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APPLICATION OF BENEFIT TRANSFER WITH CONTINGENT VALUATION METHOD TO THE ROOT RIVER WATERSHED

SUBMITTED TO

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ABSTRACT

Ecological and flood risk often increase as a consequence of existing and ongoing urbanization. Watershed projects that focus on flood control and on improving the ecological integrity of urban watersheds typically are expensive. Indeed, it is common for a watershed improvement with both flood control and ecological risk reduction characteristics to cost more than $50 million. If decision makers are to efficiently allocate public resources, then the relative costs and benefits of such watershed improvement must be quantified. The valuation of flood control and ecological risk reduction characteristics of watershed projects is challenging because both characteristics may involve nonmarket goods. That is, consumers of these goods (flood control and ecological risk reduction) do not reveal their preferences in traditional markets. Rather, nonmarket techniques must be used. One of the most popular nonmarket techniques is the Contingent Valuation Method (CVM). This method is a survey-based approach in which residents of a region are directly asked to state their willingness to pay for the good. A recent study sponsored by the U.S. Environmental Protection Agency and the U.S. National Science Foundation used the CVM to derive separate benefits of maintaining flood risk at the current levels in opposition to urbanization pressures and improvements in stream water quality in the Oak Creek and Menomonee River watersheds. These watersheds are located in Milwaukee County, Wisconsin. Most CVM studies are costly since they involve primary data collection. For example, the survey cost associated with the aforementioned study exceeded $200,000. Given the expense, use of the CVM frequently is not feasible. A less costly alternative is to use the Benefit Transfer Technique (BTT) in which a study done in a particular location (i.e., study site) is used to derive benefits in another location (i.e., policy site). In this study, the various issues that need to be considered before the BTT is applied are evaluated. Then the BTT, where Oak Creek and Menomonee River watersheds are used as the study site, is applied to derive benefit estimates for flood control and ecological risk reduction to the Root River watershed (policy site), which is a contiguous watershed to the south of the study site. The findings suggest that flood risk benefits are minor and relatively lower than the benefits associated with ecological risk reduction.

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CHAPTER ONE

INTRODUCTION

Poor water quality and flood risk are major problems in many urban watersheds. Presently, the Root River Watershed is affected by both of these problems. One of the main reasons for increased flooding is change in land use. Urbanization affects the infiltration of water into the soil, reduces the water holding capacity of the soil, and reduces the pervious area. Reduction of the pervious area results in higher runoff volumes and reduces the time of concentration, which in turn increases the magnitude of the peak flow and frequency of damaging floods.

The alternatives for watershed management are functionally different scenarios according to how water moves through a site and through the environment. Each management alternative can implement a unique combination of objectives for storm water control, conservation, or restoration (Ferguson, 1998). Decision makers always want to know the relative costs and benefits of such management alternatives.

In many development projects, the benefit cost (B/C) ratio has been used as the criterion for evaluating the feasibility and the relative value of competitive projects (Tung, 1992).

The B/C analysis is used in situations in which a proposed program or project would divert resources from their current use to some other alternative. In this approach, the analyst must determine “no action ” benefits, which equal the net present value of the stream of services that would be provided by the resource in its current use over the life of the proposed project (Brookshire et al., 1980). These benefits can then be compared with those obtained from the proposed alternative projects.

In the market-place, an individual has fairly clear information on which to base valuations and choices. The product tends to be visible, its characteristics are generally well known, and it has a market price. The individual, on the basis of the available information, weighs up quantity, quality, and price on offer. But environmental goods, e.g., clean air, quietness, etc., and services often have no market price tag and a considerable amount of uncertainty can surround their true value and significance. Many environmental assets also are public goods and this makes it difficult for markets to evolve in such assets. For this reason, if the Root River Watershed is considered, it might be difficult to calculate benefits of maintaining the current level of flooding risk, and improvements in overall stream water quality that reduce ecological risks because they are natural phenomena.

Several non-market valuation techniques are available through which the benefits of the environmental projects can be calculated. The Contingent Valuation Method (CVM) is the most popular method among these non-market valuation techniques. The Contingent Valuation Method is a survey-based approach for the valuation of non-market goods and services that relies on a questionnaire to obtain direct information about the value of the good or service in question.

Novotny et al. (2001) used the CVM to calculate benefits of maintaining flood risk at current levels in opposition to urbanization pressures and improvements in stream water quality for the Menomonee River and Oak Creek Watersheds. It is possible to transfer the findings obtained in that study (*study site*) to calculate similar benefits for the Root River Watershed (*policy site*) since both areas have similar problems and solution techniques. This process is called “Benefit Transfer”.

The aim of this study is to calculate the benefits of maintaining flood risk at current levels and improving in stream quality in the Root River Watershed using principles of benefit transfer with the CVM, which is a nonmarket valuation technique. This essay first discusses the theory of non-market valuation, followed by a brief review of the CVM methodology. Then, a review of the “Benefit Transfer” process follows. Finally, characteristics of *the study site* and *the policy site* are compared and benefit estimates for the related watersheds are given.

CHAPTER TWO

NON-MARKET VALUATION TECHNIQUES

It is difficult to deal with the valuation of many public goods, since they tend to occur in non-market situations. It is impossible to buy or sell peace, quietness, or clean air in the open market (Barde and Pearce, 1986). According to Hanley et al. (1997) environmental resources such as ecosystem and biodiversity services are systematically mispriced by the market and this has forced policy makers to consider other means to assess the value of these resources. This recognition resulted in the development of new techniques to deal with non-market situations.

Preferences of individuals are the starting point of the non-market valuation. An individual is assumed to have a set of preferences over goods and services that can be ordered in a logical and consistent manner. Individuals are assumed to be able to value changes in the environment despite their absence from the market. Willingness to pay (WTP) and willingness to accept (WTA) represent the two general measures of economic value for an environmental service.

WTP is the maximum amount of money one would give up to buy some good or service (Lesser et al., 1997). WTA is the minimum amount of money one would accept to forgo some good or to bear some harm. Both concepts are monetary indicators of user preferences.

WTP is expressed as an expenditure function m (p, q, u). Here, the expenditure function is a function of prices, p, environmental quality, q, and utility level, u. In addition, the expenditure function measures the minimum amount of money a consumer must spend to achieve a fixed level of the desired good or service (Imer, 1997). Whitehead (1995) gave the following formal definition of the valuation function for the improvement in water quality:

$$WTP = m(p_1, q_1, u) - m(p_1, q_1^*, u) \qquad (2.1)$$

where q_1 is a degraded level of water quality such as a polluted lake, and q_1* is an improved level of water quality, p_1 is the on-site use of the related resource. Expenditures to maintain the utility level decrease with the increase in quality (q_1 to q_1*) so that WTP is greater than zero.

The economic aspects of the environmental benefits can be measured by direct and indirect techniques. Direct methods use surveys to ask individuals for a valuation of hypothetical changes in the resources (Smith et al., 1986). This method considers environmental gains and seeks directly to measure the monetary value of those gains

(Pearce and Turner, 1990). Indirect procedures for benefit estimation do not seek to measure direct revealed preferences for the environmental good in question. Instead, they calculate a dose-response relation between pollution and some effect (Pearce and Turner, 1990).

Three primary methods have been used to evaluate recreational benefits, which are one form of non-market environmental goods:

1. The Travel Cost Method
2. The Hedonic Price Method
3. The Contingent Valuation Method

2.1 TRAVEL COST METHOD

The travel cost method (TCM) is the most widely used framework for estimating the features of a recreation demand function (Smith et al., 1986). The TCM is based on the observed number of trips to a recreation site in response to travel cost (Walsh et al., 1992).

This method is often used to estimate the value of public recreation sites, which usually have a zero or nominal admission price. The travel cost method is based on three observations. First, the cost of using a recreation site is more than the admission price. It includes the monetary and time costs of travelling to the site and may include other costs.

Second, people who live different distances from a recreational site face different costs for using the site. Third, if the value that people place on a site does not vary systematically with distance, travel cost can be used as a proxy for price in deriving a demand curve for the recreation site (Lesser et al., 1997)

The TCM may be estimated as;

$$V_{ij} = f(P_{ij}, T_{ij}, Q_j, S_j, Y_i) \quad (2.2)$$

where V_{ij} is the number of visits made by individual *i* to site *j*; P_{ij} is the travel cost incurred by individual *i* when visiting site *j*; T_{ij} is the time cost incurred by individual *i* when visiting site *j*; Q_j is a vector of the perceived qualities of the recreation site *j*; S_j is a vector of characteristics of available substitute sites; and Y_i is the household income of individual *i*. The various travel cost models that appear in the literature are similar to the example given above, with variations arising from the manner in which the variables are defined and measured, and from the estimation procedure applied.

The procedure undertaken within the TCM requires researchers to undertake an on-site questionnaire survey of visitors aimed at eliciting estimates of household or individual visit frequencies over a given time period, plus information of the cost of travel to the site, recreational preferences, use of substitute sites, and socio-economic characteristics. These data are used to derive a demand curve from which consumer surplus may be estimated. Average household consumer surplus may be estimated by integrating under the demand curve between zero visits and the average number of visits made by the households in the sample over the specified time period. Once the household consumer surplus has been estimated, this must be multiplied by the average number of household visits to the site in a given time period to generate the aggregate estimates. In this study, the TCM is not used because it is hard to apply for flood control benefits, and indirect benefits could be omitted for the ecological improvement.

2.2 THE HEDONIC PRICING APPROACH (HPA)

The hedonic price approach (HPA) derives from the characteristics theory of value first proposed by Lancaster (1966) and Rosen (1974). As Lesser et al. (1997) mentioned the HPA is based on a straightforward premise: the value of an asset, whether a piece of land, a car, or a house, depends on a stream of benefits that are derived from that asset.

The property value approach for the benefit estimation is based on the following simple underlying assumption. Given that different locations have varied environmental attributes, such variation will result in differences in property values. With the usage of proper statistical techniques the hedonic approach attempts to (a) identify how much of the property differential is due to a particular environmental difference between properties and (b) infer how much people are willing to pay for an improvement in the environmental quality. The formal form of the HPA can be expressed as follows (Pearce and Turner, 1990):

Property Price = f (property variables, neighborhood variables, accessibility variables, environmental variables). (2.3)

The identification of the property price effect due to a difference in pollution levels usually is done by means of a multiple regression technique in which data are taken either on a small number of similar residential properties over a period of years (time series), or on a large number of diverse properties at a point in a time (cross section), or on both (pooled data). Since the property value is related to the willingness to pay, property price estimates can be used to value environmental damage or improvement.

