THE ECONOMIC VALUE OF FISHING SUCCESS: AN APPLICATION OF SOCIOECONOMIC SURVEY DATA

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ABSTRACT

This paper focuses on an economic framework for analyzing some of the elements in the management of marine recreational fisheries. In addition, estimates are provided for valuing fishing success to marine anglers targeting on three Atlantic coast species: bluefish, summer flounder, and weakfish.

Demand functions for sport fishing are estimated with cross-section data using the travel cost method. Fishing trips per season are related to travel cost, fishing success, and income for individual fishermen. The marginal value of fishing success is determined using alternative models and estimation techniques. The data come from a one-time socioeconomic survey conducted by the National Marine Fisheries Service in 1981.

The findings show that marginal valuations for fishing success as measured by the number of fish kept by fishermen vary considerably among target species. In addition, these marginal values are quite sensitive to the empirical formulation of the model. The findings provide managers with some objective basis for evaluating policies affecting marine recreational fisheries. The wide range of values computed from the same data set, however, should caution us, and indicates the need for more theoretical and applied economic research in this area.

In order to efficiently manage marine recreational fisheries, information on economic valuations is required. Since recreational fisheries are typically in the nonmarket sector, traditional markets do not provide much direct information on recreational values in total or at the margin. As a result, management is hampered for recreational fisheries especially when attempting to evaluate activities which have potential effects on these fisheries.

In recent years, many studies have been performed to determine economic valuations of changes in several dimensions of recreational experiences. Examples from a variety of areas include water quality (Bouwes and Schneider 1979; Desvousges et al. 1983), congestion levels on beaches (McConnell 1977), and harvest rates for hunting (Miller and Hay 1981). For recreational fisheries, most studies traditionally have focused on freshwater sports fishing where the data base is generally stronger. Examples of empirical studies focusing on valuation of freshwater recreational fishing with emphasis on the importance of fishing success include Stevens (1966), Vaughan and Russell (1982), and Samples and Bishop (1985). In recent years, more attention has been directed towards saltwater recreational fisheries (examples include McConnell and Strand 1981 and Thompson and Huppert 1987).

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Marine recreational fishing is particularly important because of its size and interactions with other sectors. It is estimated that more than 17 million marine anglers catch over 717 million pounds of fish and contribute over $7.5 billion dollars to the U.S. economy (U.S. Department of Commerce 1985). Although commercial marine harvests are considerably larger (6.3 billion pounds in 1985), conflicts between the two sectors are increasing and provide additional rationale for investigation into marine recreational valuation (Bishop and Samples 1980).

In this paper we focus on an economic framework for analyzing some of the crucial elements in managing marine recreational fisheries. In addition, findings are presented which provide an empirical basis for valuing fishing trips and fishing success to marine anglers targeting on three Atlantic coast species: bluefish, *Pomatomus saltatrix*; summer flounder, *Paralichthys dentatus*; and weakfish, *Cynoscion regalis*.

THEORETICAL BACKGROUND

The management of recreational fisheries would be enhanced if the value of the fishing experience and the impact of fishing effort on the resource base (and, hence, the future value of the fishing experience) were known. The former consideration involves measurement of economic demand which, for recreational fishing, can be complicated since mar-

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ket prices and quantities are generally not available. Even less well known is the impact that fishing effort (both past and present) has on the resource base and, hence, the current and future value of the fishing experience (e.g., quantity and average size of catch, crowding, etc.). Effects of stock externalities have been studied extensively for commercial fisheries and, although these externalities may exist for sport fisheries, little empirical evidence is available.[2]

We present an economic methodology for valuing recreational fishing assuming no stock externalities. Of particular interest is to separate the value of the quantity of fishing (e.g., the number of trips) from the value of the quality or success of the fishing experience (e.g., catch rate). Economic value can be derived from a demand relationship where the level or quantity (Q) demanded is related to price (P), income (I), and a vector of other relevant variables (S) including quality measures such as fishing success. The demand relationship is given as

$$Q = f(P, I, S), \tag{1}$$

where P, I, and S are treated as exogenous in the individual's demand or consumption level decision.

For recreational fishing, Q is usually measured as the number of fishing trips; P may reflect an entry price but more often is measured in terms of trip related costs; I reflects angler income (e.g., annual salary or hourly wage); and S reflects such things as fishing success and prices of substitute and complementary goods. Fishing success may be measured in terms of number and size of fish caught and/or kept.

