Validation of Empirical Measures of Welfare Change: A Comparison of Nonmarket Techniques

Christine Seller, John R. Stoll, and Jean-Paul Chavas

Since the passing of the Flood Control Act of 1936, the attention of many resource economists has been directed towards measuring the benefits and costs of alternative uses of natural resources. Increasingly, it has been recognized that the value of some of these uses is not explicitly determined through market transactions. This has led to the focus of much attention upon the development of nonmarket methods to estimate the value of these uses. In the 1940s the groundwork for the travel cost method was established by Hotelling (Prewitt 1949). Following this, in the 1960s Davis initiated the basic foundation for bidding methods (Davis 1963), which were later to be subsumed under the heading of contingent valuation methods (Brookshire, Randall, and Stoll 1980; Schulze, d'Arge, and Brookshire 1981; Thayer 1981). Both of these methods will be further discussed below. In addition to these two methods, a third approach, the unit day value method, has been recognized as acceptable but not preferred for the valuation of recreational uses of water and related land resources (Dwyer, Kelley, and Bowes 1977; U.S. Water Resources Council 1979).

Given the existence of alternative methods of estimating the value of resource uses, several obvious questions arise. One of the first of these is, under what circumstances is each method most appropriate? Existing literature has focussed sufficiently on this question and pointed out limitations of each, especially the travel cost method and unit day value methods (Brookshire, Ives, and Schulze 1976; Dwyer, Kelly, and Bowes 1977; Freeman 1979; McConnell 1975; Randall, Ives, and Eastman 1977; Schulze, d'Arge, and Brookshire, 1981; Smith 1981; Smith and Kopp 1980). The second question, which has been called to the attention of researchers in recent years (Freeman 1979; Bishop and Heberlein 1979), is the need to address the comparative validity of estimates derived from the alternative valuation methods under similar conditions or problem settings. Little attention has been devoted to the examination of this latter question (Bishop and Heberlein 1980; Brookshire et al. 1982; Thayer 1981).

The remainder of this paper will be divided into four sections. In the first, a preliminary discussion of alternative theoretical measures of welfare change is presented. The second section will be devoted to a brief discussion of the travel cost and contingent valuation methods of nonmarket valuation. Following this characterization of the valuation methods, focus will be directed to the description of three previous comparative studies. The results of these studies will be summarized and their divergences from the tack taken in the present study will be pointed out. A detailed description of the present study will be presented in the fourth section. In this study the travel cost method and two variants of the contingent valuation method are used to estimate the value of recreational boating in East Texas. This fourth section will draw upon the first one in order to clarify which measures of welfare change are estimated by each method. The concluding section is used to discuss the

The authors are, respectively, former post-doctoral researcher and assistant professor in the Department of Agricultural Economics at Texas A&M University, and associate professor in the Department of Agricultural Economics, University of Wisconsin, Madison. Helpful comments were provided by David Brookshire, Myrick Freeman, Rod Ziemer, and participants in Western Regional Project W-133 are gratefully acknowledged. This article is TA-18040 of the Texas Agricultural Experiment Station.

Land Economics, Vol. 61, No. 2, May 1985
0023-7639/85/002-0156 $1.50/0

implications of the present study, its relationship to previous comparative studies, and problems in need of consideration for future nonmarket valuation work.

MEASUREMENT OF WELFARE CHANGE

Nonmarket valuation techniques are used for the purpose of estimating the changes in individual welfare which would result from the alternative use of resources for which competitive markets do not exist. Welfare change measurement has been a topic of considerable debate throughout the history of economics. Consumer's surplus was first defined as the residual difference between the value of a consumption bundle to the consumer and the amount which that consumer actually paid for it (Marshall 1930). In the 1940s, Hicks proposed four measures of a consumer's welfare change: compensating variation, compensating surplus, equivalent variation, and equivalent surplus (Hicks 1943). Following the conventions used by previous authors (Brookshire, Randall, and Stoll 1980; Currie, Murphy, and Schmitz 1971):

> The "equivalent" measures are defined as the amount of compensation, paid or received, which would bring the consumer to the "subsequent" welfare level "if the change did not take place."
>
> and
>
> The "compensating" measures are defined as the amount of compensation paid or received, which would keep the consumer at the "initial" welfare level "after the change had taken place."

The equivalent measures use the subsequent welfare level as a reference level and treat the consumer as if he or she must be willing to pay (WTP) to avoid a less preferred situation or willing to accept (WTA) to forego a more preferred situation. Alternatively, the compensating measures use the initial welfare level as a reference level and treat the consumer as if he or she must be willing to accept (WTA) a less preferred situation or willing to pay (WTP) to obtain a more preferred situation. WTP and WTA may be either Hicksian equivalent or compensating measures of welfare change depending upon the circumstances facing the consumer.

TRAVEL COST AND CONTINGENT VALUATION METHODS

The travel cost method of valuation has been extensively used in the valuation of recreational sites. With this method, demand curves are estimated for the recreation site using travel costs as a surrogate for the price of the site (Clawson and Knetsch 1966; Knetsch 1963). Most studies have used the travel cost method to examine a single recreation site. However, if substitute sites exist and are not taken into consideration in the estimation of the demand curve, missing variable bias will exist. If there is a systematic positive correlation between the availability of substitutes and the distance from the site when substitutes are not considered, the slope of the demand curve may be expected to be underestimated (Dwyer, Kelly, and Bowes 1977). Thus, the value of benefits for the site under analysis will be overestimated. The degree of overestimation will depend on the elasticity of substitution between alternative sites. The further a recreationist travels to a site, the greater the likelihood that substitute sites exist.

There have been different approaches to dealing with this concern. Some studies have specified a variable in the demand equation to reflect the existence of substitute sites (Knetsch 1963). More recent developments in the travel cost methodology have led to regional studies which estimate benefits for a group of sites, rather than benefits for one site in isolation. In some studies a single equation model has been used to estimate benefits of a system of sites within a region (Cesario and Knetsch 1976). An alternative to this single equation approach is the joint estimation of a system of demand equations (Burt and Brewer 1971; Cicchetti, Fisher, and Smith 1976). This latter method was selected for use in this study. It was preferred over the single equation model for two reasons. First, the single equation model uses an attractiveness index in its specification, implying some subjectivity on the part of the researchers in its formulation. It was decided to avoid this problem in the present study. Secondly, joint estimation of the demand equations facilitates the imposing and testing of restrictions from economic theory.

As with any valuation technique the travel cost method does have weaknesses which determine under which conditions it is most appropriately used. The model works best when visitors travel from a wide range of distances to the site (Dwyer, Kelly, and Bowes, 1977). Additionally, if the recreationist makes a multipurpose trip, there is a problem determining the proper allocation of costs between each activity. The model works best when the recreationist visits only one site during his trip. There is also a problem when the visitor enjoys a scenic drive to the site; what proportion of travel costs are attributable to visiting the site itself?

Contingent valuation is defined as any approach to valuation of a commodity which relies upon individual responses to contingent circumstances posited in an artificially structured market. Bidding approaches are by far the most widely recognized form of contingent valuation. Studies which used personal interview administration of bidding questions have been most commonly reported in the economics literature (Brookshire, Ives, and Schulze 1976; Brookshire, Randall, and Stoll 1980; Brookshire, Thayer, Schulze, and d'Arge 1982; Gramlich 1977; Harmmack and Brown 1974; Randall, Ives, and Eastman 1974; Thayer 1981; Schulze, d'Arge, and Brookshire 1981). Only a few studies have been reported which used mail administration of the bidding instrument (Bishop and Heberlein 1980; Brookshire, Eubanks, and Randall 1983).

Problems encountered when using the bidding approach to valuation center upon the existence of biases claimed to be inherent to the technique. The most obvious of these has been termed hypothetical bias and is most pointedly described by the statement "ask a hypothetical question and you get a hypothetical answer." The best way to confront this problem is by asking an alternative question: if the hypothetical circumstances come to bear, will the previously hypothetical response be validated by actual behavior? In many instances the application of bidding approaches is conducted for situations in which the exact structure of the contingent market is not likely to ever be replicated in the "real world." Thus, validation of empirical results by observing actual behavior is not possible. This forces the researcher to use the only other validation alternative available, albeit a second best alternative: to compare the results of the bidding approach to valuation with other approaches.