Numerous hedonic price studies that specifically address the issue of flooding have been done. Novotny et al. (2001) examined some of these studies, which are summarized as follows. Schaefer (1990) examined the effect of floodplain regulations on residential property values whereas Shilling et al. (1987) evaluated the impact of subsidized and nonsubsidized flood insurance on property values. Likewise, the impact of different measures of flood risk on property values also have been considered in a number of different studies (Barnard 1978; Park and Miller 1982; Donnelly 1989; Speyrer and Ragas 1991; Shabman and Stephenson 1996). For the most part, the results from these studies indicate that location in a floodplain, or proxies for flood risk, negatively impacts residential property values. One study examined a major flood event (Babcock and Mitchell 1980); however, this analysis was done by a comparison of prices before and after the event, and, thus, was vulnerable to bias due to omitted factors in the analysis. Bartosova et al. (1999) found that other things equal, real housing prices are 12% lower for homes selling in the Menomonee River 100-year floodplain, as compared to those selling outside the floodplain. In addition, housing prices rise as the recurrence interval rises within the 1000-year floodplain.

An important advantage of the hedonic approach is that benefit estimates are based on actual behavior in real world markets. However, the model has some shortcomings that limit its applicability to flood risk reduction/ecological restoration studies. Novotny et al. (2001) listed some of the shortcomings as follows. First, the model is best adapted to evaluate nonmarket goods that are already in place. For example, the benefits of flood control can be derived by examining the housing price differentials that result from properties that face different levels of flood risk. In contrast, goods that are only proposed, such as ecological restoration, could not be evaluated if there were no experience with the good in the particular market. That is, no real estate impacts could be reflected if the improvements had not been realized at any location within the region. Second, the benefits that can be derived from the hedonic model would reflect private direct benefits, and would neglect indirect benefits to other residents (e.g., resulting from altruistic beliefs) within the community. As a result, the hedonic model would be expected to underestimate the general level of benefits that could result if the good has important public good attributes.

2.3 CONTINGENT VALUATION METHOD

The Contingent Valuation Method (CVM) is one of the many economic methods that can be used to estimate the benefits of environmental improvement. In recent years the Contingent Valuation Method has gained popularity as the major technique for the assessment of the value of environmental features (Kahneman and Knetsch 1992). According to Green and Tunstall (1991), in practice, the choice of method frequently is restricted to the CVM because the two remaining methods (recreational user benefits in case of the Travel Cost Method and amenity benefits which are captured through house prices in the case of Hedonic Price Method) are limited in the range of environmental goods to which they can be applied. Loomis (1996) stated that “The Contingent Valuation Method is recommended for use by US Federal agencies for performing benefit/cost analysis (U.S Water Resources Council, 1983) and for resource damages valuation (U.S. Department of Interior, 1986) and was upheld by the Federal courts (State of Ohio versus U.S Department of Interior, 1989)”. The U.S. EPA (U.S. Environmental Protection Agency) has contributed extensively to the development of the CVM. From 1973 to the present, the EPA has provided extensive research assistance funding for both basic research on the CVM and its applications to determining the economic benefits of EPA programs. EPA research has resulted in more than 150 books, research reports, and articles on the CVM (U.S. EPA, 1994).

Lesser et al. (1997) stated that the premise of the CVM is straightforward: if you wish to know the value that people place on something just ask them. The CVM asks people what they are willing to pay for an environmental benefit or what they are willing to accept to tolerate an environmental cost. Such inquiries may be done through the use of direct questionnaires or surveys or through the use of experiments that determine how individuals respond (Lesser et al., 1997).

2.3.1 Performing a Contingent Valuation Study

There are several steps for performing the CVM. Hanley et al. (1997) suggested 4 stages for any CVM exercise:

1. Setting up the hypothetical market
2. Obtaining bids
3. Estimating mean WTP/WTA and estimating bid curves
4. Aggregating data

2.3.1.1 Hypothetical Market

The process of developing a CV scenario consists of a number of elements. The first step is to set up a hypothetical market for the environmental good that is the subject of the study. The basic idea of the CVM is to elicit hypothetical bids that conform to actual bids if an actual only market existed (Pearce and Turner, 1990). In this way, it is possible to value the environment, which is in a non-market situation. For this purpose different types of *bid vehicles* can be used. Some of the bid vehicles are: property taxes, income tax, utility bills, trust fund payments, and entry fees (Hanley et al., 1997). Several examples from different studies are given in the following paragraphs.

Loomis (1990) setup a hypothetical market to address the benefits from preservation of a relatively unique hypersaline lake. A mail questionnaire was developed that described the issue as one of paying a higher monthly water bill to reduce diversions of streams feeding the hypersaline lake. Sanders et al. (1990) did a CVM to estimate the benefits of protecting rivers in the Rocky Mountains of Colorado. In this study, respondents were asked to make a series of five budget allocation decisions based on annual benefits received from increments in river protection, i.e., to write down the maximum amount of money they would be willing to pay annually for an increase in the number of rivers protected.

Loomis (1996) used the CVM to obtain estimates of willingness to pay for removing the two dams on the Elwha River on the Olympic Peninsula in Washington State and restoring the ecosystem. Respondents were read the following statement:

> " If a majority of people are not willing to pay the cost of dam removal, the dams would remain.
>
> If a majority of people agree to pay the costs, the dams would be removed, the river would be restored to a natural state, and fish populations would increase.
>
> If an increase in your federal taxes for the next 10 years cost your household $X each year to remove two dams and restore both the river and fish populations would you vote in favor? "

It can be seen from the statement, federal taxes were selected as the payment vehicle. Green and Tunstall (1991) have used water bills as payment vehicles to estimate recreational benefits that would result from improvements in water quality. They want respondents to think about how much extra would they are willing to pay on their water rates so that more money can be spent on reducing water pollution.

2.3.1.2 Obtaining Bids

Once the survey instrument is set up, the survey is done. Numerous types of survey instruments are available such as: face-to-face interviewing, telephone interviewing, or mail interviews. Each of them has its own benefits and costs. Lesser et al. (1997) stated that phone surveys, for example, have higher response rates than mail surveys. However, they are more expensive to undertake. They also preclude the use of visual material, such as photographs showing pollution levels. Mail surveys generally are the cheapest but can have a low response rate and provide no opportunities to explain questions that respondents find confusing or to clarify confusing answers. Face to face interviews are the most reliable survey method but also the most costly.

In the CVM individuals are asked to state their maximum willingness to pay/willingness to accept for the increase or decrease in environmental quality, which is the subject of the survey. A variety of questioning formats has been used in contingent valuation studies to obtain WTP/WTA, such as: bidding game, payment card, open-ended question, and close-ended referendum.

Bidding Game : In this technique, respondents are suggested higher and higher amounts until their maximum WTP is reached (Hanley et al., 1997). The questioner suggests the first bid and the respondent agrees or denies that she/he would be willing to pay it. Then, the starting point price is increased to see if the respondent would still be willing to pay it, and so on until the respondent declares he/she is not willing to pay the extra increment in the bid (Pearce and Turner, 1990). The last accepted bid, then, is the maximum willingness to pay.

Payment Card: A range of values is presented on a card which may also indicate the typical expenditure by respondent in a given income group. This helps respondents to calibrate their replies.

Open-ended choice: Individuals are asked for their maximum WTP with no value being suggested to them.

The dichotomous choice: A single payment is suggested, to which respondents either agree or disagree (yes/no reply).

The dichotomous choice (DC), close-ended, and open-ended formats are the commonly used response formats to estimate the willingness to pay. Open-ended questions ask people to specify their willingness to pay, and close-ended questions first specify a sum and then ask people to choose whether or not pay the sum (Kealy and Turner, 1993).

Most CV studies that have compared estimates of WTP obtained using the dichotomous choice and open-ended formats have found that dichotomous choice yields higher estimates. The open-ended direct question may provide a lower more conservative estimate of value than would the interactive bidding technique. The iterative procedure has been preferred because it is specifically designed to assist respondents as they approach the point of indifference between having the amount of income stated or the environmental amenity. However, open-ended questions in mail surveys may have several advantages of their own. The questions can be answered at home and at a time convenient to the respondents (Walsh et al., 1984).

Several studies investigated the reliability of these different formats. But there is no consensus about the reason for the difference in the results of the formats or about which format will yield the most accurate estimate of actual WTP (Brown et al., 1996).

Both the open-ended and iterative approaches are used to estimate the same underlying construction, i.e. mean willingness to pay, but it is not known whether the two methods yield the same contingent values in practice (Haneman, 1984; Boyle and Bishop, 1988). Both the open-ended and iterative approaches are recommended by the U.S. Water Resources Council of the U.S (1983).

2.3.1.3 Estimating mean WTP/ WTA and estimating bid curves

If open-ended, bidding game, or payment card approaches have been used, then the calculation of mean and/or median WTP or WTA is straightforward. A bid curve can be estimated for open-ended CVM formats using WTP/WTA amounts as the dependent variables and a range of independent variables. For example, in an open-ended CVM survey, WTP bids might be regressed against income (Y), education (E), and age (A), as well as some variable measuring the "quantity" of environmental quality being bid for (Q), if this is variable across respondents:

$$WTP = f\ (Y, E, A, Q) \qquad (2.4)$$

Dependent variables should clearly be chosen with regard to those variables, which from a theoretical perspective might be expected to explain WTP. Bid curves also are useful to predict the valuation of changes in Q other than those suggested in the survey, and to test the sensitivity of WTP amounts to variations in Q (Hanley et al., 1997)

Since the stated willingness to pay amounts varies across the sample, the close-ended format allows the analyst to statistically trace out a demand like relation between the probability of a "YES" response and the willingness to pay amount (Hanneman, 1984). The basic relation is:

$$\text{Prob (YES)} = 1- \{1+ \exp[B_0-B_1(X\$)]\} \qquad (2.5)$$

where B_0 and B_1 are coefficients to be estimated using logistic regression and X$ is the stated WTP amount. In DC framework, bid curves are the logit functions which predict the probability of a "YES" response to a particular offer price. From this equation Hanneman (1984), provides a formula to calculate the expected value of WTP when WTP must be greater than or equal to zero as:

$$\text{Mean WTP} = (1/B_1)\ln(1+\exp(B_0)) \qquad (2.6)$$

2.3.1.4 Aggregating Data

Aggregating refers to the process whereby the mean bid or bids are converted to a total value figure for the population (Hanley et al., 1997). As Loomis (1987) states, the objective of the CVM as a tool of benefit-cost analysis is to provide estimates of aggregate benefits.