The model is graphically presented in Figure 1 with quantity (Q) and price (P) on the horizontal and vertical axes respectively. The relationship between

[2]The stock externality results when increased fishing effort by individual participants affects the fish stock such that catch per day or average size of catch are adversely affected, and, hence, the value of a recreational fishing day for all participants is diminished. (Anderson 1983.)

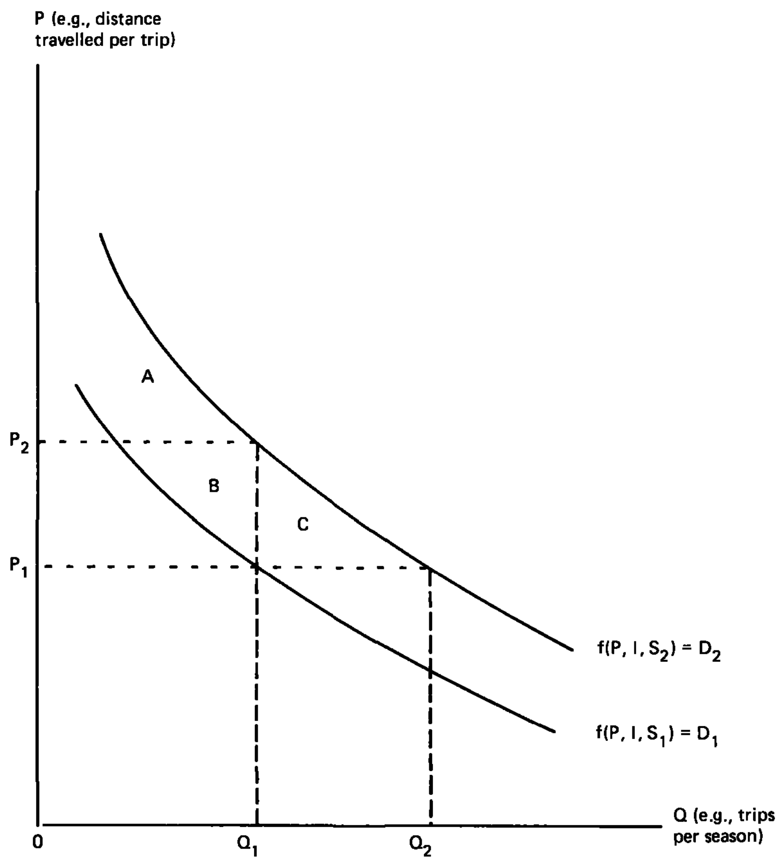

FIGURE 1.—Demand model relating travel frequency (Q) and cost (P).

Q and P is embodied in the slope of the curve. Relationships between Q and income (I) as well as other variables (S) can be shown as shifts in the demand curve. For simplicity and without loss of generality, let S represent single fishing success variable. For example, an increase in a relevant variable such as fishing success (S) from S_1 to S_2 is shown as a shift in the demand curve from D_1 to D_2 (i.e., from $f(P, I, S_1)$ to $f(P, I, S_2)$).

The value of an improvement in site quality, such as an increase in fishing success, can be measured in various ways. A common approach is to compare the areas under each demand curve and evaluate an increase in fishing success as a difference in the area over some quantity range (Freeman 1979). For example, let us assume that in a particular year or season an individual consumes Q_1 units at a price of P_1 when the level of fishing success is S_1 (i.e., reflected by demand curve D_1). Suppose the level of fishing success increases to S_2 (e.g., during the next year or season). Given the demand shift to D_2 and the old price of P_1, the individual would now consume Q_2. The economic valuation for the improvement in success or site quality totaled for the fishing season or year is approximately measured as the sum of areas A, B, and C. These areas represent an increase in consumer surplus for the fisherman experiencing an increase in fishing success and, thereby, increasing the fishing level from Q_1 to Q_2.

