A Comparison of Contingent Valuation and Random Utility Model Estimates of the Value of Avoiding Reductions in King Mackerel Bag Limits from the 1997 Add-On Marine Recreational Fishery Statistical Survey Economic Study[1]

by

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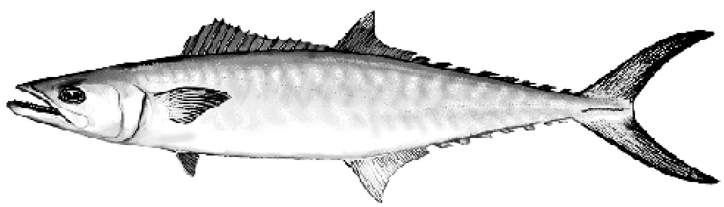

Paper prepared for the "Economics of Recreational Fishing" Symposium

American Fisheries Society Annual Meetings

St. Louis, Missouri

August 2000

[1] This paper was made possible by an ECU College of Arts and Sciences Research Award during Spring Semester 2000.
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Introduction

The purpose of this paper is to estimate the value of king mackerel bag limit changes. The data is from the 1997 Marine Recreational Fishery Statistical Survey (MRFSS) and the Add-On MRFSS Economic Study (AMES). 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 unique data allow a direct comparison of the stated and revealed preference estimates.

Relative to the value of catch rate changes (Freeman 1995), the value of bag limit changes has been estimated in relatively 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.

Carson, et al., (1996) compare stated and revealed preference estimates from 83 studies 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.

The rest of this paper is organized as follows. First we provide some background for the king mackerel valuation problem. Then 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.

Background

The king mackerel (*Scomberomorus cavalla*) is an important gamefish in the southeastern U. S. It is a silver fish with a bluish green back, a thin body and a tapered head. King mackerel reach maturity at 2-3 years and 28 inches. King mackerel are coastal migratory pelagic fish in which schools migrate from south Florida waters in winter to more northerly waters in spring. They prefer waters between 68 and 78 degrees. Therefore, the king mackerel season varies from state to state.

King Mackerel are found both nearshore 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. In the southeastern U.S. recreational king mackerel landings are largest in Florida (Table 1). North and South Carolina also have significant landings. Since 1990 landings have ranged from a low of about 673,813 fish (1990) to a high of 912,300 fish (1997).

The Gulf of Mexico stock is separate from the Atlantic stock. The Gulf of Mexico stock is currently considered overfished by the Mackerel Stock Assessment Panel (2000). The definition of overfished is when the spawning stock will not support maximum sustained yield. The Gulf king mackerel fishery is not considered to be overfishing the stock since the mortality rate is less than the recruitment rate. The Panel does not consider the Atlantic king mackerel stock overfished nor considers the Atlantic fishery to be overfishing the stock.

The Gulf of Mexico Fishery Management Council maintained a total allowable catch quota of 7.8 million pounds from 1992-93 to 1996-97 and increased the quota to 10.6 million pounds from 1997-98 to the present. The recreational quota is a bit more than two-thirds of the total allowable catch. Since 1986/87 anglers have faced a daily bag limit of two fish per person from Florida through Texas. The minimum size limit is 24 inches.

The South Atlantic Fishery Management Council maintained a total allowable catch quota of 10 – 10.5 million pounds from 1991-92 to 1994-95 and decreased the quota to 6.8-8.4 million pounds from 1995-96 to 1998-99. The quota was increased to 10 million pounds for 1999/00. The recreational quota is a bit less than two-thirds of the total allowable catch. Since 1988/89 Florida anglers have faced a daily bag limit of two fish per person except for 1991-92 when the bag limit was five fish. The daily bag limit for Georgia, North Carolina and South Carolina has been three fish per day except during 1991-92 through 1994-95 when it was increased to five fish per day. The minimum size limit is 24 inches.