According to the Hanley et al. (1997), three issues should be considered for the aggregation process. The first issue is the choice of relevant population. This should have been decided when constructing the sampling frame from which the sample was drawn. The boundary of the population should be well drawn. This population can be the local population, regional population, population of the country, or the whole continent.

The second issue is moving from the sample mean to a mean for the total population. The number of households in the population, N, could multiply the sample mean to obtain the population benefits. As Loomis (1987) states the problem of generalizing results from a sample to the population is at the heart of sampling theory and survey researcher concerns about low response rates. Samples of randomly selected households in a particular area have to be generalized to the entire population. If the researcher is dealing with a highly select population whose members are quite interested in the issue discussed in the survey, then response rates tend to be high and generalizing to this select population is quite good.

The third issue is the choice of the time period over which the benefit should be aggregated. This will depend on the setting within which the CVM exercise is being performed. If the present value of environmental benefit flows over time is of interest, then benefits normally are discounted.

2.3.2 Biases

A very large part of the literature on the CVM deals with discussion about biases of the CVM. "Bias" implies systematic over- or under-statement of true WTP/WTA. A classification of the nature of the biases is given in Table 2.1 (Pearce and Turner, 1990).

Table 2.1 Sources of Biases

Strategic	Incentive to free ride?
Design	• Starting point bias • Vehicle bias • Informational Bias
Hypothetical	Are bids in a hypothetical market different to actual market bids? What should they be?

Strategic Bias : Hanley et al. (1997) state that if respondents believe that bids will be collected, they may understate their WTP for a wellfare improving change because environmental goods are typically non-excludable in consumption (free rider problem). When an individual thinks he/she may influence an investment or policy decision by not answering the interviewer's question truthfully, this problem arises. For example, if individuals are told that a service will be provided if a) the total aggregated sum they are willing to pay exceeds the cost of provision, and b) that each will be charged a price according to their maximum WTP, the presumption is that each individual will understate his/her true demand. However, CVM studies have found that strategic bias is not a significant problem (Pearce and Turner, 1990)

Starting point bia : This problem occurs in the bidding game question format. The first bid suggested may influence the respondent in someway. CVM studies have attempted to test for this source of bias, usually by offering different starting bids, and sometimes by letting the respondent make the first bid. Then the effect of starting bid on mean WTP can be tested. As Pearce and Turner (1990) emphasise, the studies on the effect of the starting bid do not end up with the same results. Some studies found that no correlation exists between starting bid and mean bids, whereas other studies found that mean bids were affected by the stating bids.

Vehicle Bias : This problem results from choice of payment instrument, i.e. vehicle. If a respondent is sensitive to the vehicle, she/he may think it costly to pay 1$ through taxes, but it will be suitable for him/her to pay 1$ through an entrance fee. If the value of environment is different for the different payment vehicles, it means that vehicle bias exists.

Information Bias: Information style supplied by the interviewer is the reason for this problem. The sequence in which information is supplied also may influence respondents. The general amount and the quality of information also are very important.

Hypothetical Bias: Since the situation takes place in non-market conditions, the valuation is carried out by setting a hypothetical market. The basic difference between an actual and a hypothetical market is that in actual markets purchasers will suffer a cost if they get it wrong (Pearce and Turner, 1990). If the respondent does not understand the hypothetical market, he/she may state WTP for a completely different market.

CHAPTER THREE

BENEFIT TRANSFER VIA CONTINGENT VALUATION METHOD

3.1 INTRODUCTION

Benefit transfer (BT) is the application of a data set that was obtained from a particular study to a different study. In the literature there are several definitions of benefit transfer. Desvousges et al. (1992) describe a benefit transfer as follows:

> "We call the use of existing studies "benefit transfer." The river where an existing study was conducted is termed the "study site" and the river under consideration for quality improvement is the "policy site." The estimated benefits are transferred from the study site to the policy site."

Boyle and Bergstrom (1992) describe it as:

> "The transfer of existing estimates of non market values to a new study which is different from the study for which the values were originally estimated. This is simply the application of secondary data to a new policy issue."

The most important reason for using previous study results in a new policy site is cost effectiveness. According to Brouwer (2000) applying previous research findings to a similar decision situation is very attractive relative to expensive and time-consuming original research to quickly inform decision-making. Boyle and Bergstrom (1992) also outlined similar reasons for benefit transfer. These reasons are:

- Primary data collection on a site-by-site basis is expensive
- Agencies face considerable uncertainty regarding continued budget support for primary data collection
- Primary data collection is time consuming, often taking one or more years to complete a study from start to finish.

For certain policy and management decisions, agencies require inexpensive benefit estimates in a timely manner. Benefit transfer offers an opportunity to meet this need (Boyle and Bergstrom, 1992). Benefit transfer has been applied extensively in various natural resource policy contexts, ranging from water quality management (Luken et al., 1992) and associated health risks (Kask and Shogren, 1994) to waste (Brisson and Pearce, 1995) and forest management (Bateman et al., 1995).

Benefit transfer can be done in two different ways: direct transfer of benefit estimates, or the transfer of an entire benefit function. The first approach is straightforward; the benefit estimate from the study site is directly transferred to the policy site. In the second approach, the estimated benefit function for a study is transferred to a policy site. One of the advantages of deriving benefits spatially using Census block groups as the underlying data unit in this analysis is that it facilitates the transfer of the estimated benefit function, which has been described as an ideal transfer approach (Devousges et al., 1992; Loomis, 1992).

Desvouesges et al. (1992) illustrated the conceptual perspective on the issue of benefit function transfer by an example. In the example given by Desvouesges et al. (1992), the goal of benefit transfer was to construct the best prediction equation possible for estimating the benefits of water-quality improvements at policy sites using existing studies. A general form of a predicting equation for a given household can be written as:

$$E\,(cs \mid X) = f\,(Q_1\text{-}Q_0, \alpha, \beta, P; \delta) \qquad (3.1)$$

where:

- E ( ) is an expected value operator;
- δ is a vector of parameters
- cs is the compensation surplus for an improvement in a water quality from Q_0 to Q_1
- α is a vector of household characteristics such as income and household size
- β is a vector of site characteristics of the river such as natural cover, size, and recreation accommodations
- *P* is a vector of own and substitute implicit prices of recreation visits
- $X = (Q_1\text{-}Q_0, \alpha, \beta, P)$

If the model and data are available, the transfer problem is straightforward. Q_1-Q_0, α, β, and *P* values are known at a policy site and it is needed to predict the value of improving water quality from Q_0 to Q_1. To predict the expected compensating surplus for households, estimates of parameters δ are needed. Because of limited time and research resources, estimates from existing valuation studies must be used.

In the ideal transfer, estimates of each of the parameters in the vector δ would be available. Using these parameter estimates and the values of Q_1-Q_0, α, β, and P for each household at the policy site, the transfer can be conducted in a two-step process. First, the market area is established. This is the geographic area defined so that the compensating surplus of households at its boundaries is zero. Market size is a critical element in the transfer process, which is the population size used to convert benefits per household to aggregate benefits. Second, parameter estimates and variables for each household in the market area are substituted into an expression such as Equation 3.1 and the compensating surplus is estimated. The sum of the individual household estimates over the market area is the estimate of aggregate market benefits of the improvement.

3.2 STEPS IN BENEFIT TRANSFER

A number of steps have been highlighted which are considered important to the practice of benefit transfer and monetary valuation of environmental change in general by Boyle and Bergstrom (1992). The steps are as follows:

- Identification of the values at the policy site
- Identification of study site
- Transferability of study site values
- Quality of benefit transfer

i) Identification of the values at the policy site: The first step in doing a BT is to specify the theoretical definition of the values to be estimated at the policy site. BT has been used to value non-market goods, which cannot be sold and bought in the market. Two goods, flood control and ecological restoration, are under consideration in this study. The attribute and socioeconomic variables represent the key aspects of the policy site that must be considered when determining the transferability of values from the study site. In this study, the attribute vector may include flood recurrence interval, distance to the river, habitat index, frequency of visit to the river, etc. Socio-economic characteristics may include age, sex, education, income, race, etc. This information allows researchers to learn whether the object of valuation, and the user group are the same, or at least similar, at both the policy site and the study site. If differences exist, knowledge of these variables may allow for systematic manipulation of study site values so that they will be applicable at the policy site.

ii) Identification of study site: This step involves doing a thorough literature search. Reviewing journal articles and citations is one of the ways of selecting a study site. Although there are many books and technical review papers focused on contingent valuation literature review and provides extensive lists of references that can be quite useful, this step is more difficult than it may first appear. As the number and diversity of valuation studies increases, many relevant study sites may not be identified via traditional search procedures (e.g., journal search). The hard to obtain literature includes research reports of well-done studies that do not contain a new improvement that enables further publication, recently completed studies that have not yet been published, and various special publications that are not widely circulated (e.g., experiment station reports and bulletins from universities). Accepting that the quality of study site values is critical to the quality of a benefit transfer, an obvious preference may exist for using recent studies applying state of the art data collection and value estimation procedures.

In this study, identification of the study site was not as difficult as described above. A recent study that used the CVM to derive separate benefits of maintaining flood risk at current levels in opposition to urbanization pressures and improvements in stream water quality in the Oak Creek and Menomonee River watersheds was used for the study sites. In 1992, Water Resources Research (Volume 28, number 3) dedicated a special issue to the concept and technique of benefit transfer. In this issue, a number of authors outlined criteria for selecting among studies for benefit transfer (e.g., Boyle and Bergstrom, 1992; Desvousges et al., 1992). These criteria refer to the environmental goods involved, the sites in which the goods are found, the benefits and study quality. Besides these criteria, if the fact that all data related to the study site report are easily accessible is considered, the Menomonee River and Oak Creek Watershed studies can be considered as the best alternative use as a study site.

