The Economic Value of Marine Recreational Fishing:

Analysis of the MRFSS 1998 Pacific Add-on[1]

Timothy C. Haab, Ohio State University

Robert L. Hicks, College of William and Mary

John C. Whitehead[2], Appalachian State University

February 10, 2006

[1] This paper was presented at the "Fisheries, Fishermen, and Fishing Communities: Socioeconomic Perspectives on the West Coast, Alaska, and Hawaii" Symposium during the 2005 American Fisheries Society Annual Meeting in Anchorage, Alaska. The authors thank Brad Gentner for numerous helpful comments and suggestions.

[2] Corresponding Author: Department of Economics, Appalachian State University, Boone, NC 28608; email: whiteheadjc@appstate.edu.

The Economic Value of Marine Recreational Fishing:

Analysis of the MRFSS 1998 Pacific Add-on

Abstract. Marine Recreational Fishing Statistics Survey (MRFSS) economic add-on data has been collected since 1994. The data are comprised of two geographically identical datasets for the Southeast region (1997, 2000), five identical datasets for the Northeast region (1994, 1996, 1997, 1999, 2000), and one dataset for the Pacific region (1998). Measures of the economic value of fishing sites and harvest have been derived from demand models estimated with data from the Northeast and the Southeast regions. In this paper we present a demand model estimated for the Pacific region (i.e., west coast). For consistency, the model is based on the 1994 and 1997 studies. Measures of the economic value of fishing sites and harvest are developed. We demonstrate how the model can be used for fisheries management decisions.

Introduction

The importance of and need for efficient and effective management programs for recreational fisheries as a renewable resource has been recognized to accomplish an economically and biologically sustainable level of harvest. According to the National Marine Fisheries Service (NMFS), in 2001 there were 15 to 17 million marine recreational anglers, taking over 86 million fishing trips and harvesting over 189 million fish weighing almost 266 million pounds (over 254 million fish were caught and released) in 2001. Marine recreational fishing has a significant economic impact on coastal areas, non-coastal areas where market goods related with this activity are produced, and available fish stocks. To develop fishery management plans and evaluate the impacts of resulting regulations on marine recreational anglers and fisheries, the NMFS collects data on the number and socio-economic characteristics of participants; total number of fishing trips; and the number, size, and weight of recreational harvest through its Marine Recreational Fishing Statistical Survey (MRFSS).

The MRFSS is a biological creel intercept survey. The Add-On MRFSS Economic Survey (AMES) data are used for valuation of trips to fishing sites and fishing quality (Hicks et al. 1999).. Hicks et al. (1999) and Haab, Whitehead, and McConnell (2001) use the AMES to estimate the willingness to pay for (1) the opportunity of marine recreational fishing in a particular area and (2) the better opportunity of catching fish. The data was collected in 1994 in Northeast (NE) and 1997 in the Southeast (SE), respectively. The data are comprised of two geographically identical datasets for the Southeast region (1997, 2000), five identical datasets for the Northeast region (1994, 1996, 1997, 1999, 2000). Haab, Hicks and Whitehead (2004) compare the economic values across time and space in order to determine the feasibility of benefit transfer when faced with reduced data collection efforts. They find that benefit transfers are respectable across time (i.e., between the 1996 and 1997 NE analysis) but not across space (i.e., between the NE and SE regions).

The report also includes analysis of the Pacific (i.e., west coast) 1998 AMES. Comparison of the NE and SE target species, demand models and economic values to the west coast results finds that benefit transfer is not appropriate. In this paper we present the recreation demand model estimated for the 1998 Pacific region. For consistency, the model is based on the 1994 and 1997 studies involving the AMES data. Measures of the economic value of fishing sites and harvest are developed from this model. We also demonstrate how the model can be used by policy analysts.

