VALUING WETLAND ATTRIBUTES IN THE LAKE CHAMPLAIN BASIN

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Abstract: This research explores the use of conjoint analysis to assess and understand wetland values. A conjoint rating survey was designed and mailed to landowners in the Laplatte River Basin (Lake Champlain) in Vermont. Landowners rated options to protect wetlands that varied by the wetland's ability to decrease pollutants entering Lake Champlain, value in providing food and shelter for wildlife, opportunities for outdoor recreation, surrounding land use, the presence of rare or unique vegetation, and cost to each household to protect. The analytical capabilities of the conjoint rating model are discussed.

Introduction

A high-quality water supply can enhance the biological, economic, and spiritual health of communities. Residents of the Lake Champlain Basin have become increasingly concerned about water quality in the region, and are especially concerned about how water quality can contribute to "livable" communities. Wetlands are an important component of the landscape and play a crucial role in maintaining and enhancing water quality. Wetlands filter and replenish groundwater, buffer the flow of pollutants between the land and open waters, and aid in flood control. Wetlands also provide crucial habitat for many species of fish and wildlife, opportunities for recreation and aesthetic enjoyment, as well as sites for industrial, commercial, and residential development. Landowners, anglers, birders, farmers, hunters, environmentalists, businesses, and the general public all claim status in issues concerning wetlands.

This study explores the values that landowners within the Laplatte River watershed may hold toward water quality in Lake Champlain and wetlands in the Laplatte River basin. This watershed is an appropriate site to study values and value conflict because it is a traditional agricultural region undergoing significant suburbanization pressure from nearby Burlington, Vermont--the largest metropolitan area in the state and region. An influx of new residents coupled with an expansion of different types of land use can produce a growing tension over water quality and wetland use.

Developing a cohesive policy toward wetland management requires balancing many concerns and values. In theory, the inherent efficiency of a free market economy will guide society to an optimal allocation of resources. However, many wetland values, such as aesthetics, wildlife habitat, and water purification, are not adequately represented in market transactions. These types of values are called externalities. Their presence, particularly those that result from the common property nature of wetland benefits, cause market-based decisions to be inefficient and often inappropriate. Recognizing the inadequacies of the market in allocating resources to protect wetlands, managers and policymakers seek a means to assess values associated with wetlands so that they can be duly considered in decisions and policy that influence wetlands.

In this paper we explore the use conjoint analysis to assess landowner preferences and valuation of various wetland features or attributes in the 34,000-acre LaPlatte River watershed. Conjoint analysis can provide a better measure of value than traditional methods (e.g., travel-cost, willingness-to-pay measures) because it explores multiple dimensions of value and examines more realistic tradeoffs.

Conjoint Analysis

Conjoint analysis, a technique for measuring psychological judgments, is used in marketing research to measure consumer preferences (Green et al. 1988). In conjoint studies, respondents make choices between alternative products or scenarios displaying varying levels of selected attributes. For example, when studying consumer preferences for features of automobiles respondents might be asked to choose between sample vehicles that vary in attributes such as cargo space, warranty length, price, gas mileage, acceleration, and country of manufacture. The objective is to decompose a set of factorially designed stimuli or attributes so that the utility of each attribute can be inferred from the respondent's overall evaluations. These data, which outline the preferences or tradeoffs that a respondent is willing to make, can be used to solve for the partial utilities for each attribute that are imputed from the overall tradeoffs. These partial utilities or "part-worths"can be combined to estimate relative preferences for any combination of attribute levels. Thus, the analyst obtains high leverage between the options actually evaluated by respondents and those that can be analyzed after the evaluation.

Conjoint techniques are well suited for soliciting and analyzing the preferences of stakeholders in environmental decisions. These decisions frequently entail tradeoffs between costs and benefits that are not represented efficiently in market transactions. For example, Opaluch et al. (1993) described an approach that used paired comparisons to rank potential noxious facility sites in terms of social impacts. Asking respondents to make choices between alternatives mimics the real choices that managers must make and shows stakeholders the consequences of their choices.

Choice experiments can be designed and analyzed in many ways. Respondents may be asked to reveal their preferences by choosing one of two or more options,

ranking several options, or assigning numerical ratings to each option. Numerical ratings provide the most information but may place the greatest cognitive demands on respondents. Green (1974), Green and Srinivasan (1978), Louviere and Woodworth (1983), and Louviere (1988) provide information on experimental design in the context of conjoint analysis.

The Laplatte River Watershed Conjoint Survey

A conjoint rating survey was included within a survey of 1,600 landowners in the Laplatte River Basin during the fall of 1996. Approximately 57% of the mailed questionnaires were completed and returned. The 14-page questionnaire was designed to obtain information on landowner activities and values regarding water quality. The conjoint portion of the survey addressed landowner preferences for protecting wetlands with varying levels of selected features.

In the conjoint survey, landowners were asked to imagine that their town had the option to secure the development rights to one or more parcels of land that contain wetlands and to select the types of wetlands that they would most like to see protected. Each wetland differed by one or more of the following six features: ability to decrease the effect of pollutants entering Lake Champlain, value in providing food and shelter for wildlife, opportunities for outdoor recreation, surrounding land use, presence of rare or unique vegetation, and cost to each household to protect. The following descriptions appeared on the page proceeding the rating survey shown in Figure 1.

Effect on water quality: You will be asked to choose between wetlands with a low, medium, or high capacity to decrease the effects of pollutants, such as phosphorus or lawn fertilizers, on water quality in Lake Champlain.

Vegetation: Some wetland parcels contain rare or unique vegetation.

Wildlife habitat: Wetlands provide food and shelter for wildlife like migratory birds, waterfowl, local bird populations, and some mammals. The usefulness of a wetland for wildlife could be either low, medium, or high in this study.