Desvousges et al. (1992) found eight previously applied studies, which provided estimates of the value of water-quality improvements, and a published model based on a sound economic method and for which sufficient data were available at the policy site to enable transfer. But they eliminated five of the eight studies because they found that study and policy sites were not similar. Boyle and Bergstrom (1992) searched for study sites where values have been estimated for rafting under various flow regimes and they identified five potential study sites.

iii) Transferability of Study Site Values: Potential study site values must be examined to determine whether or not they are transferable. Transferability needs to be evaluated using objective criteria. Boyle and Bergstrom (1992) suggested a systematic, conceptual foundation for benefit transfer studies. They also defined technical criteria for the selection of potential study sites from which benefits could be transferred. These criteria are:

- The non-market good to be valued at the policy site must be identical to that already valued at the study site
- The population affected by the non-market good must be identical at each site
- The safe welfare measure should be theoretically appropriate at each site, e.g., property rights existing at each site should imply the use of either WTP or WTA measures.

For this study, detailed comparison of the study and policy sites is given in Chapter 4.

iv) Quality of Benefit Transfer:

Boyle and Bergstrom (1992) mentioned two aspects of quality investigation: intersite and intrasite.

Quality of Benefit Transfer- Intersite: Assuming that one or more study sites have been identified as meeting technical criteria for benefit transfer, the next step is to evaluate the quality of these estimates in terms of original quality. This statement provides the following expression:

$$E(\hat{\beta}_{ss}) = \beta_{ss} \tag{3.2}$$

where $\hat{\beta}_{ss}$ is the expected value (coefficients of the regression equation) at the study site, and β_{ss} is the true estimator at the study site. If this condition is satisfied, it means that the estimate at the study site is unbiased. This means that the study site value must be investigated in terms of value specification, data collection procedures, statistical methods, and the non-market valuation application itself. Although biased estimates at a study site certainly create serious problems about the transferability of these estimates, it does not mean that these estimates should not be considered for the benefit transfer. Rather, unbiased estimates are certainly preferred, but if estimates are biased, whether the bias is large or small should be examined. Boyle and Bergstrom (1992) stated that small bias might still be acceptable in benefit transfer. But a study with serious problems resulting in a large bias should not be considered for benefit transfer. Since any non-market valuation study has some degree of margin of error, it must be taken into consideration as benefit transfer proceeds.

Quality of Benefit transfer- Intrasite :

Boyle and Bergstrom (1992) mentioned that even statistically unbiased estimates of non market values at the study site are measured with some degree of statistical error, and non-market commodities, affected population and property right structures at the study site will rarely match up exactly, alternative ways must be found to implement technical benefit transfer criteria. One possibility is to assume that technical criteria are met if nonmarket values at the study site and policy site are statistically identical. This is a question of whether

$$E(\hat{\beta}_{ss}) = \beta_{ps} \tag{3.3}$$

where β_{ps} is the true parameter at the policy site. If Equation 3.3 is correct, the study site estimates can be used with confidence. The more likely outcome is that study site value will not be a statistically unbiased estimate of the value to be estimated at the policy site. Boyle and Bergstrom (1992) presented three different alternatives if the study site value does not provide a statistically unbiased estimate of the policy site value: i)reject the study site for benefit transfer ii) ask whether or not the bias is small and within the acceptable range of error for the investigation at the policy site, and iii) determine whether or not the study site value can be systematically adjusted to remove or reduce the bias at the study site.

Boyle and Bergstrom (1992) outlined some problems related to the benefit transfer (BT). BT values can be affected by the *ex ante-ex post* (before and after) valuation perspective, scale or quantity value, sequential position of the supply of the good, difference in attributes, and compositional effects. Even if the goods, the sites where they are found, and their user groups are similar, the benefits derived from these goods are not necessarily the same if the population and their characteristics around the sites are not the same (Loomis, 1992).

Brouwer (2000) analyzed the studies, which have tested the validity of environmental value transfer across sites. It was stated that no study has yet been able to show under which conditions environmental value transfer is valid. It should also be noted that there is a strong relation between non-market valuation estimation and benefit transfer techniques. Brookshire and Neill (1992) argued that benefit transfers could only be as accurate as the initial benefit estimates. Therefore, the problems associated with non-market valuation will be magnified in benefit transfer application. Therefore, the methodological and the empirical problems related to non-market valuation should be well investigated.

CHAPTER FOUR

APPLICATION OF BENEFIT TRANSFER:

A CASE STUDY ON THE ROOT RIVER WATERSHED

4.1 COMPARISON OF THE STUDY SITE AND THE POLICY SITE: THE MENOMONEE RIVER/OAK CREEK WATERSHEDS AND THE ROOT RIVER WATERSHED

The Milwaukee-area has been suffering from a flooding problem. In order to reduce this problem, several action plans have been initiated. The Menomonee River, Kinnickinnic River, Oak Creek, Root River, Lake Michigan tributary drainage, and some tributaries of the Milwaukee River have been included in these plans. Although it might be relatively easy to calculate the costs of the action plans, it is difficult to determine benefits of the management alternatives since the value of the environment also should be included besides property losses. In 2001, the CVM was applied to the Menomonee River and Oak Creek Watersheds to determine benefits of flood risk prevention in monetary terms by the Institute for Urban Environmental Risk Management at Marquette University (Novotny et al., 2001).

Since the application of the CVM is expensive, it was not be economically feasible to apply this method at other sites to determine benefits of the projects. For this reason benefit estimates can be transferred to the new sites to reduce the cost of benefit/cost analysis. In this project, benefits of the flood-risk prevention and water-quality improvement in the Root River Watershed are determined. Since the Menomonee River and Oak Creek Watersheds are very close to the Root River Watershed and they are all affected by the similar problems, it would be a good starting point to compare these watersheds to examine transferability of the benefits estimates from the Menomonee River/Oak Creek Watersheds to the Root River Watershed.

4.1.1 Location and Socio-Economic Characteristics of the Watersheds

The Menomonee River Watershed is located in the east central portion of southeastern Wisconsin and covers an area of approximately 135 mi^2. The Menomonee River originates in southeastern Washington County, and flows approximately 28 miles through the northeastern corner of Waukesha County and through western Milwaukee County to its confluence with the Milwaukee River in downtown Milwaukee (SEWRPC, 1995).

The Oak Creek Watershed is located in the east central portion of southeastern Wisconsin and covers an area of 28 mi^2. The main stem of Oak Creek rises in the southwestern corner of Milwaukee County and flows easterly and northerly within the County for approximately 13 miles before emptying into Lake Michigan on the eastern border of the watershed (SEWRPC, 1995).

The Root River Watershed is located in the east-central portion of the Southeastern Wisconsin Region and covers an area of approximately 197 mi^2. The main stem of the Root River originates in Milwaukee County within the city of West Allis and flows approximately southeasterly with a discharge into Lake Michigan in the city of Racine. The watershed is located in four counties – Kenosha, Milwaukee, Racine, and Waukesha - and 18 cities, villages, and towns (SEWRPC, 1995).

All of the rivers and streams in the watersheds (Menomonee River, Oak Creek, Root River) are part of the Lake Michigan drainage system. The location of the watersheds is shown in Figure 4.1.

Since the ultimate purpose of the management planning effort is to improve the environment in which the resident population lives, an understanding of the size, characteristics, and spatial distribution of this population is fundamental to the effort. The resident population levels bear a direct relation to the demand for land, water, and other elements of the natural resource base. The size and characteristics of the population of an area are greatly influenced by growth and change in economic activity. The percent distribution of counties over watersheds and watershed populations are given in Tables 4.1 and 4.2.

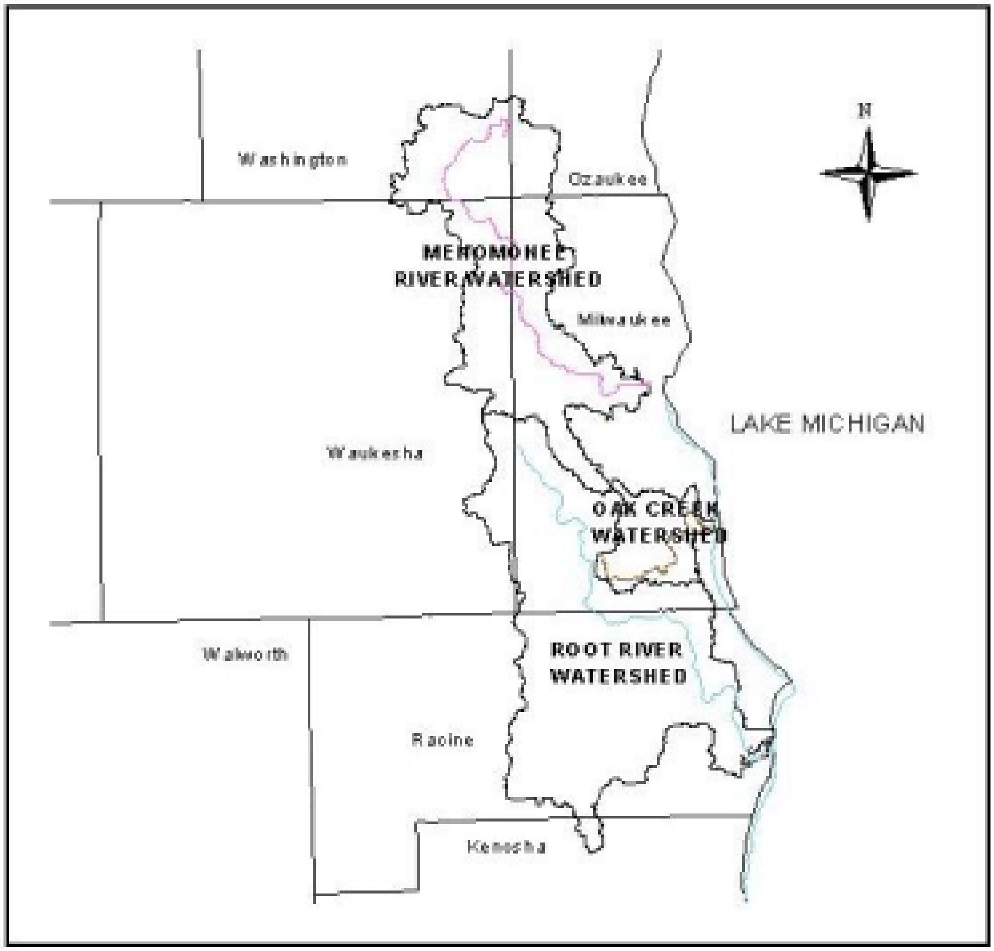

Figure 4.1 Location of the study and policy watersheds

Table 4.1 Distribution of counties over the watersheds

	COUNTY											
Watershed	**Kenosha**		**Milwaukee**		**Ozaukee**		**Racine**		**Washington**		**Waukesha**	
	Area	**%**	**Area**	**%**	**Area**	**%**	**Area**	**%**	**Area**	**%**	**Area**	**%**
Root	2.18	1.11	58.65	29.79	-	-	122.94	62.45	-	-	13.1	6.65
Menomonee	-	-	54.7	40.52	11.67	8.65	-	-	31.5	23.36	37.43	27.73
Oak	-	-	28	100	-	-	-	-	-	-	-	-

