VALUING NON-MARKET RECREATION GOODS: AN EVALUATIVE SURVEY OF THE LITERATURE ON THE TRAVEL COST AND CONTINGENT VALUATION METHODS

Garey Durden and Jason F. Shogren*

Introduction

Given competing public and private ends for natural environments, economists have advocated measuring the benefits and costs of alternative uses to ensure efficient resource allocation. The opportunity costs of devoting natural resources to public recreational use (foregone employment, wages, profit and income) are generally well known. Production costs of assimilating and making various facilities available can be estimated straightforwardly using imputed prices for capital, labor and material inputs. Recreational benefits from natural environments often are more elusive and difficult to measure. Many of the near limitless uses (hiking, sightseeing, boating, fishing) typically are unpriced by the market, except for small access fees or licensing restrictions.

The development of alternate means for measuring the benefits of non-marketed recreation goods has occupied many economists since the Flood Control Act of 1936.[1] In particular, the respective work of Hotelling in the 1940s, Clawson and Knetsch (1966), [Prewitt (1949)] and Davis (1963) in the 1960's laid the foundation for two currently used procedures, travel cost (TCM) and contingent valuation (CVM). The purpose of this paper is to survey and critically evaluate the literature on the two methods. Although both TCM and CVM provide consumer surplus measures generated from simulated market demand curves as the best estimates of social benefits, there are fundamental differences between the two.

In what follows, the travel cost and contingent valuation methods are explained and the advantages and disadvantages of each are discussed. This is done to provide guidance as to which method might be more appropriately used in a given situation.

The Travel Cost Method

The TCM is based on a model for predicting use of a recreation site or area by visitors from surrounding origins. The general model can be described by an expression such as:[2]

$$V_{ij} = f(C_{ij}, A_i, S_{ij}); \quad (1)$$

where:

V_{ij} = the number of site visits or trips per-capita from a population source or center i to a recreation site j.

C_{ij} = a vector of costs including direct travel between i and j, entry fees at site j, opportunity costs of time en route and opportunity costs of the length of stay at the destination.

A_i = a vector of taste and socioeconomic characteristics of visitors from origin i.

S_{ij} = an index of the proximity of substitute recreation areas available to visitors from each origin i.

Parameters of the model are estimated using information from a sample of visitors to existing sites. The model then is used to estimate expected visits over some time period at a series of "prices". The price or fee paid for using a given site is taken to be the (cost vector from equation (1)) direct and indirect travel expenses incurred. These expenses, of course, increase with distance and, ceteris paribus, decrease the ratio of visits to population from successively more distant origins. From the price/visitation relationships a travel demand curve is constructed.

The procedure is relatively straightforward. First, the model is applied to all appropriate origins (i) using actual data for trip cost (C_{ij}) and other variables of the model. The predicted use from all origins is summed to obtain an estimate of total use at zero price. It is then assumed that visitors will react to increases in user fees for a recreation site just as they do to travel cost increases. The imputed site user fee is incremented by fixed amounts (say $0.50) and the model used to estimate use over the relevant range of fee increases. The site demand curve is then plotted. Total consumer surplus is estimated as the area under this demand curve. This provides a measure of the

*The authors' have benefited from discussions with Tom Crocker, Ralph d'Arge, V. K. Smith, Jon Silberman, Reed Johnson, Karl-Goran Maler, Peter Bohm, Anders Carlsson, and Mark Dickie. An anonymous reviewer provided several useful suggestions. An earlier version of this paper was presented at the Southern Regional Science association meetings in 1983.

recreation benefits consumed by visitors to the site or sites.

Advantages of the Travel Cost Method

The TCM has had extensive application for measuring recreation benefits over the years. This is understandable because the method has certain very appealing qualities. In many cases the needed data already are available from visitor permits, surveys and the like. The method therefore is often relatively inexpensive. In addition, there is little need for the time consuming user contact necessary in some survey based studies such as contingent valuation, discussed below. Certain restrictions on original survey-based studies also are imposed by the Office of Management and Budget. Administrative red tape can lead to considerable delays.

Finally, if care is taken in constructing the travel cost and time cost variables, parameter estimates usually are statistically significant and R^2 values relatively high for cross-section estimates.[3]

Despite the appeal of the TCM and the widespread use and acceptance of the technique, many conceptual and econometric difficulties have surfaced. Some of these have been resolved, but others have not.

Disadvantages and Problems

Time Cost

As Cesario and Knetsch (1970) first pointed out, both out of pocket travel cost and the opportunity cost of time in travel should be considered in valuing recreation goods. Ideally, these variables should enter a regression separately. However, this approach almost always is complicated by the problem of multicollinearity since time variables usually are calculated as functions of distance. The solution is to monetize time cost and incorporate this into the "price" of traveling from the visitor origin to the recreation site. This approach has proved useful, but it entails the potential for bias.

Some important work on imputing values for time in travel has been done by Cesario (1976). Cesario reviewed a number of studies dealing with the problem and concluded that an appropriate "shadow" value would be between one fourth and one half the wage rate. However, as Freeman (1979, Chapter 8) points out, Cesario reached his conclusions primarily on the basis of trips to work. There is no reason to believe that the marginal utility of work travel is the same as that for recreation-related travel. If substantial differences exist between the perceived relative opportunity costs, the result will be biased recreation-value estimates.[4]

In addition, Bishop and Heberlein (1979) note that the wage rate of adults clearly overestimates what they could earn from second jobs and that if people were not traveling to the recreation site they probably would be engaged in some activity other than work. They consider the work of Cesario to be a beginning, but only a crude one.

Bishop and Heberlein provide empirical estimates that indicate that whether an opportunity cost factor of one fourth or of one half is used can make a substantial difference in value estimates. They also state, "TC requires that recreationists treat travel expenditures as equivalent to admissions costs, yet this is a questionable assumption that no one has examined empirically," (p. 926). Further, "A travel cost demand curve implicitly assumes that recreational quality remains constant over the range from zero use to full use at the going admission fee," (p. 927). Congestion and other quality conditions may vary as discussed below.

In a 1983 paper, Smith, Desvousges and McGivney provide an extensive and timely analysis that effectively models the problem of time cost. The model is based on a household production function and examines the implications of changes in enroute travel time and time on site, both within an opportunity cost framework. While the paper is not entirely successful in generating useful empirical information, the model clearly demonstrates that the opportunity cost of time has a complex impact that differs among individuals. The authors call for additional research based on the implications of the theory presented.

Bockstael, et al. (1987a) follow the example of Smith, et al. (1983) in providing a theoretical basis for the incorporation of time costs into the travel demand model. Bockstael, et al. model and solve the choice problem for two classes of individuals, those with fixed work commitments and those who can freely substitute work for leisure. The problem for the former is that they have two constraints, money and time. Each constraint must enter the demand function separately. For the latter group, the time constraint may be incorporated into that for money. With some adjustment, both theoretical constructs yield demand functions that Bockstael et al. test using 1983 data from a group of Southern California sports fishermen. The sample contained individuals who claimed flexible relationships between work and leisure as well as others who faced fixed work constraints.

The empirical results from the study by Bockstael, et al. were statistically strong and supported the expectation that recreation demand decisions are highly sensitive to time considerations. The importance of time was emphasized in that demand elasticities with respect to time were much higher than those for income and money-price. Finally, Bockstael, et al. note that the perceived welfare

loss of fixed-work individuals is different from the loss of those with variable work commitments.

For additional discussion and analysis of the time dimension in recreation demand see Willman (1980), Ward (1983) and Johnson (1983).

On the basis of these discussions, it is concluded that conceptual and empirical problems continue to plague the TCM with respect to travel cost. The more recent theoretical approaches obviously are superior to previous ad-hoc generalizations since they underscore the complex relationships between time and recreational choice. However, these articles also emphasize the difficulty in generalizing from any theoretical basis to the common recreational experience. The solution to the time-cost problem will continue to vary from case to case and researchers must be guided by a sense of what is practical. The potential for biased results remains and the prudent researcher will take care to err on the side of conservatism.