Model

A marine recreational angler is assumed to jointly choose species to target and fishing mode to use first, and then choose among mutually exclusive fishing sites based on their attributes (mode/species-site choice model). In this nested random utility model, the angler chooses utility maximizing mode-species choice among 15 available combinations from three modes (private/rental boat, party/charter boat, and shore fishing) and five species groups (big game, small game, bottom fish, flat fish, and others) at the fist stage. Conditional on the mode-species choice from the first stage, the angler then chooses utility maximizing fishing site (county-level zone).

If we denote alternative sites and species/mode combinations with *j* and *sm*, respectively, the indirect utility function of an arbitrary angler can be written as:

(1) $$v_{jsm} = \beta_1 c_j + \beta_2 t_j + \gamma_1 \log M_j + \sum_{s=1}^{5} \gamma_{2s} d_s \sqrt{q_{jsm}} + \varepsilon_{jsm}$$

where v_{jsm} is the deterministic utility for site *j* and species/mode *sm*, c_j is the travel cost to site *j*, t_j is the travel time for those who cannot value the travel-time at the wage rate, M_j is the number of intercept sites in the aggregated county level zone, q_{jsm} is a five-year historic harvest rate for species *s* through mode *m* at site *j*, d_s is a species dummy variable, and ε_{jsm} is a generalized extreme value random error term.

The probability of choosing site *j* conditional on species/mode choice *sm* is:

(2) $$\Pr(j \mid sm) = \frac{\exp\left[\left(\beta_1 c_j + \beta_2 t_j + \gamma_1 \log M_j + \sum_{s=1}^{5} \gamma_{2s} d_s \sqrt{q_{jsm}}\right) \big/ \theta_s\right]}{\sum_h \exp\left[\left(\beta_1 c_h + \beta_2 t_h + \gamma_1 \log M_h + \sum_{s=1}^{5} \gamma_{2s} d_s \sqrt{q_{hsm}}\right) \big/ \theta_s\right]}$$

where θ_s is a species-specific inclusive value parameter. The probability of choosing species/mode *sm* is

(3) $$\Pr(sm) = \frac{\exp(\theta_s I_{sm})}{\sum_n \exp(\theta_s I_n)}$$

where I_{sm} is a species/mode-specific inclusive value:

(4) $$I_{sm} = \log\left\{\sum_h \exp\left[\left(\beta_1 c_h + \beta_2 t_h + \gamma_1 \log M_h + \sum_{s=1}^{5} \gamma_{2s} d_s \sqrt{q_{hsm}}\right) \big/ \theta_s\right]\right\}$$

We use the two-stage limited information maximum likelihood (LIML) approach (Haab and McConnell, 2002). First, the estimation of the second stage site choice decision, equation (2), will give us estimates of the β/θ_s and γ/θ_s coefficient vectors. Second, inclusive values, equation (4), can be calculated using these parameter estimates for the estimation of the first stage species/mode choice decision, equation (3). As in the NE 1994 and SE 1997 data, the inclusive value parameters for the four targeted species groups (big game, small game, bottom, and flat) are assumed to be equal (θ_T), and the inclusive value parameter for the non-targeted species is assumed to be different (θ_{NT}) since the pattern of substitution between sites differs for those who do not target a particular species.

The standard welfare measure from a nested logit random utility recreational fishing model that is linear in travel cost compares the expected maximum utility after policy change (V^1) with a baseline level of the expected maximum utility (V^0), and then converts the difference into a money metric by normalizing with the marginal utility of income (β_1). Given the indirect utility function in equation (1), the expected maximum utility under policy situation z (V^z) is:

(5) $$V^Z = \log\left[\sum_{tm}\left(\sum_j \frac{v^z_{jtm}}{\theta_T}\right)^{\theta_T} + \sum_{nm}\left(\sum_j \frac{v^z_{jnm}}{\theta_{NT}}\right)^{\theta_{NT}}\right]$$

where the first summation is over the 12 species/mode combinations that contain targeted species, the third summation is over the 3 species/mode combinations with no target, and v^z_{jsm} is the estimated indirect utility function evaluated at independent variable values under situation *z*.