Table 4.2 Population of the watersheds (1990)

Watershed	Population	Population density
Root	156,488	794
Menomonee	330,178	2,446
Oak	40,499	1,446

As shown in Tables 4.1 and 4.2, although area of the Root River Watershed is larger than the other two watersheds, the population and population density of the Menomonee River Watershed is the largest among these watersheds. The Oak Creek Watershed is located entirely inside Milwaukee County. Residential use represents the largest urban land use in the Oak Creek watershed. Although the Oak Creek Watershed contains numerous urbanized areas, 49 % of the watershed still was rural land and other open space uses in 1990 (SEWRPC, 1995). A large portion of the Menomonee River watershed is located in Milwaukee County (40 %), Washington County (23%), and Waukesha County (27 %). Urban development exists in much of the Menomonee River Watershed, with concentrated development generally occurring in portions of Milwaukee, Washington, and Waukesha Counties. Residential land represents the largest land use in the Menomonee River Watershed. Although the watershed is largely urbanized, 41 % of the watershed was still in rural and other open space land use in 1990 (SEWRPC, 1995). Within the Root River Watershed, major concentrations of urban development exist in portions of three counties, with the majority of the development located in Milwaukee and Racine Counties. Urban development has been taking place rapidly in and around the numerous cities of the Root River Watershed. However, 28 % of the watershed was devoted to urban uses in 1990 (SEWRPC, 1995).

One of the most important requirements of the benefit transfer process is that the population affected by the non-market good must be identical at each site (study and policy site). A GIS (Geographic Information System) was used to identify differences and similarities of socio-economic characteristics of the watersheds. Census block groups were used to calculate average values for the watersheds. To test whether the values of the *Demographic* and *Residence* control variables used in the regression equations differed, t-tests comparing mean values were computed. The following hypothesis was tested:

$$H_0 : \mu_{Menomonee+Oak} = \mu_{Root} \text{ (mean values are the same)}$$
$$H_a : \mu_{Menomonee+Oak} \neq \mu_{Root} \text{ (mean values are not the same)}$$

The hypothesis was tested at 5 % level of significance, $\alpha = 0.05$. Results are presented in Table 4.3 with the corresponding p values are given in parenthesis.

Table 4.3 Mean Comparisons across Census Block Groups for 1990

	Unweighted Mean Values			
Variable	**Menomonee + Oak Creek (n=456)**	**Root River (n=135)**	**t-score (Prob. value)**	**Reject H0: mean values are the same at 5% level**
Age	36.56	35.52	t=1.63 (p=0.10)	no
Years of Education	11.87	11.76	t=1.26 (p=0.21)	no
Married	0.52	0.56	t=2.55 (p=0.01)	yes
Minority	0.12	0.14	t=1.01 (p=0.31)	no
# of Children	0.72	0.79	t=1.01 (p=0.31)	no
Real income	49,642	51,890	t=1.14 (p=0.25)	no
Single-family home	0.60	0.70	t=3.54 (p=0.00)	yes
Owner occupied home	0.60	0.67	t=2.81 (p=0.01)	yes

As shown in Table 4.3, unweighted mean values are given in the second and third column, t-scores are given in fourth column, and the conclusion of the hypothesis test is given in the fifth column. Demographically, a comparison of mean values reveals strong similarities between the three watersheds although there are slight differences between mean values. They reveal that most *Demographic Control* variables (age, education, minority, # of children, income) are statistically similar across the study (Menomonee River and Oak Creek Watersheds) and policy (Root River Watershed) sites. The one exception is *Married*, for which the mean is higher in the Root River Watershed. Both of the *Residence Control* variables (single family home, owner occupied home) differ between the study site as compared to the policy site. The fraction of homes that are owner-occupied and single-family is statistically higher in the Root River watershed. In spite of these differences, given the locational proximity of the study and policy sites, and given that most of the demographic variables do not differ significantly, the study site is judged to be sufficiently similar to apply benefit transfer.

4.2 FLOODING PROBLEMS AND MANAGEMENT PLANS

During the 1997 and 1998 floods in the Milwaukee area, some residents lost their homes. All are fearful that flooding will occur again and want something to be done before it happens again (CRCWATER, 2001). The flood that occurred in August 1998 caused an estimated $54 million in total damage and forced 300 residents to evacuate their homes in the Milwaukee area (Milwaukee Journal Sentinel, August 30, 1998).

To address the flooding problems, the Milwaukee Metropolitan Sewerage District has formed the Watercourse Policy Group. The group consists of the MMSD and other groups seeking ways to reduce the risk of flooding along six Milwaukee-area waterways (CRCWATER, 2001).

The MMSD developed flood management plans for six Milwaukee-area watercourses as part of the District's update of its Watercourse System Management Plan aimed at developing alternatives to reduce the risk of flooding in six Milwaukee-area water-courses, which encompass 24 tributary streams and rivers. The watersheds included in the plan update are the Menomonee River, Kinnickinnic River, Oak Creek, Root River, Lake Michigan tributary drainage, and some tributaries of the Milwaukee River (MMSD, 2000a). The Watercourse Policy Advisory Group was established to make recommendations on important policy issues. These recommendations included identification of cost sharing responsibilities, level of protection necessary, cost/benefit ratio standard for doing flood control, and prioritization of projects. The group included representatives of communities served by the District, Milwaukee County, the Wisconsin Department of Natural Resources, and the SEWRPC (MMSD, 2000a).

In mid-1998, the District co-sponsored a conference on “Integrated Stormwater and Floodland Management” held at Marquette University. The regional planning conference addressed the key topics of flood control and stormwater management planning, and intergovernmental cooperation. It also looked at what other communities are doing nationwide and how stormwater and flood control measures can be community assets.

The MMSD has proposed to spend about $190 million on watercourse work during the next five years. Annual spending on Watercourse Projects is given in Figure 4.2 (MMSD, 2000b).

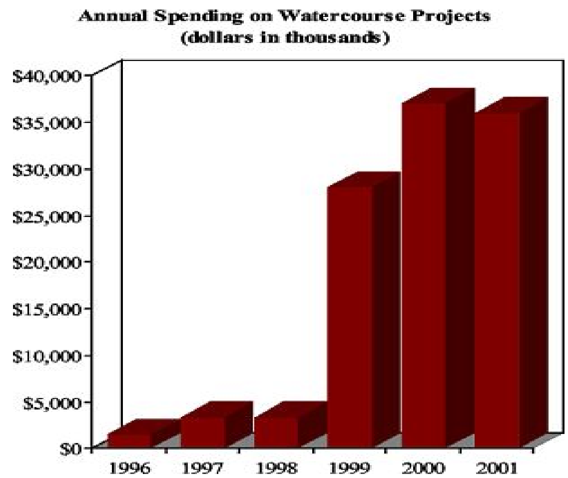

Figure 4.2 Annual spending on watercourse Projects (dollars in thousands)

If it is considered that Integrated Stormwater and Floodland Management plan covers of all of the three watersheds (Menomonee River, Oak Creek, and Root River), it can be safely concluded that these watersheds are affected by the similar problems. This conclusion brings another outcome that is the non-market good to be valued at the policy site is almost identical to that already valued at the study site.

4.3 BENEFIT TRANSFER

Novotny et al. (2001) used the CVM to determine benefits of flood control for the Menomonee River Watershed and water-quality improvement for the Oak Creek Watershed. This report will be referred as “the study-site report” in the following sections. This and follow-up studies, which were conducted by the Institute for Urban

Environmental Risk Management of Marquette University are used to calculate benefits of flood control and water-quality improvement using principles of Benefit Transfer with the CVM.

Up to this point, it has been shown that (1) the non-market good to be valued at the policy site (The Root River Watershed) is identical to that already valued at the study site (Menomonee River and Oak Creek Watersheds); and (2) the population affected by the non-market good is almost identical at each site. In the following paragraphs, a brief summary of the study site report is given, and then benefit estimates for the policy site are presented.

In the study-site report, WTP was measured as part of a two-wave, panel design sample survey of residents of two impacted watersheds in the Milwaukee area: the Menomonee River Watershed on the west and northwest side of the area, and Oak Creek Watershed on the south side. Focus groups were conducted to help the researchers prepare the survey design and questionnaire.

A two-wave, panel design sample survey was done by telephone in the winter of 1999-2000 (first wave) and 2000-2001 (second wave) by the University of Wisconsin Survey Center, a professional research organization that was a subcontractor to the project. More than 900 individuals were interviewed in each wave. The sampled population was non-institutionalized adult resident heads of households in the two study watersheds in the Milwaukee area: the Menomonee River and Oak Creek. The cases consisted of randomly selected households that were located within census blocks corresponding to the two watersheds. A total of 999 respondents were interviewed in the first wave and 967 respondents were interviewed in the second.

The interviews lasted an average of 21 minutes. Respondents were asked what would be the most they would be WTP or vote in favor of a plan if it were on the next referendum. Respondents were randomly assigned to one of three different hypothetical watershed management projects.

The questionnaire was devised for three “paths” of questions: i) Flood path, ii)Environmental path, iii) Combined path. All Oak Creek respondents were assigned to the Environmental path. The first group (*Flood Path*) were given a description of a project whose primary objective was to maintain the flood risk at its current level. They were told that scientists indicate that as the region urbanizes, the problem of river flooding increases. The potential consequences were identified, and the magnitude of additional damage, and likely location of that damage also were identified. The respondents in the second group (*Environmental Path*) were given a description of a project aimed at improving the ecological health of the river and its surrounding area. The current condition was identified, and the respondents were told that the problem has resulted from the development that has taken place in the watershed. The benefits of the project in terms of improved water quality, enhanced survival of game fish, naturalization of stream linings, etc. also were described. The third group (*Combined Path*) were given a description of a project aimed at both objectives. In the benefits transfer application, results from first and the second path surveys are used.

