characteristics about the fishing trip. (3) Expected harvest is calculated as in McConnell et al. (1995).

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, [??] > b - [DELTA]b, the expected catch rate is truncated at = b - [DELTA]b. Otherwise, [??] = [??]. The willingness to pay to avoid a reduction in the bag limit measured from the RUM is

[WTP.sub.B] = [??]([p.sub.ij], [t.sub.ij], [??], [m.sub.j], [b.sub.j]) - [??]([p.sub.ij], [t.sub.ij], [??], [m.sub.j], [b.sub.j]/[[gamma].sub.1] (19)

The value of avoiding the change in the bag limit over all j sites is

[MATHEMATICAL EXPRESSION NOT REPRODUCIBLE IN ASCII] (20)

IV. CVM DATA AND RESULTS

As theory suggests, many (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 to avoid the reduced bag limit (Table 2). Eight per cent 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 (1997 $).

We include variables that are expected to contribute to the explanation of the willingness to pay to purchase a king mackerel stamp in the Tobit model. (4) 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 3). The average change in the bag limit is 1.62. The average household income is $58,130. Forty-eight per cent of the sample generally targets king mackerel. The average number of years of fishing experience in the state of intercept is 16.55. Seventy per cent 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. 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].

V. RUM DATA

For tractability, the NMFS intercept sites are aggregated into 77 county level fishing sites (Haab et al., 2001). King mackerel anglers visited 35 of these counties in 1997. 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. The choice among the 35 sites serves as the dependent variable in the site selection random utility models.

Expected harvest rates are estimated with a Poisson household production model. Independent variables are the historic harvest rate as a measure of stock size, boat ownership, fishing experience, and a dummy variable for whether the angler generally targets king mackerel as measures of capital inputs, hours fished per trip as a measure of the labour input, the state bag limit, and dummy variables whether the angler took a multi-day trip and was intercepted during wave 5 (Table 4). Mean historic king mackerel per day harvest rates are calculated from the 1992 through 1996 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 is 4.83. Twenty-five per cent of the trips are multi-day trips.

Harvest rates increase with the average historic harvest rate at the site (Table 4). Those on multi-day trips and those who fish longer hours tend to harvest more fish per day. Anglers intercepted during wave 5 harvest more fish. Anglers fishing in states with a three fish per day bag limit, relative to a two fish limit, harvest 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.

Distances from the household zip code to the zip code at the centre of the county are calculated using PC*Miler. Travel costs, including transportation and time costs, are measured as in Hicks et al. (1999a) and Haab et al. (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 $0.30 per mile travelled. 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

[MATHEMATICAL EXPRESSION NOT REPRODUCIBLE IN ASCII] (21) where [d.sub.ij] is the round trip distance for individual i to site j. The wage, [w.sub.i], is measured as household income (in thousands) divided by 2.08 (the number of full-time 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 et al., 2001).

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

[MATHEMATICAL EXPRESSION NOT REPRODUCIBLE IN ASCII] (22)

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 5). The average expected harvest rate is 0.41 fish. The average log of the number of sites in the county is 2.93. The state bag limit is recoded from three fish and two fish to a dummy variable ([b.sub.j] - 2). Twenty-nine per cent of the individual and site combinations (n=9380) have a daily bag limit of three fish.

VI. RUM RESULTS

The signs of all coefficients in the RUM site selection model are in the expected direction with one exception (Table 5). 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 longer fishing season of the southernmost states that also have a lower bag limit.

The mean willingness to pay for the bag change is first 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 6). The willingness to pay for the entire southeastern US is $2.24 per trip. As theory suggests, many (59%) of the anglers have a zero willingness to pay to avoid the bag limit change for the entire southeastern US.

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 eight days during the two-month wave. Four of these days were spent fishing primarily for king mackerel. During the AMES telephone interview, each angler reported an average of 4.63 fishing trips during the two-month wave. Less than one of these trips is an overnight trip. About three and a 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 anglers who secondarily target king mackerel take fewer king mackerel trips than those who primarily target king mackerel. Based on an average of 3.44 primary king mackerel target 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 US is $7.71. 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 $15.42.

The median angler willingness to pay to avoid a one fish reduction in the bag limit is zero. As in McConnell et al. (1995), outliers strongly influence the mean 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 $0.06 (Georgia) to $29 in the Florida Gulf for a one fish reduction in the bag limit. The maximum willingness to pay for the entire southeast is $59.

VII. 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 when it is estimated with the RUM. The annual CVM willingness to pay estimate is $2.45 for a one fish reduction in the bag limit. While it is not made explicit in the willingness to pay question, we conservatively assume that respondents assumed that the hypothetical bag change would cover the entire southeastern US. The two-month wave RUM willingness to pay estimate is almost $8 for the southeastern US. When the RUM willingness to pay estimate is aggregated across the king mackerel season (roughly two waves) then the RUM willingness to pay estimates are that much greater than the CVM estimates.