Other types of purported biases include vehicle bias, strategic bias, information bias, and starting point bias. These have all been discussed at length in previously published literature and will not be discussed herein (Brookshire, Ives, and Schulze 1976; Rowe, d'Arge, and Brookshire 1980; Thayer 1981). In very few instances has evidence of their influences been found in empirical applications of the bidding technique and, when found, it has been in studies which used several alternative bidding approaches in an experimental setting (Brookshire et al. 1982).

COMPARATIVE VALIDATION OF BIDDING ESTIMATES OF WELFARE CHANGE

Three previous studies have used the bidding approach in conjunction with one or more alternative approaches for the purpose of providing some degree of validation for the estimated measures of welfare change. These studies were each conducted differently, by different groups of researchers, and for different commodities (Bishop and Heberlein 1980; Brookshire, et al. 1982; Thayer 1981).

Bishop and Heberlein (1980) examined the value of Canadian goose hunting in the Horicon Marsh area of central Wisconsin during 1978. They used a mail questionnaire to collect their data and compared three methods of measuring recreation demand: simulated markets, hypothetical markets (CVM), and travel cost analysis. For their simulated markets they mailed money offers to hunters and offered to buy their hunting permits. Different offer levels were used, with several offers made at each level. For the CVM this procedure was repeated with another group of hunters. This time, however, they received hypothetical offers for their permits. When compared with their simulated market results Bishop and Heberlein found that the CVM approach underestimated the "true" willingness to pay as measured by the simulated markets ($21 as compared to $63). Using the traditional zonal variant of the travel cost method, they also found WTP estimates which underestimated the "true" willingness to pay (estimates ranged from $8 to $32 depending upon whether travel time and time at the site were included). Their research findings suggest that further comparisons of the travel cost and bidding approaches to valuation are needed.

Thayer (1981) examined the environmental impacts of geothermal energy development in the Jemez Mountain area of New Mexico. Personal interview administration of an iterative bidding survey instrument was conducted in the fall of 1976 and spring of 1977. Respondents, which included both day and overnight visitors, were shown alternative pictorial representations of the impacts of geothermal development and were bid with to elicit maximum entrance fees they would be willing to pay to use the area under each set of conditions. They were also asked to provide information concerning recreation site substitutes in response to the changing environmental conditions.

The bidding portion of the analysis found an estimated mean willingness to pay equal to $2.54 ($2.56 for day visitors and $2.48 for campers). Using a site substitution approach to estimation, which was based on travel costs, resulted in an estimated willingness to pay ranging from $1.85 to $2.59 ($1.60–$2.33 for day visitors and $2.51–$3.52 for campers) when using travel costs of $.05 to $.07 per mile (1976 dollar estimates of variable driving costs provided by Hertz and AAA). Thayer concluded that these similar estimates of WTP provide evidence that hypothetical bias from the contingent valuation method was not a problem. He also rejected the existence of both starting point and information bias.

Brookshire et al. (1982) examined the value of clean air in the Los Angeles metropolitan area of California. Their data was collected during March of 1978 from a variety of residential areas in air regions classified as poor, fair, and good. The two valuation approaches used were iterative bidding and hedonic rent gradients based upon the property value approach (Rosen 1974). The bidding survey format was personally administered and 290 completed surveys were obtained.

A theoretical argument is provided which demonstrates why estimates of the value of a change in air quality should be overestimates of the true measure of willingness to pay when using the rent gradient approach. Based on this argument the authors state two hypotheses: (1) the mean value of air quality improvements derived with the bidding approach will be greater than zero, and (2) the mean value of air quality improvements derived with the bidding approach will be less than that derived from the rent gradient approach. Neither of these hypotheses were rejected in this study, thus providing further evidence that the bidding form of contingent valuation provides estimates of welfare change consistent with conceptual expectations as well as with those derived from alternative valuation approaches.

Each of the studies described above attempts to provide some degree of validation for the bidding approach to contingent valuation. The Bishop and Heberlein study used a close-ended bidding format and compared it to a single-site, zonal travel cost model (as well as a simulated market). Thayer used an iterative bidding approach and compared it to a site substitution method of valuation. Brookshire et al. compared an iterative bidding approach to an hedonic rent gradient approach. All three of these studies have been slightly different from each other and all three have also provided some degree of "validation by comparison" for the bidding approach to contingent valuation. In the study to be reported below, the intent is to expand the scope of this comparative validity literature slightly farther. Two different variants of the bidding approach will be used, a close-ended and an open-ended question format. Estimates derived from both of these bidding approaches will then be compared to estimates derived from a regional travel cost model estimated with individual, rather than zonal, observations.

A STUDY OF RECREATIONAL BOATING

Four Lakes in East Texas, a rapidly growing region, were chosen to be the focus of this recreational boating study: Lakes Conroe, Livingston, Somerville, and Houston. The lake sites were chosen because they were similar in size, and in provision of recreation opportunities. These lakes also provide almost all of the freshwater, lake recreation opportunities for boaters in the area. A 23-county region around the lakes was identified as being the major origin of users of these lakes (Texas Parks and Wildlife Department 1975). Because this region allows for sufficient variation in distance, the travel cost method is readily applicable.

The Travel Cost Method

Since market prices are unavailable, the travel cost method uses variable costs incurred by the recreationist as surrogates for site prices in the estimation of the demand equations. The travel portion of these costs in previous studies have included repairs and maintenance to the vehicle in addition to gasoline costs (Bishop and Heberlein 1980). In this study, however, the travel costs used will be only those the recreationist can most easily recognize as his costs for the trip, namely gasoline costs. Originally researchers used only travel costs for demand estimation, but more recent researchers have also used other expenditures (Burt and Brewer 1971). In addition to travel costs, variable costs incurred by the recreationist which are specific to the recreation trip will also be used in this study.

The Model

The demand equations for the four lakes were jointly estimated in the regional travel cost model used for this study. Any excluded sites are tacitly assumed to be independent of those included as far as demand characteristics are concerned.

The system of demand equations for the four lakes is specified as:[1]

$$V_{ij} = \alpha_j + \sum_{k=1}^{4} \beta_{jk} C_{ik} + \delta_j Y_i + \gamma_j Z_i + \epsilon_{ij} \qquad [1]$$

where

i = 1,. . .,n observations, i.e., recreation groups;
j,k = 1,. . .,4 sites;
V_{ij} = number of visits to the j^{th} site by the i^{th} recreation group;
Y_i = household income of the head of group i (\$/year);
Z_i = preference and behavioral variables introduced in the model;
α,β,δ,Y = parameters to be estimated;
ϵ_{ij} = random error term.
C_{ik} = costs incurred by group i, while at and travelling to site k

$$= \left(\frac{2d_{ik}}{mpg_i} \times 1.10\right) + E_{ik} + (gas_{ik} \times 1.10) + fees_{ik}$$

[1]The cost of travel time to the site was originally included in the specification of the model, in addition to other costs by adding them to C_{ik} (Commons 1973; McConnell and Strand 1981).

The cost of time was defined as

$$T_{ik} = \left(\frac{Y_i W}{2080}\right) \times (\text{time}_{ik})$$

where

$$\frac{Y_i}{2080}$$

is an appropriate hourly wage rate (The number 2080 is the total annual work time computed as (52 weeks) × (40 hours/week).), time_{ik} = time spent by the ith group while traveling to and from site k, and W is a parameter.

To parametrize the cost of time, three values were chosen for W:0, .25 and .50, or zero, one-quarter, and one-half of the wage rate, respectively (Nichols, Bowes, and Dwyer).

Note that since Y denotes total household income, $Y/2080$ is an approximate value of the hourly wage rate and will overestimate it if there is unearned income included in this total. However, this may be somewhat compensated for by dividing the annual income by 52 (weeks) × 40 (hours) since some boaters have paid vacations.

The model specification reported here corresponds to $W = 0$ (zero time cost). This choice appears to be appropriate for the following reasons. First, as the value of the parameter W was increased from 0 to .25 or .50, the explanatory power of the model (R^2) decreased. In other words, the weighted mean square error for the syswhere

d_{ik} = one-way distance for group i to site k;
1.10 = average cost of gas per gallon during 1980 in the study region;
mpg_i = miles per gallon of gas of group i's vehicle;
E_{ik} = other variable costs reported by respondent i for each visit to site k;
gas_{ik} = number of gallons of gas used for boat by group i while at site k;
$fees_{ik}$ = any user and/or entrance fees at site k.