An alternative approach to valuation of fishing success is to measure the instantaneous (or marginal) change in welfare when fishing success changes (i.e., on a per-visit basis) rather than the accumulated gain over an entire season. This is the primary focus of our paper and can be accomplished in various ways. One approach is to convert the consumer surplus over an entire season into that of a single trip by dividing areas (A, B, C) by the number of trips per season. A more direct approach can be accomplished by first solving Equation (1) for P. For the moment, let us assume that Equation (1) is deterministic (i.e., nonstochastic) in nature and can be inverted mathematically. Thus we can solve for P as

$$P = g(Q, I, S). \qquad (2)$$

Equation (2) is often referred to as the inverse demand function. The marginal value of fishing success $\partial P/\partial S$ can be measured as $\partial g/\partial S$ from Equation (2) where ∂/∂ represents the partial derivative operator. In Figure 1, this may be viewed as the distance $(P_2 - P_1)$ when the number of fishing trips is Q_1. This second approach will be the primary focus of the empirical analysis. It is more direct, has the advantage of less extrapolation from typical values of P and Q, and avoids any potential difficulty with an unbounded measure for area A arising with certain functional forms.

DATA

Since fishing trips and success are not commodities bought and sold in the marketplace, data are not readily available on P, Q, and S. As a result, survey methods are usually used to generate data on the number (Q) and price (P) of fishing trips and fishing success (S). The two most common survey approaches for relating Q, P, and S for individual fishermen have been 1) to directly ask marine anglers for valuation estimates of hypothetical changes in fishing trip frequency and success, or 2) to impute implicit valuation or trade-offs based on the various cost and activity level responses of a cross section of marine anglers. The first approach is usually referred to as contingent valuation and has been employed in fisheries valuation. Recent studies using contingent valuation surveys which attempt to incorporate catch rate and site information include Cameron and Huppert (in press) and Cameron and James (1987). The second approach using the travel cost method focusing on individual marine anglers will be used in this study. The travel cost method, although not without pitfalls, has been widely accepted as a means for valuing recreational resources when distance for fishing trips is well defined. An early implementation of the travel cost method can be found in Clawson (1959). For a recent summary of the travel cost method and its complexities, see Kealy and Bishop (1986).

The individual travel cost approach to evaluation relates travel cost and visitation frequency to recreational sites for individuals. This relationship provides an indirect way of observing how individual visitation frequency might respond to changes in an entry or purchase price as in a traditional economic demand relationship. Thus, behavior of marine anglers with respect to travel cost, travel frequency, and site quality (e.g., fishing success) provides the basis for estimating a demand equation for marine recreational fishing. The parameters of Equation (1) and/or (2) can be estimated using cross-section data on individual anglers.

In this study we are able to measure travel cost, travel frequency, success, and income variation for individuals from the Socioeconomic Survey conducted as a part of the Marine Recreational Fishery Statistics Survey (MRFSS) by the National Marine

Fishery Service (U.S. Department of Commerce 1981). Since in this study we wish to investigate the value of success by fish species, we chose samples of fishermen who preferred one of the three species of fish (bluefish, summer flounder, or weakfish). These species are of considerable importance to managers developing plans for fisheries along the Atlantic coast and are fairly similar with respect to mode, sites, and season. Since the number of observations for a given fishing site is generally quite low, and reduced further by focusing on specific fish species, pooling individual observations over sites was necessary in order to have enough interviews for statistical validity. Our sample sizes of anglers for bluefish, summer flounder, and weakfish are 270, 161, and 57 respectively and comprise sites from the Florida east coast to New York State. These data are pooled within a covariance statistical framework (i.e., with intercept and slope dummy variables) thus allowing the testing for differences across target species.

Although the survey contains a large and useful set of economic information on marine recreational fishing, the data provided are by no means ideal for an application of the travel cost method. Certain enhancements to the travel cost method could not be performed due to lack of data.[3] In addition, adjustments to travel distance and income were needed given the nature of the survey instrument.[4]

[3]Two refinements that are noteworthy, but could not be incorporated into the analysis due to the lack of data, include time costs and multiple site substitutions. It has been argued that time spent travelling as well as time spent at the recreational site reflects opportunity costs and should be included as part of the price of the fishing trip (Wilman 1980). The survey provides no information on travel nor visitation time.

Multiple fishing sites can provide an opportunity to construct prices for recreational substitutes and, thus, include these variables in the statistical estimation of the demand curve. See Samples and Bishop (1985) and Vaughn and Russell (1982). Unfortunately, no information on the angler's point of origin (e.g., ZIP code or area code) was available on the tabulated survey available to us so as to construct accurate distance (and price) measures for substitute sites.

[4]Since travel distance is a proxy for travel costs associated with fishing, travel distance from a permanent home to the fishing site might overstate travel costs for those individuals who were part-year residents of the area, vacationers, or on business. For part-time residents and those on business, the distance from last night's accommodation rather than home was used as the appropriate measure of travel distance. For vacationers, who comprised around one-sixth of the sample, one-half of the distance from home was used as their fishing travel cost.

