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Valuation of Environmental Amenities

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Valuation of Environmental Amenities

Summary

Environmental goods and services which are not priced in traditional economic markets are typically excluded from decision making approaches which are based on monetary values. Benefit-cost analysis, for example, employs monetary estimates of values with and without the project under consideration. The exclusion of environmental values in monetary terms often results in a variety of ad hoc approaches to incorporate these elements in decision making. These approaches range from the application of zero values for the environmental services to the use of measures such as equivalent energy values. Over the past 30 years economists have attempted to derive approaches to incorporate monetary values of environmental amenities into decision making frameworks. Monetary measures are used as a "metric" so that both market and non-market goods can be represented on a common base. This paper reviews the approaches currently in use to estimate values for environmental goods and services. Direct (contingent valuation) and indirect (travel cost, hedonic price and risk valuation) approaches are examined. The successes and failures are outlined. The conclusions suggest that there are classes of environmental amenities that can be assessed using these monetary tools and there are other classes for which the current techniques are questionable. Avenues for further research are identified.

Valuation of Environmental Amenities

W. L. Adamowicz

INTRODUCTION

The current interest in "Environment and the Economy" has spurred a number of initiatives, one of which is the attempt to attach monetary values to environmental goods and services. Reactions to the valuation of "a day of bass fishing" range from utter disgust that such a therapeutic activity be subject to dollars and cents to the delight that recreational activities can yield economic benefits which may be at least as large as the benefits from competing land uses. This paper will outline the various approaches to the valuation of non-market goods and services. In particular the following questions will be examined:

(a) why we need to place monetary values on these goods and services?,
(b) what does value mean?,
(c) what is being valued? and,
(d) how is this value determined?

The first statement questions the need for monetary valuation. The initial reasons for valuation of environmental goods and services were to include the benefits of these resources in benefit cost analysis so that project development decisions could include both market and non-market goods and services. An example may help illustrate the concept.

Suppose a water development project is proposed. This project will provide irrigation water to the agricultural industry. The benefits of this project are the additional goods and services produced with the project, ie. crop production will increase. The costs of the project include the construction and maintenance of the development project as well as the costs (if any) to produce the additional agricultural output. The decision to build the project depends on the value of the benefits versus the costs. In this case both the benefits and the costs are measurable in monetary terms. The fact that markets currently exist for the goods described facilitates the measurement of economic values.

Now consider that same case except include the fact that a popular trout fishing stream must be destroyed in building the project. The activity of trout fishing is not priced in a market. Individuals buy fishing licences but these fees are usually relatively small and they do not pay an entry fee each time they enter the fishing site. The activity of trout fishing does not have a comparable market value that can be included in the benefit cost analysis. If the loss of the fishing activity can be expressed in monetary terms it can be included in the cost benefit analysis as an "opportunity cost."

A second reason for the valuation of the benefits of environmental amenities is the determination of compensation in cases of loss or damage. Court battles are currently underway in cases where firms or individuals are liable for damages to environmental assets. Environmental damage assessment may include the objective measurement of the impact of these damages in order to determine compensation amounts and identify beneficiaries. The Exxon Valdez case provides one of the more catastrophic examples of such damage assessment. It is noteworthy that the techniques discussed below, particularly the travel cost and contingent valuation approaches, have been accepted as evidence in court cases in Canada and the U.S. and both techniques are sanctioned by the U.S. Water Resources Council as credible damage assessment or valuation methods.

Other types of environmental/economic analysis also require non-market value estimates. Two such approaches are "Environmental Asset Valuation" (sometimes referred to as Natural Resource Accounting) and "Full Cost Accounting". Environmental Asset Valuation has become popular with a variety of agencies. It even received mention in Canada's Green Plan (1990). This technique attempts to value a nation's natural resource and environmental assets. Some of these assets have market values (ie. the trees in a forest) while others do not (ie. the value of the forest as a recreation space). Without non-market value estimates a critical component of the asset value is ignored.

Full Cost Accounting introduces the idea that the current price of certain resource uses does not reflect their true cost. To economists this is commonly called the difference between private and social costs. The consumption of gasoline is a typical example. Gasoline price reflects the cost of extraction, processing and transportation but it may not reflect the costs of pollution, greenhouse gas effects and seepage from underground storage tanks. The costs of these latter impacts are typically non-market in nature and require non-market valuation techniques to be measured.

WHAT IS VALUE?

The concept of "value" is often quite controversial. The concepts of value in the environmental literature range from individual values to "intrinsic" values or values in nature independent of humans. Value to an economist is a somewhat narrower notion. It is the maximum amount an individual is willing to exchange for the good from the set of resources the individual controls or the minimum amount the individual would accept in exchange for the good. The exchange is usually measured in monetary units. Value, in this sense, is not the price of a good or the price times the quantity. Thus, goods without prices may have value[1]. Note that value, even defined in this relatively narrow sense, is subject to context effects and a host of perceptions which change over time (see Brown, 1984). Also, valuation in monetary terms is only one of many forms of valuation which requires individuals to assign values to objects.