In matrix form, the travel cost model for the i^{th} site can alternately be expressed as:

$$V_i = X_i b_i + \epsilon_i \qquad i = 1, 2, 3, 4,$$

where

V_i is a $(n \times 1)$ vector of dependent variables;
X_i is a $(n \times r_i)$ matrix of explanatory variables;
b_i is a $(r_i \times 1)$ vector of parameters;
ϵ_i is a $(n \times 1)$ vector of error terms;
and there are r_i independent variables for the i^{th} site.

Functional Form and Estimation Procedures

In the absence of a priori information on the choice of a functional form, the system of demand equations is specified as a linear model (Burt and Brewer 1971; Cicchetti, Fisher, and Smith 1976). In the model it is assumed that $E(\epsilon_i) = 0$ and that the error terms across equations are correlated, that is $E(\epsilon_i \epsilon_j) = 0$. Hence, the covariance matrix of ϵ is given by $E(\epsilon\epsilon') = \Omega$. This covariance represents the only link between the j^{th} and k^{th} equations. The system corresponds to Zellner's seemingly unrelated regression (SUR) system, except for possible heteroskedasticity problems. Given that previous research (Burt and Brewer 1971) identified such problems, in order to obtain a more efficient estimator, both correlation of the error term across equations (for a particular group) (Zellner 1962) and heteroskedasticity (Harvey 1976) are taken into consideration in the estimation of the model.

If the elements of the matrix Ω are not known, as in this case, Ω must be consistently estimated. To do so, the model is first estimated using seemingly unrelated regression (Zellner 1962). In the process, the error correlation across models is estimated. The residuals from these equations are then used to estimate the heteroskedasticity by assuming that the standard deviation of the error terms is a function of the exogenous variables (Harvey 1976; Judge et al. 1980, 133). This provides a consistent estimate, $\hat{\Omega}$, of the covariance matrix, Ω. The model is then reestimated using $\hat{\Omega}$ which yields

$$\hat{b} = (X'\hat{\Omega}^{-1}X)^{-1}(X'\hat{\Omega}^{-1}V)$$

$$X = \begin{bmatrix} X_1 & & & 0 \\ & X_2 & & \\ & & X_3 & \\ 0 & & & X_4 \end{bmatrix}, \qquad V = \begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \end{bmatrix}$$

where

$$b = \begin{bmatrix} b_1 \\ b_2 \\ b_3 \\ b_4 \end{bmatrix}, \quad \text{and } \hat{b} \text{ is an efficient estimator of } b.$$

By specifying the demand system as linear in the variables (Burt and Brewer 1971; Cicchetti, Fisher, and Smith 1976), theoretical restrictions can be easily imposed and tested. Of particular interest in this study is the symmetry of cross price effects since this symmetry is important in welfare analysis. With a relatively small proportion of the respondent's income spent on boating, the income

---

tem was smallest when W equalled zero, i.e., when time cost was zero.

In addition, as the time cost increased to one half of the wage rate, the resulting coefficients did not provide the expected signs in every case. For instance, the coefficient on own cost in the demand equation for Lake Conroe is positive and insignificant.

Thus, the model with zero time costs seems to have provided the better results. One possible explanation is that leisure time may be institutionalized, with most people in the study making their trips during the weekend when their opportunity cost of time is close to zero.

effect of a price change is expected to be small. With a negligible income effect, the symmetry of compensated cross price effects, given from economic theory, become approximately equivalent to the symmetry of uncompensated cross price effects (Willig 1976). Thus, in the model it appears reasonable to test and impose for the symmetry of uncompensated cross price effects (Burt and Brewer 1971). If this restriction is shown to hold, it ensures the path independence of the line integral used for benefit estimation.

Benefit measures for site 1 are estimated from the travel cost model using

$$M = \int_{C_1^0}^{C_1^1} V(C_1, \ldots)\, dC_1$$

where

M = the Marshallian measure of consumer's surplus, assuming a change in travel costs from C_1^0 to C_1^1. (In our case, C_1^1 is the vertical intercept of the demand curve.)

Contingent Valuation: Open-Ended Format

The open-ended format allowed the respondent to specify a monetary figure for a boat ramp permit at the lake he or she visited most often in 1980, with no suggested amount provided in the question format. Thus, responses were direct estimates of willingness to pay. After an initial explanation of the purpose of an annual ramp permit at the lake, that it would replace any existing launch fees, and how it would be administered, the following questions were asked of the respondent:

(a) What is the most the annual boat ramp permit could cost before you would have stopped using your boat at *this* lake between January and December 1980? $ ______

(b) The above question was again asked following the statement: Suppose you could only visit this lake *half as many times* as you did between January and December 1980.

Asking the amount the respondent would pay for a permit to use the lake the same number of times as in 1980, and the amount he or she would pay for half as many visits, provided points on the individual's bid curve (Bradford 1970) or total value curve (Brookshire, Randall, and Stoll 1980). The basic bid curve is specified as a function of income and the number of visits the respondent made to the lake in 1980. The dependent variable is the respondent's willingness to pay for the boat ramp permit, WTP, i.e., the annual value of the site for boating.

Combining the responses to both of the above open-ended questions is a source of some concern as to whether both values lie on the same total value curve. If they do, then there are twice as many data points on which to base the analysis. Theoretically, they should. Yet, it is possible that respondent's could not credibly accept a hypothetical change in visits without associating this with some causal factor leading to this change. If this is in fact the case, then one would expect the estimated coefficients to be different when the empirical model described below is estimated separately for each set of responses.

The Model and Estimation Procedures

The open-ended contingent valuation model was specified as

$$WTP = f(Q, Y) \qquad [2]$$

where

Q = the level of provision of the service, in this case, the number of visits;
Y = income;
WTP = Hicksian equivalent measure of willingness to pay.

This equation is estimated for each of the four lakes. Since there was no information a priori about the choice of a functional form, the bid curve [2] is estimated three ways: linear, linear with a squared term in Q, and a double logarithmic form.

Differentiating the bid curves provides an inverse Hicksian demand curve for each of the lakes. This demand curve in unique to the reference welfare level of the boater given in the posited contingent market; non-participation. The area under this curve, to the left of the mean number of visits, provides a Hicksian equivalent measure of welfare change for the average boater.

Contingent Valuation: Close-Ended Format

Members of the boating sample used in the analysis of the close-ended format of the contingent valuation method received the same explanation of the purpose of a boat ramp permit as those responding to the open-ended format question. Following this, they were asked to give one of two responses, "Yes" or "No," to the following question:

> If the annual boat ramp permit cost $\$x$ in 1980, would you have purchased the permit so that you could have continued to use the lake throughout the year?

Where x was one of 5, 25, 50, 75, 100, 125, 150, 200, 250, or 300. The appropriate model to analyze this type of response data is a binary response model. That is, models where the dependent variable takes one of only two values.

The most widely used binary response models use a transformation approach. In this case, the larger the value of the index, in this study the permit price, the greater the probability that the event in question will occur. The "event" in this study is a "no" response to the permit price. A monotonic relationship between the value of the index and the probability of the event occurring can be assumed. Under these assumptions, the "true" probability function would have the characteristic shape of a cumulative distribution function (CDF). The two most commonly used CDF's are the normal and logistic, with the associated analysis called probit and logit, respectively. Since the logistic cumulative density function can closely approximate that of a normal random variable, there is usually little difference in the empirical results produced by the two models. Unless there are theoretical reasons for preferring the normal to the logistic cumulative distribution function, the logit model is preferred to the probit model when repeated observations are available, due to the fact that estimates are somewhat easier to obtain (Judge et al. 1980). These models have been used in many different fields, including work in travel demand (Domencich and McFadden 1975) and also in recreation (Bishop and Heberlein 1980). The logit was used in this study because of its computational simplicity.

The Model and Estimation Procedures

The logit model was specified as[2]

$$P_i = F(Z_i) = \frac{1}{1 + e^{-Z_i}}$$

$$= \frac{1}{1 + e^{-(\ln\alpha + \beta\ln X_i + \partial\ln V_i)}}$$

where

P_i = the probability that a respondent will answer "no" to a given permit price X_i

V_i = the number of visits made to the lake in 1980.