In March 2000, state health officials in the south Atlantic issued a fish consumption advisory for king mackerel. The advisory stated that king mackerel over 39 inches should not be eaten due to high levels of mercury. Seventeen percent of the landings in South Carolina are greater than 39 inches while less than 4% of the lands in Florida, Georgia, North Carolina are greater than 39 inches (North Carolina Division of Marine Fisheries, 2000). The advisory also warned that women of child bearing age and children age younger than twelve should limit their consumption of 33 to 39 inch fish. Between 24% and 40% of the king mackerel recreational landings in Florida, Georgia, North Carolina, and South Carolina are 33 to 39 inches. King mackerel less than 33 inches are safe to eat.

Theory

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

$$U = u(X, Q)$$

where U is utility, u(.) is the utility function, X is a vector of recreational fishing trips, X = (X_1, X_2, … , X_n), j = 1, …, 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

$$Q = q(k, t, b_j)$$

where Q is the harvest, q(.) is the household production function, b_j is the daily bag limit at site j, k is a vector of capital inputs, and t is a vector of labor inputs including time spent fishing and experience. Hereafter, the subscript on the bag limit will be dropped for notational simplicity. The harvest is increasing in capital and labor inputs. The marginal product of the bag limit on harvest, $\partial q/\partial b$, is either positive or equal to zero. For those anglers who tend to catch and keep their daily limit an increase in the bag limit will increase harvest. For those anglers who tend to catch and keep one fish less than their daily limit a decrease in the bag limit by two fish will decrease harvest. For all other anglers, the daily bag limit is non-binding and will not affect harvest.

Substitution of the household production function into the utility function yields

$$U = u(X, q(k, t, b))$$

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

$$V = v(p, q(k, t, b), y)$$

where v(.) is the indirect utility function which is decreasing in p, increasing in q, and increasing in y. The marginal utility of harvest is $\partial v/\partial q$. Dividing the marginal utility of catch by the marginal utility of income yields the marginal value of harvest

$$WTP(harvest) = (\partial v/\partial q)/(\partial v/\partial y)$$

where WTP is the willingness to pay for additional harvest. Likewise, for reductions in q, WTP is the willingness to pay to avoid decreases in harvest. Since the marginal product of the bag limit on harvest is either positive or zero, the willingness to pay for harvest is not equal to the willingness to pay for changes in the bag limit.

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

$$\partial v/\partial b = (\partial v/\partial q)(\partial q/\partial b)$$

It is easily seen that 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 non-binding 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.

The value of 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

$$WTP_{bag} = [(\partial v/\partial q)(\partial q/\partial b)]/(\partial v/\partial y)$$

After rearranging, it can be seen that the value of a change in the bag limit is equal to the marginal value of a change in the harvest multiplied by the marginal product of the bag limit

$$WTP_{bag} = [(\partial v/\partial q)/(\partial v/\partial y)](\partial q/\partial b)$$

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

The AMES Data

The MRFSS consists of two parts, an intercept survey and a telephone survey (National Marine Fisheries Service, 1999). We use data from the intercept survey that gathers trip, catch and demographic information. Sampling is stratified by state, mode (party/charter boat, private/rental boat, shore), and wave and allocated according to fishing pressure. Sampling sites are randomly selected from 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.

During 1997 approximately 10,000 AMES telephone interviews were conducted with MRFSS intercept respondents (QuanTech, 1998). The interviews consist of wave 2 (March, April) through wave 6 (November, December) intercepted anglers. Wave 1 (January, February) interviews are not collected in Georgia, North Carolina, and South Carolina and are not included in our analysis. The AMES collected economic information about the intercepted fishing trip including expenditure and travel cost information. Merging the intercept and telephone survey data and omitting observations with missing data on key variables, results in 8865 useable cases.

The contingent valuation method and random utility models are estimated for those anglers who fish from the party/charter boat, private/rental boat, and shore modes who were either primarily or secondarily targeting king mackerel. Two hundred sixty-eight of these anglers are included in the sample (Table 2). 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. 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.

The Contingent Valuation Model

In this section we present the welfare estimates for changes in the bag limit from the contingent valuation model. First, we describe the willingness to pay questions and data. Then we present a Tobit model of willingness to pay estimates.