Congestion

Another problem with the TCM is that it generally is difficult or impossible to account empirically for the effects of congestion on consumer benefits. Recall, that TCM uses travel cost rather than direct user fees as a proxy for willingness to pay. Obviously, congestion will affect the utility associated with a given recreation experience and, consequently, the surrogate price [Fisher and Krutilla(1972), and Cicchetti and Smith (1976)]. If the TCM assumes no congestion or a constant congestion level when congestion exists and varies among individuals [Wetzel(1977)] or between time periods, then true benefits will be underestimated. Contrary to Wetzel, Anderson (1980) argues that using the TCM in cases with congestion yields a demand curve holding congestion constant at a level consistent with the observed level of use. The technique thus provides a correct estimate of welfare for this level of output, but overestimates the reduction of user-days when user fees are introduced.

Interesting extensions of congestion modeling have been introduced by Freeman and Haveman (1977), and Cory (1979-80; 1985). This literature explores the relationship between increasing income and increasing willingness to pay for reduced congestion. The inferences are that efficiency requires one approach to the application of user fees for recreation facility use while questions of equity introduce a mutually inconsistent consideration. The age-old question of equity versus efficiency will be an interesting one to watch as congestion theory is wedded to policy application.

The effect of congestion on willingness to pay is an important issue and one that continues to be controversial. Given the present state of the art, the TCM appears to be inferior to the more recently developed contingent valuation method (CVM) for incorporating congestion. The CVM can be used to examine directly the relationship between willingness to pay and the degree of observed congestion through on-site interviews [McConnell (1977)].[5]

Problems in Empirical Estimation

Functional Form

In a lively exchange Bowes and Loomis (1980), Christensen and Price (1982), Vaughan, et al. (1982) and Bowes and Loomis (1982) discuss problems of correct functional form that arise when zonal populations are unequal. Bowes and Loomis offer the following criticisms: a) ordinary least squares regression (OLS) may result in heteroskedasticity when using samples of varying sizes from each zonal area; b) the lack of variation in entry fees makes it impossible to estimate the true demand curve so that the TCM essentially is a contrivance; c) estimated trip costs may differ significantly from actual trip costs; d) the estimated number of trips at a zero price may grossly over- or underestimate the actual observed number; and e) predicted negative visits from distant zones must be set at zero, which is arbitrary and may not be appropriate.

Bowes and Loomis suggest that generalized least squares be used instead of OLS to deal with criticism "a" because this technique removes the problem of heteroskedasticity. They report that empirical estimates derived by these regressions vary widely. The OLS method estimated 1,083 trips and benefits of $77,728 when negative trips were set at zero (a commonly used practice). The GLS method estimated 211 trips (the actual number) and benefits of $24,073.

Vaughan, et al. (1982) criticize Bowes and Loomis for their naive acceptance of the TCM in linear form. They suggest that, instead of a-priori linear specification, the Bowes and Loomis data should be subjected to tests for linearity and heteroskedasticity. Using the recently developed Lahiri and Egy (1981) maximum likelihood test, Vaughan et al., reject the linear homoskedastic and linear heteroskedastic models in favor of a semilog model. Thus, it is the form of the model that causes the problem, and this is not solved by adopting the GLS procedure.

Christensen and Price (1982) suggest that Bowes and Loomis may be creating problems where they do not exist with respect to what they call "negative visits". "More analytically, the regression line has overestimated the actual positive visits from some nearer origins, and an unbiased estimate of total visits must compensate this by

underestimating from some distant origins," (p. 398).

More recently, Rosenthal and Anderson (1984) found that different heteroskedasticity problems are different among sampling techniques. A weighted least-squares approach is necessary, but the approach used must be adjusted for the different heteroskedasticity problems that arise when data are collected randomly at (1) the recreation site, (2) from individuals surrounding the site, and (3) from individuals holding licenses to participate in certain site activities such as hunting or fishing.

The question whether a linear, double log or a semilog specification is more appropriate has been discussed extensively in the literature. The use of a linear estimating model is not likely to be appropriate in any case [Vaughan, et al. (1982)]. Whether or not a double or semilog specification should be chosen may depend upon the problem being addressed. At least one study [Sutherland (1982)] finds the semilog to be superior in estimating ability, less sensitive to the definition of origin zone (10 or 20 mile concentric), more stable in measuring consumer surplus and a much better predictor of the number of visits at zero price. The prudent researcher will try both double and semilog models, using the criteria of Sutherland, before choosing the one most appropriate for the task at hand.

Substitute Sites

Another criticism that arises frequently is the effect of substitute vacation sites on value estimation using the TCM. Substitute sites obviously are important determinants of visits, but substitute site variables and travel cost to the site being examined usually are highly correlated. In addition, many, probably most substitutes are not known to the researcher. This probably is the main reason why the log-log or log-linear form explains more variation than the linear form in many studies [Vaughan, et al. (1982)]. However, substitutions of the non-linear form in estimation does not really solve the conceptual problems even though it may remove statistical bias and improve prediction and estimation.

One method that has had some success is overcoming the problem of controlling for substitute sites is the use of dummy variables. Even so, problems remain.

In a related empirical and theoretical area, the question arises whether or not it is necessary to derive a system of demand functions for the set of alternative recreation sites in order to estimate the benefits associated with the establishment of a new site. Responding to the "state of the art" paper by Cichetti and Smith (1976) that employs the simultaneous equation approach, Hof and King (1982) and Ward (1983a) argue that a simpler alternative can be employed which is theoretically less complex, generally much less expensive and subject only to small estimation error.

Hof and King state that, "In order to evaluate a single site with this approach (possibly proposed or existent), use data must be collected on all substitute and complementary sites. In contrast, if only the own demand function is regressed, then prices of substitutes and complements can still be included, based on travel distance, and use data need only be collected for the one site" (p. 547). Hof and King present a theoretical justification for their conclusion that (p. 552), "...when only one price change is involved and when cross-price terms are symmetrical, the use of the simple integral of the own recreation demand function is theoretically tenable." "If cross-price terms are not symmetrical, then neither the line integral nor the *simple* integral yield [sic] theoretically tenable results, but the error in the simple integral is likely to be small [Willig (1976)]. Thus it would appear that the usefulness of the multisite, travel cost model is not hurt terribly if only one site's demand curve is estimated and utilized at a time."

Multiple Purpose Visits and Varying Lengths of Stay

A crucial assumption of the TCM is that each trip is undertaken for a single purpose [Smith and Kopp (1980)]. This is obviously not true for many recreational experiences. A beach, for example, provides swimming, sunbathing and fishing but many users also visit nearby tourist attractions, relatives or friends. How much of the benefit derived from the TCM should be assigned specifically to the beach visit? Without direct information based on contact interviews, this proportion must be determined arbitrarily.

Articles by Ward (1984) and Kealy and Bishop (1986) note that implicit assumptions underlying benefit estimation can lead to significant overestimation of consumer surplus. Specifically, Ward notes that recreationists from relatively distant origins may substitute more time at a given site and take fewer trips than others. If these factors are not accounted for in the estimation procedure the estimated travel cost coefficient (Bc) will be an upwardly biased estimate of the unobserved coefficient (Bp) which explains visits as a function of user fees. To solve the problem, Ward suggests that a three-equation recursive system be estimated. In addition to the standard trip-generation equation, estimates of endogenous money (on-site money expenditures) and time (discretionary on-site time) can be used to adjust the coefficient on the travel cost variable. The result will be that Bp=Bc and another source of bias will be removed.

The Kealy-Bishop paper extends the traditional model to include the demand for on-site days and provides

a useful addition to the literature. Recreationists times number of days on site gives a better indication of the value of the recreational experience. The number of days spent at a given facility by recreationists is not always available but Kealy and Bishop provide, at minimum, another avenue through which possible biases in the TCM may be recognized and improvements in benefit estimation made. When the length of stay per trip is known, a new problem arises. Specifically, how may single trips with several days on site be reconciled with several trips with one or two days on site? Wilman (1987) suggests that the trip/days per visit decision be "repackaged" into an equivalent measure in which the visitor takes one trip and stays the average number of days observed in the visitor population. The new "package" trip/stay choice is a constant number of days per trip at each point on the demand curve.

For example, if the average days observed per trip is three (as in the Wilman data), all one and two-day visits must be transformed to their three-day equivalent. A constant 3-days per trip demand curve then can be estimated.

Wilman develops a straightforward theory of the repackaging process that assumes that visitors want to minimize the cost of an optimal package of one trip, n days. For details in addition to the Wilman paper, see Muelbauer (1974).

