J. ENVIRONMENTAL SYSTEMS, Vol. 21(4) 357-364, 1991-92

BENEFITS OF QUALITY CHANGES IN RECREATIONAL FISHING: A SINGLE-SITE TRAVEL COST APPROACH*

JOHN C. WHITEHEAD
East Carolina University, Greenville

ABSTRACT

This study extends the travel cost literature on valuing quality improvements by measuring the benefits of improved quality in a single-site recreation demand model. Measures of exogenous recreation quality are used instead of the more typically used endogenous measures. Recreation demand for freshwater fishing on the Tar-Pamlico River in North Carolina is specified to depend on access price, income, and expected recreation quality. Variation in expected recreation quality is found from predictions of a catch rate regression model. The number of fishing trips decreases with increases in travel and time costs and increases with increases in recreation quality. Changes in consumer surplus from quality changes are estimated using the individual variation in quality and estimates of recreation benefits.

INTRODUCTION

Knowledge of the economic value of natural resource-based outdoor recreation is essential when decisions about allocation of natural resources must be made. Development of nonmarket valuation methods, such as the travel cost method (TCM), has permitted the nonmarket benefits of recreation activities and sites to be estimated [1]. Extensions of the TCM to include measures of recreation quality (catch rate, water quality, harvest, etc.) in multi-site models has produced a

* This project received support from the Research/Creative Activity Committee funds administered by the East Carolina University Faculty Senate.

doi: 10.2190/71KJ-DMFM-DB65-QH1B
http://baywood.com

general understanding of the effects of recreation quality changes on recreation benefits.

Two primary TCM approaches are available to measure quality changes with multi-site data. The regional travel cost approach pools individual site demands into a single model and uses the quality variation across sites to measure the effects of quality changes on demand [2-4]. The hedonic travel cost approach first measures the implicit price of site quality and, then, measures the demand for quality directly to infer the value of quality [5-7]. Both approaches require extensive multi-site data sets.

Often the policy question of interest concerns the effects of improved quality at a single recreation site. For instance, a polluted river faces a proposed clean up program. What is the value of the proposed clean up? Finding an answer to this question using either the regional or hedonic travel cost models may be prohibitively costly in terms of time and money. A relatively inexpensive, single-site approach would be an attractive alternative. Several studies have employed a single-site model but measure quality using endogenous measures of quality, such as the individual angler's catch rate [8]. In this article, measures of exogenous recreation quality are employed.

This study will extend the recreation demand literature by measuring the recreation benefits of improved quality in a single-site recreation demand model. A recreation demand model for freshwater fishing is specified with fishing trips depending on access price, income, and expectations of the individual recreation quality at a single-site. Expectations of individually-faced recreation quality are measured by the conditional mean of the quality distribution found from a regression equation. This technique is an improvement over past research which uses the endogenous, unconditional mean of quality to explain recreation demand. Changes in consumer surplus from quality changes are the recreation benefits of quality changes.

A MODEL OF RECREATION DEMAND AND BENEFITS

The consumers' goal is to maximize utility u(x,q,z), subject to the income constraint, y = px + z, where u(•) is the utility function, x is recreational fishing trips, q is the quality of the natural resource site, z is a composite commodity, y is income, and p is the access price of a recreational fishing trip. Recreational fishing is a nonmarket good, that is, it is not traded in well-established markets. The access price is an implicit price constructed from travel and time costs. The solution to the consumer maximization problem is the Marshallian demand function, x(p,y,q), which is decreasing in p, and increasing in y (for normal goods), and q.

Incorporating recreational quality in the demand function is problematic in that quality is, to some extent, an endogenous variable. For instance, fishing quality depends on angler choices concerning fishing effort such as the number of hours to fish, type of equipment to use, boat or bank fishing, etc. Many of these choices depend on the angler's production technology. Weather conditions, fish populations, and water quality may also influence recreational quality. Given that the determinants of realized recreational quality are exogenous, expected recreational quality is an exogenous variable, $\hat{q}$.