The probability function can be rewritten as:

$$L = \log\frac{P_i}{1 - P_i} = \ln\alpha + \beta\ln X_i + \partial\ln V_i + \epsilon_i . \quad [3]$$

This equation was estimated using maximum likelihood estimation. The function estimated in the study is of the graphical form represented in Figure 1.

The shaded area in the graph represents the expected willingness to pay for the typical boater. This is a Hicksian equivalent measure of welfare change. That is:[3]

---

[2]Respondent income was used as a variable but was insignificant. In part this was believed to be due to measurement problems; other variables referred to the recreation group rather than the respondent per se. It was, therefore, removed from the specification for this reason and to eliminate degrees of freedom problems from missing data.

[3]This is found from

$$E(WTP) = \int_0^{X_{\max}} (1 - F(X))\, dX$$

where $f(X)$ = probability distribution for responding "yes" to permit price X. Let $F(X)$ be the cumulative dis-

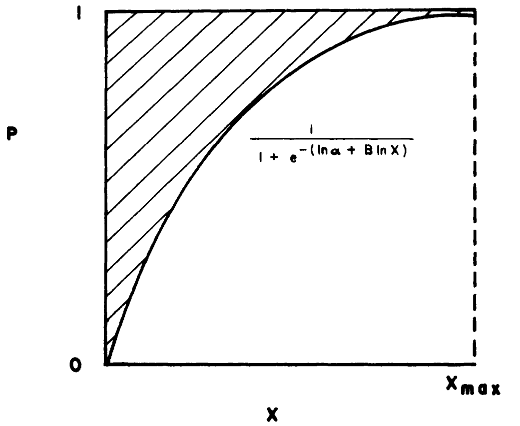

FIGURE 1
THE LOGIT MODEL

$$E(WTP) = X_{\max} - \int_0^{X_{\max}} \frac{1}{1 + e^{-(\ln \alpha + \beta \ln X)}}\, dX \qquad [4]$$

where V, the number of visits to the lake has been implicitly fixed at the mean value $\bar{V}$.

Allowing the number of visits to vary allows the problem to be more general. In this case, when visits are variable,

$$E(WTP) = X_{\max} - \int_0^{X_{\max}} \frac{1}{1 + e^{-(\ln \alpha + \beta \ln X + \partial \ln V)}}\, dX, \qquad [4a]$$

This can also be expressed as

$$E(WTP) = X_{\max} - \int_0^{X_{\max}} \frac{1}{1 + \frac{1}{\alpha} X^{-\beta} V^{-\partial}}\, dX.$$

A demand curve can be derived by taking the first derivative of the expected value of WTP with respect to visits (V). That is,

$$\frac{dE(WTP)}{dV} = \frac{-\partial}{\alpha} \int_0^{X_{\max}} \frac{1}{\left(1 + \frac{1}{\alpha} X^{-\beta} V^{-\partial}\right)^2 X^{\beta} V^{\partial + 1}}\, dX.$$

The expected signs of the estimated coefficients are α, positive; β, positive; and ∂, negative. That is, the probability of a "no" response is expected to increase with the magnitude of the suggested permit price, X, and decrease as the number of visits, V, increases. This means that $dE(WTP)/dV$ will always be positive.

The sign of the second derivative with respect to V, indicates the direction of the slope of the demand curve. The demand curve will be downward sloping if the coefficient ∂ satisfies $-1 < \partial < 0$.[4]

Data Collection

Data for the study was collected using an eight-page questionnaire booklet, mailed to a sample of 2,000 registered pleasure-boat owners in a 23-county area of East Texas. A response rate of 62.4% was received. After

---

tribution function corresponding to $f(X)$, then $P(X-)$ = (the probability of responding "no") = $1 - F(X)$.

$$E(WTP) = [(1 - F(X))X]_0^{X_{\max}} - \int_0^{X_{\max}} (1 - F(X))\, dX$$

$$= X_{\max} - \int_0^{X_{\max}} P(X)\, dX$$

$$= X_{\max} - \int_0^{X_{\max}} \frac{1}{1 + e^{-(\ln \alpha + \beta \ln X)}}\, dX.$$

[4] $$\frac{d^2E(WTP)}{dV^2} = -\frac{\partial}{\alpha} \int_0^{X_{\max}} \frac{-(\partial + 1)}{\left(1 + \frac{1}{\partial} X^{-\beta} V^{-\partial}\right)^2 X^{\beta} V^{\partial + 2}} + \frac{2\frac{\partial}{\alpha}}{\left(1 + \frac{1}{\alpha} X^{-\beta} V^{\partial}\right)^3 X^{2\beta} V^{2(\partial + 1)}}\, dX$$

with $\alpha > 0$ and $\partial < 0$. For

$$\frac{d^2E(WTP)}{dV^2} < 0,$$

it is required that $\partial + 1 > 0$, i.e., $\partial > -1$, which implies that $-1 < \gtreqless < 0$.

removing ineligible responses[5], 731 questionnaires remained for use in the travel cost model, and 623 for use with the contingent valuation method models (340 open-ended format, 283 close-ended format).

Further removed from the contingent valuation method analyses were questionnaires where the response to the permit question was missing, or was considered to be a protest[6] concerning the contingent market. This reduced the number of observations to 275 and 211 for the open-ended and close-ended formats, respectively.

Accuracy

Since there has been concern in the literature about the reliability of extracting answers from people in a hypothetical situation, the respondent was given an opportunity to say how accurate he felt his answers were. At the end of the questionnaire he was asked to circle one of the three statements: "Quite accurate"; "There is no way I could come up with accurate answers"; or "Accurate in a 'ball park' kind of way." These three statements were given for the questionnaire as a whole and for the permit questions in particular (Table 1).

For the questionnaire as a whole, only 8.2% of those responding to the evaluation said that "There is no way I could come up with accurate answers." This percentage was more than doubled in the evaluation of the permit question: 17.6% could not come up with an accurate answer.

The open-ended format seemed to cause the most problems; almost 25% of the respondents in this form of contingent valuation analysis said that they could not provide an accurate answer. For the close-ended format this figure was only 9.2%.

Of the respondents who gave values of willingness to pay for a permit of 0 or 1¢, 38 recorded the accuracy of their response to the permit. Of these 38 boaters, 20 replied that their answers were inaccurate. This adds to the justification for removing them from the sample. In doing so, the percentage of perceived inaccurate responses to the open-ended question falls to 20.0%.

For the close-ended format, only 22 boaters reported that their answers were inaccurate. These answers did not seem to reflect the amount of the permit price suggested

[5]Respondents who had not used at least one of the four lakes in the study in 1980 (travel cost method); respondents who had not visited one of the four lakes in the study most often in 1980 (contingent valuation method).

[6]Respondents who had refused to purchase the boat ramp permit at the fee posited were asked why they had said "no". Responses of "I object to having to purchase a ramp permit" and "I cannot imagine the situation occurring" were considered protests (close-ended format); zero permit fees (which in the context of the question posed was nonsensical) or a value of 1¢ were considered protests (open-ended format).

TABLE 1

NUMBER OF RESPONSES TO THE ACCURACY QUESTIONS, FOR THE QUESTIONNAIRE AS A WHOLE, AND FOR THE PERMIT QUESTIONS

	Questionnaire as a Whole				Open-Ended Form of Permit Question				Close-Ended Form of Permit Question			
Lake	Quite accurate	Inaccurate	Ball-park accuracy	Non-response	Quite accurate	Inaccurate	Ball-park accuracy	Non-response	Quite accurate	Inaccurate	Ball-park accuracy	Non-response
Conroe	92	11	65	18	30	13	36	15	47	7	18	19
Livingston	116	22	89	24	36	26	48	28	57	9	29	16
Somerville	70	12	51	14	23	21	22	15	37	4	13	11
Houston	28	2	17	0	7	10	10	0	10	2	5	3
Total	306	17	222		96	70	116		151	22	65	
Percentage	53.2	8.2	38.6		34	24.8	41.1		63.4	9.2	27.3	

since respondents reporting inaccurate responses were distributed fairly evenly over the whole suggested price range, $5 to $300. This is encouraging in that original expectations were that the inaccurate responses would be greater for intermediate suggested prices. Very high or very low suggested prices would be easily identified.

Only five of the inaccurate responses were those who had answered either "I object to having to purchase a ramp permit" or "I cannot imagine the situation occurring." When these were removed from the analysis the percentage of inaccurate responses dropped to 7.2%.