For additional discussion of statistical, conceptual and econometric problems, see Brown and Nawas (1973) on aggregation bias; Wetstein and McNeely (1980) and Allen, et al. (1980) on specification error; Ziemer, et al. (1980) on the choice of functional form and, Smith and Kopp (1980), Strong (1983) and Sutherland (1982) on problems associated with zonal population size, non-nested hypotheses and other limitations associated with spatial considerations. Also important are Ward (1984), Ward (1986), Green (1986), and Caulkins, et al. (1985) on biases associated with misspecification of own-price and omission of cross-price effects; Stynes, et al. (1986) on log-transformation bias and, especially, Bockstael and Strand (1987) on common sources of regression error in benefit measurement.

This brief survey provides some insight into the theoretical and empirical problems associated with using the travel cost method for estimating recreation benefits. This discussion is not intended to suggest that the TCM is an inappropriate method. Instead, the intention is to help researchers achieve the best results possible in given measurement situations. Once again, however, practicality often must be the bottom-line guiding consideration. Even so, these discussions should be useful in the often-necessary qualification of empirical results.

Because of the problems associated with the TCM and its inapplicability to limited travel activities and to some non-recreational goods (e.g.pollution control),the contingent valuation method has evolved as a major alternative for benefit estimation with respect to non-marketed goods. A discussion of the method of contingent valuation is presented below.

Contingent Valuation Method[6]

The contingent valuation method (CVM) estimates the economic benefit of a non-market good through construction of a hypothetical market. The hypothetical market creates an auction in which the non-market good can be bought and sold. The market is framed so that features of non-hypothetical markets and institutions are used as mechanisms to reveal demand for the non-market commodity. By carefully constructing understandable demand-revealing mechanisms, economic benefits are ascertained through a survey or interview that elicits from each respondent an implicit price for the good: i.e., a maximum willingness to pay (WTP) for provision of the good or a minimum willingness to accept compensation (WTA) for removal of the good.[7]

To avoid misrepresentation of preferences, several demand-revealing mechanisms have been developed. The payment vehicle in each demand-revealing mechanism usually is in the form of higher taxes, increased user fees, or higher prices. The first mechanism is the open-ended direct question, "How much would you pay ...?" without cues from the interviewer. Some of the earlier CVM studies such as Hammack and Brown (1974) used the direct question mechanism. The direct question has been criticized because respondents often are not sufficiently familiar with the non-market commodity to provide an accurate, definitive WTP. To avoid the above criticism, payment cards with monetary anchors (i.e., taxes per year, access fee) have been developed to provide more information about the market.[8] Using these, the respondent is asked to pick a definitive WTP from those listed on the payment card.

The second mechanism is the iterative bidding process [see, e.g.,Randall, et al.(1974)]. Two general bidding games exist. In the first game, a respondent is asked to state a definitive WTP. The interviewer then asks if the respondent is willing to pay X percent or $X more than the definitive bid. If the response is affirmative, the process continues until the respondent will not go any higher. The highest value stated then represents the true WTP of the individual for provision of the non-market good. In the second game, the respondent accepts or rejects a stated value. The respondent is asked "Would you pay $X?" If the response is affirmative, the interviewer raises the

hypothetical fee by some arbitrarily chosen increment until the respondent will not go higher. If the initial response is negative, the interviewer lowers the hypothetical fee until agreement is reached.

The third mechanism is the "closed-ended" direct question in which the respondent is asked whether or not he would accept or pay a single specified amount. This dichotomous choice approach to a "take-it or leave it" (yes/no) response has been used with success by Bishop, et al. (1983), Loomis (1987), Cameron and James (1987) and Bowker and Stoll (1988). The advantage of the closed-ended question is that it approximates the situation that most consumers face in usual market transactions, i.e., take-it or leave-it at the posted price. In addition, the closed-ended approach avoids asking the respondent to provide a "true" value of the good, and the potential bias of establishing the starting point in the bidding process. Empirical examination of the closed-ended approach requires use of a qualitative regression model such as Logit, Probit, or Weighted maximum likelihood estimation. See Cameron and James (1987) and Sellers, et al. (1986) for a discussion of interpreting the estimated coefficients of the qualitative model as regression coefficients. See Boyle and Bishop (1988) for an empirical comparison of the first three mechanisms.

The fourth mechanism was developed by Peter Bohm of the University of Stockholm. Bohm (1979, 1984) argues that preference discovery can be improved by utilizing two demand-revealing methods simultaneously to estimate a confidence interval of WTP. The "interval method" structures incentives so that a random sample of, say, 50 percent of the respondents would underreport individual WTP, while the remaining respondents would overreport WTP. Doubling the aggregate response from each group provides lower and upper bounds on the true aggregate WTP. If the interval lies above (below) the cost of provision dictated by the Pareto criterion, the non-market good would (would not) be provided. Bohm (1984) tested the interval method in a non-hypothetical and non-laboratory experiment with satisfactory results.

Finally, the fifth mechanism is the recent field application of the Smith auction process traditionally reserved for the laboratory [Brookshire and Coursey (1987)]. The Smith Auction process, developed by Vernon Smith (1980, 1982), has had great success in revealing preferences for nonmarket goods in experimental laboratory settings,and holds promise for use in CVM analysis. The field auction involves collecting bids from respondents and applying the criterion that, if the sum of the bids of all respondents equals the cost of provision of the non-market good, then the respondents will pay their bids or pay proportionally scaled back amounts if the sum of the bids exceeds costs. If the bids do not equal costs, the non-market good will not be provided. Since it presents information to the respondents about the bids of other respondents, the Smith Auction is a more realistic mechanism of traditional non-market good provision, and therefore provides a better estimate of value.

To explain the WTP of respondents, the interview process determines income, socio-economic information, subjective variables such as perceived quality of the recreation facility, number of trips per period, length of visit, years of experience with the facility, parking cost and availability, and perceived availability and quality of substitutes. The independent variables then are regressed (e.g. by ordinary least squares, Tobit, maximum likelihood estimates) on willingness to pay. Information from the regression estimates is used to determine total consumer surplus given total use and characteristics of the user population. Forecasts of expected consumer surplus values for future changes in the recreation facility (expansion, quality changes) or for changes in user characteristics also may be made.

Advantages of the Contingent Valuation Method[9]

A well-structured non-market valuation technique allows respondents to solve their own trade off problems if the trade off is defined so that the respondents will interpret the problem identically. A major advantage of defining a trade off problem using CVM is that the contingent valuation experiments are comparatively flexible, inexpensive to conduct, and can construct markets where none exist [Brookshire and Crocker, (1981)]. The market structure and institutions of the trade off can be manipulated easily to conform to the needs of the researcher. Quantity and quality dimensions such as temporal context, spatial dimensions, property right entitlements, and stochastic reference points can be varied in a conscious experimental design strategy. The substance of contingent questionnaires can be made to reflect specific policy requirements. Since contingent markets do not rely on the actual delivery of goods and services their use is not limited to cases in which delivery is feasible and convenient.

Another advantage, perhaps the most important from the view of economists, contingent valuation data can be generated in a manner consistent with the theory of individual choice and welfare measurement [Bradford (1970), Graham (1981), Smith (1987)]. Generally, individual choice and welfare change can be measured either from a planned expenditures perspective (ex ante) or from a realized costs view (ex post) [See Buchanan (1969)]. In a world of complete Arrow-Debreu contingent claims contracts, the distinction between the ex ante and ex post views

would be immaterial. Complete contingent contracts rarely if ever exist for non-market goods, however, implying that the distinction between ex ante and ex post views is relevant. Therefore, since individual consumption decisions inherently are ex ante, planned expenditures and not realized outcomes explain individual choices [Helms (1985)]. Consequently, CVM has the advantage over indirect valuation methods (e.g., TCM) in that only CVM captures the increasingly accepted view that ex ante planned expenditures are the correct measure of individual choice and welfare change.

In addition, the contingent valuation method has several advantages over such indirect valuation methods as the travel cost method. First, the CVM can elicit both user and nonuser values, thereby determining a complete ex ante measure of value for a nonmarket good. User values are simply the values individuals place on current use of a resource. User values are captured by both the CVM and TCM. Nonuser values are values individuals place on future use or on the existence of the nonmarket good. Nonuser values are not revealed by the indirect methods since indirect methods capture only current consumption. The CVM captures nonuser values since CVM can construct markets for future use through institutional mechanisms that reveal individual preference for time and space.