It is possible to introduce a policy regime that changes the value of independent variables included in the indirect utility function. Two policy situations considered in the analysis are a closure of all sites in a state and an increase in historic harvest rate at all sites. The first measures the access value of fishing in the state for all anglers and the second measures the marginal willingness to pay for a one fish increase in harvest rate at all sites. In these cases, the expected maximum utility will be changed by either eliminating the affected sites or increasing harvest rate from the corresponding summations in equation (5). Using this notation, the willingness to pay (*WTP*) for welfare change from policy situation $z = 0$ to $z = 1$ is:

$$(6) \qquad WTP = \frac{V^0 - V^1}{\beta_1}$$

where V^0 is a baseline level of the expected maximum utility under situation 0, V^1 is the expected maximum utility after a policy change to situation 1, and β_1 is the estimate of travel cost coefficient obtained from the estimation of the second stage site choice decision, equation (2).

Model Structures

The random utility models for the MRFSS data follow the basic structure of Hicks et al. (1999) and Haab, Whitehead, and McConnell (2000). The model assumes that anglers first make a decision between the set of available species/mode combinations. The modes are shore fishing, fishing from party or charter boats, and fishing from private or rental boats. The species groups are big game, small game, bottom fish and flat fish (e.g., halibut). An additional species category is included to capture those anglers that do not target a specific species. Conditional on the species/mode choice, the angler then chooses the specific destination for angling that maximizes the utility of a fishing trip conditional on the first stage species/mode choice.

Sites are defined at the county level such that MRFSS intercept sites are aggregated across counties. Any distance measures required for travel time and travel cost calculation are measured to the mid-point of the coast for that particular county. The conditional site choice is explained using a series of angler and site specific attributes. The conditional indirect utility function is assumed to be a linear in parameters (and variables) function of the travel costs to the county of intercept and the expected harvest rate for each of the species groups.

Travel costs are split into two separate variables depending on the ability of the angler to trade-off labor and leisure. Ideally, travel costs would represent the full opportunity costs of taking an angling trip in the form of foregone expenses and foregone wages associated with taking an angling trip. Because not all anglers can trade-off labor and leisure at the margin, we allow for flexibility in modeling these tradeoffs. For anglers that can directly trade-off labor and leisure at the wage rate (those that indicate they lost income by taking the trip), travel costs are defined as the sum of the explicit travel cost (i.e., round trip distance valued at $.30 per mile) and the travel time valued at the wage rate. Travel time is calculated by dividing the travel distance by an assumed 40 miles per hour for travel. For anglers that do not forego wages to take a trip, travel cost is simply defined as the explicit travel cost. For these anglers, those that did not lose wages, the travel time to the site is included as a separate variable to directly estimate the opportunity cost of time.

As in previous MRFSS modeling efforts, the square root of historic harvest rates of targeted species for the five species groups (big game, small game, bottom fish, flat fish and other) are used as the site specific characteristic. For anglers that do not target a specific specie the harvest rate variable is the small game catch rate, but we allow parameter estimates to differ. To control for aggregation to the county level, the natural logarithm of the number of MRFSS interview sites in each county is used as an independent variable.

Data

There are 7745 Pacific coast day-trip anglers with complete data available for analysis.[3] Most (58%) anglers fish from private or rental boats (Table 1). Twenty-one percent fish from party or charter boats and shore. Most (45%) of the Pacific coast anglers target small game fish (Table 2). Twenty-five percent target bottom fish, 7% target flat fish, 2% target big game fish and 21% either do not target fish or target other species.

Species groupings differ for the Pacific coast relative to the Northeast and Southeast fisheries.[4] Big game fish include tunas, dolphin, shark and marlin. These species account for all of the species targeted by big game anglers. Small game fish include species such as salmon, yellowtail, surfperches, and striped bass. These species account for 93% of the species targeted by small game anglers. Bottom fish include groundfish, rockfish, sturgeon, sandbass, kelp bass, lingcod, and barred sandbass. These species account for 96% of the species targeted by bottom fish anglers. Flat fish species include California and Pacific halibut. These account for 95% of the species targeted by flat fish anglers. Ninety-three percent of the other anglers do not target species. Forty-five percent of Pacific anglers target small game and 25% target bottom fish (Table 2).