Adjustments for the income variable included 1) assigning midrange values since respondents were asked for their income category rather as an actual dollar amount and 2) dealing with missing data since the income question appeared on a follow-up telephone survey for which the response rate was approximately half that of the field survey. Missing observations were handled by the zero-order approach whereby means replace missing values (Maddala 1977). Since income is an exogenous control variable and not central to the valuation calculations, these procedures were felt to be acceptable.

The actual survey questions providing the data base can be found in Table 1.

A final point about the data base concerns the fishing success measure. Since trip frequency represents activity over the past year, ideally one would like a measure of fishing success to be reflective of the last year and thus reflect *ex ante* or expected fishing success. Unfortunately, the survey provides no longitudinal information on individual anglers. The measure of success is only for the day of the interview and may not have been typical and, therefore, inconsistent with the fisherman's past behavior.[5] We are forced to assume that *ex post* fishing success is a proxy variable for *ex ante* (expected) success. Travel frequency, distance, and fishing success thus reflect long-run equilibrium adjustment by the fishermen.[6] The empirical significance of fishing success reflects on both the importance of success to fishermen and the closeness of success realizations versus expectations.

EMPIRICAL MODEL

Trip demand for the ith fisherman is specified as a long-linear equation of either of the following forms:

$$\ln Q_i = b_0 + b_1 \ln P_i + b_2 \ln S_i + b_3 \ln I_i + bZ + e_i \quad (3)$$

$$\ln P_i = a_0 + a_1 \ln Q_i + a_2 \ln S_i + a_3 \ln I_i + aZ + v_i \quad (4)$$

where P, Q, S, I > 0; and

Q_i = the number of site-specific fishing trips (including the day of the survey) made in the last 12 months (Table 1, question 16),

P_i = round-trip cost in dollars to the site from either home or last night's accommodation (Table 1, question 18, as mod-

[5]An attempt was made to improve the success measure by focusing only on fishermen for whom the fishing success on the day of survey could be considered normal. This was done by utilizing a satisfaction level variable (Table 1, question 23) and eliminating those observations whose satisfaction was very high or very low. By eliminating those individuals with extreme satisfaction, it was felt that those individuals for whom the day's catch was not normal (or what was expected), would be eliminated from the sample. Unfortunately, the filter did not distinguish perfectly, and, in addition, reduced the sample to unacceptably low levels in part because satisfaction is measured on the follow-up telephone survey which had a lower response rate. The statistical results using this filter were less significant and, thus, the approach was abandoned.

[6]The implication of these potential errors in measurement is that the coefficient of success will be underestimated to a degree depending on the ratio of the variance of the error in measuring true success over the variance of observed success.

TABLE 1.—Survey questions used in the estimations.

From intercept survey

16. Including today's trip, about how many times would you say you have fished from [this (specify exact mode) in the last 12 months?/a (specify exact boat mode) leaving from this launching area in the last 12 months?]
18. To the nearest highway mile, about how far is it from your home to this fishing location?
29. May I look at the fish that you caught that you're taking with you? Enter species codes and number kept. Did you land any (specify common name) that you're not taking with you?
30. How many additional (specify common ,name) did you land?

From telephone survey

23. How satisfied were you with your fishing trip on (Month/Day)? Would you say you were

Very satisfied	(1)
Somewhat satisfied	(2)
Not too satisfied	(3)
Not at all satisfied	(4)

28. Finally, how much do you estimate that you personally earned in 1980 before taxes? Would that be

Less than $5,000	1
$5,000 to $10,000	2
$10,000 to $15,000	3
$15,000 to $25,000	4
$25,000 to $35,000	5
More than $35,000	6

(rescaled to 1987 dollars using the GNP price deflator).

ified in the above discussion,[7]

S_i = fishing success measured by the total number of fish kept (Table 1, question 29),

I_i = previous year's income of the respondent (Table 1, question 28), and

bZ, aZ = vector products of additive and multiplicative dummy variables and parameters allowing pooling across species to be tested using a covariance model (Kmenta 1986),

e_i, v_i = independent, identically distributed random errors.