The most commonly discussed nonuser values are option value, existence value, and bequest value.[10] Option value is the premium an individual would pay beyond expected consumer surplus to ensure future provision of a non-marketed good [Weisbrod (1964), Bishop (1982)]. Essentially, an option value is a risk premium to preserve the right to future access. The literature on establishing the size and sign of option value is substantial and will not be reviewed here; the reader is referred to Smith (1983) and Freeman (1985). Any existence value is simply the value individuals place on knowing that some nonmarket good exists in the environment [Krutilla (1967), Brookshire, et al. (1986)]. Bequest value is the desire of current generations to ensure that future generations will have access to non-marketed goods, thus it is an intergenerational option value.[11] Although nonuse values typically have not been well motivated, they point out how the flexibility of CVM can be an advantage in determining a complete ex ante measure of value [see Madariaga and McConnell (1987)].

Second, although the market is hypothetical, CVM is a direct method of collecting value data. By comparison, indirect methods are considerably inferior with respect to the relationship between theory and the related empirical analysis.[12] Other advantages that the CVM enjoys over indirect methods include: (1) consideration of small changes in quality at existing sites that might not affect travel costs or the number of visits; (2) the value of the site being examined more easily can be determined independently of side trips to other destinations; (3) the effects of crowding or other subjective conditions can be evaluated; (4) large numbers of visitors may come from the immediate area (at zero or invariant travel costs) so that the TCM is an inappropriate device [Also see Duffield (1984)].

Disadvantages and Problems[13]

Despite rather widespread and growing use, the CVM is not without drawbacks and detractors. "Since the seminal article by Samuelson (1954), general agreement among economists suggests that any direct effort to value public goods will be plagued by the incentive structure facing individual consumers encouraging them to misrepresent their true preferences." [Brookshire, et al. (1981): p. 135]. Fromm (1968) and many other economists believe that hypothetical questions asked in evaluating contingent markets generate invalid value estimates. Consumers believe that they would do just as well by bidding zero or lower than the true value and letting someone else pay.[14] This is the classic argument as to why markets fail to provide the optimal quantity of public or quasi-public goods or, in the case examined here, of any non-marketed good.

Certain more specific concerns about the value of information from contingent markets have arisen and must be addressed. Included are concerns that inaccurate valuations may result either from incentives in the survey instrument (framing biases) or from structural characteristics (procedural biases) of the survey instrument. Framing biases include strategic bias, information bias, and instrument bias. See Tversky and Kahneman (1981) for a general discussion on framing and individual choice.

Strategic Bias

Strategic bias may arise if respondents systematically over- or understate the true value of the non-market good. For example, if users are asked how much they would be willing to pay for using a recreational facility they might overstate WTP if they thought the costs would be borne by someone else. Their behavior would be to understate if they thought they actually might have to pay. Thus individuals have two incentives to behave strategically. They can either become free-riders and gain benefits and avoid costs, or try to influence the outcome in ways perceived to be individually beneficial.

Users of CVM traditionally believed that if respondents think that their answers will influence policy decisions, then strong incentives for strategic bias exist. Consequently, hypothetical surveys may obtain incorrect

responses [Freeman (1979)]. Hoehn and Randall (1987) have questioned this view, however, arguing that incentives for more careful value formation exist when respondents perceive the experiment as meaningful to policy makers. By examining a type of incentive-compatible Smith auction process wherein the policy is implemented with unanimity among respondents, Hoehn and Randall argue that truth-telling is the optimal strategy for the respondents. Hoehn and Randall note that if the respondents see the exercise as meaningless, they may give little serious thought to answering value questions accurately. If so, the usefulness of such data would be diminished. [Also see Mitchell and Carson (1987)].

Information Bias

Information implicitly or explicitly passed on to respondents may bias their willingness to pay response. If respondents are not given enough information about the quality of the site being examined and the available substitutes, biased value estimates may result. For example, beach users might offer low bids thinking that nearby sites are good substitutes. In a real situation, however, the individual might try alternatives in the face of actual fees but find these unsatisfactory. He then might be willing to pay a higher user fee than would be supposed in the hypothetical situation. The point is that information gained in real market experiences conditions consumers behavior. In that regard, designers of contingent market experiments should be careful and thorough in developing the information to be provided.

Hoehn and Randall (1987) note that by definition the value chosen by an individual's is dependent on the policy design institutions and payment mechanism. No unique value of amenity changes is formed independent of these institutions. Therefore, differing policy implementations and payment mechanisms cannot be interpreted as information bias, but simply as conditional valuations under differing contexts.

Instrument Bias

Characteristics of the survey instrument that may lead to bias include the selected payment vehicle and the starting point for initiating the bidding process. Studies have shown that bids may differ when different means of payment are used [Randall, et al. (1974)]. For example, fee payments and changes in taxes to pay for a non-marketed good may not result in the same value estimates.

The value of the point at which the iterative bidding process is begun may influence the final bid. The starting bid may suggest an "appropriate" value range for the good. Thus, responses may differ with the value of the starting bid. In addition, if the starting point differs greatly from the true preference or if incremental changes are too small, the respondent may become bored and stop the process short.

Procedural Bias

Any survey approach is subject to sampling bias, non-respondent bias and interviewer bias. Any of these biases can affect adversely the results obtained from contingent markets. Since their potential and qualities are well known, they are not discussed in detail here. See Edwards and Anderson (1987) and Nowell, et al. (1988) for *enlightening* discussions of these "neglected" CVM biases.

How Serious Are Contingent Market Biases?

The biases that might accompany contingent market valuation have the potential for limiting the usefulness of the technique. This emphasizes the obvious need for research designed to discover whether the biases are present. A drawback to such research is that direct comparisons of contingent market and market valuations for the same good often are not available. If real markets existed for most goods examined in contingent markets the latter would not be needed in the first place.

The empirical evidence from existing CVM studies on potential biases is encouraging but far from conclusive. Evidence can be found to support or reject most types of bias. One of the first studies that attempted to deal with the problem of strategic bias in non-market valuation was that of Bohm (1972). He used a non hypothetical laboratory experiment that elicited payment for a nonmarket good (public TV), and found no evidence of strategic behavior. However, in a related experiment where the conditions were hypothetical he did find evidence of strategic behavior. Babb and Scherr (1975) used an experimental setting and three different mechanisms to reveal value and two publicly provided commodities: a concert fund and a library fund. They found little evidence of strategic behavior. Brookshire, et al.(1976) and Blank, et al. (1977) tested for strategic behavior with respect to valuation of changes in environmental conditions. Specifically, they asked respondents were asked to value changes in emissions from coal-fired electric generating plants. Both studies concluded that strategic bias was not evident. In addition,Schulze, et al. (1981) reviewed six CVM studies and found no evidence of rampant strategic behavior.

On the other hand, Rowe and Chestnut (1983) reviewed five CVM experiments and found positive or at least ambiguous evidence of strategic behavior. Evidence of strategic behavior also was found by Bennett (1987) in

a laboratory experiment designed to test the direct question and the Smith auction process CVM payment mechanisms. Bennett determined that respondents overestimated value using the direct question and underestimated value using the Smith auction process. Bennett concluded that perhaps a combination of the two mechanisms offers the most potential for revealing the value of nonmarket goods.

The evidence on information bias also is ambiguous. Rowe, et al. (1980) attempted to test iterative bidding as a source of bias. They discovered that information bias and, in some instances, strategic bias can distort values derived through the iterative bidding technique. Schulze, et al. (1981) reported little evidence of information bias in six studies. Studies designed to discover evidence of instrument bias [Randall, et al. (1978) and Brookshire, et al., (1980)] failed to do so. Several studies have explored whether starting point bias exists. Here the result is somewhat mixed. Thayer and Schulze (1977) and Randall, et al. (1978) found no evidence of bias, while Blank, et al. (1977) suggest that it is significant. Finally, Boyle, et al. (1985) found encouraging evidence of no starting point bias where the experiments were non-hypothetical auctions.[15]

In summary, the evidence for the existence of damaging biases with respect to valuation in contingent markets is mixed. The authors agree with what seems to be a developing consensus in the literature. Specifically, CVM needs additional study and analysis. This includes not only tests for biases but also refinement of theory and empirical techniques. However, CVM is an important tool for valuing non-market goods. In many cases it is the superior tool among the alternatives.