4.3.1 Empirical Specification

The generalized model specified in equation 4.1 guides the selection of variables used in the empirical analysis. The model estimated is given by

$$\text{Ln(WTP)} = f(\textit{demographic, residence controls, survey controls, psychological controls, risk, } \epsilon) \tag{4.1}$$

where *demographic*, *residence controls*, *survey controls*, *psychological controls*, and *risk* are vectors of variables contained in the models. Given that the lowest WTP is zero, the dependent variable was shifted by $1 to facilitate the taking of the natural log of the variable. Since ln(1)=0, the regression is censored at zero. When a substantial number of zero observations result, OLS (ordinary least squares) regression can generate biased and inconsistent parameter estimates. In addition, OLS models could predict WTP to be less than zero. Since accurate prediction of WTP is a goal in the simulations, the Tobit model was applied. The description of the variables and the descriptive statistics for each variable, in each of the paths, is given in Table 4.4.

Table 4.4 Variable definitions and descriptive statistics

		Descriptive Statistics	
Variable	**Description**	**Flood Path (386 obs)**	**Ecological Path (562 obs)**
Real Maximum WTP	Continuous measure of Willingness to Pay deflated to January 2000 using the CPI (Consumer Price Index) Urban for the Midwest	mean=78.57 σ=119.219 min=0 max=958.163	mean=88.31 σ=136.158 min=0 max=1192.76
Age	Age of respondent in years	mean=51.89 σ=15.70 min=18 max=86	mean=52.37 σ=15.71 min=20 max=94
Years of education	Number of years of respondent's formal education	mean=14.42 σ=2.689 min=4 max=18	mean=13.95 σ=2.13 min=4 max=18
Married (yes=1)	Is the respondent married?	mean=0.615 σ=0.483 min=0 max=1	mean=0.615 σ=0.485 min=0 max=1
# of Children	Number of Children in the household imputed from number of people-number of adults age 18 or over	mean=0.604 σ=1.017 min=0 max=9	mean=0.685 σ=1.120 min=0 max=7
Minority (yes=1)	Is the respondent a minority group member (0=non-hispanic white, 1=otherwise)?	mean=0.062 σ=0.242 min=0 max=1	mean=0.027 σ=0.161 min=0 max=1
Real Income (in levels)	Total household income from all sources before taxes deflated to January 2000 using the CPI Urban for the Midwest	mean=59,867 σ=35,627 min=1919 max=300,547	mean=56,196 σ=35,833 min=702 max=401,460

Table 4.4 Variable definitions and descriptive statistics (cont.)

Real Starting Point	Opening WTP bid price presented to individual, deflated to January 2000 using the CPI Urban for the Midwest.	mean=237.55 σ=119.21 min=1 max=473	mean=234.9 σ=136.18 min=1 max=476.7
Political philosophy	Self described political philosophy - 5 point Likert-type scale 1=Liberal, 2=somewhat liberal 3=middle of the road 4=somewhat conservative; 5=conservative	mean=3.489 σ=1.205 min=1 max=5	mean=3.446 σ=1.117 min=1 max=5
Subjective norms	Perceived social pressure to provide money for goals of project.	mean=-0.197 σ=1.001 min=-2 max=2	mean=0.144 σ=0.989 min=-2 max=2
Awareness of Consequences	General beliefs about effects of human actions on ecosystem and vice versa.		mean=2.249 σ=2.333 min=1 max=4
Taxpayer duty	Attitude: Taxpayers have a duty to share in the cost of improving the health of urban rivers - 5 point Likert-type scale 1=strongly disagree; 2=disagree; 3=feel neutral; 4=agree; 5=strongly agree		mean=3.784 σ=0.820 min=1 max=5
Owner(yes=1)	Does the respondent own the home in which he/she resides?	mean=0.818 σ=0.441 min=0; max=1	mean=0.814 σ=0.388 min=0; max=1
Single Family Home (yes=1)	Is the residence a single-family home?	mean=0.736 σ=0.412 min=0; max=1	mean=0.739 σ=0.348 min=0; max=1

Table 4.4 Variable definitions and descriptive statistics (cont.)

Protest vote	Was the zero bid classified as a protest vote?	mean=0.054 σ=0.227 min=0; max=1	mean=0.44 σ=0.206 min=0; max=1
Biocentric Ethic	Attitude: The health of urban rivers should be improved for the sake of nature itself - 5 point Likert-type scale 1=strongly disagree 2=disagree; 3=feel neutral; 4=agree 5=strongly agree;		mean=3.868 σ=0.851 min=1 max=5
Floodplain 100 year (yes=1)	Is the residence located within the 100 year floodplain?	mean=0.015 σ=0.134 min=0; max=1	
Floodplain 101 to 1000 year (1=yes)	Is the respondent located in the 101 to 1000 year floodplain?	mean=0.018 σ=0.134 min=0; max=1	
Recurrence interval*1000 year floodplain dummy	Recurrence interval measured in years interacted with a 1000 year floodplain dummy variable. 1000 year floodplain dummy variable: Is the residence located within the 1000 year floodplain?	mean=8.880 σ=74.132 min=0;max=922	
Habitat score	Score of ecological quality of closest monitoring site to property - increases in the score indicate the better habitat		mean=67.05 σ=28.27 min=26 max=106
Frequency of visits to the river	1=never; 2=rarely; 3=sometimes; 4=frequently		mean=2.456 σ=1.066 min=0; max=4

The dependent variable used in the regression equation is the real WTP. Since CV theory suggests that socio-economic characteristics of the respondents play an important role in the determination of the WTP function, several demographic variables also were included in the survey. These include the age of the respondent, their years of education, marital and minority status, number of children, and the real income.

The variables in the *residence controls* category account for whether the respondent was a home owner and/or whether that individual resides in a single-family home. Two variables were included in the *survey controls* category to mitigate potential biases in the estimation. Another potential bias associated with the use of bidding procedures for CV is instrument bias, further breaking down into starting point and payment vehicle bias. The first of these is the starting point bias. Specifically, the WTP response may be influenced by the point at which the iterative bidding process begins. The starting point was included to control for this potential bias. Second, some respondents provided zero bids because they truly place a zero value on the good. However, some zero bids reflected protest bids. For example, respondents may choose to offer a zero bid because they believe taxes are too high, or that it is the responsibility of government to take care of the problem. Others may be philosophically opposed to assigning a value to the good. When a zero response was given, the respondent was queried as to the reason for the response. It is stated that a zero-one dummy variable was used to control for protest bids. Several *psychological control* variables also were included in the model.

Finally, there were two different kinds of risk measures evaluated in the study-site report. The flood risk was derived by evaluating the flood risk faced by each respondent, based on their geocoded address. A dummy variable for the 100-year floodplain was included, because those individuals currently must carry flood insurance as a condition for obtaining a mortgage. A second floodplain dummy variable was the floodplain with a 101 to 1000-year expected recurrence. This was included separately to account for the fact that these respondents might reasonably expect to find themselves within a 100-year floodplain were the plan not adopted. Finally, the recurrence interval was included as a separate measure. However, it was stated that changes in the recurrence interval were unimportant for those outside the 1000-year floodplain. Thus, the variable was interacted with a zero one dummy for the 1000-year floodplain.

Ecological risk was proxied by two measures. First, a score of habitat health was computed for each of the monitoring sites in the area, and the value of the closest site was assigned to the respondent. The higher the habitat score, the greater the habitat quality of the water. An alternative measure, that is impacted by the habitat score is the index of biotic integrity which was defined for fish species. This measure was tested and found to be inferior to the habitat score. Since the two variables were highly correlated, and since the IBI measures were not available for all sites, the habitat score was employed. A second measure included in this category was the frequency of visiting the stream. While this is not a measure of risk, it is a factor that contributes to the appreciation of ecological quality, and, hence, it is included as a control.

4.3.2 Empirical Findings on Willingness to Pay

Willingness to pay functions were estimated separately for all three paths. The sample for each regression included all respondents from wave 1, and the new respondents from wave 2. Since there were some re-interviewed respondents in the second wave, they were excluded from the sample and new respondents were considered for the regression. Since only path-1 and path-2 are of interest, these results are presented in the following sections.

4.3.2.1 Flood Path

The regression result for the flood path is presented in Table 4.5. The model explains 38.5% of the variation in the dependent variable, log of the real maximum willingness to pay, given that the real willingness to pay is not zero.

The Z-values that are given in the third column are used to examine the significance of the variables. If absolute value of the Z-value is greater than 1.65, the coefficient is said to be significantly different from zero at the 10 % level in a two-tailed test. If absolute value of Z-value is greater than 1.28, the coefficient is said to be significantly different from zero at the 10 % level in a one-tailed test. The significance levels at which the value of the coefficients are not significantly different from zero in a two-tailed test is given in the fifth column. Among the demographic variables only the *Log(Real Income)* is statistically significantly different from zero at the 5 % level, although the coefficients on *Years of Education* and on *Minority* would be significantly different from zero at the 10%

level in a one-tailed test. Increases in income and education both increase the real maximum willingness to pay. In contrast, minority respondents had lower willingness to pay. Respondents who were homeowners had significantly higher willingness to pay than non-owners.

The coefficient on *Floodplain -100 year* was positive, but it was not significantly different from zero, as was the value for *Floodplain - 101 to 1000 year.* Finally, the variable *Recurrence* Floodplain 1000 year* had a negative and significant at the 10 % level coefficient in a one-tailed test. Thus, the higher is the recurrence interval, the lower is the real WTP. Turning to the psychological proxy measures, the more conservative the political philosophy of the respondent, the lower is the real WTP, whereas perceived beliefs that those who are important to the respondent expect them to support a project (*Subjective Norms)* increases WTP. Likewise, the cognitive structure (both economic and noneconomic) significantly increase real WTP. Collectively, these findings suggested that a variety of factors contribute to willingness to pay for flood control projects, not all of which are related to the expected property damage that increased flooding would generate.