The log linear specification is used since it provides a better fit over linear and semilog models in terms of t-statistics and the equation F-statistics. Recent studies estimating travel cost models have also found that log models provide better fits to the data. The choice of functional form has received much attention in the literature. Discussions of some of the issues including utility consistency, benefit sensitivity, and transformed parameter biases can be found in Bockstael et al. (1986), Stynes et al. (1986), and Ziemer et al. (1980).

Whether Equation (3) or Equation (4) is the appropriate model depends on the individual angler's choice process. If we assume that trip frequency (Q) is chosen after the site and thus travel cost (i.e., distance) is specified, Equation (3) is appropriate. If, on the other hand, anglers choose travel distance or cost (P) by choosing a recreational site after the frequency of visitation (i.e., the number of trips per year, Q) is determined, then Equation (4) is appropriate. Most likely both Q and P are endogenous to an individual angler so that ideally a multiequation model should be estimated that would include many competing sites as well as determinants of residential location choice. Unfortunately our data do not allow us to employ such a model.[8]

In our empirical analysis Equations (3) and (4) are estimated as single equation models and compared. Although Equation (3) is standard in the literature

[7]Dollar valuations are obtained by assuming a driving cost of $0.16 per mile. This figure reflects a rescaling to 1987 dollars of estimates appearing in "Cost of Owning and Operating Automobiles and Vans 1984," U.S. Department of Transportation, and includes only variable driving costs averaged over several vehicle types.

[8]Fishing success (S) also could be treated as an endogenous variable related to angler skill, experience, equipment, and the fish stock. An additional equation would be added to the model if one wished to "explain" S. The empirical approach would be affected depending on whether the model were simultaneous or recursive in nature. To the extent that fishing success (S) is related to travel frequency, Q (a proxy for experience), and travel cost, P, the model should be estimated as a simultaneous equation system. Unfortunately, additional variables required to adequately identify such a system are not available.

(e.g., see Kealy and Bishop 1986), our focus on marginal success valuations (i.e., $\partial P/\partial S$) makes Equation (4) more appropriate since no parameter transformations are necessary.[9]

Equations (3) and (4) were estimated first by ordinary least squares (OLS). Because the data are cross sectional on individual marine anglers, large variations in travel frequencies and cost exist which could lead to errors with unequal distributions. Various tests for heteroscedasticity were performed on the OLS residuals including Park, Glejser, and Bruesch-Pagan tests. The results were mixed with some tests indicating insignificant heteroscedasticity and some indicating significant (0.05 level, two-tailed) relationships between OLS residuals and travel cost (ln P) or travel frequency (ln Q) in Equations (3) and (4) respectively. Since the Glejser tests indicated the strongest relationship between the absolute OLS residual and the square root of ln P or ln Q in Equations (3) and (4) respectively, weighted least squares (WLS) was performed using $1/\sqrt{X}$ (i.e., where X is ln P or ln Q in Equations (3) and (4) respectively).

The results are found in Tables 2 and 3 for both OLS and WLS applied to the demand frequency (Q endogenous) and demand price (P endogenous models). The variables trip frequency (Q), trip cost (P), fishing success (S), and income (I) were defined

[9]Two statistical issues are relevant in the context of choice of dependent the variable: 1) The choice of dependent variable (e.g., ln Q or ln P) affects the regression slope unless the correlation (e.g., between ln Q and ln P) is perfect. Thus, estimating the ln Q relationship and solving for ln P generally yields a different estimate for $\partial \ln P/\partial \ln Q$ than estimating the ln P relationship directly. For a clear treatment of this point, see Wonnacott and Wonnacott (1979). 2) In addition, we note that parameter unbiasedness generally does not hold under nonlinear transformation although consistency does. Thus, partial effects on P using Equation (4) are potentially both unbiased and consistent whereas when using Equation (3) unbiasedness is lost for partial effects on P.

TABLE 2.—Log-linear demand frequency regressions (Equation 3). OLS = ordinary least squares; WLS = weighted least squares.