In light of the potential biases, Cummings et al. (1986) suggest the following reference operating conditions (ROC) to help facilitate formation of accurate values of non-market goods:

1. Respondents must understand and be familiar with the commodity to be valued.
2. Respondents must have had or be allowed to obtain prior choice experience at valuing the consumption levels of the commodity.
3. There must be little uncertainty to avoid distortions from respondents using heuristic decision devices.[16]
4. Willingness to pay bids should be elicited, not willingness to accept.[17]

Experimental Economics and CVM

Since the original experiments of Bohm (1972), there has been renewed interest in the use of non-hypothetical laboratory experiments to isolate and control potential biases associated with CVM [Coursey and Schulze (1986), Coursey (1987), Shogren (1988)]. As pointed out by Hoffman and Spitzer (1985), laboratory experiments "provide the cleanest possible test of fundamental theories in economics" since experiments can control for real world noise, and match individual preferences with theory by structural incentives. Due to the generation of substantial and inexpensive data, laboratory experiments offer an alternative to field experiments that are plagued by many unrecognizable errors.

The attractiveness and validity of CVM can be increased with expanded emphasis on laboratory experiments that isolate and control potential biases prior to field experimentation. Through experimenter control, potential biases can be examined faithfully in a scientifically based framework of rigor and repetition. CVM also can be improved by verification through repeated application and comparison, and extensive pre-testing of payment vehicles and other instruments.

Researchers in experimental economics have developed and examined several institutional demand revealing mechanisms to elicit individual preference for nonmarket goods. For example, the oral and sealed bid auctions described in Smith (1982) and the first price and second price auction described in Coursey and Schulze (1986) have been examined extensively in laboratory settings. However, their application to field experimentation still is in its infancy [see Brookshire, et al. (1987), Dickie, et al. (1987), and Brookshire and Coursey (1987)]. One interesting area for future research is the trade off when a mechanism facilitates value formation but increases participation costs to the respondent.

Bohm (1984) has set forth two criteria for assessing a mechanism to reveal preferences for non-market commodities: (1) the method must be simple, and (2) the results derived must be easy to verify. The first criterion is satisfied by the CVM since the technique is straight forward [Bennett (1987)]. It is expected that the second criterion will be satisfied by continuing experimental replication and verification of the CVM techniques. As replication and laboratory experiments increase, more and more refinement and wider acceptance of the contingent valuation method appear likely.

Choosing A Valuation Method[18]

In choosing between the travel cost and contingent valuation methods, it must be recalled that both methods require three basic underlying assumptions [d'Arge (1985)]. First, the underlying axioms of welfare economics are valid or closely approximated. Second, the WTP bid is not unique, but can be generalized over time, space, and environmental characteristics. Third, the method is scien-

tifically valid and entails no potentially damaging biases. How well a method satisfies these assumptions should dictate its acceptance or rejection by cost-benefit practitioners and policymakers.

The first assumption is satisfied better by the CVM than by the TCM for one primary reason. Both methods estimate consumer surplus; the TCM estimates a Marshallian measure while the CVM estimates Hicksian equivalent and compensating measures. Economists recently have preferred the Hicksian equivalent surplus measure since it is a money equivalent of a utility change induced by provision of the good. This is the closest thing to a quantitative measure of changes in utility that is available [McKenzie and Pearce (1982)]. Since this is the case, CVM would seem to have the advantage. In defense of TCM, the Marshallian surplus measure closely approximates the equivalent and compensation measures when the income effect is small [Willig (1976)]. The Willig argument fails, however, if provision of a nonmarket good induces large implicit price changes, and thereby induces potentially large differences in welfare measures [Hanemann (1980)].

The second assumption is satisfied better by CVM due to its greater flexibility. The CVM can structure the hypothetical market so that time and space are the exact dimensions of the problem at hand. The TCM, however, is restricted to the temporal and spatial dimensions of the current visit.[19] Extrapolating beyond those current dimensions is difficult and often leads to oversimplification. The CVM can estimate nonuser values that capture the willingness of individual's to pay for guaranteed future access by themselves or others.

Although both the TCM and CVM have bias problems, the third assumption arguably is better satisfied by TCM. The biggest asset of the TCM is its use of actual market data: the biggest weakness of the CVM is its reliance on hypothetical data. "Hypothetical markets generate hypothetical willingness to pay bids" is a common reaction among doubtful economists. However, continued experimentation and verification in laboratory settings will give greater credence to CVM.

Every recreational good is unique. The reader is left to use his/her own judgment in deciding which assumptions are most important, and which method best estimates the economic value of recreational goods.

Notes

[1]The term "non-marketed goods" is used advisedly because many of these are not really public goods of the type described by Samuelson (1954). Public projects frequently result in recreation use increases that do not stem from pure public goods. For example when a dam transforms a river into a lake, the exclusion principle could be applied to most users and the free-rider problem reduced or eliminated. Public beaches certainly could be used profitably by the private sector. Society has chosen to place beaches, reservoirs and the like in the public sector because a short-run maximizing market system may use those resources in a way that is inconsistent with their long-run optimal use from a societal point of view [Weisbrod (1964), Burt and Brewer (1971)].

[2]The model delineated here is ad-hoc and considerably abbreviated. For a more sophisticated treatment that contains one of the first attempts at relating the TCM to utility maximization theory, see McConnell (1975). Chapter six in the excellent book by Freeman (1979) provides more detailed information and analysis. Also see Mendelsohn (1987), Bockstael, et al. (1987b), and Brookshire and Smith (1987).

[3]Sinden and Wyckhoff (1976) point out that this is not always true. Thus, if a survey is necessary (as would have been the case in order to incorporate day users and campers into our model) the results could be meaningless.

[4]In a related issue concerning the components of time McConnell (1975) has argued that the opportunity cost of time at the site also is a part of the visit cost. If so, relevant information should be included in the TCM estimates; see also the exchange between Cesario and Knetsch (1976) and McConnell (1976).

[5]Also of interest in the analysis of congestion for various types of activity are articles by McConnell and Duff (1976), Deyak and Smith (1978), and Stevens and Allen (1980).

[6]Originally called bidding games or survey methods, the CVM derived its name during discussions between Tom Crocker, Ralph d'Arge, David Brookshire, William Schulze and colleagues at the University of Wyoming during the late 1970s. Admittedly an early skeptic, Crocker argued that designing hypothetical markets for non-market goods attempts to approximate the Pareto optimal Arrow-Debreu world of complete contingent claims contracts; hence the name contingent valuation.

[7]Applications of the CVM range from estimating the value of water quality [Smith and Desvousges (1986), d'Arge and Shogren (1988)], Atmospheric Visibility [Rowe et al. (1981), Crocker and Shogren (1987)], hunting [Hammack and Brown (1974), Bishop, et al. (1983)], forest stock [Crocker (1985), Bojo (1985), Kristrom (1988)], air pollution [Brookshire, et al. (1981), Strand (1985)], beaches [McConnell (1977), Durden and Silberman (1983)], national recreational fishing [Russell and Vaughen (1982)], to wilderness [Walsh, et al. (1984)].

[8]Rowe et al. (1980) used market information in their CVM survey design. After soliciting an initial bid, each respondent was allowed to adjust his bid based on new market information (e.g., the mean bid of other respondents). Since Rowe et al., however, the use of new market information for bid adjustment has not been addressed. The rapid value formation results in lab experiments of Shogren (1988) on the value of risk reductions indicate that the

neglect is unjustified, and further field CVM experimentation on "second-chance" bidding is warranted.

[9]This section draws on similar discussions found in Dwyer, et al. (1977), Randall and Hoen (1982), Cummings, et al. (1986), and Mitchell and Carson (1987).

[10]These three nonuser values have been lumped together and referred to as preservation value [Sutherland and Walsh (1985)], guardian value [d'Arge (1985)], access value [Crocker (1986)], and intrinsic value [Fisher and Raucher (1984)]. The three types of nonuser values, however are in no way the full spectrum of values derived from nonmarket goods [see Ralston (1985)]. However, the wide array of values suggested by Ralston (e.g. religious, scientific) are difficult to place in an economic context. This leaves open an interesting area for future research.