Table 4.5 Tobit Results for Flood Path Regression Model (Path 1)

Dependent variable: Natural Log (Real WTP)				
	Coefficient	Std. Error	z-Statistic	Prob.
Intercept	-5.09805	2.514103	-2.028	0.0426
Demographic Variables				
Age	-0.00606	0.00854	-0.709	0.4782
Years of Education	0.08271	0.058298	1.419	0.156
Married	-0.16071	0.275838	-0.583	0.5601
Minority	-0.82741	0.553498	-1.500	0.1349
# Children	-0.08823	0.142893	-0.617	0.5369
Log(Real Income)	0.639147	0.240657	2.656	0.0079
Residence Controls				
Owner	1.03756	0.398541	2.603	0.0092
Single Family Home	-0.40095	0.348874	-1.149	0.2504
Survey Controls				
Real Starting Point	0.001957	0.0008	2.446	0.0145
Protest Vote	-19.8453	0.831001	-23.881	0
Psychological Controls				
Political Philosophy	-0.15707	0.093622	-1.678	0.0934
Subjective Norms	0.545537	0.113627	4.801	0
Perceived Behavioral Control	-0.02971	0.128348	-0.231	0.817
Cognitive Structure Economic	0.439486	0.176046	2.496	0.0125
Cognitive Structure NonEconomic	0.975432	0.124655	7.825	0
Flood Risk Measures				
Floodplain - 100 year	0.447801	0.913326	0.490	0.6239
Floodplain - 101 to 1000 year	1.70463	1.021888	1.668	0.0953
Recurrence * Floodplain1000 year	-0.00272	0.001407	-1.936	0.0528
Mean dependent var	2.956795	Adjusted R-squared		0.385415
S.E. of regression	1.631634	Log likelihood		-509.45
Left censored obs	108			
Uncensored obs	278			

4.3.2.2 Ecological Risk Path

The regression result for the ecological path is given in Table 4.6. The model explained 40% of the variation in the WTP variable. Unlike the flood path regression, income did not have a statistically significant influence on WTP, although it should be noted that it would be significant at the 10% level of significance in a one-tailed test. *Years of Education* had a positive impact on the real WTP, and older respondents had lower real WTP, other things equal.

Similar to the flood path regression, home owners have higher WTP, but the coefficient is only significant at the 10% level in a one-tailed test. The habitat risk score was positive, and significant at the 10% level in a two-tailed test. This implied that higher levels of habitat quality, for the closest monitoring site to the property, lead to higher willingness to pay for reducing ecological risk. Finally, the more frequently the respondent visits the river, the higher was the WTP.

Table 4.6 Tobit Results for Environmental Path Regression (Path 2)

Dependent variable: Natural Log (Real WTP)				
	Coefficient	Std. Error	z-Statistic	Prob.
Intercept	-3.70531	2.03251	-1.823	0.0683
Demographic Variables				
Age	-0.02415	0.007015	-3.443	0.0006
Years of Education	0.155207	0.044112	3.518	0.0004
Married (yes=1)	0.091816	0.209753	0.438	0.6616
Minority (yes=1)	-0.54221	0.634789	-0.854	0.393
# of Children	-0.06237	0.082345	-0.757	0.4488
Log of Real Income	0.274747	0.187712	1.464	0.1433
Residence Controls				
Owner (yes=1)	0.481773	0.313434	1.537	0.1243
Single Family Home (yes=1)	-0.32418	0.262805	-1.234	-0.2254
Survey Controls				
Real Starting Point	0.000303	0.000595	0.509	0.6104
Protest Vote (yes=1)	-18.2058	0.581195	-31.325	0
Psychological Controls				
Political Philosophy	-0.06722	0.081281	-0.827	0.4082
Perceived Behavioral Control	0.080442	0.114861	0.700	0.4837
Subjective Norms	0.416326	0.097263	4.280	0
Cognitive Structure Economic	0.591539	0.120723	4.900	0
Cognitive Structure NonEconomic	0.449983	0.11871	3.791	0.0002
Awareness of Consequences Scale	-0.13471	0.216657	-0.622	0.5341
Taxpayer Duty	0.379618	0.138453	2.742	0.0061
Biocentric Ethic	0.052072	0.123504	0.423	0.6733
Ecological Risk Variables				
Habitat Risk Score	0.005945	0.003305	1.799	0.072
Frequency of Visits to River	0.323177	0.090919	3.555	0.0004
Mean dependent var	3.122078	Adjusted R-squared		0.400686
S.E. of regression	1.590953	Log likelihood		-986.311
Left censored obs	135	Uncensored obs		427

4.3.3 Benefit Estimates

The Tobit model was used to predict the value of the dependent variable for both paths. The average household WTP was multiplied by the imputed population (approximately equal to the number of households) for the block group to derive the total annual WTP for each of the Census block groups within the watershed. Since the projects described in the questionnaire indicated that the project would be done over a period of 20 years, the stream of payments were discounted to the present value. The discount rate used was the risk-free real market rate of interest (Kahn, 1995), which is the 30-year treasury bill rate minus the expected inflation rate. The treasury bill rate was averaged over the last 24 months (December 1999 to November 2001) and the expected inflation rate was determined by averaging inflation between 1990 and 2000. This generated a discount rate of 2.76% (i.e., 5.75%-2.99%). The findings from the simulation are summarized in Table 4.7

Table 4.7. Benefit Estimates for Menomonee River and Oak Creek Watersheds

(constant January 2000 dollars)		
Watershed	Menomonee River	Oak Creek
Number of households	127,598	14,985
WTP Flood Control - Annual	$602,585	$48,776
WTP Flood Control - 20 years	$9,167,152	$742,024
WTP Ecological Risk Reduction - Annual	$1,471,667	$161,341
WTP Ecological Risk Reduction - 20 years	$22,388,513	$2,454,481

The willingness to pay for flood control was less than half that of ecological risk reduction in both watersheds. The present discounted value of the benefits derived for flood control in Menomonee River watershed was $9.2 million, whereas the benefits for ecological risk reduction/habitat restoration was $22.4 million. Not surprisingly, the benefits for flood control in the Oak Creek watershed were quite low (i.e., just $48 thousand per year, or $742 thousand for the life of the project). This implies that projects that primarily are aimed at ecological risk reduction are valued between 2.4 and 3.3 times greater than similar projects aimed solely at flood control.

4.4 BENEFIT TRANSFER – THE ROOT RIVER WATERSHED

Parameter estimates of the regression model given in Tables 4.5 and 4.6 are used in the Root River Watershed simulation. All of the independent variables that are presented in these tables are used in the benefit transfer procedure. As can be seen from the regression results, there are some coefficients, which are not significantly different from zero. Eventhough these coefficients are not significant, they are used in the benefit transfer. If insignificant variables were irrelevant variables, it would not create any bias to keep them in the model. Simply, values of the independent variables that belong to the Root River Watershed are plugged in to the regression models presented in Tables 4.5 and 4.6. Census block group data (demographic variables, residence controls) take on the values specific to the specific block group and all other data (survey control, psychological controls, ecological risk variables) are either evaluated at their mean value (evaluated at the mean for the combined Menomonee River and Oak Creek samples) or for the floodplain measures, assumed to be outside the 100 year and 1000 year floodplain. The income measure is derived in the same fashion as was income in the simulations for the Menomonee River and Oak Creek watersheds. The findings are reported in Table 4.8.

Table 4.8 Benefit Estimates - Root River Watershed

(constant January 2000 dollars)	
	Root River
Number of households	42,246
WTP Flood Control - Annual	$47,987
WTP Flood Control - 20 years	$730,030
WTP Ecological Risk Reduction - Annual	$484,876
WTP Ecological Risk Reduction - 20 years	$7,376,430

The spatial distribution of WTP and aggregated WTP over the watershed are given in Figures 4.3- 4.6. Legends show the WTP amount range that corresponds to each census block. Maximum WTP ($/household) is varying between $1-19 and $2-21 for the flood control and ecological restoration, respectively. Maximum total annual census block group benefits are $21,200 and $41,500 for the flood control and ecological restoration, respectively. The findings show that while flood risk benefits are minor, the calculated benefits for ecological risk reduction are more than 10 times greater. One potential shortcoming of this analysis is the necessity to use mean values for some independent variables that inevitably vary spatially. Specifically, the assumption of uniform flood and ecological risk has influenced these results. Thus, while the results suggest that public policymakers in the Root River watershed might want to emphasize watershed management projects that focus on ecological improvement of the watershed, some investigation of potential spatial relation of the spatial variation of floodplain variables and ecological risk variables probably is needed. There is an important outcome of the results. It is well know that there is a flood problem in the area. But it was found that residents of the watersheds are more interested in stream restoration projects. MMSD has been spending more than $100 Million on flood control. In order to get the public support for this project, decision makers should also include an ecological component in the flood control project.

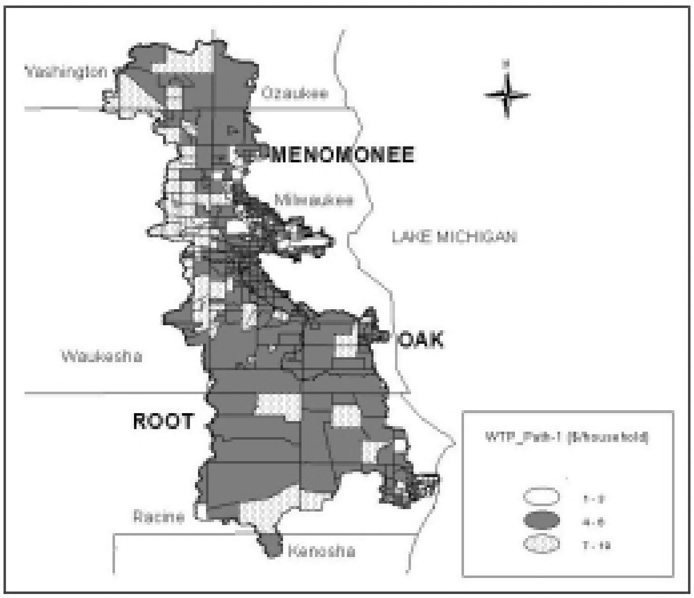

Figure 4.3 Distribution of Max WTP over the study site and policy site– Flood Control

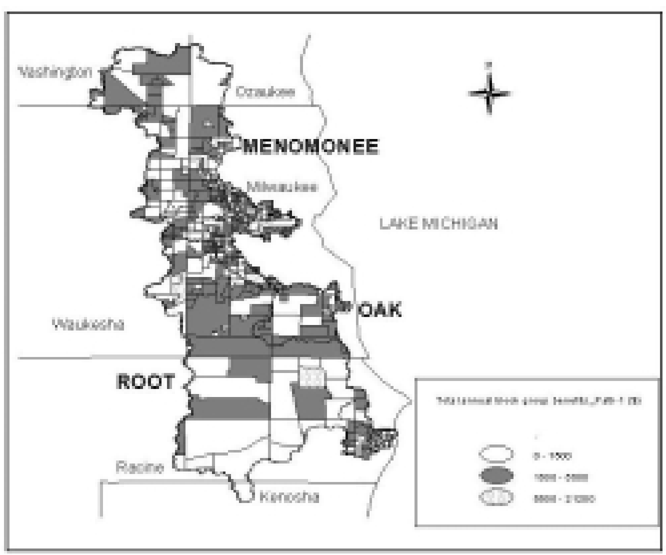

Figure 4.4 Distribution of total annual WTP over the study site and policy site– Flood Control