	Estimated coefficients (absolute t-values in parenthesis)					
	OLS			WLS		
Exogenous variable	(1)	(2)	(3)	(1)	(2)	(3)
Constant	1.930 (2.17)	1.970 (2.22)	1.792 (1.59)	2.383 (2.54)	2.421 (2.57)	2.833 (2.21)
Log travel cost (P)	−0.173 (4.85)	−0.171 (4.74)	−0.181 (4.08)	−0.096 (1.87)	−0.096 (1.87)	−0.149 (2.02)
Log fish kept (S)	0.050 (3.13)	0.048 (3.05)	0.074 (3.53)	0.034 (2.28)	0.034 (2.25)	0.055 (2.72)
Log income (I)	−0.000 (0.00)	−0.005 (0.06)	0.020 (0.17)	−0.072 (0.78)	−0.075 (0.82)	−0.100 (0.78)
Flounder (F)		−0.062 (0.44)	−0.124 (0.06)		−0.069 (0.51)	−1.799 (0.91)
Weakfish (W)		0.290 (1.29)	1.966 (0.49)		0.182 (0.85)	0.622 (0.16)
Interactions						
F and P (FP)			0.089 (1.00)			0.182 (1.66)
F and S (FS)			−0.079 (2.22)			−0.071 (2.15)
F and I (FI)			−0.031 (0.16)			0.112 (0.58)
W and P (WP)			−0.100 (0.85)			−0.113 (0.62)
W and S (WS)			−0.020 (0.36)			0.010 (0.20)
W and I (WI)			−0.154 (0.39)			−0.012 (0.03)
R^2	0.057	0.061	0.074	0.016	0.019	0.035
F (model)	9.71	6.28	3.45	2.66	1.86	1.56
F (species)[1]		1.03	1.08		0.74	1.31
n	488	488	488	488	488	488

[1]Computed from the formula $(\Delta R^2)(n\text{-k-1})/(1 - R^2)(r)$ where r, R^2, and (n-k-1) represent the number of restrictions, coefficient of determination, and degrees of freedom of the unrestricted model in hierarchial order (1), (2), and (3) respectively. See Wonnacott and Wonnacott 1979.

previously. The variables in the Z vector are defined in Tables 2 and 3. These variables reflect the additive and interactive (multiplicative) dummy variables which allow us to test for parameter differences across target species. Since the control group in all regressions is bluefish (i.e., anglers indicating bluefish as the species preference), qualitative (0,1) variables for flounder (F) and weakfish (W), along with their interactions with other exogenous variables are included in each regression. F tests (noted as F (species) in Table 2 and 3) were performed on the interaction and additive dummy variable terms. For the demand frequency regressions (Table 2), since the F (species) statistics for both the additive and multiplicative terms are insignificant, the data can be combined across target species. Thus, model (1) for both OLS and WLS are most appropriate when using Table 2). In the demand price regressions (Table 3), the species terms have significant F-statistics (to at least the 0.05 level) indicating that intercept and slope coefficients are different across species. Thus, models OLS (3) and WLS (3) are most appropriate from Table 3.

The empirical findings for the demand price model (Table 3) are stronger than for the demand frequency model (Table 2) although both have significant equation F-statistics (probability values < 0.05). WLS increases the significance of the results in Table 3 but lowers significance levels in Table 2. The parameter estimates for the travel cost and frequency coefficients (b_1 and $a_1 < 0$) as well as the success coefficients (b_2 and $a_2 > 0$) generally confirm theoretical expectations. Travel cost and frequency are significantly inversely related, and fishing success as measured by the number of fish kept is generally a significant determinant of both fishing frequency and travel distance. Various measures and combinations of fishing success were investigated,

TABLE 3.—Log-linear demand price regressions (Equation 4). OLS = ordinary least squares; WLS = weighted least squares.

	Estimated coefficients (absolute t-values in parenthesis)					
	OLS			WLS		
Exogenous variable	(1)	(2)	(3)	(1)	(2)	(3)
Constant	−0.310 (0.28)	−0.442 (0.40)	−1.892 (1.36)	0.372 (0.33)	0.225 (0.20)	−1.314 (0.96)
Log trip frequency (Q)	−0.268 (4.85)	−0.261 (4.74)	0.289 (4.20)	−0.413 (5.59)	−0.393 (5.38)	−0.433 (4.54)
Log fish kept (S)	0.087 (4.45)	0.089 (4.59)	0.113 (4.45)	0.088 (4.32)	0.095 (4.72)	0.135 (5.23)
Log income (I)	0.260 (2.37)	0.253 (2.32)	0.408 (2.97)	0.228 (2.04)	0.215 (1.95)	0.388 (2.87)
Flounder (F)		0.501 (2.86)	3.891 (1.64)		0.718 (3.84)	4.051 (1.66)
Weakfish (W)		0.234 (0.84)	6.634 (1.33)		0.104 (0.38)	11.79 (2.28)
Interactions						
F and P (FP)			0.182 (1.47)			0.243 (1.55)
F and S (FS)			−0.027 (0.63)			−0.056 (1.25)
F and I (FI)			−0.371 (1.58)			−0.404 (1.68)
W and P (WP)			−0.316 (1.51)			−0.632 (2.33)
W and S (WS)			−0.108 (1.57)			−0.144 (2.10)
W and I (WI)			−0.600 (1.23)			−1.02 (2.07)
R^2	0.087	0.103	0.126	0.097	0.125	0.164
F (model)	15.42	11.02	6.24	17.41	13.74	8.49
F (species)[1]		4.30	2.13		7.71	3.70
n	488	488	488	488	488	488