These results suggest that the boaters who responded were more comfortable giving responses to the close-ended type format. Providing a guide as to what a permit price could be seemed to make it easier for the respondents to give accurate replies. This is evidenced by the much larger percentage of respondents who said that they could not come up with an accurate answer to the open-ended permit question (25% as compared with 9.2% for the close-ended question).

RESULTS OF ESTIMATION PROCEDURES

Results from the Travel Cost Method

The results of estimating the coefficients for the travel cost model (equation [1] by SUR, following corrections for heteroskedasticity, and with symmetry imposed[7] are given in Table 3. All variables are defined in Table 2.

The R^2 in the model is low because individual observations were used, rather than grouped data. Gum and Martin (1975) found mean R^2 of .33 in their recreation study in Arizona using individual observations. The R^2 in this study, .25, is comparable although a little lower.

As expected, the coefficients on own cost are significantly different from zero (at the 1% level of confidence in most cases) and negative. The signs on other cost coefficients indicate whether lakes are substitutes for each other. Signs on those cost coefficients that are significantly different from zero at the 1% level of confidence indicate that: Livingston and Somerville are substitutes for Conroe; Conroe is a substitute for Livingston; Conroe and Houston are substitutes for Somerville; and finally, Somerville is a substitute for Houston.

The elasticities estimated in this study were comparable to those calculated by Burt and Brewer (1971) in their regional travel cost model study of water-oriented recreation at lakes in Missouri. Burt and Brewer found

[7]The null hypothesis that the cross-price coefficients were equal to each other could not be rejected at a .36 level of confidence.

TABLE 2

DEFINITION OF VARIABLES

Variable	
C1, C2, C3, C4	Expenditures when visiting Lakes Conroe, Livingston, Somerville & Houston respectively
V1, V2, V3, V4	Number of visits in 1980 to Lakes Conroe, Livingston, Somerville and Houston respectively
FC2	Dummy variable = 1 if an annual user fee paid at Lake Livingston
FC3	Dummy variable = 1 if an annual user fee paid at Lake Somerville
C0, L0, S0, H0	Quality rating scores of Lakes Conroe, Livingston, Somerville and Houston, respectively
YROWN	Number of years owned a boat
DL	Dummy variable = 1 if stayed overnight at the lake
SKI	Dummy variable = 1 if engaged in water-skiing at the lake
Y	Annual household income of the respondent
LFEE	Dummy variable = 1 if respondent paid a launch fee at the lake
PERMIT	Dummy variable = 1 if responses to the questionnaire were at least accurate in a ball park way

TABLE 3

TRAVEL COST METHOD ESTIMATES OF THE COEFFICIENTS FOR THE MODEL CORRECTED FOR HETEROSKEDASTICITY SYMMETRY IMPOSED

Lake	Dependent Variable	Estimated Coefficients (Standard Errors) [Elasticities]†														
		Intercept	FC2	FC3	C1	C2	C3	C4	Y	CO	LO	SO	HO	DL	YROWN	SKI
Conroe	V1	.49***			−.23***	.12***	.10***	0.004	−.07	1.40***	−.26*			−1.03*		
		(.18)			(.06)	(.03)	(.03)	(.03)	(.15)	(.17)	(.15)			(.61)		
					[−3.22]	[1.80]	[1.53]	[.04]	[−.07]							
Livingston	V2	.54***	12.23***		.12***	−.12***	−.003	0.01	.05	−.38**	1.52***	−.80***	−.44*		.06*	
		(.17)	(2.5)		(.03)	(.03)	(.02)	(.01)	(.16)	(.17)	(.16)	(.16)	(.24)		(.03)	
					[1.30]	[−1.52]	[−.04]	[.11]	[.06]							
Somerville	V3	.92***		5.71***	.10***	−.003	−.13***	.03***	−.12		−.13	.78***				1.08***
		(.16)		(1.19)	(.03)	(.02)	(.02)	(.01)	(.09)		(.09)	(.09)				(.37)
					[2.13]	[−.07]	[−3.03]	[.64]	[−.20]							
Houston	V4	.40*			.004	.01	.03***	−.04**	−.01		−.11*		1.17***	−.34		
		(2.4)			(.03)	(.01)	(.01)	(.02)	(.06)		(.06)		(.10)	(.28)		
					[.16]	[.57]	[1.73]	[−2.12]	[−.04]							

Weighted R^2 for the system = 0.25

*Significant at the .10 level of confidence.
**Significant at the .05 level of confidence.
***Significant at the .01 level of confidence.
†Elasticities calculated at the mean values of the variables.

own price (cost) elasticities ranging from $-.60$ to -2.67 and cross price (cost) elasticities ranging from $-.12$ to 1.44. In this study, those ranges are -1.52 to -3.22 and up to 2.13 for own cost elasticities and cross-cost elasticities, respectively.

Quality rating scores assigned to the lakes by respondents (on a scale of 1 to 5; 0, for those who had not visited the lake) were also important in explaining the variation in the number of visits. Own quality rating score coefficients were significantly different from zero at a 1% level of confidence and were positive, indicating that as the rating score increases so do the number of visits. Negative signs on other rating score coefficients, that were significantly different from zero, indicated that substitution would occur if quality ratings were increased at another lake. Specifically, increasing the rating score for Lakes Conroe, Somerville, and Houston would reduce the number of visits to Livingston, and increasing the rating score for Livingston would reduce the number of visits to Conroe and Houston.

Fixing the variables other than own cost at their mean values provides demand curves for the lakes in terms of only visits and own cost. those demand curves are:

Conroe $V1 = 14.46 - .23C1$
Livingston: $V2 = 10.04 - .12C2$
Somerville: $V3 = 8.63 - .13C3$
Houston: $V4 = 3.28 - .04C4$

The average consumer's surplus for each lake is calculated as the area under the demand curve and above the expenditure level, at the mean level of visits. The estimates of average consumer's surplus are $32.06, $102.09, $24.42, and $13.01 for Conroe, Livingston, Somerville, and Houston, respectively.

Results from the Contingent Valuation Method: Open-Ended Format

Using equation [2], bid curves were established for each of the lakes in the study using the data collected with the open-ended format. Results are tabulated in Table 4. In all cases the R^2 value was low, ranging from .06 to .13, indicating that most of the variation in willingness to pay was not explained.

Although not reproduced here, the model was estimated using seemingly unrelated regression for both open-ended questions for each lake. An F test was performed and indicated that, for all but Lake Houston, the estimated coefficients were significantly different for the two question responses at the .10 level. Thus, the estimated models reported here were reestimated and are based only on the respondent's actual 1980 level of visits for

TABLE 4

OPEN-ENDED CONTINGENT VALUATION METHOD: BID CURVES; ESTIMATED COEFFICIENTS (STANDARD ERRORS)

Lake	Dependent Variable	Intercept	ln (Visits)	ln *(Y)*	ln (Opinion Score)	LFEE	ln (C2)	PERMIT	N	R^2
Conroe	ln WTP[E]	1.22**	.25**	.03	.38	.42*			69	.14
		(.50)	(.12)	(.07)	(.27)	(.24)				
Livingston	ln WTP[E]	.38	.20**	−.11	.53		.26*		75	.14
		(.71)	(.10)	(.21)	(.38)		(.15)			
Somerville[a]	WTP[E]	22.49***	−.27*	−.95				−4.64	48	.08
		(4.92)	(.14)	(.92)				(3.19)		
Houston	ln WTP	1.29***	.30***	.08					46	.06
		(.32)	(.08)	(.08)						

*Significant at the .10 level of confidence.
**Significant at the .05 level of confidence.
***Significant at the .01 level of confidence.
[a]Independent variables 'visits' and 'Y' not ln(visits) and ln(Y).

Lakes Conroe, Livingston, and Somerville. The estimated model for Lake Houston, however, is based on pooled data from both questions; actual 1980 visits and one-half the 1980 visits.

For all four lakes the coefficient on the variable log(visits) (but "visits" at Somerville) was significantly different from zero at a 10% level of confidence or better. Economic theory underlying the derivation of the bid curve indicates that this curve is of positive slope. This is the case for all lakes except for Lake Somerville. It appears that specifying a contingent market under conditions where boaters were not used to paying a launch fee may have caused problems (Some boaters did pay launch fees at the other three lakes). It is also hypothesized that the open-ended nature of the question made it more difficult for boaters to respond since they had no previous experience on which to base their offers.