A popular functional form for the recreation demand equation $x(p,y,\hat{q})$ is the semi-log form

$$lnx = \beta_o - \beta_1 p + \beta_2 y + \beta_3 \hat{q} + \varepsilon \, , \tag{1}$$

where β_0, β_1, β_2, β_3, are parameters to be estimated. (Subscripts on variables to indicate individuals in the sample are suppressed for simplicity. Specification of the travel cost model should also include substitute site prices. Failure to incorporate substitute prices will upwardly bias benefit estimates. Substitute sites were included in regression models but without reliable signs on coefficients and significance levels were lower than acceptable levels. Some substitute prices were too correlated with the own-price variable to be included in the models. Therefore, in order to simplify model specification and estimation, substitute prices are not included.)

Estimated benefits of recreational fishing are measured by the area underneath the estimated Marshallian demand curve and above the access price faced by each individual

$$CS = \int_{p}^{\infty} exp(\hat{\beta}_o - \hat{\beta}_1 p + \hat{\beta}_2 y + \hat{\beta}_3 q) \, dp \, , \tag{2}$$

where CS is the consumer's surplus. (The Marshallian consumer surplus should be considered an approximation of the more appropriate Hicksian surplus measures.) The demand function is integrated up to infinity since the semi-log functional form does not lead to a finite reservation price for trips. The solution to equation (2) is

$$CS = \frac{1}{\hat{\beta}_o} \exp(\hat{\beta}_1 p - \hat{\beta}_1 p + \hat{\beta}_2 y + \hat{\beta}_3 \hat{q}) \, , \tag{3}$$

or

$$CS = \frac{1}{\hat{\beta}_o} \hat{x}(p,y,\hat{q}), \tag{4}$$

which is the consumer's surplus for the year. Consumer's surplus per trip is the inverse of the coefficient on the access price.

The recreation benefit of a resource quality improvement is the change in consumer's surplus $\Delta CS = CS(q') - CS(q^o)$, where $q' > q^o$. Considering this formula and equation (4), the recreation benefits of a quality change are

$$\Delta CS = \frac{1}{\hat{\beta}_o}\hat{x}'(p,y,\hat{q}) - \frac{1}{\hat{\beta}_o}\hat{x}^o(p,y,\hat{q}^o) \tag{5}$$

or

$$\Delta CS = \frac{1}{\hat{\beta}_o}\left\{x'(p,y,\hat{q}') - \hat{x}^o(p,y,\hat{q}^o)\right\}, \tag{6}$$

where x' > x^o. Conceptually, the recreation benefit is equal to the additional number of trips taken, as a result of the quality change, multiplied by the consumer's surplus per trip.

STUDY SITE AND DATA

The Tar-Pamlico River, the fourth largest in North Carolina, is the study site. The Tar River flows from the eastern piedmont region of the state into the Pamlico River which widens and flows into the Pamlico Sound on the Atlantic coast. As a result of point and nonpoint source pollution, the Tar-Pamlico River has experienced declining fish catches, diseases in fish, algae blooms, shellfish bed losses, and underwater grass loss. Several government programs exist which are aimed at improving water quality in the Tar-Pamlico River. However, the benefits of improved water quality in the Tar-Pamlico River are currently unknown.

Recreation demand data was collected from recreational anglers on the Tar-Pamlico River. A five week intercept survey was conducted at two boat launch sites, one each on the Tar and Pamlico Rivers, during the Fall of 1990. Only boat anglers who have experience fishing the Tar-Pamlico River were considered. Forty-seven observations are available for the analysis. Since sampling intensity was greater on weekends, the data is weighted by weekly participation estimates so that weekday data is more accurate.

Intercept surveys often over sample those who are more likely to participate in the activity. This study appears to be no exception since the average number of fishing trips per year seems high for this river. The results that follow must be interpreted with care and in the context that the data contains anglers with intense preferences for fishing the Tar-Pamlico River.

Data was gathered on current weather conditions, socioeconomic variables, and aspects of the fishing trips (see Table 1). Sky conditions, precipitation, and wind conditions were reported by the interviewer at the time of the interview (operationalization of weather variables appears in parentheses): sky conditions ranged from clear (1) to scattered clouds, up to 50 percent cloud cover (2), to broken sky, 50 to 99 percent cloud cover (3); precipitation did not vary, always with no rain in the preceding twelve hours; wind conditions ranged from calm (1) to light (2), gentle (3), and strong (4) breeze.