[11]Examples of empirical estimates of nonuse values include Brookshire, et al. (1983), Walsh, et al. (1984), Bennett (1984), Crocker and Shogren (1987), and Boyle and Bishop (1987).

[12]McConnell (1975) attempts to develop a theoretical base for travel cost estimates, but was not entirely successful.

[13]This section draws on similar discussions in Brookshire, et al. (1981), Brookshire and Crocker (1981) and Schulze, et al. (1981), Cummings, et al. (1986), and Mitchell and Carson (1987).

[14]On a technical note, if a large number of WTP bids are truncated at zero, Tobit estimation is required to explain bidding [Crocker (1985)]. Tobit estimation derives a regression line using all data, even observations at the limit (zero bid). Tobit coefficients provide information on changes in probability of being above the limit and changes in the value of the dependent variable if it is already above the limit [see McDonald and Moffit (1980)].

[15]As noted in Crocker and Shogren (1987), abundant evidence, both in economics (e.g. Markowitz (1952)) and psychology (e.g. Tversky and Kahneman (1981)) exists that the decision problem of individuals is solved conditional on a reference point rather than with respect to final wealth. Therefore, if the experimenter chooses the reference point and the respondent chooses the value estimate, value estimates are comparable across individuals. If the respondent chooses both the reference point and value estimation, however, the reference point is unobservable and the value estimates are noncomparable. Consequently, a finding of starting point bias fails to invalidate the reference point view of decision-making.

[16]For a discussion of heuristics and decision making under risk and uncertainty see Tversky and Kahneman (1981).

[17]Although theoretically equivalent, there is an often-noted empirical divergence between the WTP and WTA measures of value [see for example Knetsch and Sinden (1984)]. The disparity in WTP and WTA can be explained by (i) the different entitlement implications, or (ii) by noting that WTP measures are subjectively bound by the income of respondents while WTA bids are not and lead to unbounded responses. Therefore, Cummings, et al. (1986) advise against the use of WTA. For an opposing view see Gregory and McDaniels (1987) who argue that, even with its difficulties, WTA should not be ignored.

[18]See Cummings, et al. (1986) for a detailed description of four empirical comparisons of the TCM and CVM approaches. The four studies include Knetsch and Davis (1966), Bishop and Herberlien (1979), Desvousges, et al. (1983) (or *Smith, et al.* (1986)), and Sellers, et al. (1985). However, since there is no true benchmark of value, these empirical comparisons often raise more questions than they answer. As noted by Gregory and Furby (1987) the empirical comparisons "suggest shared flaws rather than parallel strengths" (p. 275).

[19]See Loomis, et al. (1986) for a discussion of spatial implications of the CVM and TCM approaches.

References

Allen, P. G., Stevens, T. H. and Barrett, S. A. (1980). "The Effects of Variable Omission in the Travel Cost Technique." Land Economics, 57: 173-179.

Anderson, L. G. (1980). "Estimating the Benefits of Recreation Under Conditions of Congestion: Comments and Extension." Journal of Environmental Economics and Management, 7: 401-406.

Babb, E. M. and Scherr, B. A. (1975). "Pricing Public Goods: An Experiment with Two Proposed Pricing Systems." Public Choice, 23: 25-48.

Bennett, J.W. (1984). "Using Direct Questions to Value the Existence Benefits of Preserved Natural Areas." Australian Journal of Agricultural Economics 28: 135-152.

_____. (1987). "Strategic Behavior." Journal of Public Economics 32: 355-368.

Bishop, R. C., and Heberlein, T. A. (1979). "Measuring Values of Extra Market Goods: Are Indirect Measure Biased?" American Journal of Agricultural Economics, 61: 926-930.

_____. (1982). "Option Value: An Exposition and Extension." Land Economics, 58: 1-15.

_____, Heberlein, T. A., and Kealy, M. J. (1983). "Contingent Valuation of Environmental Assets: Comparisons with a Simulated Market." Natural Resources Journal 23: 619-633.

Blank, F., et. al. (1977). "Valuation of Aesthetic Preferences: A Case Study of Economic Value of Visibility." Research Report to the Electric Power Research Institute, Resource and Environmental Economics Laboratory, University of Wyoming, Laramie.

Bockstael, N. and Strand, I. (1987). "The Effect of Common Sources of Regression Error on Benefit Estimates." Land Economics 63: 11-20.

_____, Strand, I., and Hanneman, M. (1987a). "Time and the Recreation Demand Model." American Journal of Agricultural Economics 69: 293-302.

_____, Hanemann, W. M., and Kling, C. L. (1987b). "Estimating the Value of Water Quality Improvements in

Recreational Demand Framework." Water Resources Research 23: 951-960.

Bohm, P. (1972). "Estimating the Demand for Public Goods: An *Experiment.*" European Economic Review, 3: 111-130.

_____. (1979) "Estimating Willingness to Pay: Why and How?" Scandinavian Journal of Economics, 81: 142-153.

_____. (1984). "Revealing Demand for an Actual Public Good. Journal of Public Economics, 24: 1-17.

Bojo, J. (1985). "Kostnadsnyttoanalysis av Fjallnara Skogar (Cost-Benefit Analysis of Mountain Forests). EFI. Stockholm School of Economics. Stockholm, Sweden. Mimeo.

Bowes, M. D., and Loomis, J. B. (1980). "A Note on the Use of Travel Cost Models with Unequal Zonal Populations." Land Economics, 56: 465-470.

_____, and Loomis, J. B. (1982). "A Note on the Use of Travel Cost Models with Unequal Zonal Populations: Reply." Land Economics, 58: 408-410.

Bowker, J. M. and Stoll, J. R. (1988). "Use of Dichotomous Choice Nonmarket Methods to Value Whooping Crane Resource." American Journal of Agricultural Economics 70: 372-381.

Boyle, K., Bishop, R. and Welsh, M. (1985). "Starting Point in the Contingent Valuation Bidding Games." Land Economics, 61:188-194.

_____ and Bishop, R. C. (1987). "Valuing Wildlife in Benefit-Cost Analysis: A Case Study Involving Endangered Species." Water Resources Research 23: 943-950.

_____ and Bishop, R. C. (1988). "Welfare Measurements Using Contingent Valuation: A Comparison of Techniques." American Journal of Agricultural Economics 70: 20-28.

Bradford, D. F. (1970). "Benefit Cost Analysis and Demand Curves for Public Goods." Kyklos, 23: 667-791.

Brookshire, D. S., Ives, B. C. and Schulze, W. D. (1976). "The Valuation of Aesthetic Preferences." Journal of Environmental Economics and Management, 3: 325-346.

_____, Randall, A. and Stoll, J. (1980). "Valuing Increments and Decrements in Natural Resource Service Flows." American Journal of Agricultural Economics, 62: 478-488.

_____, and Crocker, T. D. (1981). "The Advantages of Contingent Valuation Methods for Benefit-Cost Analysis." Public Choice, 36: 235-252.

_____, d'Arge R., Schulze, W. D. and Thayer, M. A. (1981). "Experiments in Valuing Public Goods." Advances in Applied Microeconomics, V. K. Smith, ed., JAI Press.

_____, Eubanks, L., and Randall, A. (1983). "Estimating Option Prices and Existence Values of Wildlife Resources." Land Economics 59: 1-15.

_____, Eubanks, L. S., and Sorg, C. F. (1986). "Existence Values and Normative Economics: Implications for Valuing Water Resources." Water Resources Research 22: 1509-1518.

_____, Coursey, D. L., and Schulze, W. D. (1987). "The External Validity of Experimental Economics Techniques." Economic Inquiry 25: 239-250.

_____ and Coursey, D. L. (1987). "Measuring the Value of a Public Good: An Empirical Comparison of Elicitation Procedures." American Economic Review 77: 554-567.

_____ and Smith, V. K. (1987). "Measuring Recreation Benefits: Conceptual and Empirical Issues." Water Resources Research 23: 931-935.

Brown, Wm. and Nawas, F. (1973). "Impact of Aggregation on the Estimation of Outdoor Recreation Demand Functions." American Journal of Agricultural Economics, 50: 246-249.

Buchanan, J. (1969). Cost and Choice. Chicago: University of Chicago Press.

Burt, O. and Brewer, D. (1971). "Estimation of Net Social Benefits from Outdoor Recreation." Econometrica 39: 813-827.