A variety of other notions of value exist including an entire set of non-anthropocentric values. The latter term refers to the concept that nature has value in itself, independent of humans. One can debate the merits of such a value systems but that is beyond the scope of this paper (for a discussion of these issues see Redclift, 1990 or Pearce and Turner 1990). Suffice it to say that the measure of value used in current non-market valuation techniques is anthropocentric. In fact, it is a value defined at an individual level.

The total value of a good is not usually the item of interest. The value of changes in quantity, price or quality is often more important. The measurement of value changes in an economic context is defined as the "compensating or equivalent variation." These measures are designed to evaluate the impact of an imposed change in an individual's consumption of goods or services, including environmental services. The compensating variation is the amount of money that must be given (or taken away) to make the person as well off as they were before a change. The equivalent variation is the amount that must be given (or taken away) to a person before a change to make the person as well off as they would be after the change (Boadway and Bruce, 1984). For example, suppose the impact of a decrease in fishing quality at a particular stream is being investigated. The compensating variation is the amount of money an individual would accept in compensation for the decline in fish quality.

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1 For market goods, the price system may function as a mechanism for the valuation of the marginal unit of a good or service.

The equivalent variation is the amount the individual would be willing to pay to avoid the quality change. These notions of value are central to the analysis of non-market benefits. There is still considerable controversy surrounding these measures (eg. Kahneman, et al., 1990) yet they provide the footing for economic measurement of environmental impacts.

The use of individual values in non-market analysis suggests that some form of aggregation be used to determine values to communities or societies. The typical approach in economics is a summation of individual values (although this has recently come under fire; see Blackorby, 1990). The result is an aggregate value of a good or service based on individuals' preferences for these goods or services. The values will change over time if preferences and/or available information changes, just as values for market goods change.

A number of types of value can be identified at the individual level. The main categorization used in the non-market valuation literature is "Use value" versus "Non-Use value." Use value refers to the value an individual holds for participating in an activity. Examples include hunting, fishing, camping, etc. Within the category of Use-Values are the so-called consumptive Use values and non-consumptive Use values. The former are values associated with an activity that consumes the resource in question (ie. fishing). The latter refers to the value associated with an activity that does not affect the resource (ie. birdwatching). These constructs may be experienced simultaneously by any individual.

Non-Use values are those values held by an individual for goods or services they do not actually consume or actively participate in. For example, I may "value" the existence of Ontario wetlands even though I may never visit one or be affected by one directly. These values are the most controversial. The recent case of the Exxon Valdez oil spill raised the issue of Non-Use values to the extreme. Individuals who value the pristine existence of the Alaska coast line were affected by the oil spill. These individuals live around the world, not only near the area affected. Estimating and capturing these values, in an economic framework, is a difficult task indeed.

Non-Use values can be further classified into existence and bequest values. The former refers to the value one places on the existence of a good (independent of its use) and the latter is the value placed on being able to pass the good on to future generations. A number of reviews of this type include the notion of Option value in the set of Non-Use values. Option value has a very specific definition in the economics literature. Option value is the premium (over the willingness to pay in a deterministic case) that may be attached to a "value" when the supply of (or demand for) the good is affected by uncertainty. Option value is the difference between an *ex-ante* welfare measure (option price) and an *ex-post* measure (expected willingness to pay). The concept of option value has been the subject of considerable debate and has not been significant in the measurement of benefits (see Mitchell and Carson, 1989).

An extension of Use and Non-Use values is the determination of the change in these values in response to a quality change. The value of a day of recreational fishing will likely increase with an increase in water quality or fish catch. Similarly, my value for the Ontario wetland may increase if I realize that the wetland has somehow been improved.

A final type of non-market value which will be discussed in this paper is the value of risk reduction. Reductions in cancer risks or other risks associated with food products or drinking water can be considered quality changes in the product being consumed. The risk itself is a non-market good since it is not priced or traded in the market, rather, the price and quantity sold may implicitly reflect the value of the risk.

WHAT IS BEING VALUED?

Valuation techniques are designed to determine values of non-market goods and services as they accrue to individuals. Within the economic paradigm, goods and services only have value insofar as they affect humans or they are within a set which humans have preferences over. This set of goods, however, may be quite large. Examples of the goods and services being valued by these techniques include; days (or seasons) of recreational activities (fishing, hiking, etc), the effect of changes in environmental attributes (wildlife populations, water quality, scenery, etc) on recreational values, the effect of environmental attributes on property values (air, water and noise pollution), the impact of changes in water quality on drinking water consumers and the impact of various levels of perceived risks in food products. Also, a host of Non-Use values are being investigated using these techniques. Non-Use values encompass a wide variety of environmental amenities including the value of endangered species, the value of rainforests and the value of nature preserves.

Since individuals have different preferences there will be variability in the values across individuals. Note that resources often possess various forms of value. A fish has value as a potential increase in the quality of a recreational experience, as a commercial catch or perhaps some individuals have existence values for this species. It is the service flow that arises from the resource which produces the value.