Private or rental boat anglers are most likely to target small game fish (26% of all anglers), bottom fish (12%), and flat fish (6%) (Table 3). The most likely species target for party and charter boat anglers is bottom fish (8%) and small game fish (7%). Nine percent of all anglers target small game fish from the shore. Ten percent of all anglers do not target species and

[3] AMES survey administration details can be found at NOAA Fisheries (2005).

[4] Species groups were developed by NOAA Fisheries.

fish from private or rental boats. Five percent of all anglers do not target species and fish from shore. Eight percent of all anglers do not target species and fish from party or charter boats. All other species/mode combinations are below 5% of all anglers.

Forty-seven percent of all trips were taken to southern California (defined as San Luis Obispo County and south) (Table 4). Seventeen percent of all trips were to northern California (Santa Barbara County and north) and Washington. Eighteen percent of all trips were to Oregon.

There are 38 county choices available to respondents. The county choices are, for the most part, descending north to south. Most of the fishing sites are on the Pacific Ocean. However, in Washington and California some of the sites are inland. In Washington, Whatcom, Skagit, Snohomish, King, Pierce, and Kitsap Counties border Puget Sound. San Juan County is an island in Puget Sound. Clallam and Jefferson Counties are on the Pacific Ocean and Puget Sound. Mason and Thurston Counties have sites that are on rivers that flow into Puget Sound. Grays Harbor and Pacific Counties have sites on the Pacific Ocean and bays. In California, Marin, Sonoma, and San Mateo Counties have sites on the Pacific Ocean and San Francisco Bay. All of the sites in Solano, Contra Costa and Alameda Counties are on the San Francisco Bay.

The most likely destinations in Washington are King County (3%), Island County (3%) and Pierce County (3%). The most likely destinations in Oregon are Curry County (6%) and Lincoln County (3%). Within northern California, the most likely destinations are Santa Cruz County (3%) Monterey (3%), and Alameda County (3%). Within southern California, the most likely destinations are Los Angeles County (16% of all trips) and San Diego County (11%).

Nested RUM Results

The average trip cost to all of the 38 sites across 7745 anglers is $439 (Table 5). Note that the mean trip cost includes 92% zero values for opportunity cost of time as only those anglers that forgo wages to fish are assumed to have a non-zero opportunity cost. The average travel time to all of the sites across all anglers is 28 hours. The square root of the historic small game catch rates across all sites for those targeting small game fish is largest of all catch rates. The historic catch rate for bottom fish is the next highest. The historic catch rates of big game and flat fish are very low.

The model chi-squared statistic for the site choice model indicates that all parameters are jointly significantly different from zero. The likelihood that an angler would choose a county fishing site is negatively related to the travel cost and travel time. The likelihood that an angler would choose a county fishing site is positively related to the square root of the big game, small game, bottom fish, and flat fish historic targeted catch rates. The square root of the small game fish historic catch rate for those targeting other fish has no statistically significant effect on site choice. The log of the number of interview sites in the county is positively related to the choice of county.

The species/mode choice is specified to depend on the inclusive value for all targeted species and a separate inclusive value for other and nontargeted species. This is due to the large number of anglers who do not target species or target other species and the low utilities associated with this choice. The model chi-squared statistic for the species/mode choice model indicates that all parameters are jointly significantly different from zero. Both of the parameter estimates on the inclusive values are significantly different from 0 and 1 which indicates that the nested model is appropriate.