[1]Computed from the formula (ΔR^2) (n-k-1)/(1 − R^2) (r) where r, R^2, and (n-k-1) represent the number of restrictions, coefficient of determination, and degrees of freedom of the unrestricted model in hierarchial order (1), (2), and (3).

including the number of fish caught as well as kept. These numbers were available in total as well as by species. Since the total number of fish kept consistently provided the best statistical fit, we report these results only.[10]

Our findings on income are mixed and appear to depend on the equation specification. While an important theoretical variable in most demand functions, we find that income is a significant positive determinant of travel cost but not travel frequency. Thus anglers with higher incomes travel greater distances but do not fish with greater frequency. This result is perhaps not surprising given the higher time opportunity cost for anglers with higher income. Our results for the lack of significant income effects on demand frequency are similar to findings in other studies (e.g., Vaughan and Russell 1982).

The coefficients for travel cost (P), frequency (Q), and success (S) in Tables 2 and 3 provide the basis for valuing fishing success. The valuation algorithm is outlined below using the instantaneous (marginal) approach discussed in the paper. Of particular interest is the measurement of the marginal value of fishing success ($\partial P/\partial S$) shown as ($P_2 - P_1$) in Figure 1).[11] We illustrate these calculations for summer flounder using the WLS model (3) results from Table 3. Since the regression slope coefficients reflect log derivatives (sometimes referred to as elasticities or price flexibilities), we begin by noting that

$$\frac{\partial \ln P}{\partial \ln S} = \frac{\partial P}{\partial S} \cdot \frac{S}{P}. \tag{5}$$

Solving this equation for $\partial P/\partial S$ provides a basis for valuing fishing success (S) using a log-linear model.

$$\frac{\partial P}{\partial S} = \frac{\partial \ln P}{\partial \ln S} \cdot \frac{P}{S}. \tag{6}$$

For summer flounder $\partial \ln P/\partial \ln S = (0.135 - 0.056) = 0.079$ which reflects the combination of the fish kept (S) term and the flounder and fish kept (FS) interaction term. Evaluating P and S at their sample means of \$50.61 and 1.94 respectively we obtain

$$\frac{\partial P}{\partial S} = 0.079\ (\$50.61/1.94) = \$2.06.$$

This number reflects the extra travel cost that a typical or representative fisherman is willing to incur in order to keep an additional fish per trip. In reality, since fishermen incur varying travel costs and experience a variety of success levels, the value of success is not unique.

Given that S in the calculation above was set at its mean for the entire sample, we refer to $\partial P/\partial S$ in this case as the marginal value of success for the typical fisherman (i.e., mean value). Alternatively, S can be set at different levels to obtain valuations other than at the mean since in a logarithmic model elasticities are constant but derivatives are not. For example, setting $S = 1$ we obtain a marginal value for the first fish kept of \$4.00, which is predictably higher than the marginal value of success evaluated at the mean (\$2.06). Since many fishermen catch one fish or even no fish, setting $S = 1$, although less reliable, does not reflect a large extrapolation. The logarithmic model allows us to observe the behavior of the value gradient for success across species and models.

In Table 4, marginal success valuations for all three species using various models (demand frequency and price) and statistical methods (OLS and WLS) are presented. The demand frequency results are based on the regression estimates from Table 2, models OLS (1) and WLS (1) since species pooling is appropriate. For the demand frequency results, different valuations are solely a reflection of alternative mean values of P and S across anglers preferring the various species. The combined valuation results reflect the weighted means of P and S across all anglers. The demand price results are based on the regression estimates from Table 3, models OLS (3) and WLS (3) because species pooling was not appropriate. Different valuations thus reflect both differences in regression coefficients as well as mean values of P and S. For comparison purposes with the demand frequency model, combined valuations in the case of the demand price model are based on the regression results of OLS (1) and WLS (1) in Table 3.