VALUATION TECHNIQUES

The main objective of non-market valuation is to derive a money based measure of the impact of changes in the quality or quantity of a good or service which is not typically priced in a market. There are two main approaches to valuation, the direct (or survey) approach and the indirect (or inferential approach). The indirect approach is the method which is most comfortable to economists. Almost all traditional economic analysis employs information on actual behavior and attempts to construct models which represent (or could generate) this behavior. Interpolation or extrapolation of this model can be used to estimate the monetary impact of changes in quantity or quality. The direct approach is more foreign to economists. The direct approach involves "conversation" (Smith, 1990) with individuals in an attempt to reveal their "values" for the non-market good or service.

The indirect approach tries to build representations of behavior which can then be used to determine the value an individual will assign to a change in the existing conditions. The impact of the change in monetary units is calculated using the compensating or equivalent variation measures defined above. The direct approach, on the other hand, ignores the individual's behavior and attempts to structure a situation so that the individual understands the change in environmental conditions and is able to describe values for these goods *as if they were in a market setting*. The market setting notion is crucial for the assignment of monetary values. The advantages and disadvantages of each approach will be discussed below.

CONTINGENT VALUATION

Contingent valuation (CV) is the most popular of the direct techniques. The term contingent valuation arises from the fact that the valuation of the good is contingent on the assumption of a market for the good. For example, a day of recreational hunting is presented as a market good where one must pay to receive a permit to hunt for the day. CV in its simplest form is a description of the situation (a day of moose hunting) and a question of the form "what would you be willing to pay for a day of moose hunting, over and above all other expenses you might incur." The latter part of the phrase is included to guarantee that

the individual is not reporting the expected expenditures on the activity but the willingness to pay over and above expenses. It is this willingness to pay that corresponds to the theoretical measure of equivalent variation mentioned above.

The assumptions required for CV to produce the theoretical welfare measure described above are that the respondent have: (a) an accurate description/understanding of the current level of the good or service being valued (the base level), (b) an accurate understanding of the good being valued (or change in the quality or quantity), (c) an understanding of the time dimension of the change in quality or quantity and how the payment is made, (d) an understanding of what the payment amount is to represent (ie. not a "fair" price but the maximum willingness to pay) (Mitchell and Carson, 1989). The last assumption may be altered slightly depending on the variant of CV chosen.

Although the basic form of CV involves questions about willingness to pay (or willingness to accept compensation) a number of variants of the technique have been developed. CV questions of the form "What would you be willing to pay ..." with a range of values to choose from or a blank for the respondent to place a value in are termed *Open-Ended Contingent Valuation Questions*. A number of variations of this approach include bidding games (ie. would you be willing to pay $X, if NO ask about a smaller value, if YES ask about a larger value) and a variety of mechanisms used to provide benchmarks for the respondent. For example, the respondent could be asked about their willingness to pay for an increase in water quality from the present condition to one in which there would be no odor in the spring months. The respondent may then be presented with benchmarks of the amount they currently spend on water per year and the amount they spend per year for other services (power, libraries, police services, etc.). These benchmarks are used to provide the respondent with an idea of their spending on similar services; municipal utility services are used in this example (see Mitchell and Carson, 1989).

A variant of the approach described above is one which does not require the respondent to determine a value, rather the respondent "votes" on whether the presented value is acceptable or not. This approach is called *Closed-Ended Contingent Valuation*. For example, the respondent could be asked if (s)he would vote YES to a referendum which required individuals to pay an additional $50 per year in exchange for water services which removed the spring run-off smell. The respondent only needs to indicate Yes or No and need not calculate the exact amount they would be willing to pay. The actual amount listed in the referendum ($50 above) is varied across a sample of individuals. These data are used to produce a statistical model which determines the probability of accepting the bid as a function of the bid amount. The expected value of the bid can then be determined from the probability of acceptance times the actual bid (Hanemann, 1984).

An obvious extension of the Closed-Ended CV is to ask respondents a number of referendum questions. Three variants of this multiple question format exist. First, some CV analysts choose to ask a variety of closed ended questions while varying the attribute levels (quality) and/or changing the good in question slightly (ie. valuing increased fish catch versus increased salmon catch). A second alternative is a form of Bidding Game with the respondent moving towards the maximum willingness to pay. A further extension is to have the respondent vote on packages of payment amounts and quality attributes and use a statistical design such that the impact of changes in attributes and willingness to pay can be examined. The latter has seen limited use in the economics literature (an example is Carson, Hanemann and Steinberg, 1990) but is relatively common in the marketing and business literature and is known as a type of conjoint analysis (Louviere, 1988). All of these approaches have potential for the valuation of non-market goods. However, in each case the situation and the good must be presented to the respondent clearly. Also, the willingness to pay amount must be structured as a true maximum rather than a "fair" price or a price the respondent is used to paying for some other good.

Contingent valuation has been considered by some to be a virtual panacea to the valuation of non-market goods. Both Use values and Non-Use values have been "captured" by the practitioners as well as values of goods and/or quality changes in those goods. Table 1 provides a sampling of CV experiments. Note that the goods being valued range from a day of hunting to the value of Whooping Crane habitat. Clearly, the main advantage of CV is its flexibility.