Surroundings: The benefits of wetlands may depend on whether they are surrounded by forests, farms, or residences. For example, the retention of phosphorous or other pollutants may be greater in wetlands surrounded by farmland or residential development. Remote wetlands may be used by more wildlife but enjoyed by fewer people than those found in more developed settings.

Recreation: Wetlands may or may not provide opportunities for outdoor recreation such as fishing, wildlife viewing, hunting, and hiking.

Cost: Protection costs may differ according to the location of the wetland and generosity or goals of the landowner. In this example, the cost to each household ranges from $0 if a landowner donated the development rights to as much as $120 (in $40 increments) if development rights were purchased by the town. Respondents were instructed to assume that town tax revenues would be used to fund wetland protection.

Respondents rated each wetland on a 1 to 5 scale (Fig. 1). Each respondent rated a different set of alternatives consisting of a base option (#1 in Figure 1) common to all respondents, and four additional options that were randomly selected from the remaining 431 possible combinations of wetland features. The base wetland had the following features: a low ability to decrease the effects of pollutants on water entering Lake Champlain, a low value for providing food and shelter to wildlife, did not provide opportunities for outdoor recreation, was surrounded by forestland, did not contain rare or unique vegetation, and would be free to protect. The base option was positioned randomly among the five alternatives.

Analytical Model

Although statistical analyses have not been completed, we will outline the basic procedures that will be used for analyzing the conjoint data as well as the types of results expected. When presented with a set of alternatives, individuals are assumed to make choices that maximize their utility or satisfaction. The utility that the ith individual derives from the choice of the jth alternative (U_{ij}) can be represented as:

$$U_{ij} = \sum_{m=0}^{5} b_n \, x_{nij} + e_{ij}$$

where the x_{nij}'s represent values for each of n attributes of the jth alternative to the ith individual, b_n's are unknown parameters, and the e_{ij}'s are random disturbances, which may reflect unobserved attributes of the alternatives, random choice behavior, or measurement error. In the empirical study under consideration, a respondent's utility level (U_{ij}) for each of the J wetland alternatives is not observed but a rating (r_j) is observed that corresponds to his or her underlying utility.

Following McKenzie (1990, 1993) and others, the analytical capabilities of the conjoint rating model can be illustrated by assuming that rating (r_j) can be modeled as a linear combination of the variables representing the attribute levels:

$$r_j = a + b_1x_{1j} + b_2x_{2j} + \ldots + b_nx_{nj} \qquad (2)$$

The estimated part-worths (b_n's) measure the effect of a discreet change in the level of the associated attribute on overall preference for protecting a particular wetland. Thus, one can determine the relative contribution or reduction in desire to protect wetlands that can be attributed to a change in a particular wetland attribute or feature.

Relative overall preference for wetland protection can be determined by summing across Equation 2. By doing so, a group of wetland parcels can be prioritized by desire to protect. Similarly, the optimal mix of wetland features can be determined by maximizing Equation 2.

Figure 1. The conjoint portion of the LaPlatte River watershed survey.

Please imagine that your town can secure the development rights to one or more parcels of land that contain wetlands. Each wetland will provide different benefits, and will cost a different amount to protect. Please rate each of the five options below on a scale of 1 to 5. Use 5 for the parcel that you definitely would vote to protect, and 1 for the parcel that you definitely would not vote to protect. If you are not sure, use 2 thru 4 to indicate how likely you would be to vote for each parcel.

	WETLAND PARCELS				
	#1	#2	#3	#4	#5
Ability to decrease pollutants entering Lake Champlain	LOW	MED	HIGH	HIGH	LOW
Value in providing food and shelter for wildlife	LOW	HIGH	HIGH	MED	MED
Opportunities for recreation	NO	NO	YES	YES	YES
Is surrounded by	FOREST	FARM	HOMES	HOMES	FOREST
Rare or unique vegetation	NO	YES	YES	NO	NO
Cost to each household	$0	$40	$80	$40	$120
	↓	↓	↓	↓	↓
Please write a score from 1 to 5 for each option					

WRITE SCORES HERE USING THE SCORING SYSTEM BELOW

would definitely not vote for	would probably not vote for	neutral	would probably vote for	would definitely vote for
1	2	3	4	5

The marginal rate of substitution (MRS) is the rate at which an individual is willing to trade one good for another while remaining equally well off (Nicholson 1978). The MRS or acceptable tradeoff of one attribute for another is determined by the ratio of the marginal responses. Setting the total differential of (2) to the point of indifference and solving:

$$dr_j = b_1 dx_{1j} + b_2 dx_{2j} + \ldots + b_n dx_{nj} = 0 \qquad (3)$$

$$dx_{1j} / dx_{2j} = -b_2 / b_1$$

yields the marginal rates of substitution or the acceptable tradeoffs for the respective attributes.
If the linearity assumption is not tenable, the analyses become more complicated but the basic reasoning remains.

Summary
Conjoint techniques are well suited for soliciting and analyzing the preferences of stakeholders in decisions that entail tradeoffs between costs and benefits that are not efficiently represented in market transactions. A conjoint rating survey was used to solicit landowner preferences for protecting wetlands with varying levels of six features: ability to decrease the effect of pollutants entering Lake Champlain, value in providing food and shelter for wildlife, opportunities for outdoor recreation, surrounding land use, presence of rare or unique vegetation, and cost to each household to protect.

Although the statistical analyses have not been completed, we outlined the basic procedures used to estimate the relative contribution of different wetland features to preference for protection, a means to prioritize wetlands by the overall composition of features, and a procedure for estimating respondent's willingness to trade among wetland features and cost. Additional work will include relating preference structures to demographic, behavior, and value-related variables that were assessed in other portions of the questionnaire.

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