Cameron, T. A. and James, M. D. (1987). "Efficient Estimation Methods for 'Closed-Ended' Contingent Valuation Surveys." Review of Economics and Statistics 69: 269-276.

Caulkins, P., Bishop, R. and Bouwes, N. (1985). "Omitted Cross-Price Variable Biases in the Linear Travel Cost Model: Correcting Common Misperceptions." Land Economics 61: 182-187.

Cesario, F. J. and Knetsch, J. L. (1970). "Time Bias in Recreation Benefits Estimates: Water Resources Research, 6: 700-704.

_____. (1976). "Value of Time in Recreation Studies." Land Economics, 52: 32-41.

Christensen, J. B. and Price, C. (1982). "A Note on the Use of Travel Cost Models with Unequal Zonal Populations: Comment." Land Economics, 58: 395-399.

Cicchetti, C. J. and Smith, V. K. (1976). The Costs of Congestion, Cambridge: Mass., Ballinger.

Clawson, M. and Knetsch, J. (1966). Economics of Outdoor Recreation, Baltimore: Johns Hopkins University Press.

Cory, D. (1979-80). "Equity-Efficiency Tradeoffs in Natural Resource Management: The Case of Congestion." Journal of Environmental Systems 4: 325-334.

____. (1985). "Congestion Costs and Quality-Adjusted User Fees: A Methodological Note." Land Economics 61: 452-455.

Coursey, D. and Schulze, W. (1986). "The Application of Laboratory Experimental Economics to the Contingent Valuation of Public Goods." Public Choice, 49: 47-68.

_____. (1987). "Markets and the Measurement of Value." Public Choice 55: 291-297.

Crocker, T. D. (1985). "On the Value of the Condition of a Forest Stock." Land Economics 61: 244-254.

_____. (1986). "Economic Features and Materials Degradation." Degradation of Materials Due to Acid Rain. (R. Baboian, ed.), Washington, D.C.: American Chemical

Society.

_____ and Shogren, J. F. (1987). "A Complete Ex ante Valuation of an Aesthetic Phenomena: Atmospheric Visibility." University of Wyoming. Mimeo.

Cummings, R. G., Brookshire, D. S., and Schulze, W. D. (1986). Valuing Environmental Goods: An Assessment of the Contingent Valuation Method. Totowa, N.J.: Rowman & Allanheld.

d'Arge, R. C. (1985). "Environmental Quality Benefits Research for the Next Five Years: Some Observations and Recommendations." Final Draft Report for U.S. Environmental Protection Agency CR-808893-02-2.

_____ and Shogren, J. F. (1988). "Non-Market Asset Prices: A Comparison of Three Evaluation Approaches." Evaluation Methods and Policy-Making in Environmental Economics. Congress on Environmental Policy in a Market Economy. (H. Folmer and E. von Ierland, editors). Amsterdam: North-Holland Publishers (forthcoming).

Davis, R. (1963). "Recreation Planning as an Economic Problem." Natural Resources Journal, 3: 239-249.

Desvousges, W., Smith, V. K., and McGivney, M. (1983). "A Comparison of Alternative Approaches for Estimating Recreation and Related Benefits of Water Quality Improvements." Washington, D.C. U.S. Environmental Protection Agency EPA-230-05-83-001.

Deyak, T. A., and Smith, V. K. (1978). "Congestion and Participation in Outdoor Recreation: A Household Production Function Approach." Journal of Environmental Economics and Management, 5: 63-80.

Dickie, M., Fisher, A., and Gerking, S. (1987). "Market Transactions and Hypothetical Demand Data: A Comparative Study." Journal of the American Statistical Association 82: 69-75.

Duffield, J. (1984). "Travel Cost and Contingent Valuation: A Comparative Analysis." Advances in Applied Micro-Economics Volume 3, (V. K. Smith and A. D. Witte, eds.). Greenwich, CT: JAI Press Inc.

Durden, G. C. and Silberman, J. I. (1983) "Measuring the Demand for Beach Recreation." Old Dominion University and Appalachian State University. Mimeo.

Dwyer, J. F., Kelley, J. R. and Bowes, M. D. (1977). "Improved Procedures for Valuation of the Contribution of Recreation to National Economics Development." Water Resources Center Res. Rep. #128, University of Illinois.

Edwards, S. F. and Anderson, G. (1987). "Overlooked Biases in Contingent Valuation Surveys: Some Considerations." Land Economics 63: 169-178.

Fisher, A. C. and Krutilla, J. V. (1972). "Determination of Optimal Capacity of Recreation Facilities," in John Krutilla, ed. Natural Environments: Studies in Theoretical and Applied Analysis, Baltimore: Johns Hopkins University Press for Resources for the Future.

Fisher, A. and Raucher, R. (1984). "Intrinsic Benefits of Improved Water Quality: Conceptual and Empirical Perspectives." Advances in Applied Micro-Economics Volume 3 (V. K. Smith and D. White, eds.). Greenwich, Conn: JAI Press.

Freeman, A. M., III, and Haveman, R. H. (1977). "Congestion, Quality Deterioration, and Heterogeneous Tastes." Journal of Public Economics, 8: 225-232.

_____. (1979). The Benefits of Environmental Improvement: Theory and Practice, Baltimore: Johns Hopkins University Press for Resources for the Future.

_____. (1985). "Supply Uncertainty, Option Price, and Option Value." Land Economics, 61: 176-181.

Fromm, G. (1968)."Comment." Problems in Public Expenditure Analysis,(S. B. Chase, Jr., ed.) Washington, D.C.: Brookings Institution, 166-176.

Graham, D. A. (1981). "Cost-Benefit Analysis under Uncertainty." American Economic Review 71: 715-725.

Green, Trillis (1986). "Specification Considerations for the Price Variable in Travel Cost Demand Models: Comment. Land Economics 62: 416-418.

Gregory, R. and Furby, L. (1987). Auctions, Experiments, and Contingent Valuation. Public Choice 55: 273-289.

_____ and McDaniels, T. (1987). "Valuing Environmental Losses: What Promise Does the Right Measure Hold?" Policy Sciences 20: 11-26.

Hammack, J., and Brown, G. (1974). Waterfowl and Wetlands: Toward Biometric Analysis, Baltimore: Johns Hopkins University Press.

Hanemann, W. M. (1980). "Measuring the Worth of Natural Resource Facilities: Comment." Land Economics, 56: 482-486.

Helms, L. J. (1985). "Expected Consumer Surplus and the Welfare Effects of Price Stabilization." International Economic Review 26: 603-617.

Hoehn, J. P. and Randall, A. (1987). "A Satisfactory Benefit Cost Indicator from Contingent Valuation." Journal of Environmental Economics and Management 14: 226-247.

Hof, J. and King, D. (1982). "On the Necessity of Simultaneous Recreation Demand Equation Estimation." Land Economics 4: 547-552.

Hoffman, E. and Spitzer, M. (1985) "Experimental Law and Economics: An Introduction." Columbia Law Review 85: 991-1036.

Johnson, G. (1983). "Measuring the Cost of Time in Recreation Benefit Estimation." American Journal of Agricultural Economics 65: 169-17.

Kealy, M. and Bishop, R. (1986). "Theoretical and Empirical Specifications Issues in Travel Cost Demand Studies." American Journal of Agricultural Economics 68: 660-667.

Knetsch, J. and Davis, R. K. (1966). "Comparison of Methods of Recreation Evaluations." Water Research (A. V. Kneese and

S. C. Smith, eds.). Baltimore, MD: John Hopkins University Press.

_____ and Sinden, J. (1984). "Willingness to Pay and Compensation Demanded: Experimental Evidence of an Unexpected Disparity in Measures of Value." Quarterly Journal of Economics 99: 507-521.

Kristrom, B. (1988). "On the Benefits of Preserving Virgin Forests." The Swedish University of Agricultural Sciences, Umea.

Krutilla, J. (1967). "Conservation Reconsidered." American Economic Review 57: 777-786.

Lahiri, K., and Egy, D. (1981). "Joint Estimation and Testing for Functional Form and Heteroskedasticity," Journal of Econometrics, 15: 299-307.

Loomis, J. B., Sorg, C. F. and Donnelly, D. M. (1986). "Evaluating Regional Demand Models for Estimating Recreation Use and Economic Benefits: A Case Study." Water Resources Research 22: 431-438.

