ESTIMATING RELATIVE VALUES FOR MULTIPLE OBJECTIVES ON PRIVATE FORESTS

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Abstract: Conjoint and other techniques were used to examine private forest-land owner's willingness to manage for timber and nontimber objectives. The objectives were to: maintain apple trees to benefit wildlife, protect rare ferns to enhance aesthetics and biodiversity, improve recreational trails, and harvest timber. Ecological objectives were found to be more important than objectives related to use. Acceptable trade-offs (relative values) are estimated among the various objectives and with respect to management costs. A mail survey sent to 1,250 nonindustrial private forest-land owners in Franklin County, Massachusetts, provides the basis for the analyses.

Introduction

Privately owned forests, which comprise nearly three-quarters of the forest land in the United States, are expected to play an important role in meeting future needs for timber, recreation, wildlife habitats, and many other forest-related benefits (USDA Forest Service 1988, 1995). There is concern that these lands may not meet their potential in achieving objectives related to overall ecosystem health and sustainability and in providing benefits that transcend legal and political boundaries, such as biodiversity, water quality, and some wildlife habitats. The large number of owners, diversity of objectives, increasing fragmentation, and nonmarket nature of many benefits pose problems in estimating what can be expected from these lands and in designing policy to influence behavior (Dennis et al. 2000). This is particularly true when coordination across ownerships is needed to achieve landscape-level objectives.

Surveys of private forest-land owner attitudes conducted by the USDA Forest Service show that many owners hold their woodland primarily for noncommercial reasons (Birch 1996). Commonly cited reasons for owning forest land include that it is part of their farm or residence, aesthetic enjoyment, wildlife viewing, and other forms of forest-related recreation. Landowner attitudes and motivations suggest that they are favorably disposed to providing nontimber benefits and protecting the health of the forest ecosystem. However, a better understanding is needed regarding the relative importance that they place on various objectives, their willingness to incur costs associated with achieving these benefits, and how the relative importance of objectives differs between different types or groups of landowners.

In this study, we use conjoint techniques to solicit landowner preferences for management involving varying levels of timber harvesting, recreational trail improvement, apple tree maintenance to benefit wildlife, protection of a rare species of fern, and cost. A tobit model is used to estimate preferences. The tobit results are used to compute marginal rates of substitution (MRS), or the costs that landowners are willing to incur to achieve changes in the levels of other objectives.

Methods

The Dillman (1978) Total Design Method was used to design a survey that was mailed to 1,250 forest-land owners who own at least 10 acres of forest land in Franklin County, Massachusetts. In addition to questions on attitudes toward land management and demographics, each respondent completed a conjoint survey. The useable response rate was 61.3 percent.

Conjoint analysis is a technique for measuring psychological judgments and is frequently used in marketing research to measure consumer preferences (Green et al. 1988). Respondents make choices between alternative products or scenarios displaying varying levels of selected attributes. The utility of each attribute can be inferred from the respondent's overall evaluations. These partial utilities indicate the relative importance of each attribute's contribution to overall preference or utility. They can then also be combined to estimate relative preferences for any combination of attribute levels. Conjoint techniques are well suited for soliciting and analyzing preferences in environmental decisions that frequently entail tradeoffs between costs and benefits that are not represented efficiently in market transactions.

Forest-land owners in Franklin County were asked to rate four alternative management scenarios for a hypothetical property shown in a figure within the survey. The figure included an area of apple trees, a section of rare ferns, and a recreational trail that passed through the sample property. Each alternative was rated on a scale of 1 to 10, with 10 representing alternatives that they would definitely undertake and 1 those that they would definitely not undertake. Ratings of 2 to 9 were used to represent how likely they would be to undertake alternatives that they were not sure of. Each alternative varied by one or more of the following five attributes: the proportion of the apple trees to maintain on the hypothetical property, the proportion of rare ferns to protect, the extent of the trail network to improve, the extent of timber harvesting, and cost. An orthogonal array was used to create a succinct subset of attribute combinations that permits estimation

over the entire range of attribute values. The resulting 18 alternatives were assigned to questionnaires in equal frequency. Each attribute had one of the three possible levels appearing in parentheses and alternatives appeared as follows:

- Maintain (none/half/all) of the apple trees shown on the figure that benefit wildlife.
- Protect (none/half/all) of the acres containing a rare species of fern shown on the figure by not harvesting timber in this area or otherwise disturbing the ferns.
- Improve (none/half/all) of the trail network shown on the figure. Improvements, if any, would include the cost of building a footbridge over the stream and clearing scenic vistas.
- Harvest timber from (none/half/all) of the lands shown on the figure. Any harvest would be selective, designed to remove poorly formed and leave some high-quality trees; 25 to 30 percent of all trees would be removed.
- This option would have a net cost to you of $ (50/250/500).