Welfare Estimates

A wide range of welfare estimates can be estimated with the nested RUM. We present two. First, the willingness to pay values for access to a one-day fishing trip to each state with California divided into northern and southern regions (Table 6). All welfare measures are converted to 2000 dollars using the consumer price index. The values are presented for each two-month sampling wave. These welfare measures are equivalent to the losses that would be suffered if all of the fishing sites in the state were unavailable for the two-month period (e.g., due to an oil spill).

The willingness to pay for site access values range from $13 to $285 across survey wave and state. The willingness to pay values for access are largest for southern California with a range of $175 to $285 across survey wave. The value of northern California sites ranges from $83 to $94 across survey wave. The willingness to pay values are lowest for Oregon with a range of $13 to $28 across survey wave. Willingness to pay for site access to Washington ranges from $43 to $71. There is little variation across wave. The average across wave ranges from $88 to $103.

We also present the one-day trip willingness to pay values for a one-unit increase in the historic harvest rate across all sites (Table 7). The values are presented for each state and all states combined. The willingness to pay values for a one-unit catch increase is largest for big game fish. These range from $10 to $13 across state with the value largest for anglers choosing fishing sites in Washington. The value for a one-unit increase in small game fish and flat fish are between $1 and $2 for all states. The value for a one-unit increase in bottom fish is between $3 and $4 in each state.

Policy Implications: An Illustration

In order to illustrate how these values can be used for policy analysis and fisheries management decisions we combine the welfare estimates with trip and harvest data from the NMFS (personal communication, 2005). We consider first the value of a ten percent reduction in the number of trips that might arise due to recreational effort restrictions. The number of trips taken to Washington, Oregon, northern California and southern California are 1.5 million, .89 million, 1.6 million and 3.6 million, respectively. The product of willingness to pay for site access by wave and a ten percent reduction in the number of trips is the willingness to pay to avoid the reduction in trips. The willingness to pay values for Washington, Oregon, northern California and southern California are $8 million, $2 million, $15 million and $59 million, respectively.

We next consider the value of changes in harvest using the California halibut harvest as an example. This provides an example of how changes in harvest due to quotas, bag limits and stock improvements can be valued. In northern California, the California halibut harvest rose by 42.9 thousand fish from 2000 to 2001 and rose by 26.3 thousand fish from 2001 to 2002 in southern California. Applying the northern California flat fish value, the economic effect of these changes is $77 thousand and $42 thousand, respectively. The California halibut harvest fell by 13.3 thousand fish from 2000 to 2001 and rose by 18.8 thousand fish from 2001 to 2002 in southern California. Applying the southern California flat fish value, the economic effect of these changes is -$17 thousand and $24 thousand, respectively.

Conclusions

In this paper we have demonstrated the usefulness of the AMES data for fisheries management. Demand models can be estimated and used to estimate monetary values for a wide variety of changes in trips and harvest. Unfortunately, the MRFSS was discontinued on the west coast after 2002. Future NMFS valuation efforts must rely on the analysis of the 1998 west coast AMES.

References

Haab, Timothy, John C. Whitehead, and Ted McConnell. *The Economic Value of Marine Recreational Fishing in the Southeast United States: 1997 Southeast Economic Data Analysis.* U.S. Department of Commerce, National Oceanic Atmospheric Administration, National Marine Fisheries Service, NOAA Technical Memorandum NMFS-SEFSC-446, September 2001.

Haab, Timothy C., and Kenneth E. McConnell, *Valuing Environmental and Natural Resources: The Econometrics of Non-Market Valuation*, Edward Elgar: Northampton, MA, 2002.

Hicks, Rob, Scott Steinbeck, Amy Gautam, and Eric Thunberg. *Volume II: The Economic Value of New England and Mid-Atlantic Sportfishing in 1994*. U.S. Department of Commerce, National Oceanic Atmospheric Administration, National Marine Fisheries Service, NOAA Technical Memorandum NMFS-F/SPO-38, August 1999.