Differentiating these bid curves (excluding Lake Somerville) provides a Hicksian compensated demand curve for each lake.[8] Those demand curves are (Figure 2):

Conreo: $dWTP/dV = 1.79V^{-.75}$
Livingston: $dWTP/dV = 1.52V^{-.8}$
Houston: $dWTP/dV = 1.22V^{-.7}$

The average Hicksian consumer's surplus per boater for each lake is estimated as the area under each demand curve for an average boater who is assumed to make the mean number of visits to the lake in 1980. The gross surplus values calculated are \$9.06, \$8.87, and \$3.81 for Conroe, Livingston, and Houston, respectively.

These values are calculated assuming that the boater pays no launch fee. At the three lakes, Conroe, Livingston and Houston, this is not the case. Some of the boaters did report paying a launch fee each time they visited the lake. The net surplus is obtained by deducting from this the mean expenditure on a launch fee per year. The average expenditures on a launch fee each year were \$17.71, \$7.78, and \$6.09 for Conroe, Livingston, and Houston, respectively. The net average consumer's surplus for these three lakes is, therefore, −\$8.65, \$1.09 and −\$2.28 for Conroe, Livingston, and Houston, respectively.[9]

The negative values for the surplus for Lakes Conroe and Houston seem to indicate that people reported they were willing to pay less for an annual ramp permit than they already paid in total launch fees over the year on a per visit basis. Although the surplus measure at Lake Livingston is not negative, it is very low. At this lake, some boaters reported that they were willing to pay less for an annual permit than they already paid in launch fees each visit, over the year. These results raise questions about the reliability of the open-ended contingent valuation method. There seems to be more than one possible reason for this. The boater may not be prepared to make a one-time payment for an annual fee when he does not know how many visits he will make in a year. There is a certain risk attached to paying a large fee and then discovering during the year that you do not make as many trips as expected. Second, this one-time payment may create a cash-flow problem if the boater is not able to make one large lump-sum payment. Third, although the cover letter with the questionnaire (for all respondents) stated that the results of the questionnaire would not be used for specific pricing policies, it was apparent from the comments of the respondents that this was not always heeded. Boaters may have been concerned that if they said they would pay a large sum for a ramp permit that they would be asked to pay this much in the future.

The obvious problems with this form of the contingent valuation method are further illustrated by the number of respondents who said that they could not give accurate answers to

[8]The estimated demand relationship for Somerville was considered unreliable. See note 10.

[9]The mean WTP response for each lake could also be used rather than the estimated area under the demand curve. when this is done, the net average surplus figures for the lakes are −\$.87, \$6.21, \$11.17, and \$5.40 for Lakes Conroe, Livingston, Somerville, and Houston, respectively. A distinction between this latter approach and that reported in the text is that the text version is a mean WTP calculated at the mean level of visits while the footnote version is a mean response across differing respondent visit levels. Either approach can be justified, however, the footnote version could fail to identify instances of apparent inconsistencies of responses with consumer theory, e.g., the positively sloped demand curve at Lake Somerville.

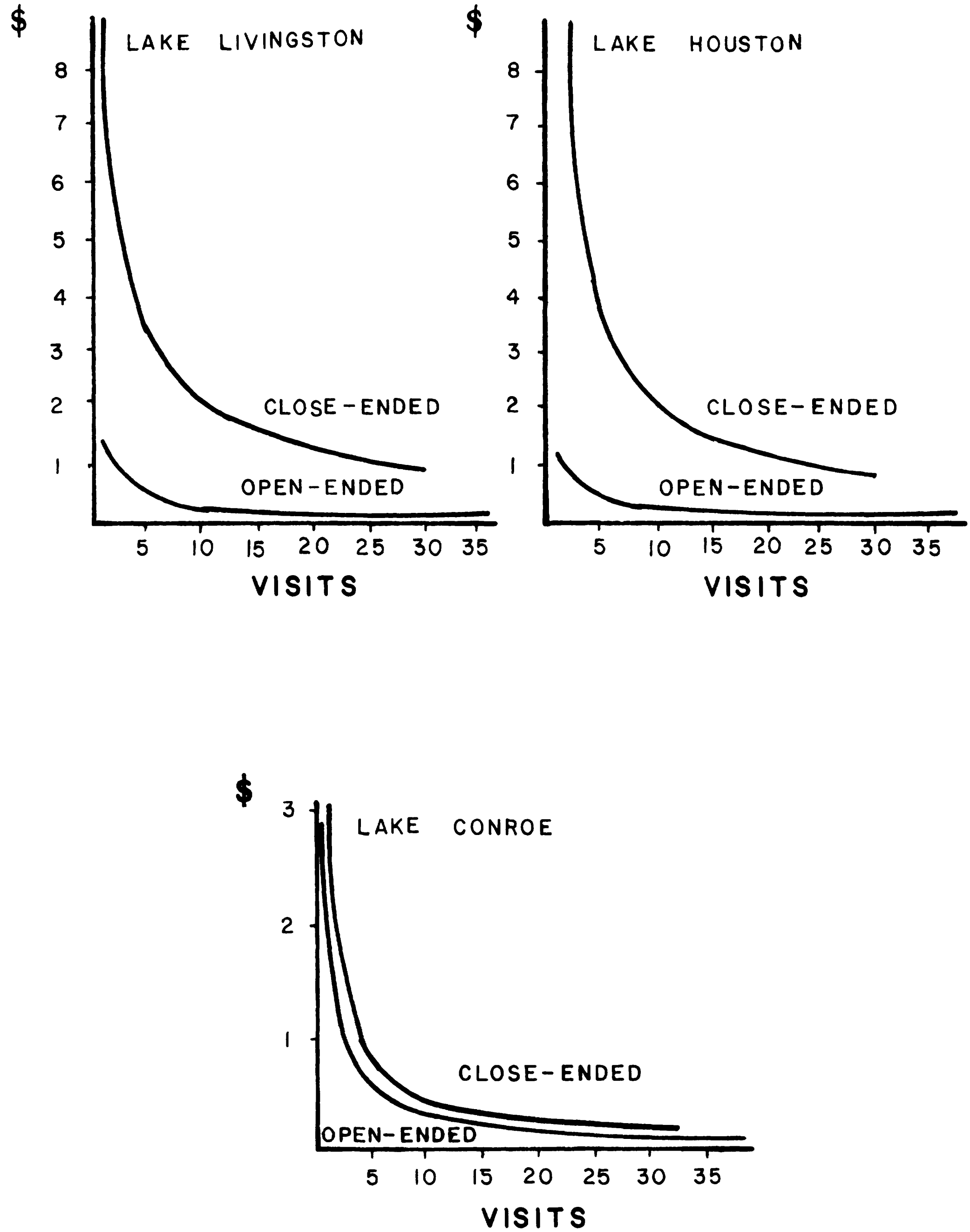

FIGURE 2
Demand Curves Estimated with the Contingent Valuation Method

these permit questions. The size of the group reporting this was almost 25% of those responding (See Table 1).

Results from the Contingent Valuation Method: Close-Ended Format

The logit model was specified as in equation [3]. This equation was estimated for each lake using maximum likelihood estimation. The results are given in Table 5.

For each of Lakes Conroe, Livingston, and Somerville, the coefficient on the suggested price of the ramp permit was significantly different from zero at the 1% level of confidence, indicating that the suggested permit price was significant in determining the probability that the respondent would answer "no" to paying this price. The suggested permit price was only significant at the 10% level in determining this probability at Lake Houston. As expected, the signs on the estimated coefficients were $\hat{\alpha}$, positive, and β, positive. In addition, to ensure a downward sloping demand curve, $\hat{\partial}$ had to be negative, but greater than minus one. $\hat{\partial}$ would be expected to be negative, the greater the number of visits to the lake, the less likely the probability of a "no" response. This was true for all lakes except Somerville, though the estimated coefficient was not significantly different from zero at the 5% level at this lake. Livingston was the only lake at which the coefficient on visits ($\hat{\partial}$) was significantly different from zero at the 5% level of confidence. The percentage of correct forecasts for the lakes from the analysis was 87, 85, 87, and 80, with goodness of fit statistics ρ^2 (analogous to R^2): .39, .39, .40, and .31 for Conroe, Livingston, Somerville, and Houston, respectively.