_____. (1987). "Balancing Public Trust Resources of Mono Lake and Los Angeles' Water Right: An Economic Approach." Water Resource Research 23: 1449-1456.

McConnell, K. (1975). "Some Problems in Estimating the Demand for Outdoor Recreation." American Journal of Agricultural Economics 57: 330-334.

_____. (1976). "Some Problems in Estimating the Demand for Outdoor Recreation: Reply." American Journal of Agricultural Economics, 58: 598-599.

_____, and Duff, V. A. (1976). "Estimating Net Benefits of Recreation Under Conditions of Excess Demand." Journal of Environmental Economics and Management 2: 224-230.

_____. (1977) "Congestion and Willingness to Pay: A Study of Beach Use." Land Economics 53: 185-195.

McDonald, J. and Moffit, R. (1980). "The Uses of Tobit Analysis." The Review of Economics and Statistics 62: 318-321.

McKenzie, G. and Pearce, I. (1982). "Welfare Measurement — A Synthesis." American Economic Review 72: 669-682.

Madariaga, B. and McConnell, K. E. (1987). "Exploring Existence Value." Water Resources Research 23: 936-942.

Markowitz, H. M. (1952). "The Utility of Wealth." Journal of Political Economy 60: 149-167.

Mendelsohn, R. (1987). "Modeling the Demand for Outdoor Recreation." Water Resources Research 23: 961-967.

Mitchell, R. C. and Carson, R. T. (1987). Valuing Environmental Goods: A State of the Arts Assessment of the Contingent Valuation Method. Washington, D.C.: Resources for the Future.

Muellbauer, J. (1974). "Household Production Theory Quality, and the `Hedonic Technique.'" American Economic Review 54: 977-994.

Nowell, C., Evans, M. A. and McDonald, L. (1988). "Length-Biased Sampling in Contingent Valuation Studies." Land Economics (forthcoming).

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

Ralston, H. III (1985). "Valuing Wildlands." Environmental Ethics 7: 24-48.

Randall, A., Ives, B., and Eastman, E. (1974). "Bidding Games for Valuation of Aesthetic Environmental Improvements." Journal of Environmental Economics and Management, 1: 132-149.

_____, et. al. (1978). "Reclaiming Coal Surface Mines in Central Appalachia: A Case Study of the Benefits and Costs." Land Economics, 54: 472-489.

_____, and Hoehn, J. P. (1982). "The Structure of Contingent Markets: Some Results of a Recent Experiment." Unpublished Manuscript, University of Kentucky and University of Chicago.

Rosenthal, Donald and Anderson, Jane (1984). "Travel Cost Models, Heteroskedasticity, and Sampling." Western Journal of Agricultural Economics 9: 58-65.

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

____ and Chestnut, L. (1983). "Valuing Environmental Commodities: Revisited." Land Economics, 59: 404-410.

Russell, C. S. and Vaughen, W. J. (1982). "The National Recreational Fishing Benefits of Water Pollution Control." Journal of Environmental Economics and Management 9: 328-354.

Samuelson, P. A. (1954). "The Pure Theory of Public Expenditure." Review of Economics and Statistics, 36: 387-389.

Schulze, W., d'Arge, R., and Brookshire, D. (1981). "Valuing Environmental Commodities: Some Recent Experiments." Land Economics, 57: 151-172.

Sellers, C., Stoll, J., and Chavas, J. P., (1985). "Validation of Empirical Measures of Welfare Change: A Comparison of Nonmarket Techniques." Land Economics 61: 156-175.

_____, Chavas, J. P. and Stoll, J. (1986). "Specification of the Logit Model: The Case of Valuation of Nonmarket Goods." Journal of Environmental Economics and Management 13: 156-175.

Shogren, J. F. (1988). "Valuing Risk in Experimental Markets: Some Initial Results." Appalachian State University Working Paper Series.

Sinden, J. A. and Wyckhoff, J. B. (1976). "Indifference Mapping: An Empirical Methodology for Economic Evaluation of the Environment." Regional Science and Urban Economics, 6: 81-103.

Smith, V. K., and Kopp, J. (1980). "The Spatial Limits of the Travel Cost Recreational Demand Model." Land Economics, 56: 64-72.

_____. (1983). "Option Value: A Conceptual Overview."

Southern Economics Journal, 49: 654-668.

_____, Desvousges, W. H. and McGivney, M. P. (1983). "The Opportunity Cost Of Travel Time in Recreation Demand Models." Land Economics, 59: 259, 278.

_____ and Desvousges, W. (1986). Measuring Water Quality Benefits. Dordrecht: Kluwer/Nijhoff/Kluwer Academic Publishers Group.

_____, Desvousges, W. and Fisher, A. (1986). "A Comparison of Direct and Indirect Methods for Estimating Environmental Benefits." American Journal of Agricultural Economics 68: 280-290.

_____. (1987). "Nonuse Values in Benefit Cost Analysis." Southern Economic Journal 54: 19-26.

Smith, V. L. (1980). "Experiments with a Decentralized Mechanism for Public Good Decisions." American Economic Review 70: 584-599.

_____. (1982). "Microeconomic Systems as an Experimental Science." American Economic Review 72: 923-955.

Stevens, T. H., and Allen, P. G. (1980). "Estimating the Benefits of Recreation Under Conditions of Congestion." Journal of Environmental Economics and Managements 7: 395-400.

Strand, J. (1985). "Verdsetting av Reduserte Luftforurensninger Fra Biler I Norge." (Value of reduced air pollution from Automobiles in Norway) Sosialkonomisk Institutt, University of Oslo.

Strong, E. (1983). "A Note on the Functional Form of Travel Cost Models with Zones of Unequal Populations." Land Economics 59: 247-254.

Stynes, D., Peterson, G. and Rosenthal, D. (1986). "Log-Transformation Bias in Estimating Travel Cost Models." Land Economics 62: 94-103.

Sutherland, R. (1982). "The Sensitivity of Travel Cost Estimates of Recreation Demand to the Functional Form and Definition of Origin Zones." Western Journal of Agricultural Economics 64: 136-141.

Sutherland, R. J. and Walsh, R. G. F (1985). "Effect of Distance on the Preservation Value of Water Quality." Land Economics 61: 281-291.

Thayer, M., and Schulze, W. (1977). "Valuing Environmental Quality: The Contingent Substitution and Expenditure Approach." Unpublished manuscript.

Tversky, A. and Kahneman, D. (1981). "The Framing of Decisions and The Psychology of Choice." Science 211: 453-458.

Vaughan, W. J., Russell, C. S., and Hazilla, M. (1982). "A Note on the Use of Travel Cost Models in Unequal Zonal Populations: Comment." Land Economics, 58: 400-407.

Walsh, R. G., Loomis, J. B. and Gillman, R. S. (1984). "Valuing Option, Existence and Bequest Demands for Wilderness." Land Economics 60: 14-29.

Ward, F. (1983). "Measuring the Cost of Time in Recreation Demand Analysis: Comment." American Journal of Agricultural Economics 65: 167-168.

_____. (1983a). "On the Necessity of Simultaneous Recreation Demand Equation Estimation." Land Economics 59: 455-458.

_____. (1984). "Specification Considerations for the Price Variable in Travel Cost Demand Models." Land Economics 60: 301-305.

_____. (1986). "Specification Considerations for the Price Variable in Travel Cost Demand Models: Reply." Land Economics 62: 419-421.

Weisbrod, B. A. (1964). "Collective Consumption Aspects of Individual Consumption Goods: The Quarterly Journal of Economics, 78: 471-477.

Wetstein, M. E. and McNeeley, J. G., Jr., (1980). "Specification Errors and Inference in Recreation Demand Models." American Journal of Agricultural Economics, 62: 798-800.

Wetzel, J. N. (1977). "Estimating the Benefits of Recreation Under Conditions of Congestion." Journal of Environmental Economics and Management, 4: 234-246.

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

Wilman, E. (1980). "The Value of Time in Recreation Benefit Studies." Journal of Environmental Economics and Management 7: 272-286.

_____. (1987). "A Simple Repackaging Model of Recreational Choices." American Journal of Agricultural Economics 69: 603-612.

Ziemer, R. R., Messer, W. N., and Hill, R. C. (1980). "Recreation Demand Equations: Functional Form and Consumer Surplus." American Journal of Agricultural Economics, 62: 136-141.