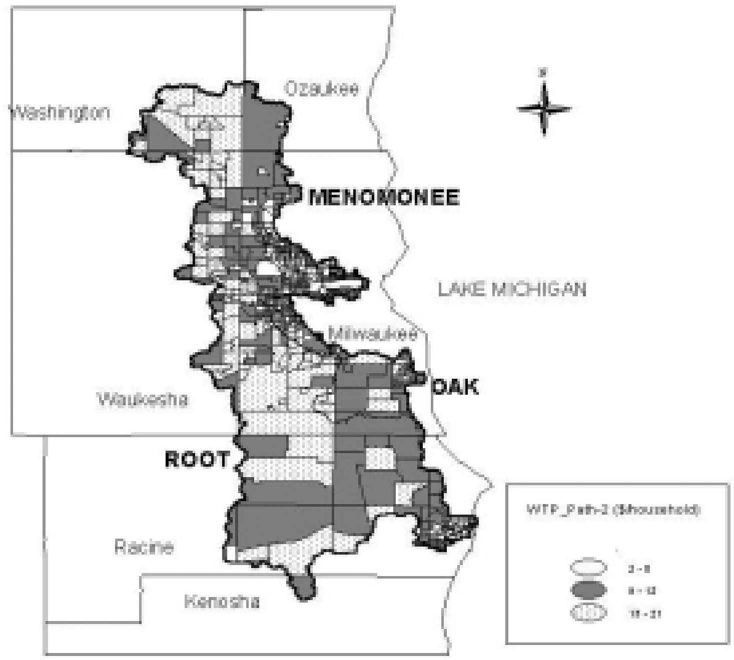

Figure 4.5 Distribution of Max WTP over the study site and policy site– Ecological restoration

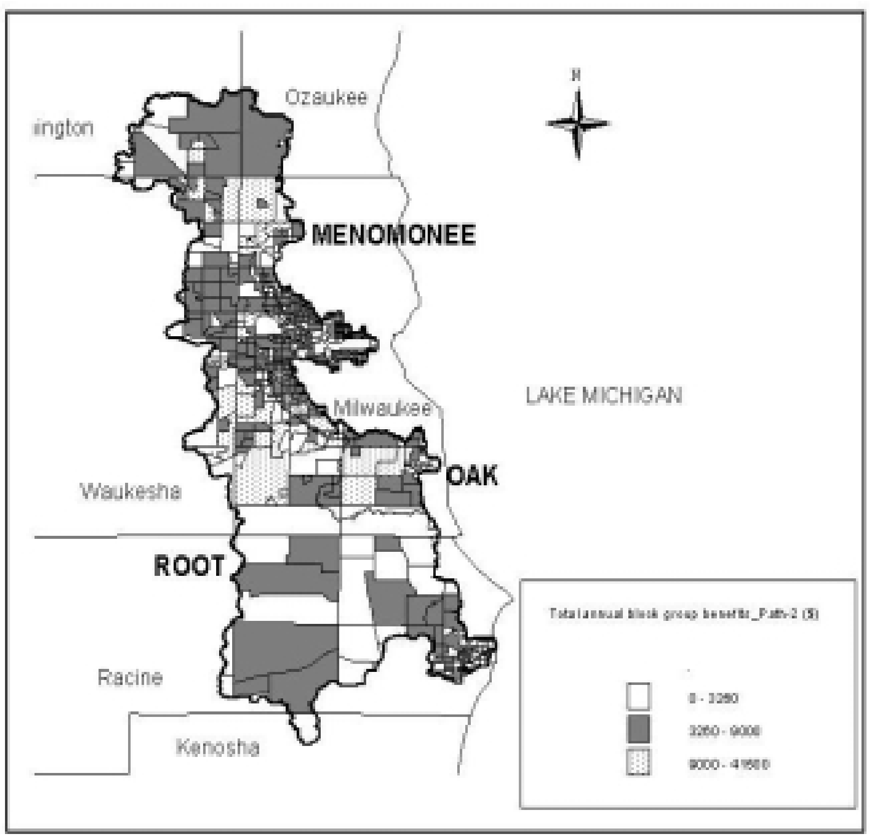

Figure 4.6 Distribution of total annual WTP over the study site and policy site– Ecological restoration

CHAPTER FIVE

DISCUSSION AND CONCLUSIONS

The evaluation of management alternatives makes it necessary to determine benefits of the flood management and stream restoration/preservation plans for the Root River Watershed. Environmental values are used in policy and project assessments in a variety of ways. Environmental valuation of use and non-use values is explicitly and systematically applied by the U.S. Environmental Protection Agency (EPA), under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980 and various other acts (Garrod, and Willis, 1999).

The Contingent Valuation Method (CVM) is one of several economic methods that can be used to estimate the benefits of environmental improvement. But it has a number of weaknesses as well. The idea of the CVM is straightforward; if you want to know the value that people place on something, just ask them.

Novotny et al. (2001) used the CVM to determine the benefits of a Watershed Management Plan for the Menomonee River and Oak Creek Watersheds (*study site*). Since application of the CVM is expensive and it might take too much time to get final results, decision makers are interested in alternative approaches to use in decision making. This fact causes a rise in demand for Benefit Transfer, which is defined as the transfer of existing estimates of non-market values to a new study that is different from the study for which the values were originally estimated. Financial and time limitations of this study create a need for Benefit Transfer to apply in the Root River Watershed. Therefore, the study-site report was used to calculate benefits of the flood control and water-quality improvement in the Root River Watershed by using principles of Benefit Transfer. The Menomonee River/Oak Creek Watershed study is the most appropriate site on the basis of the benefit transfer criteria explained in Chapter 3. Comparison of the study site and policy site is given in Chapter 4.

In the study-site report it was shown that a variety of factors affect willingness to pay for flood-control projects. Similarly, there are several factors determining WTP for a ecological restoration project. The present discounted value of the benefits obtained for flood-control in the Menomonee River Watershed was calculated as $9.2 million whereas the benefits for ecological risk reduction/habitat restoration was $22.4 million. It is surprising that benefits of the flood-control project are much smaller than that of ecological restoration project if it is considered that the main problem of the Menomonee River Watershed is flood risk. Not surprisingly, the benefits for flood control in the Oak Creek Watershed were quite low.

Parameter estimates derived from study-site application are used for benefit transfer application. Site-specific values that belong to the Root River Watershed are plugged into the regression model that was obtained for the Menomonee River and Oak Creek. Findings show that while flood risk benefits are minor, the calculated benefits for ecological risk reduction are more than 10 times greater. This might result because of the fact that mean values for some variables from the survey were used to derive the WTP function although these variables might take different values over the census block groups inside the watersheds. Specifically, the assumption of uniform flood and ecological risk has influenced these results.

These results suggest that further studies should be done to get real values for some of the variables that show variations among the census block groups. Although the results imply that the ecological risk problem is much more important than flood risk, decision makers should consider the shortcomings of the analysis that were previously mentioned. This is a question of "is some number better than no number." Brookshire (1992) recommends that the final use of the benefit estimate should be the determining factor in its required accuracy and he proposed a spectrum of the required accuracy for BT, which is given in Figure 5.1

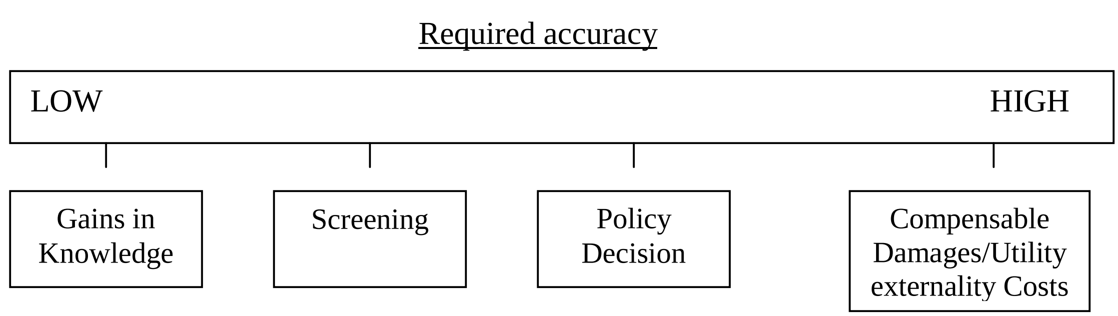

Figure 5.1. Continuum of decision settings from least accuracy to most required accuracy

Brookshire and Neill (1992) recommend that BT should be used only towards the ‘low’ end of the continuum. Devousges et al. (1992) also offer a continuum similar to that in Figure 5.1. However, they seem to be more optimistic about the potential for BT. Their continuum runs from ‘ initial screening assessment of damages through to ‘litigation’, and their recommendation is that BT can play a important role in both ‘screening assessment’ and in ‘negotiated settlement’ which is located in the middle of their continuum scale. O’Doherty (1995) mentioned that use of BT depends both on the required accuracy of the benefit estimate and upon the standpoint (or optimism) of the researchers. Table 5.1 illustrates this point.

Table 5.1 The use of Benefit Transfer

		Required Accuracy	
		LOW	HIGH
Degree of Optimism in the use of BT	LOW	Unsure, possibly tempered use	Don’t use
	HIGH	Use	Tempered use

The low and high on the degree of optimism scale corresponds to the two camps identified among researchers by Smith (1992). Smith (1992) suggested that many economists fall into on of two camps when the concept of BT is on agenda: those who see merit in waiting for the ideal data and those who believe that some information is better than none. These groups can also be allied to the ‘idealists’ and ‘pragmatists’ identified by Boyle and Bergstrom (1992).

In the light of given ideas above, BT estimates derived in this study could be used screening purposes. Although there might be bias related to the benefit estimates, they can still be used in decision-making. The results show that residents of the Root River Watershed are aware of ecological risk reduction. Benefits of a flood reduction project are less than that of an ecological risk reduction project. Since there is an important flood problem, MSSD has been spending more than $100 Million to reduce flood risk. As a conclusion, decision makers should include ecological risk reduction component in the flood control project to get the support of the watershed residents.

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