Willingness to Pay Questions

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, and 2 for anglers intercepted in states with a bag limit of 3 and 0 and 1 for anglers intercepted in states with a bag limit of 2. The difference between STLIMIT and VER_KM is used to construct the change in bag limit variable.

Almost 60% of the anglers are not willing to pay anything for the stamp. 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 that it is unfair (Table 3). 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 are they don't fish for king mackerel, practice catch and release, and the lower limit is sufficient or they do not fish for king mackerel often enough. However only 2.5% openly 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 the bag limit does not matter, they would stop fishing, or fish less for king mackerel.

The Willingness to Pay Model

The contingent valuation method allows willingness to pay to be estimated directly and the determinants of willingness to pay to be estimated by regression. Since a large proportion of the willingness to pay responses are zeros, the Tobit model for censored data is appropriate

$$WTP^* = \alpha' w + e$$

$$WTP = 0 \qquad \text{if } WTP^* \leq 0$$

$$WTP = WTP^* \qquad \text{if } WTP^* > 0$$

where α is a vector of coefficients, w is a vector of independent variables, WTP* is an unobserved variable, and e is a normally distributed error term (Greene, 1997). The expected value of WTP is

$$E[WTP \mid z] = \Phi[(\alpha' w)/\sigma](\alpha' w + \sigma\lambda)$$

$$\lambda = \phi[(\alpha' w)/\sigma]/\Phi[(\alpha' w)/\sigma]$$

where Φ is the cumulative distribution function, ϕ is the probability density function, and σ is the standard deviation of the regression. The marginal effect of an independent variable on the dependent variable is

$$\partial E[WTP \mid z]/\partial z = \delta\Phi[(\alpha' w)/\sigma].$$

Data. 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 4). 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 5). The average change in the bag limit is 1.62 with a range of 1 to 3. For the king mackerel anglers 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 own boat.

Results. Only two of the five Tobit coefficients on the independent variables are statistically significant (Table 5). 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 marginal effect for the change in the bag limit is $2.45 with a 95% confidence interval of [$0.51, $4.38]. This is the CVM estimate of a one unit increase or decrease in the king mackerel bag limit. 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.

The Random Utility Model

In this section we present the welfare estimates for changes in the bag limit from the random utility model. The random utility model used here includes a Poisson household production model and a conditional logit site selection model. First, we describe and estimate the household production model used to estimate the expected harvest of king mackerel. Second, we describe and estimate the site selection model that uses the expected harvest rate as an independent variable. Finally, we use this model to estimate the value of avoiding changes in the bag limit. For comparison we also present welfare estimates for the value of additional catch.

The Household Production Model

The Poisson count data model is used to estimate expected catch 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).

In the Poisson model, the probability of catching Q fish is

$$\text{Prob}(Q) = e^{Q} Q^{\lambda}/Q! \quad \text{for } q = 0, 1, 2, \ldots.$$

The probabilty is conditioned on measures of fishing characteristics through the conditional mean

$$q = \lambda = \exp(\beta' z)$$

where q is the expected catch rate, β is a vector of coefficients and z is a vector of independent variables. Since the conditional mean of the Poisson model is log-linear, $\log(q) = \beta' z$, the marginal effect of an independent variable on the mean of the dependent variable is equal to $\beta \exp(\beta' z) = \beta q$. Therefore, the marginal effects vary with the mean harvest.

Data. Dependent variables in the household production model 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 1991-1996 MRFSS and aggregated at the county level. The average 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.

Results. 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. Considering the coefficient values and the average harvest across anglers, the marginal effect of the historic harvest on actual catch is .96, indicating that historic harvest and actual harvest are proportional.

The Site Selection Model

Following the standard derivation of the conditional logit RUM, we assume that the individual will choose to visit the site that provides the maximum utility of all the available alternatives. 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

$$V_{ij} = v_{ij} + \varepsilon_{ij}$$

where v_{ij} is the deterministic portion of the indirect utility function and ε_{ij} is the random error term. The conditional logit model specifies that the probability of individual i selecting site j is

$$P_{ij} = \exp(V_{ij})/\Sigma_j \exp(V_{ij})$$

where P_{ij} is the empirical probability.