Two socioeconomic variables are used in this analysis. Fishing experience is equal to respondent age minus the age when the respondent fish fished.

Table 1. Data Summary

	Weighted Mean	Standard Deviation
Sky	2.33	0.48
Wind	2.00	0.67
Experience	30.71	12.22
Income	$34.87[a]	13.38
Trips	33.74	34.42
Price	$5.62	8.29
Quality	1.37	1.83

[a] In thousands of 1990 dollars.

Respondents also reported their annual income before taxes on a four-point scale. Scalar income was converted to dollars using the mid-point of the interval categories. Benefit estimates may be sensitive to coding of the income variable; however, since the purpose of the case study is illustrative, this issue is not explored.

Respondents were asked about the number of trips they had made to the Tar-Pamlico River within the past year for the purpose of sportfishing. The weighted average number of trips is thirty-four trips per year with a range of ninety-eight trips. The access price variable is constructed using round trip distance reported by the respondent, travel costs equal to $.12 per mile, and one-third the wage rate (income divided by 2000 annual work hours) to estimate time costs. The choice of travel cost per mile and opportunity cost of time is made after reviewing the travel cost literature. What appear to be standard estimates are used. Recreation benefits will be sensitive to the choice of travel cost per mile and the opportunity cost of time.

Recreation quality should be measured by anglers' subjective judgments of the quality of the recreation experience. While several variables may contribute to recreation quality, angler catch rates may best measure this variable. Therefore, the quality variable is set equal to angler catch rate. The catch rate is equal to the number of fish caught during the most recent fishing trip divided by fishing effort (number of hours spent fishing). Since most anglers considered their most recent trip a typical trip, measurement error from generalization of the most recent trip to all trips is not considered a particularly serious problem.

EMPIRICAL RESULTS

In order to obtain a measure of exogenous recreation quality, each angler's conditional mean of his expected catch rate distribution was determined from

Table 2. Weighted Least Squares Estimates of Recreation Quality
Parameter Estimate (t-Statistic)

	Intercept	Sky	Wind	Experience	$\bar{R}^2$	F
Quality	−2.76**	1.51*	−1.06*	0.09*	.55	19.67*
	(−2.24)	(3.66)	(−3.57)	(5.59)		

* Significant at the .01 level.
** Significant at the .05 level.

Table 3. Maximum Likelihood Estimates of Recreation Behavior
Parameter Estimate (t-Statistic)

	Intercept	Price	Income	Expected Quality	Log-Likelihood
Log Trips	2.48*	−0.07*	0.01	0.34*	−63.76*
	(5.94)	(−2.72)	(1.00)	(2.85)	

* Significant at the .01 level.

exogenous variables. Recreational fishing quality is measured by catch rates per boat hours fished which holds fishing effort constant. Expected recreation quality is measured from the predicted value of the weighted least squares regression of quality on fishing experience and weather variables (see Table 2). Recreation quality increases with the amount of cloud cover and individual fishing experience and decreases with wind speed. The overall performance of this model is satisfactory with a significant F statistic. The independent variables explain 55 percent of the variation in recreation quality.

Recreation demand data that is gathered on-site results in samples that are truncated at one since nonusers do not have the opportunity to be interviewed. Smith and Desvousges [3] show that ordinary least squares regression on truncated samples underestimates recreation benefits (the effects of truncation bias are assessed in [9]). A truncated maximum-likelihood estimator which corrects for the bias in the OLS estimates is used (see Table 3), using the Limdep econometrics package [10]. Recreation demand is specified to depend on access price, income, and quality. The number of trips taken is a decreasing function of price and an increasing function of expected recreation quality, where expected recreation quality is the individual predicted value from the recreation quality equation in Table 2. The parameter estimate on income is positive but insignificantly different from zero.