A random utility model was used to explain forest-land owner preferences. 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 jth alternative (U_{ij}) can be represented as:

$$U_{ij} = X'_{ij}\beta + e_{ij} \quad (1)$$

where X_{ij} is a vector of variables representing values for each of the five attributes of the jth alternative to the ith individual, β is a vector of unknown parameters, and e_{ij} is a random disturbance, 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 alternative is not observed, but a rating (r_j) is observed that is assumed to proxy for 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:

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

The estimated partial utilities (b_n's) measure the effect of a discreet change in the level of the associated attribute on overall preference. Relative overall preference for any alternative (combination of attribute levels) can be determined by summing across Equation 2.

The 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:

$$dr_j = b_1dx_{1j} + b_2dx_{2j} + \ldots + b_ndx_{nj} = 0 \quad (3)$$

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

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.

Results

Seventy-eight percent of Franklin County is forested, most of which is in nonindustrial private ownership. The average respondent owned 60 acres of forest land, and 70 percent of the parcels were less than 100 acres. Approximately 78 percent of the respondents lived within 5 miles of their woodland, 60 percent had owned their land more than 15 years, and one-third had a management plan. Approximately half of the owners were 55 or more years old, and 74 percent had completed at least 1 year of college.

The model was estimated using a tobit procedure where the dependent variable (r_j) is censored at 1 and 10. The explanatory variables (attributes) were coded 0.0, 0.5, and 1.0 for the proportions of apple trees to maintain, trail improvements, fern protection, and extent of timber harvesting. Cost was coded in units of $100 (0.5, 2.5, and 5.0). Each respondent rated four alternatives for a total of 2,504 rated scenarios. The tobit results are shown in Table 1.

As expected, increased levels for each of the attributes except cost had a positive effect on ratings. The magnitude of the positive effects of maintaining apple trees to benefit wildlife and fern protection were significantly greater than those for trail improvements and extending the area of harvesting (which also may be interpreted as less restriction on harvesting). Landowners placed higher value on the ecological aspects of the alternatives than on use aspects. These findings are consistent with previous studies that suggest that nonindustrial private forest-land owners place high values on wildlife and other nontimber amenities (Birch 1996, Brunson et al. 1996) and with the attitudinal aspects of this survey (Rickenbach et al. 1998).

The results also may be used to examine preferential differences between various groups or types of landowners. Separate tobit models were estimated for men and women respondents (Table 2). Although the differences were not dramatic, gender did seem to influence preferences. Although both men and women favored protecting the ecological aspects of the property, women weighted these aspects more heavily than the men. This is demonstrated by the magnitude and significance levels for the

Table 1.--Tobit results (dependent variable is alternative rating with limit values of 1 and 10.

Explanatory variables	Coefficients	S.E.
Constant	1.166*	0.255
Apple trees	2.271*	0.209
Fern protection	2.361*	0.209
Trail improvement	0.717*	0.219
Timber harvesting	0.764*	0.209
Cost	-0.170*	0.046

N = 2,504

*All variables significant at the 1-percent level.

coefficients associated with apple tree maintenance and fern protection.

The marginal rates of substitution between cost and the other objectives are shown in Table 3 for the entire sample and for men and women. Overall, respondents were willing to incur significantly greater cost to enhance the ecological aspects of the property (apple tree maintenance and fern protection) than to either improve the trail system or extend the area available for timber harvesting. The differential was greatest for the women respondents who were willing to incur $15.41 and $17.30 for 1-percent increases in apple tree maintenance and fern protection, respectively. By contrast, they were willing to incur $3.91 to extend timber harvesting by 1 percent and $4.67 to increase trail improvements by 1 percent.

Table 2.--Tobit results for men and women respondents (dependent variable is alternative rating with limit values of 1 and 10)

	Men (N = 1,946)		Women (N = 507)	
Explanatory variables	Coefficient	S.E.	Coefficient	S.E.
Constant	1.431*	0.283	0.591	0.594
Apple trees	2.144*	0.231	2.835*	0.499
Fern protection	2.065*	0.232	3.183*	0.488
Trail improvement	0.704*	0.243	0.719	0.504
Timber harvesting	0.639*	0.233	0.860**	0.484
Cost	-0.168*	0.051	-0.184**	0.186

* Significant at the 1-percent level.

** Significant at the 10-percent level.

Summary

A survey of landowner preferences in Franklin County, Massachusetts, indicated that protecting rare ferns and maintaining apple trees to benefit wildlife were more important aspects of management than improving recreational trails or harvesting timber. Increasing the levels of the two ecologically related aspects contributed more to overall preference for a management scenario than increasing the level for either of the use-related aspects. Landowners also were willing to incur significantly greater costs to enhance these ecological aspects of the

Table 3.-- Marginal rates of substitution between cost and selected attribute (dollars per percent change in listed attribute)

		Attribute			
Sample	N	Apples	Ferns	Trails	Timber
All	2,504	13.36	13.89	4.22	4.49
Men	1,946	12.76	12.76	4.19	3.80
Women	507	15.46	17.30	3.91	4.67

hypothetical property than they were to enhance the use aspects. Although differences were not dramatic, women respondents expressed greater preference and were willing to incur higher costs to maintain apple trees and protect a rare species of ferns than the men were.

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