The deterministic part of the indirect utility function is linear

$$v_{ij} = \gamma_1 tc_{ij} + \gamma_2 tt_{ij} + \gamma_3 m_j + \gamma_4 q_{ij} + \gamma_5 b_j$$

where tc_{ij} is the travel cost, tt_{ij} is the travel time for those who do not lose income on the trip, m_j is the log of the number of NMFS intercept sites aggregated to the county level (see Parsons and Needleman, 1992), q_{ij} is the expected harvest rate, and b_j is the bag limit.

Given the form of the logit model, 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. As the money and time cost of a trip increases, the probability that the site will be selected decreases. We expect site aggregation to have a positive effect on site selection. The more interview sites in the county zone, the more likely that anglers visited the county site. As the expected number of fish harvested 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.

Data. For tractability, the National Marine Fisheries Service intercept sites are aggregated into seventy-seven county level fishing sites (Table 7). 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.

Distances from the household zip code to each county zip code are calculated using PC*Miler. Travel and time costs are measured as in Hicks, et al., (1999) and Haab, Whitehead, and McConnell (2000). Time costs are calculated using estimated travel times and the wage rate. Travel costs are calculated at $.30 per mile traveled and time costs are calculated using estimated travel times (assuming 40 mph). 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. The trip cost variable is

$$tc_{ij} = \begin{cases} \$.30 * D_{ij} + wage_i * (D_{ij}/40) & \text{if LOSEINC} = 1 \\ \$.30 * D_{ij} & \text{otherwise} \end{cases}$$

where D_{ij} is the round trip distance for individual i to site j. The wage is measured as household income (in thousands) divided by 2.08 (the number of fulltime hours potentially worked annually in thousands).

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

$$tt_{ij} = \begin{cases} 0 & \text{if LOSEINC} = 1 \\ D_{ij}/40 & \text{otherwise} \end{cases}$$

Wage rates are estimated for the large portion of 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).

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 and time cost to the visited county is $282 and the median is $67.

The predicted harvest rate is measured with the specific variables 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.

Once aggregrated over all sites, the average travel cost is $377 and the average travel time is 20.45 hours (Table 8). 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 – 2). Twenty-nine percent of the individual site combinations have a daily bag limit of 3 fish.

Results. The sign of all coefficients on the independent variable is in the expected direction with one exception (Table 8). The travel cost and travel time coefficient estimates are negative and statistically significant. 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.

Welfare Estimates

The individual's welfare change is based on the difference in the indirect utility from a change in bag limits or catch rates divided by the marginal utility of income. The estimate of the marginal utility of income is the coefficient on the travel cost variable. The value of a change in the bag limit could be modeled as a change in the bag limit (b – k; where k is the catch rate change, k=1, 2) and also as a restriction on the expected catch rate. Since the coefficient on the bag limit is of opposite sign we do not alter it in the welfare calculations.

For those anglers who are expected to catch more fish than the restricted bag limit, $q > b - k$, the expected catch rate is truncated at $b - k$: $q(b - k)$ and the welfare measure is

$$WTP_{bag} = -[v(tc, tt, q(b - k), m, b) - v(tc, tt, q, m, b)]/\gamma_1$$

For comparison, the value of avoiding a decrease in the harvest rate is estimated as

$$WTP_{harvest} = -[v(tc, tt, q - k, m, b) - v(tc, tt, q, m, b)]/\gamma_1$$

Results. In this section we present welfare estimates from the RUM. For each of the welfare measures the change in indirect utility is calculated over a subset of sites. We consider each state's Atlantic or Gulf of Mexico coastline an aggregate site. Therefore each state is one site except for Florida, which is broken down into South Atlantic (SA) and Gulf of Mexico (Gulf) sites.

The WTP to avoid a one fish reduction in the bag limit ranges from zero for several states to $1.47 for the Florida Gulf (Table 9). A willingness to pay of zero indicates that a reduction in the bag limit is not restrictive. 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/trip.