Equation [4a] was estimated using numerical methods for a range of visits, *V*, from 1 to 30. This provided a total value curve for each of the lakes. An estimate of the slope at points along this curve provided an estimated Hicksian demand curve for each lake (Figure 2).

Estimating the Hicksian consumer's surplus for each lake at the mean number of visits to that lake as the area under the demand curve at that level, provided estimates of \$53.94, \$42.40, and \$36.34 for Conroe, Livingston, and Houston, respectively.[10]

In order to derive a net average willingness to pay, the average expenditure on a launch fee per year has to be removed from the surplus value calculated above. The average expenditure per year on a launch fee was \$14.56, \$7.19, and \$22.53 at Conroe, Livingston, and Houston, respectively. Hence, the

[10]An estimate of consumer's surplus was not calculated for Somerville because the demand curve was not downward sloping, lay in the fourth quadrant and was considered unreliable.

TABLE 5

LOGIT ANALYSIS OF THE CLOSE-ENDED FORM OF THE CONTINGENT VALUATION METHOD

	Estimated Coefficients (t Statistics)					
Lake	Intercept ($\ln\alpha$)	Suggested price	Number of visits	ρ^{2a}	N	Percent of correct forecasts
Conroe	−6.13*** (−2.88)	1.79*** (3.53)	−.16 (−.47)	.39	70	87
Livingston	−3.06** (−1.86)	1.37*** (2.92)	−.67** (−1.75)	.39	74	85
Somerville	−4.78*** (−2.48)	1.26*** (2.92)	.88 (1.54)	.40	47	87
Houston	−2.32 (−.88)	.99 (1.75)	−.47 (−.84)	.31	15	80

$^a\rho 2$ = goodness-of-fit (analogous to R^2)
***Significant at the .01 level of confidence
**Significant at the .05 level of confidence

net average willingness to pay per boater is $39.38, $35.21, and $13.81 for Conroe, Livingston, and Houston, respectively.

A CONCLUDING NOTE ON THE ESTIMATES OF CONSUMER'S SURPLUS PRODUCED BY THE TWO METHODS

In comparing the results of the travel cost method and the contingent valuation methods, there are two points which should be noted. First, the travel cost method provides estimates of the Marshallian consumer's surplus, whereas the contingent valuation methods used provided estimates of Hicksian equivalent measures of welfare change. However, when the income effect is small, the difference should be small (Willig 1976; Randall and Stoll, 1980). In this study, the income effect is small since recreational boating takes only a small part of the boater's total income. This is also evidenced by the income elasticities which are not significantly different from zero at the 10% level.

Second, the travel cost method gives estimates of consumer's surplus for the total recreation experience, whereas the contingent valuation methods provide estimates of consumer's surplus for just the boating aspects of that experience. For this reason we expect the travel cost method to provide a larger estimate of consumer's surplus. However, if the respondent were only to picnic and camp, he could do this at any number of other sites, and would not necessarily travel to this lake-site for activities not involving his boat or water. This suggests that the benefits from this part of the experience may be small, so that the travel cost method estimates of consumer's surplus would be expected to be comparable with the estimates from the contingent valuation method.

The open-ended contingent valuation method provided significantly lower estimates of average consumer's surplus at each lake (See Table 6). With a 95% confidence interval constructed around each estimate of consumer's surplus, the estimates of consumer's surplus from this method, for all three lakes, are lower at this level of confidence than the estimates from either the travel cost model or the close-ended contingent valuation model.[11] By examining the demand curves estimated from the two contingent valuation methods (Figure 2), one can see that the open-ended method provides a lower measure of consumer's surplus than the close-ended method since the demand curve estimated from the open-ended method lies underneath the demand curve estimated from the close-ended method at every point, for each lake. There seemed to be some problems with the open-ended method of estimating the surplus values: boaters did not appear to reveal their true value for the lakes through this contingent market situation. Currently, some boaters pay a launch fee each visit, but there is no market fee for an annual permit. If the boater was not sure how many visits he would make over the year, he may not be able to estimate his per visit price for paying an annual fee. This could be one of the reasons that boaters in some instances offered to pay less for a permit than they already paid in total for the year on a per visit basis. There also appeared to be a concern on the part of the boaters that the information given in the questionnaire would be used for specific pricing policies, even though the cover letter with the questionnaire had said this was not the case.

These arguments also apply to the close-ended contingent valuation method. However, this latter method provided measures of consumer's surplus which appeared more reasonable. The reason for this may be the format of the question. In most markets when a consumer faces the decision as to whether to purchase a commodity, he is given the price for that commodity. He can either accept this price and buy the good, or refuse the price and therefore not trade in this commodity. There are few market situations where the

[11]Because willingness to pay is a nonlinear function of the parameters in all three methods, hypothesis testing for differences between willingness to pay is problematic. The usual t-statistic is not appropriate and confidence intervals for comparison have been used as an alternative approach. Confidence intervals were calculated corresponding with upper and lower bounds on the estimated visits coefficient and then shifting the demand curves about their horizontal (visits) intercepts. Narrower bounds on the surplus estimates would have been yielded if the curves had instead been shifted about the mean visit level.

TABLE 6

MEAN AND 95% CONFIDENCE INTERVAL ON AVERAGE CONSUMER'S SURPLUS ESTIMATES USING THE TRAVEL COST METHOD AND TWO CONTINGENT VALUATION METHODS

		Contingent Valuation		
Lake	Travel Cost	Open-ended[a] (integrated)	Open-ended[b] (mean)	Close-ended
Conroe:				
Mean	$ 32.06	$ −8.65**	$ −.87**	$39.38
Upper bound	67.01	−4.09	4.72	68.41
Lower bound	21.06	−16.34	−6.46	19.58
Livingston:				
Mean	102.09	1.09**	6.21**	35.21
Upper bound	204.19	6.08	9.81	76.01
Lower bound	68.06	−6.70	8.61	13.04
Somerville:				
Mean	24.42	—	11.17**	—
Upper bound	35.28	—	13.75	—
Lower bound	18.67	—	8.59	—
Houston:				
Mean	13.01	2.28**	5.40	13.81
Upper bound	520.20	−2.03	−10.05	14.43
Lower bound	6.50	−3.25	.75	13.18

**The null hypothesis that the value estimates was the same as the other estimates for the same Lake was rejected at the 95% level.

[a]Area under estimated demand curve at the sample mean 1980 visit level.

[b]Mean WTP response based on each respondent's actual 1980 visit level.

consumer sees a commodity and he, himself, gives the price he is willing to pay. This argument would seem to be reflected in the responses to the last part of the questionnaire where the respondent was asked how accurately he felt he had answered the permit questions. Almost 25% of the respondents said that there was no way they could come up with an accurate answer in response to the open-ended contingent valuation method. This figure was reduced to 9.2% for those respondents who received the close-ended contingent valuation question (see Table 1).

Comparing the close-ended method estimates of consumer's surplus with those of the travel cost reveals that the results for Lakes Conroe and Houston are similar, with the contingent valuation method providing slightly larger estimates (See Table 6). A 95% confidence interval constructed around estimates for Lakes Conroe and Houston suggests that these estimates may not be different. At Lake Livingston the difference between the two estimates of consumer's surplus is large, with the travel cost method providing an estimate of $102.09 and the close-ended method giving $35.21. However, a 95% confidence interval constructed around estimates for Lake Livingston also suggests that there may be no difference between them. It should be noted that the upper bound on the estimate of consumer's surplus is derived from a coefficient ($\hat{\partial}$) in the logit model that falls outside the range which ensures a downward sloping demand curve.[12] This estimate of the upper bound on consumer's surplus may therefore be unreliable.

With the travel cost method, the surplus value for Livingston is the largest of the four lakes, whereas for the contingent valuation method, the surplus value for Conroe is larger than that for Livingston. The travel cost result seems more reasonable. Livingston is the largest of the four lakes, received more visitors and more total visits in 1980 than the other three lakes. In addition, Livingston re-

[12]See note 4.

ceived the highest mean quality rating score of the four lakes. In 1980 Lake Conroe had a hydrilla problem which many of the respondents complained about. This probably reduced the quality rating score for this lake and affected the number of visits. This would also suggest that one would expect the surplus for Livingston to be larger than that for Conroe.