The divergence of willingness to pay estimates is not surprising for several reasons. In this application the CVM willingness to pay 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 et al. (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 are stated by those who reject the scenario or considered it unfair. (5)

The RUM willingness to pay estimates will be biased upward for at least three reasons. First, 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. In a nested RUM, anglers faced with reductions in bag limits for king mackerel might switch to targeting another species. The lack of substitution opportunities will upwardly bias the willingness to pay to avoid the bag limit reduction.

Perhaps most importantly, welfare estimates from the RUM are biased upwards because we include multi-day trips in our analysis. Multi-day trippers travel further distances which decreases the coefficient on travel cost compared to a model that only includes day trippers and increases willingness to pay estimates in the RUM. Unfortunately, exclusion of multi-day trippers renders the coefficient on the predicted harvest variable insignificant, prohibiting the comparison in willingness to pay values for a bag limit reduction between the CVM and RUM for only day trippers.

A final 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.

VIII. CONCLUSIONS

Differences in willingness to pay between the CVM and RUM are in the expected direction for theoretical and empirical 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 large number 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 somewhat questionable since only a few of the anglers have experience with king mackerel fishing (see Whitehead and Haab, 2001).

One benefit of the RUM is 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 et al., 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 US. 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 and better survey design could produce willingness to pay estimates that are convergent valid with their RUM counterparts.

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NOTES

(1) See Whitehead and Haab (2001) for analysis of the red snapper and gag grouper data.

(2) See Thornton (2000) for an application of the RUM in a different context.

(3) One important characteristic about the fishing trip, hours fished, is potentially an endogenous variable. The number of hours fished should increase the harvest. It is also possible that an angler would increase or decrease the amount of time spent fishing with additional harvest. Endogeneity, a correlation in the error term of hours fished and harvest, would bias the coefficient on hours fished downward in the household production function. We attempted an instrumental variables approach to mitigate the endogeneity in the harvest model but could not identify an instrument that leads to a statistically significant coefficient on the predicted hours fished variable. See McConnell et al. (1995) for further explanation of the problem and some evidence that on-site time does not necessarily increase with angler success. See Smith et al. (1993) and Schuhmann (1998) for more successful efforts at handling endogeneity.

(4) Since the purchase of the king mackerel stamp is good for the fishing season, these variables will differ from those that help explain selection of the site of a king mackerel trip (Equation 16). Only site specific variables, not individual characteristics such as income, can be used in the conditional logit model (Haab and McConnell, 2002). For example, the expectation of site-specific harvest per day is more appropriate to the site-selection decision. Variables that are more generally related to king mackerel fishing, such as whether the angler targets king mackerel, is more appropriate for the willingness to pay decision. The differences in model specification should not affect the estimation of willingness to pay.

(5) The difference in CVM and RUM results do not change when "protest zero" responses from the CVM analysis (n = 79) are excluded from both models (see Strazzera et al., 2003).

TABLES

Table 1. Sample properties

	Percent
Site	
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 (March-April)	23
3 (May-June)	19
4 (July-August)	25
5 (September October)	18
6 (November-December)	15
Mode	
Party/Charter	20
Boat	71
Shore	9
Cases	268

Table 2. 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 3. Tobit willingness to pay model

Variable	Mean	Std. dev.	Coeff.	t-ratio
Constant			-9.15	-1.48
Change in bag limit ([DELTA]b)	1.62	0.66	6.41	2.48
Income	58.13	35.09	-0.01	-0.21
Generally target kings	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 4. Household production model

Variable	Mean	Std. dev.	Coeff.	t-ratio
Intercept			1.852	1.82
Mean historic harvest	0.21	0.41	1.382	6.23
Own a boat	0.70	0.46	-0.485	-1.69
Years fished in state	16.55	13.36	0.001	0.08
Log(hours fished)	4.83	1.88	0.829	2.10
Generally target	0.48	0.50	0.191	0.69
Multi-day trip	0.25	0.43	0.938	3.39
Wave 5	0.18	0.39	-1.650	-3.59
State bag limit	2.29	0.46	2.342	
Scale			2.03	
Cases			268	

Table 5. Random utility model

Variable	Mean	Std. dev.	Coeff.	t-ratio
Travel cost (tc)	376.55	402.01	-0.008	-6.94
Travel time (tt)	20.45	16.88	-0.183	-8.59
Expected harvest (q)	0.41	0.45	0.049	3.13
Log(sites) (m)	2.93	0.79	1.033	10.59
State bag limit (b-2)	0.29	0.45	-2.556	-6.77
Chi-squared			813.55	
Sample size	9380			
Cases	268			
Sites	35			

Table 6. Willingness to pay to avoid a one fish reduction ([DELTA]B= 1) in the bag limit

	Mean WTP	Std. dev.	Maximum	WTP over two-month wave
Alabama	0.26	1.13	8.54	0.89
Florida (SA)	0.18	0.87	10.33	0.62
Florida (Gulf)	1.10	3.66	29.56	3.78
Georgia	0.00	0.01	0.06	0.00
Louisiana	0.01	0.11	1.50	0.03
Mississippi	0.02	0.14	1.80	0.07
North Carolina	0.04	0.51	8.41	0.14
South Carolina	0.52	2.72	25.32	1.79
Southeastern US	2.24	7.11	59.29	7.71