The per trip willingness to pay estimates can be aggregated up to the two-month wave or king mackerel season level. Detailed fishing days and trip per wave information was 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. 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 king mackerel 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 change 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. The WTP for a two fish reduction is more than two times greater than the WTP for a one fish reduction because more anglers are affected by the change and included in the calculation. The willingness to pay for the entire southeastern U.S. is $29.09/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 WTP 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, 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 WTP 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.

For comparison we estimate the value of avoiding one less fish harvested per trip. A one fish decrease in the expected harvest rate at each site in the state is $.19 in Louisiana, $.66 in Mississippi, $.79 in Georgia, $3.69 in Alabama, $6.86 in South Carolina $12.59 in Florida (SA), $12.69 in North Carolina, $32.19 in the Florida Gulf. As predicted by theory, the willingness to pay to avoid catching one fewer fish per trip exceeds the willingness to pay to avoid a one fish decrease in the bag limit.

Comparing CVM and RUM Estimates

The willingness to pay to avoid a reduction in the bag limit is lower when estimated using the CVM when compared 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. Comparisons of the two fish reduction in the bag limit also results in larger divergences between CVM and RUM estimates.

This 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 closed-ended questions (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 (eg, stating willingness to pay greater than true willingness to pay) respondents will underbid in open-ended questions.

Carson, Groves, and Machina (1999) provide several theoretical reasons why open-ended willingness to pay estimates will be less than closed-ended estimates. One is that the open-ended question is one in which the cost of the policy is not revealed to respondents. This creates 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. In fact, this application of CVM generated several “protest” responses. Over 30% of the zero willingness to pay values were by those who rejected the scenario or considered it unfair.

The RUM estimates will be biased upward for two reasons. The simple 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, more abundant, 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 RP 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 and practical reasons and are consistent with other stated and revealed preference comparison studies (Carson, et al., 1996). While an explanation of the divergence may be comforting to RUM and, especially, CVM researchers, it does not answer the question about how best to value changes in bag limits for important recreational fisheries. The goal of using multiple valuation methods is the convergent validity of the estimates. Convergent validity results when estimates 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, as here, policy makers will be undecided whether to use the CVM or RUM estimates of value.

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 small samples. While all anglers in the AMES telephone survey were asked the king mackerel questions (leading to a large sample size), the validity of these data is questionable since only a few of the anglers have experience with king mackerel fishing.

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, catch 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. Even so, the RUM appears to be the most efficient 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. and who would enforce it. If the CVM is to be used in future applications with the MRFSS, the incentive compatible discrete 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 discrete choice question should produce willingness to pay estimates that are closer to their RUM counterparts.

With the current application, the non-nested form of the RUM is used which will produce estimates of willingness to pay for bag limit and harvest changes that are upward biased. Use of the nested RUM should produce willingness to pay estimates that are closer to their CVM counterparts.

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Table 1. King Mackerel Recreational Landings*

Year	AL	FL (SA)	FL (GULF)	GA	LA	MS	NC	SC
1990	53,451	185,133	195,315	10,939	11	805	168,915	59,244
1991	24,771	166,648	303,472	1,450	1,365	17,568	153,421	137,458
1992	40,960	263,814	197,147	21,094	12,248	6,427	143,381	218,937
1993	56,206	164,915	283,582	964	3,956	1,072	89,913	49,528
1994	67,195	150,770	279,782	11,288	9,157	4,376	97,167	70,207
1995	54,064	243,901	260,219	9,635	7,714	7,690	109,891	53,810
1996	25,545	159,146	476,162	3,868	3,551	8,722	72,116	48,565
1997	49,160	196,350	374,766	1,686	11,400	23,039	189,059	66,840
1998	33,184	211,005	362,623	2,395	3,261	4,984	88,554	106,337
1999	41,173	331,186	262,486	4,112	2,318	4,306	61,361	15,127

*Based on Observed Harvest by NMFS enumerators.

Table 2. 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 3. 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 4. 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 5. 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 7. 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 8. Random Utility Models

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	
N	9380			
Cases	268			
Sites	35			

Table 9. Willingness to Pay to Avoid Bag Limit Change

Bag Limit (k = 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

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 trips.