Although the absolute dollar values in Table 4 are subject to qualification, they do provide managers with numbers which can be compared across species as well as with market-determined commercial values. With the exception of the demand price models for weakfish where the combination of the

[10]The design of the survey may in part be responsible for the better fit with fish kept versus fish caught. Fishermen were asked to recall the number of fish landed, whereas the number kept were actually inspected by the interviewer (see Table 1, questions 29 and 30).

[11]We also note that by utilizing the marginal trip valuation algorithm outlined earlier rather than a consumer surplus integration calculation intercept estimates can be ignored. Thus, since only slopes are relevant there is not need to transform parameters by the factor $\exp(\sigma^2/2)$ in order to obtain unbiased mean rather median estimates (where σ^2 is the error variance; see Stynes et al. 1986).

TABLE 4.—Implicit marginal valuations of fishing success for Atlantic recreational anglers (1987 $). OLS = ordinary least squares; WLS = weighted least squares.

Model	Bluefish		Flounder		Weakfish		Combined	
	First	Mean	First	Mean	First	Mean	First	Mean
Demand frequency								
OLS	$4.66	$1.11	$14.63	$7.54	$4.89	$1.46	$7.98	$2.38
WLS	5.71	1.36	17.73	9.24	5.99	1.79	9.77	2.92
Demand price								
OLS	1.82	0.43	4.35	2.24	0.10	0.03	2.40	0.72
WLS	2.18	0.52	4.00	2.06	([1])	([1])	2.43	0.73
Means								
Travel cost	$16.14		$50.61		$16.93		$27.61	
Number of fish kept	4.20		1.94		3.35		3.35	

[1]Not computed since the net coefficient of log of fish kept for weakfish from Table 3 (WLS model (3)) was negative.

S slope coefficients and the WS interaction coefficients from Table 3 (OLS (3) and WLS (3)) resulted in either very small positive or negative values, the valuations in Table 4 provide us with interesting comparisons. Disaggregating the analysis by species appears to make a substantial difference. Recreational fishermen placed the highest valuation on summer flounder when compared with bluefish and weakfish. This holds regardless of whether one focuses on the first fish or the average number of fish kept. Generally, the value of fish kept at the mean level of success is between 1/2 and 1/4 that of the first fish. In our log-linear model, this diminishing valuation gradient is simply of function of the average number of fish kept. Thus, for summer flounder anglers where the average number of fish kept is 1.94, the value of the average fish is 1/1.94 that of the first fish. For bluefish and weakfish anglers, the value of the average fish is 1/4.2 and 1/3.35 that of the first fish respectively.

The demand specification appears to matter at least as much as species preferred when valuing success. The demand price model consistently generates significantly lower valuations than the demand frequency approach. As discussed earlier, the demand price model may be more appropriate since travel cost (P) is treated as endogenous, and thus the equation need not be inverted to find effects on price (i.e., $\partial P/\partial S$). For comparison with studies of freshwater fishing using a demand frequency approach, we note that Samples and Bishop (1985) found a value of $6.75 for an additional lake trout or salmon landed, while Vaughan and Russell (1985) found marginal values of $0.45 and $0.31 for trout and catfish anglers respectively. Our results for valuing fishing success offer some comparability with their findings and support the hypothesis that marginal valuations can vary greatly by species and by study. What is especially noteworthy is that success valuations can also vary dramatically by model specification within a species and study (i.e., for the same data set). In our study the method of estimation (i.e., OLS vs. WLS) has little effect on the parameter estimates of their significance levels. In general to the extent that the weighting procedure is appropriate, WLS provides a more accurate picture of reliability.

CONCLUSIONS

In this paper we have presented a theoretical and empirical economic framework for valuing fishing success of marine recreational anglers. The empirical analysis reveals that the number of fish kept by Atlantic marine anglers is generally associated with positive and significant dollar valuations. Sports fishermen implicitly reveal substantial variation in willingness to pay for catching and keeping Atlantic bluefish, summer flounder, and weakfish. These valuations also vary considerably by empirical model and the average level of success. Management policies aimed at promoting catch success have a stronger empirical basis for measuring the benefits of increased catch and comparing these benefits to losses in other areas. Managers should be cautioned, however, that values can be sensitive to many factors and that more theoretical and empirical research in this area is needed.

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