The CV approach also suffers from a number of drawbacks. The statement attributed to Anthony Scott is most notable. Scott stated "If you ask a hypothetical question you get a hypothetical answer." The notion of asking what essentially constitute "attitude" questions does not rest well with the economics profession. Other social scientists have not had as much philosophical difficulty with attempts to elicit attitudes as a method to predict behavior. In fact, social scientists in psychology, sociology, human geography and various forms of business have examined these "conversational" (Smith, 1990) approaches and while they admit the task is not easy, they state that there is merit in the approach (Peterson, et al., 1988). The criticism attributed to Scott may not be the most difficult one for CV to overcome.

A number of other drawbacks to the CV approach have been identified. Most of these deal with the difficulty of structuring the design in such a manner that an unbiased estimate of value is produced. The first design issue which plagues CV is the issue of Strategic Behavior. Since most CV approaches are hypothetical the respondent is not penalized for behaving strategically. The respondent has no incentive to reveal their valuation accurately. While the little research performed on strategic behavior in CV surveys suggests that the bias is "small" there is still a need for considerable research in this area (Mitchell and Carson, 1989; Cummings, et al., 1986).

A number of measurement issues also arise in the design of CV experiments. Interviewer effects, implied value cues (starting point issues, anchors, implied ranges on the values), situation misspecification (context effects) and sampling problems (nonresponse, sample selection, etc.) all plague the CV practitioner (Mitchell and Carson, 1989). Furthermore, valuation questions asked in different sequences may produce different results (sequence issues) and the value of subsets of goods may not produce different values than the entire set (embedding) (Kahneman and Knetsch, 1991). All of these suggest that the value obtained by CV approaches may be significantly affected by the question design and the sampling frame.

The most critical attack on CV has been lead by Jack Knetsch of Simon Fraser University. Knetsch suggests that most applications of CV to elicit Non-Use values are examples of "The wrong answer to the wrong question." In a series of papers Knetsch and his co-authors make a variety of contributions. First, they suggest that willingness to pay and willingness to accept compensation are not similar values (Knetsch and Sinden, 1984; 1987). Traditional economic theory predicts that these two measures will be similar. Empirical research has consistently revealed a 3 to 10 fold difference between willingness to pay and willingness to accept compensation. There are a variety of potential reasons for this including an endowment effect and the possibility of a kinked utility function for gains versus losses. Most CV practitioners, however, use willingness to pay because willingness to accept compensation is more difficult to elicit (especially for environmental goods) and because the values they collect are "unreasonable." Even in cases of environmental damage, where willingness to accept compensation is the appropriate measure to use, willingness to pay is used and thus provides the answer to the wrong question. The reason that Knetsch suggests this is also the wrong answer is obtained from a number of experiments with CV and Non-Use values. The answers reveal that CV valuations suffer from embedding, design

issues and the endowment effect to the point that they may not reflect a true valuation of a good or service. They may be representations of "good feelings" toward a particular good (Kahneman and Knetsch, 1991; Knetsch, 1990).

The evidence on CV is certainly mixed. Several authors state that it is a useful mechanism while others claim it is not a true monetary measure of value. Some studies have compared actual market behavior with CV (Bishop and Heberlein, 1979; Bishop et al., 1988; Kealy et al., 1988) and their findings have been complimentary to the CV approach. However, these tests are typically performed on CV estimates of Use value or values of goods the respondents are well acquainted with purchasing. The Non-Use values which currently permeate many of the policy debates (existence values) provide a much greater challenge to CV. The CV measures of Non-Use value have not been tested against actual markets, in fact, it may not be possible to test such values. Thus the most important application of CV remains in question.

INDIRECT METHODS

While contingent valuation methods use survey research techniques to try to uncover the value of environmental goods and services, indirect methods rely on observations of existing behavior, usually behavior in economic markets, to discover the value of amenities. There are three general categories of indirect methods, the valuation of recreational activities (Travel Cost Model), the valuation of environmental services embodied in property values (Hedonic Price Methods) and the valuation of environmental risks (Risk Valuation). Indirect methods are based on models of economic behavior that are developed by the analyst and tested using observable data. These methods are valid as long as the behavioral model is a reasonable representation of the actual underlying decision making framework. In the following sections each of the three categories is examined for strengths and weaknesses.

The market methods of valuation require one fairly strong assumption. This assumption, called weak complementarity, requires that the environmental good (or service or quality change) has associated with it some market purchase (travel cost, property value or some other market process). Also, when none of the market good is consumed, it is assumed that there is no demand for the environmental good. This assumption allows the isolation of the effect of the environmental good through the market for the private good. It also rules out the estimation of Non-Use values. Nevertheless, it provides a practical method of estimating Use values.