Hicks, Robert L., Amy B. Gautam, David Van Voorhees, Maury Osborn, and Brad Gentner, "An Introduction to the NMFS Marine Recreational Fisheries Statistics Survey with an Emphasis on Economic Valuation," Marine Resource Economics 14(4):375-385, 1999.

Hicks, Robert L., Timothy C. Haab, and John C. Whitehead, "Assessing the Stability of Marine Recreational Resource Values Across Space and Time," Final Report to the National Marine Fisheries Service, 2004.

NOAA Fisheries, "West Coast 1998 (Valuation Round)," URL: http://www.st.nmfs.gov/st1/econ/surveys/pac_1998_v_r.html, 2005.

Personal communication from the National Marine Fisheries Service, Fisheries Statistics Division, Silver Spring, MD, URL: http://www.st.nmfs.gov/st1/recreational/queries/index.html, 2005.

Table 1. Mode Choice

Mode	Frequency	Percent
Party/Charter	1658	21.41
Private/Rental	4491	57.99
Shore	1596	20.61

Table 2. Species Group Choice

Species	Frequency	Percent
Big Game	190	2.45
Small Game	3467	44.76
Bottom	1906	24.61
Flat	566	7.31
Other	1616	20.87

Table 3. Mode/Species Choice

Mode/Species	Frequency	Percent
Big Game Party/Charter	24	0.31
Big Game Private/Rental	166	2.41
Big Game Shore	0	0.00
Small Game Party/Charter	576	7.44
Small Game Private/Rental	2157	27.85
Small Game Shore	734	9.48
Bottom Party/Charter	595	7.68
Bottom Private/Rental	911	11.76
Bottom Shore	145	1.87
Flat Party/Charter	55	0.71
Flat Private/Rental	437	5.64
Flat Shore	74	0.96
Other Party/Charter	408	5.27
Other Private/Rental	820	10.59
Other Shore	643	8.30

Table 4. State Choice		
State	Frequency	Percent
Washington	1320	17.04
Oregon	1407	18.17
California (Northern)	1347	17.39
California (Southern)	3671	47.40

Table 5. LIML Nested RUM Parameter Estimates

Site Choice Model				
Variable	Description	Mean	Coefficient	t-stat
TC	Trip cost to county	439.41	-0.014	-19.91
TT	Travel time to county (minutes)	28.44	-0.493	-38.96
BIG	Square root of historic big game catch	0.008	0.748	4.77
SMALL	Square root of historic small game catch	0.336	0.174	3.92
BOTTOM	Square root of historic bottom fish catch	0.296	0.402	11.15
FLAT	Square root of historic flat fish catch	0.045	0.204	2.35
OTHER	Square root of historic catch for other species	0.156	0.080	1.07
LOGNSITE	Log of number of sites in zone	2.19	0.878	25.30
Model Chi-square	All parameters = 0		36,554	
Cases			7745	
Choices			38	
Species/Mode Choice Model				
Variable	Description	Mean	Coefficient	t-stat
IV	Inclusive value: Targeted Species	1.790	0.663	18.99
IVOTHER	Inclusive value: Non-Targeted Species	0.410	0.743	18.92
Model Chi-square	All parameters = 0		333	
Cases			7745	
Choices			15	

Table 6. Willingness to Pay for a One-Day Fishing Trip by Wave (2000 dollars)

State	March-April	May-June	July-August	Sept-Oct	Nov-Dec
Washington	57.80	46.58	71.49	59.98	43.39
Oregon	27.67	24.62	13.16	34.36	18.46
California (Northern)	89.71	83.15	93.30	94.26	64.13
California (Southern)	188.03	209.20	174.55	178.49	284.80

Table 7. Willingness to Pay for a One-Unit Increase in Harvest (2000 dollars)

State	Big Game Fish	Small Game Fish	Bottom Fish	Flat Fish
Washington	12.60	1.56	4.34	2.12
Oregon	10.61	1.26	2.96	2.07
Northern California	10.80	1.33	3.30	1.79
Southern California	9.56	0.79	2.78	1.27