Bockstael and Strand argue that when measurement error is suspected in recreation demand data, the appropriate consumer surplus estimate is found using trips

Table 4. Annual Benefits of Recreation Quality Improvements

Δ in Quality	Δ in Consumer's Surplus[a]
10%	$14
25%	$34
50%	$73

[a] 1991 dollars.

estimated from a behavioral model and not self-reported trips [11]. In this application, the reported number of trips may be subject to measurement error so that consumer's surplus estimates from equation (4) incorporate the predicted number of trips from the maximum-likelihood estimates in Table 3. Consumer's surplus per season is found by inserting values of independent variables into equation (4) to obtain predicted trips. From this procedure, estimated consumer's surplus per trip is $14 and per year is $269. This approximates the national consumer's surplus per warmwater fishing day ($12.53) estimated by Bergstrom and Cordell [12]. The estimates are comparable since all Tar-Pamlico fishing trips were day trips.

Increases in consumer's surplus per year are found using equation (6) for increased recreation quality of 10 percent, 25 percent, and 50 percent (see Table 4). Consumer's surplus per year increases by $14 with a 10 percent increase in recreation quality, $34 with a 25 percent increase in recreation quality, and $73 with a 50 percent increase in recreation quality.

CONCLUSION

This study extends the travel cost literature on valuing quality improvements by measuring the benefits of improved quality in a single-site recreation demand model. Measures of exogenous recreation quality are used instead of the more typical endogenous measures. A recreation demand model for freshwater fishing is developed. The number of fishing trips decreases with increases in travel and time costs and increases with increases in recreation quality. Variation in recreation quality at the single-site is found from predictions of a catch rate regression model. Changes in consumer surplus from quality changes are measured using the individual variation in quality and estimates of recreation benefits. If water quality managers can determine the link between water quality and catch rates, this type of procedure can be used to determine how much water quality improvement should be pursued.

These results have significant implications since water quality policy often concerns effects of improved quality at a single recreation site. While it is still preferable to estimate quality benefits with quality variation across sites, often this is infeasible due to extensive data and computing requirements. The approach presented here is relatively inexpensive, more forgiving methodologically, and less demanding in its data requirements.

ACKNOWLEDGMENT

The author would like to acknowledge the assistance of Greg Drury in survey design and implementation.

REFERENCES

1. B. A. Forster, Valuing Outdoor Recreational Activity: A Methodological Survey, *Journal of Leisure Research, 21*, pp. 181-201, 1989.
2. W. J. Vaughan and C. S. Russell, Valuing a Fishing Day: An Application of a Systematic Varying Parameter Model, *Land Economics, 58*, pp. 450-463, 1982.
3. V. K. Smith and W. H. Desvousges, The Generalized Travel Cost Model and Water Quality Benefits: A Reconsideration, *Southern Economic Journal, 52*, pp. 371-381, 1985.
4. E. Balkan and J. R. Kahn, The Value of Changes in Deer Hunting Quality: A Travel Cost Approach, *Applied Economics, 20*, pp. 533-539, 1988.
5. G. Brown, Jr. and R. Mendelsohn, The Hedonic Travel Cost Model, *Review of Economics and Statistics, 66*, pp. 427-433, 1984.
6. V. K. Smith and Y. Kaoru, The Hedonic Travel Cost Model: A View from the Trenches, *Land Economics, 63*, pp. 179-192, 1987.
7. V. K. Smith, R. B. Palmquist, and P. Jakus, Combining Farrell Frontier and Hedonic Travel Cost Models for Valuing Estuarine Quality, *Review of Economics and Statistics, 74*, pp. 694-699, 1991.
8. D. D. Huppert, Measuring the Value of Fish to Anglers: Application to Central California Anadromous Species, *Marine Resource Economics, 6*, pp. 89-108, 1989.
9. G. S. Maddala, *Limited-Dependent and Qualitative Variables in Econometrics*, Cambridge University Press, London, 1983.
10. W. H. Greene, *Limdep: User's Manual*, 1986.
11. N. E. Bockstael and I. E. Strand, Jr., The Effect of Common Sources of Regression Error on Benefit Estimates, *Land Economics, 63*, pp. 11-20, 1987.
12. J. C. Bergstrom and H. K. Cordell, An Analysis of the Demand for and Value of Outdoor Recreation in the United States, *Journal of Leisure Research, 23*, pp. 67-86, 1991.

Direct reprint requests to:

John C. Whitehead
Assistant Professor
Department of Economics
East Carolina University
Greenville, NC 27858