The Travel Cost Model

The travel cost model is a general form of model used to determine the value of recreational activities and the value of quality changes associated with recreational activities. This model can be used for any Use value estimate. The variants of the model range from the basic travel cost model (in which travel costs are used as a proxy for the price of visits to a particular recreation site) to the discrete choice models which analyze recreational site choice as a function of site attributes and travel costs. The former has been commonly used to estimate the value of recreation sites and the latter is being used to value changes in site quality characteristics and the impact of closing existing sites or adding new ones. (Three summaries of the travel cost method are available: Smith, 1989, Fletcher et al., 1990 and McConnell, 1985.)

Depending on the environmental good in question, a variety of travel cost models are available. Table 2 provides some examples of the travel cost models used in the valuation of recreational activities.

The basic travel cost model assumes that travel cost is a proxy for price. If there is variation in the distance from individuals' residences to a particular site and subsequent variation in the number of trips they take, a demand curve for the quantity of trips demanded as a function of travel costs can be obtained from cross section data. This demand curve (price-quantity relationship) provides the necessary elements to estimate the value of the site as the area under the demand curve and above the actual amount spent on travel (see Boadway and Bruce, 1984, for a discussion of the relationship between compensating and equivalent variation and area under the demand curve).

The basic travel cost model assumes a form of behavior that may not be correct for certain forms of recreation. This model assumes that individuals choose the number of trips they are taking to a site at the beginning of the season. This approach also tends to ignore or limit the influence of substitute sites on the demand for visits to a particular site. A number of statistical and theoretical drawbacks to this basic model become evident upon close examination. A summary of these issues is provided in Fletcher et al. 1990 and Smith, 1989.

One of the major disadvantages of the basic travel cost model is that is cannot be used to value quality changes. The values produced are values for the site. Since cross section data are used to estimate the model, temporal site quality changes are ignored. The majority of interest in recreation valuation is on the valuation of quality changes, ie. the value of improved water quality for fishing and swimming. A number of variants of the basic model have been derived to analyze quality changes.

Three models which incorporate quality effects are currently in use in the literature. The first is the "Varying Parameter Model" (see Smith and Desvousges, 1986). The basic travel cost model can be specified as :

$$V = a + b\,P$$

where V is the number of visits by an individual to a site, P is the travel cost (or price) of a visit and a and b are parameters to be estimated. The Varying Parameter model examines basic travel cost models across a number of sites. For sites i = 1 through n the models

$$V_i = a_i + b_i\,P_i$$

are estimated. In a second stage estimation process the parameters a_i and b_i are regressed against quality attributes from the sites producing a systematic parameter variation. The results provide a method of examining the impact of a quality change on the value of a site. While this model can provide estimates of the value of quality changes, the underlying behavioral model is unclear. Also, a number of questions about the possibility of substitution between sites and the defintion of the relevant sites arise in the formation of the model.

A second approach to evaluating quality effects is the Hedonic Travel Cost Model (Brown and Mendelsohn, 1984). This approach assumes that individuals are willing to pay more in travel cost to visit sites with higher quality attributes. Estimation techniques are used to determine the implicit price of quality attributes (the change in travel cost attributable to a change in a quality attribute) from information on site attributes and individual choices. While this model provides estimates of the impact of changes of quality attributes it suffers from a number of theoretical and empirical drawbacks. These drawbacks include the difficulty of site definition and the potential for negative prices (see Smith and Kaoru, 1987).

The third, and currently most promising approach to the valuation of quality changes is the Discrete Choice or Random Utility Model. This model has its roots in the transportation literature where it has commonly been used to describe the choice of alternative modes of transport. The appealing aspects of this model include; consistency with the notions of utility as a function of site attributes and socioeconomic characteristics,

the ability to substitute from one site to another, the ability to model complex behavioral processes (nested choice processes) and the determination of the compensating or equivalent variation directly from the estimated model. The Random Utility Model most commonly in use assumes that trip choices are made independently over the season. The choice of one site over the others is assumed to have a deterministic and stochastic portion. The deterministic portion is made up of variables observable to the researcher (travel cost, site attributes and individuals' characteristics). The stochastic portion is the set of determinants unknown to the researcher.

If one site was chosen and others were not, that alternative must have yielded the highest utility for the individual. The available attribute and travel cost information (deterministic portion of the utility function) is used to describe the choice in a discrete choice (or limited dependent variable) statistical model (see Maddala, 1983). The selection of a particular distribution for the stochastic component provides a mechanism to estimate the parameters of the utility function. The result is a fully parameterized utility function which can be used to predict choices and evaluate welfare measures.

Discrete choice models can be used to estimate fairly sophisticated decision making structures. The basic model suffers from the Independence of Irrelevant Alternatives assumption, however, more complex structures are not encumbered by this assumption (Maddala, 1983).

A variety of discrete choice models have been used to examine the value of quality changes. Carson, Hanemann and Wegge (1989) have constructed a sophisticated model of the Alaska Fishery which includes decisions about participation in fishing, the target fish species chosen, and the site chosen. Each choice is determined as a function of site quality attributes and individual characteristics. This model facilitates the valuation of fishing site closures (perhaps for water quality or contamination reasons), the valuation of changes in fish stock numbers and the valuation of other water quality attribute changes. Similar models have been constructed for recreation hunting site choice (Coyne and Adamowicz, 1990; Adamowicz, et al., 1990[2]), recreational beach use (Bockstael, et al., 1987; Feenberg and Mills, 1980) and off-shore recreational fishing (Bockstael, et al., 1989).