The difference between the two surplus estimates for the lake with the largest travel cost surplus estimate (Livingston) and the comparable estimates from the two methods for lakes with lower surplus values (Conroe and Houston) suggests that respondents may be more reluctant to reveal their true willingness to pay through a direct method when their surplus value is high (e.g., $100), but at lower levels this is not a problem. The results for Conroe and Houston are similar to those of Bishop and Heberlein who reported that they found values estimated with the travel cost method (travel time cost valued at zero) to be less than those estimated using a logit analysis. However, at least in this study, these differences are not significant.

Lake Somerville is the only lake of the four in the study at which no launch fees are currently charged. Both contingent valuation methods failed to produce downward sloping demand curves at this lake, the only one of the four lakes where this problem was encountered. This seems to add to the evidence that the contingent valuation instruments used to collect data for analysis must be designed so that behavior by the respondent is as familiar as possible (Rowe, d'Arge and Brookshire 1980). The design of the instrument is very important to the reliability of the results obtained from the contingent valuation method (Randall, Ives, and Eastman 1974).

Although further work in direct comparison of the travel cost and contingent valuation methods is needed, this study has provided some useful results. The open-ended form of the contingent valuation method has been shown to provide very low estimates of consumer's surplus, and the negative values found indicate problems with this approach. The close-ended form of the contingent valuation method and the travel cost method provided comparable estimates of consumer's surplus for all three lakes. When possible, the two methods should be used in future studies as a validity check on the consumer's surplus measures estimated.

References

Bishop, R. C., and Heberlein, T. A. 1980. "Simulated Markets, Hypothetical Markets, and Travel Cost Analysis: Alternative Methods of Estimating Outdoor Recreation Demand." Dept. Ag. Econ. Staff Paper No. 187, University of Wisconsin.

———. 1979. "Measuring Values of Extramarket Goods: Are Indirect Measures Biased?" *American Journal of Agricultural Economics* 61(Dec.):926–30.

Bradford, D. 1970. "Benefit-Cost Analysis and Demand Curves for Public Goods." *Kyklos* 23:775–91. 1970–Fasc. 4.

Brookshire, D. S.; Eubanks, L. S.; and Randall, A. 1983. "Estimating Option Prices and Existence Values for Wildlife Resources." *Land Economics* 58(1):1–15.

———; Ives, B. C.; and Schulze, W. D. 1976. "The Valuation of Aesthetic Preferences." *Journal of Environmental Economics and Management* 3(Dec.):325–46.

———; Randall A.; and Stoll, J. R. 1980. "Valuing Increments and Decrements in Natural Resource Service Flows." *American Journal of Agricultural Economics* 62(Aug.):478–88.

———; Thayer, M. A.; Schulze and d'Arge, R. C. 1982. "Valuing Public Goods: A Comparison of Survey and Hedonic Approaches." *American Economic Review* 72(Mar.):165–77.

Burt, O. R., and Brewer, D. 1971. "Estimation of Net Social Benefits from Outdoor Recreation." *Econometrica* 39(Sept.):813–27.

Cesario, F. J., and Knetsch, J. L. 1976. "A Recreation Site Demand and Benefit Estimation Model." *Regional Studies* 10:97–104.

Cicchetti, C. J., Fisher, A. C.; and Smith, V. K. 1976. "An Econometric Evaluation of a Generalized Consumer Surplus Measure: The Mineral King Controversy." *Econometrica* 44(Nov.):1259–76.

Clawson, M., and Knetsch, J. L. 1966. *Economics of Outdoor Recreation.* Baltimore: The Johns Hopkins University Press for Resources for the Future.

Commons, M. S. 1973. "A Note on the Use of the

Clawson Method for the Evaluation of Recreation Site Benefits." *Regional studies* 7:401–6.

Currie, J. M.; Murphy, J. A.; and Schmitz, A. 1971. "The Concept of Economic Surplus and Its Use in Economic Analysis." *Economic Journal* 81(Dec.):741–99.

Davis, R. K. 1963. "Recreation Planning as an Economic Problem." *Natural Resources Journal* 3(Oct.):239–49.

Domencich, T. A., and McFadden, D. 1975. *Urban Travel Demand a Behavioral Analysis*. Amsterdam: North Holland.

Dwyer, J. F.; Kelly, J. R.; and Bowes, M. D. 1977. "Improved Procedure for Valuation of the Contribution of Recreation to National Economic Development." Water Resources Center, University of Illinois, Research Report No. 128.

Freeman, A. M. III. 1979. "Approaches to Measuring Public Goods Demands." *American Journal of Agricultural Economics* 61(Dec.):915–20.

Gramlich, F. W. 1977. "The Demand for Clean Water: The Case of the Charles River." *National Tax Journal* 30(June):183–94.

Gum, R. L., and Martin, W. E. 1975. "Problems and Solutions in Estimating the Demand for and Value of Rural Outdoor Recreation." *American Journal of Agricultural Economics* 57(4):558–66.

Hammack, J., and Brown, G. M., Jr. 1974. *Waterfowl and Wetlands: Towards Bioeconomic Analysis*. Baltimore: The Johns Hopkins University Press for Resources for the Future.

Harvey, A. C. 1976. "Estimating Regression Models with Multiplicative Heteroskedasticity." *Econometrica* 44(May):461–65.

Hicks, J. R. 1943. "The Four Consumer's Surpluses." *Review of Economic Studies*. Winter:31–41.

Judge, G. G.; Griffiths, W. E.; Hill, R. C.; and Lee, T. C. 1980. *The Theory and Practice of Econometrics*. New York: John Wiley and Sons, Inc.

Knetsch, J. L. 1963. "Outdoor Recreation Demands and Benefits." *Land Economics* 39(Aug.):387–96.

Marshall, A. 1930. *Principles of Economics* (8th Edition). London.

McConnell, K. E. 1975. "Some Problems in Estimating the Demand for Outdoor Recreation." *American Journal of Agricultural Economics* 57(May):330–34.

———, and Strand, I. 1981. "Measuring the Cost of Time in Recreation Demand Analysis: An Application to Sportfishing." *American Journal of Agricultural Economics* 63(Feb.):153–56.

Prewitt, R. A. 1949. "The Economics of Public Recreation—An Economic Survey of the Monetary Evaluation of Recreation—The National Parks." Washington, D.C.: National Park Service (memo).

Randall, A.; Ives, B. C.; and Eastman, C. 1974. "Bidding Games for Valuation of Aesthetic Environmental Improvements." *Journal of Environmental Economics and Management* 1(Aug.):132–49.

———, and J. R. Stoll. 1980. "Consumer's Surplus in Commodity Space." *American Economic Review* 70(June):449–55.

Rosen, S. 1974. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." *Journal of Political Economy* 82(Jan./Feb.):34–55.

Rowe, R. D.; d'Arge, R. C.; and Brookshire, D. S. 1980. "An Experiment on the Economic Value of Visibility." *Journal of Environmental Economics and Management* 7(Mar.):1–19.

Schulze, W. D.; d'Arge, R. D.; and Brookshire, D. S. 1981. "Valuing Environmental Commodities: Some Recent Experiments." *Land Economics* 57(May):151–72.

Smith, V. K. 1981. "Congestion, Travel Cost Recreational Demand Models, and Benefit Evaluation." *Journal of Environmental Economics and Management* 8(June):92–6.

———, and Kopp, R. J. 1980. "The Spatial Limits of the Travel Cost Recreational Demand Model." *Land Economics* 56(Feb.):64–72.

Texas Parks and Wildlife Dept. Comprehensive Planning Branch. 1975. *Texas Outdoor Recreation Plan*. Austin: Texas Parks and Wildlife Dept.

Thayer, M. A. 1981. "Contingent Valuation Techniques for Assessing Environmental Impacts: Further Evidence." *Journal of Environmental Economics and Management* 8(Mar.):27–44.

U.S. Water Resources Council. 1979. "Procedures for Evaluation of National Economic Development (NED) Benefits and Costs in Water Resources Planning (Level C); Final Rule." *Federal Register* 44, No. 242, Part IX 72891–72976.

Willig, R. D. 1976. "Consumer's Surplus Without Apology." *American Economic Review* 66(Sept.):589–97.

Zellner, A. 1962. "An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias." *Journal of the American Statistics Association* 57:348–68.