The advantages of the travel cost approaches are that they derive values from observations of past behavior rather than intentions or attitudes. This corresponds to the traditional economic approach to demand estimation and valuation. The travel cost methods also provide a behavioral model and a set of testable hypotheses. The accuracy of the behavioral model can be tested.

The drawbacks of the travel cost approach include the following. (1) The behavioral model is specified by the researcher and may not accurately reflect that actual decision making structure. (2) The observations of travel cost and site attributes are usually not enough to fully describe the decision makers' choice process. In order to describe choices one must recognize that individuals have spatial perceptions that are different than objective measures of distance (see Fletcher et al., 1990). Considerable research effort has been and still needs to be expended on this topic. The fact that perceptions of attributes affect decisions is not surprising to the psychology/geography profession yet there has been little use of perceived measures of quality in recreation choice models. Limited examination has been carried out by David, 1971 and Bockstael et al., 1987. Time constraints and values

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2 The Adamowicz et al. (1990) model is a discrete choice model with sequential choice behavior. This model assumes that the choice of the next trip is a function of the travel cost and the experiences on previous trips. It is a relatively simple model of dynamic behavior in recreation choice.

also play an important role in spatial choice behavior. The value of time may be more relevant as an explanator of site choice than the cost of travel. The value of time issue has plagued travel cost models since their inception (Cesario and Knetsch, 1970) and has an effect on both the specification of the behavioral model and the welfare estimate.

In summary, the travel cost approach provides a framework for the examination of recreation choice behavior in a variety of contexts (choice of visits to a site, site choice, sequential site choice etc.). The valuation of sites and quality attributes is possible. The validity of these values depends on the accuracy of the behavioral model assumed by the researcher. Different behavioral assumptions result in significantly different values[3]. In sharp contrast to the Contingent Valuation method, the travel cost methods make explicit assumptions about human behavior and the perceptions of the individual. Contingent Valuation relies on the individual to factor their own perceptions and decision making frameworks into the valuation process.

Hedonic Price Models

The travel cost model and contingent valuation are oriented to individual valuations based on individual decision making. The hedonic price model determines values for environmental quality changes from the implicit effect that quality has on **market** transactions. Hedonic price models are also indirect approaches to valuation as they employ observable information on prices of goods and levels of market and non-market attributes. This technique attempts to identify the contribution of market and non-market aspects of a particular good to market price. For example, the value of residential housing includes the contribution of market goods (square footage, fireplaces, etc) and the surrounding environmental conditions (air quality, noise levels).

Hedonic price models usually employ statistical procedures to determine the role market and non-market goods play in the determination of price. The marginal value of the house with respect to any attribute is called the implicit price of the attribute. In such a fashion, the implicit prices of air quality and noise levels can be determined and used to evaluate the impact of a general reduction in quality levels (see Bartik, 1988).

The hedonic price technique has been primarily used to evaluate the effect of air quality on urban property values (Harrison and Rubinfeld, 1978; Nelson, 1978; Freeman, 1979). However, there have also been applications to cottages and rural hotels (Wilman, 1984) and noise levels (McMillan, et al., 1980). The approach assumes that individuals have willingness to pay curves for levels of environmental quality attributes. Since individuals are different, each person will have a different curve. Also, a variety of properties are available and these have varying levels of quality associated with them. The interaction between an individual's willingness to pay curve and the supply of properties with various levels of quality produces one point on the hedonic price locus, the locus of points in quality and willingness to pay space (Wilman, 1984). Each property value observation provides one point on this locus. This relationship between willingness to pay and environmental quality allows the estimation of the impact of a change in quality levels on the welfare of the individuals through the property values.

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3 Recently, Smith and Kaoru (1990) conducted a "meta analysis" on estimates of welfare from the basic travel cost model. The analysis revealed a surprising degree of consistency between models and supports the use of this approach to modeling some forms of recreation behavior.

The main criticisms of the hedonic price models revolve around the assumptions required to estimate the hedonic price function. First, it is assumed that the prices reflect equilibrium conditions within the market. Second, both the buyers of properties and the sellers (builders) must have all information about market and non-market goods. Since perceptions are often important in property value selection this assumption seems somewhat weak. Also, it is assumed that movement between properties, in response to changes in market conditions, is relatively costless. Statistical issues of specification and functional form have also been raised in this literature. Finally, the identification of the marginal bid function (for a particular attribute) from the hedonic price function requires that there is variation in an individual's bid function across various levels of the attribute supplied (Wilman, 1984). Identifying the variation in an individual's bid function requires some assumptions on the elasticity of the marginal offer function (the supply of attributes). In the case of multiple attributes some more stringent assumptions on the preferences over attributes are required. One common assumption is that the marginal willingness to pay for each attribute is independent of the other attributes.

The assumptions required for hedonic price analysis may be relatively difficult to meet. This technique, however, does provide another component of the impact of environmental change on value, the property value dimension. One should note that this component may or may not be distinct from the impact of a quality change on recreational activity. If the property values contain the capitalized values of recreation (at varying quality levels) adding the hedonic and recreation values together will produce some double counting (McConnell, 1990). Of course, the group of recreationists may be larger than the group of property owners and the values may accrue differently to these two groups.

The hedonic approach provides a method of revealing the value of environmental damage through property value assessments. The final market based approach to be discussed here is the use of demand analysis to analyze the impact of perceived environmental risks on the prices and quantities demanded of market goods.

Risk Valuation Models

There are two different approaches to risk valuation models. The first develops the "value of additional risks" from an examination of wages and the relative risks associated with different occupations and uses this measure to value the risk generated by a pollutant or toxic chemical. The second approach examines the effect of perceived risks on the demand for a particular commodity (eg. apple demand in light of the perception of alar risks) and determines the implicit value of risk as the willingness to pay to reduce the risk. The first approach uses market data on wages and occupation risks to arrive at the risk value while the second approach uses market data on the commodity being studied and the impact of a change in the perceived risk. Note that both are market based approaches[4].

The risk valuation method which employs market data on wage rates is essentially a hedonic analysis of wages. Just as hedonic methods can be used to disaggregate property values into their market and non-market components, hedonic wage studies disaggregate wages (across occupations) into market and non-market elements of the occupation. Included in the determinants of the wage are socioeconomic characteristics (age, education, etc.) and workplace characteristics, including the risk of death. All else held constant, one

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4 There are also contingent valuation equivalents for the valuation of risk. Surveys which elicit a respondent's willingness to pay to avoid risk offer an alternative method of risk valuation (Smith and Desvousges, 1987). The Contingent Valuation methods of risk assessment have the advantages and disadvantages of the contingent valuation method described above.

would expect the wage to be higher for high death risk occupations. The hedonic wage models use these relationships to provide an estimate of the amount one is willing to give up in wages for an increase in safety (a decrease in the probability of death). These approaches suffer from the same type of criticisms as the hedonic property value studies, namely, a host of statistical concerns and the problem of the perception of risks by the wage earner. In particular, if an individual does not perceive higher risks associated with an occupation, the wage information will not reflect value of risk reduction. Examples of this type of risk valuation are Thayler and Rosen (1975) and Smith (1974). The values for the prevention of one death found in these studies range from $340,000 to $1 million in 1975 dollars. It may seem somewhat unethical to place values on human life, yet these studies are actually only estimating the implied value of reducing the probability of death associated with occupational hazard (see Kneese, 1984 for a discussion of the uses of these values in water and air quality studies).

Using the values described above, the value of risk reductions due to pollution control (for example) can be computed from estimates of the changes in mortality due to pollution control. For example, Crocker et al. (1979) value the benefits of reductions in particulates and SO2 in the U.S. at between $5.1 and $15.9 billion per year. Note that these values only relate to mortality and not morbidity or other health effects.

The second approach to risk valuation uses changes in the demand for goods as the perception of increased risks occurs. Apples and alar are an example of how the demand for a market good is affected by risk perceptions. An estimate of the demand for apples as a function of the price of apples, prices of substitutes and the perceived contribution of alar to cancer risk suggests that an individual would be willing to pay for the reduction of cancer risk (van Ravenswaay and Hoehn, 1990). Assuming that individual perceptions of alar risks correspond to the risks available from public agencies, the value of carcinogenic risk reduction can be deduced from this model. In the case of apples and alar, van Ravenswaay and Hoehn (1990) find that consumers would be willing to pay a premium of 12 cents per pound (17% increase) for alar free apples. Translated into a willingness to pay for reduction in cancer deaths this amounts to approximately $1 million per cancer death avoided.

NON-MARKET VALUES, AGRICULTURE AND WATER QUALITY

Recently the link between agriculture and water quality has become of increasing interest to physical and social scientists. One of the major benefits of the Conservation Reserve Program in the U.S. is the improvement in water quality (Ribaudo, et al., 1989)[5]. Reduced sediment loadings, decreased agricultural chemical and fertilizer leaching and other aspects of water quality improvement from agricultural management changes are expected to produce large benefits (estimated benefits of $79 per acre enrolled in the CRP). The question to be asked is, are the benefits large enough to rationalize the costs of implementing such a program? In Canada we are examining similar changes in agricultural management practices. The costs of such changes to the farmer can be fairly easily estimated but the benefit estimates require non-market valuation techniques.

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5 Ribaudo et al. describe a number of ways that the Conservation Reserve Program will produce benefits. Some of these are nonmarket values (hunting benefits, fishing benefits) while some are market values (for example, cost reductions in water treatment). The latter are opportunity cost measures of the value of environmental improvement and do not measure the demand for water quality *per se*.

The largest beneficiaries of improved water quality may be recreationists. Anglers, waterfowl hunters, birdwatchers, swimmers and other participants in forms of water based recreation should benefit. The non-market benefit estimation techniques described above can be used to evaluate these benefits. Beyond these Use value benefits a host of Non-Use value changes will likely occur if water quality changes.

Water quality changes will likely affect risk perceptions about drinking water. These benefits, while perhaps among the more difficult to capture, will also be important in the valuation of the effect of environmental improvements. A variety of market based elements will also be affected by changes in sediment loads or water pollutants. Water treatment costs, dredging of waterways[6] and cleaning of ditches and drainage systems will also constitute benefits (reduced costs). These, however, are market based measures of the benefits of water quality improvement.

CONCLUSIONS

The various techniques applied to non-market valuation have been the result of a great deal of creativity and a burgeoning demand for such information. While this creativity has only been active in the economics community for about thirty years, a number of useful techniques have been developed. However, a great deal still needs to be done. The contingent valuation technique is currently the only available mechanism for the measurement of Non-Use values. These values may be among the most significant, and the most difficult to elicit, of all non-market values. Furthermore, contingent valuation is under attack on a number of fronts but mostly on the apparent weakness in the Non-Use value measures. Progress must be made in this area. The most interesting problems in environmental valuation, greenhouse effects, rainforest values, endangered species valuation, etc, are Non-Use value problems. Some answers may lie in the more sophisticated choice experiments with strong emphasis on structuring and bias reduction.

A host of travel cost models are available to the researcher, a number of which seem to provide relatively accurate behavioral models for a number of situations. However, there needs to be more work done in this area as well. The link between perceived and objective measures of environmental quality must be explored further. Decisions are probably based on perceptions of environmental quality, spatial location (of recreation sites), time requirements and a variety of other factors. Undoubtedly this is an area where economists and other social and physical scientists could collaborate. Without the development of these links, however, not only will behavioral models be inaccurate, policy responses to environmental quality problems will be difficult to determine.

Even with an understanding of perceptions, travel cost models must still be refined to reflect the underlying behavioral model. While the current literature offers a choice among many behavior models, there are very few which consider dynamic elements such as habits, learning by doing or other such processes. This is an area which may produce significant insights into choice behavior and valuation.

In the current political and social environment there is considerable support for exercises which attempt to reflect the true worth of environmental services. Non-market valuation is one such exercise. There is no doubt that values for environmental services will vary across individuals or jurisdictions nor is there any doubt that values will change over time, just as they do for market goods. Trying to provide the definitive value estimate is not the role of non-market valuation. In fact, there may be very useful information in measures

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6 Although this may not be a significant cost in many parts of Canada watercourse dredging constitutes a relative major cost in many U.S. waterways.

of the variability of these value measures. The task of non-market valuation is to try to capture the tradeoff between market goods and environmental services in an attempt to reflect the demand for these services. Such information should be useful to policy makers and resource managers alike.

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TABLE 1: Examples of Contingent Valuation Estimates of Environmental Amenities

Object	Method	Source	Value
Hunting (season)	Open Ended	Filion et al., 1990	$268 /year
NonConsumptive Recreation (season)	Open Ended	Filion et al., 1990	$122 /year
Whooping crane habitat	Closed Ended	Bowker & Stoll, 1988	$21-$149 per year
Water Quality improvement (Boatable to Fishable)	Bidding Game	Mitchell & Carson,1984	$80/year
Water Quality improvement (Boatable to Swimable)	Bidding Game	Smith & Desvousges,1986	$10-$51 per year
Deer Hunting Permits (hypothetical question)	Closed Ended	Bishop et al., 1988	$32/permit
Deer Hunting Permits (actual cash offers)	Closed Ended	Bishop et al., 1988	$24/permit
Fishing Trip	Open Ended	Sorg & Loomis, 1986	$40/trip
Fishing Trip (double # of fish caught)	Open Ended	Sorg & Loomis, 1986	$51/trip
Fishing Trip (50% increase in fish size)	Open Ended	Sorg & Loomis, 1986	$54/trip

TABLE 2: Examples of Travel Cost Models for Recreation Valuation

Model	Object	Source	Value
Basic Travel Cost	Hunting permit	Bishop & Heberlein, 1979	$11-$45 permit
Basic Travel Cost	Water Rec.	Smith & Desvousges, 1986	$3.5/visit
Generalized Travel Cost	Water Rec.	Smith & Desvousges, 1986	$37 for a water qual. improvement: boatable to swimable.
Sequential Choice Model	Hunting	Adamowicz et al., 1990	$35/visit
MNL (Discrete Choice) Model	Beach Use	Bockstael et al., 1987	$12/ year for a 30% decrease in turbidity & 3 other pollutants
MNL (Discrete Choice) Model	Fishing	Bockstael et al., 1989	$.3-1.5/trip for a 20% increase in catch rate
MNL (Discrete Choice) Model	Fishing	Bockstael et al., 1989	$.8-$7.9 per trip
MNL (Discrete Choice) Model	Fishing	Carson et al., 1989	$21 /trip loss due to closing 1 fishing site