Protecting Oregon Old-Growth Forests from Fires: How Much Is It Worth?[1]

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Abstract: Current fire management policies in the USDA Forest Service includes traditional multiple uses, but these policies do not adequately incorporate non-traditional uses such as preservation of biodiversity and related nongame and endangered animals. A contingent valuation methodology was used for valuing the general public's desire to know that rare and unique ecosystems exist and will be protected from fire for current and future generations. The methodology was applied to old-growth forests and critical habitat units for the northern spotted owl in Oregon. A mail survey describing a simulated voter referendum on an Oregon old-growth fire prevention and control fund that reduces by half the number of acres of old-growth burned each year was sent to a random sample of 1,000 Oregon households. Each household was randomly assigned one of 20 alternative program cost levels ranging from $2 to $300. The mean dichotomous choice willingness to pay estimate was $90.00. By expanding the sample to Oregon's population yields, estimates ranged from $45 to $99 million for the whole State (a low of $45 to $90 per household). The resulting value per acre saved from fire under the proposed scenario is more than $24,000; and the cost per acres of old-growth protected is $28.

Incorporating the protection of natural values beyond recreation into fire management decision making is a growing concern of Federal agencies with wildland fire protection responsibilities (González-Cabán 1993; González-Cabán and Chase 1991). These values include people's desire to know that rare and unique ecosystems exist (existence value), that they will be protected for future generations (bequest value), and that they will be available for visits at future times (option value) (Randall and Stoll 1983). Existence and bequest values have been quantified in monetary terms for eliminating logging of old-growth forests in Washington (Rubin and others 1980), and Colorado (Walsh and others 1984), but not for protecting these old-growth ecosystems from fire.

The USDI Fish and Wildlife Service has designated about 2.9 million hectares (7 million acres) of the remaining old-growth forests in the Pacific Northwest as Northern Spotted Owl Critical Habitat Units. The direct effects of such designation is to eliminate clearcutting and to impose severe logging restrictions, but a significant threat remains to the preservation of these habitat types: catastrophic fires. Different fire management policies and programs can reduce the frequency of human caused fires and the extent and severity of all fires. Lack of economic values in fire management models is a major concern of fire managers in the Pacific Northwest (Gregory and von Winterfeldt 1992).

This paper describes the performance of contingent valuation method (CVM) for measuring the total economic value (sum of recreation, existence, bequest, and option values) for protecting old-growth forests in Oregon from catastrophic fires.

Methods

Contingent valuation is a widely used method for obtaining information about willingness-to-pay (the maximum amount a person would be willing to pay) for recreation, existence, bequest, and option values (Mitchell and Carson 1989). Federal agencies recommend this method for performing benefit-cost analysis (U.S. Water Resources Council 1983) and for valuing natural resource damages (U.S. Department of Interior 1986). Its use has been upheld in Federal courts (U.S. District Court of Appeals 1989).

By creating a simulated market, the contingent valuation method (CVM) obtains an individual's values for use or preservation of natural resources. The simulated market is conveyed in a mail questionnaire, a telephone call, or personal interview. In this study we used a mail questionnaire.

A CVM survey design involves three elements: 1) portrayal of the resource to be valued; 2) description of the particular mechanism used to pay for the resource; and 3) the question format used to elicit the respondent's dollar amount willingness-to-pay (WTP).

The resource to be valued was a fire prevention and control program for three million hectares of old-growth forests in Northern Spotted Owl Critical Habitats Units (CHUs) in Oregon. This program consisted of: a) Greater Fire Prevention; b) Earlier Fire Detection; and c) Quicker and Larger Fire Response. Respondents were told that the proposed program would reduce by half the current number of fires (300) and acreage burned in the CHUs (7,000 acres).

A voter referendum was the means by which all households would pay. Individuals were told in the survey "Because Oregon's old-growth forests are also Federally designated critical habitat units for the threatened northern spotted owl *all U.S. households* would pay into a Special Oregon Old Growth Fire Control Program. This fund, by

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law, could only be used for fire protection in federally owned old-growth forests shown on the map. Adoption of the program would be decided as part of a national election".

Using the voter referendum approach, the WTP question format was dichotomous choice. The dichotomous choice mimics an actual vote by simply asking if the person would vote (e.g., pay) for the item if it cost the household a particular dollar amount each year. The individual must then decide if the values to him/her are worth this price. Varying the dollar amount across the sample allows the analyst to statistically develop a demand-like relationship between probability of a "yes" response and the dollar amount. The basic relationship corresponds to equation (1):

$$\text{Prob}_{yes}(X) = 1-\{1+\exp[B_0-B_1X+B_2X_2+B_3X_3+B_4X_4+B_5X_5]\}^{-1} \qquad (1)$$

in which B's are coefficients estimated using logit regression, X is the dollar amount the household is asked to pay, X_2 represents Fire Harm, X_3 represents Existence Importance, X_4 represents Education level of respondents, and X_5 represents Forest Recreation.

By using Hanemann's (1989) formula we can compute the expected value of WTP as:

$$\text{Mean WTP} = \left(\frac{1}{B_1}\right) \cdot \ln\{1+\exp[B_0+B_2X_2+B_3X_3+B_4X_4+B_5X_5]\}. \qquad (2)$$

Survey respondents were randomly assigned to 20 different bid amounts ranging from $2 to $300. The wide range was chosen so that at the low end, anyone who valued old-growth forests or the northern spotted owl would very likely indicate that they would pay, but almost no one was expected to pay $300 per year.

Two check questions followed the WTP question. One determined if responses to the WTP question from persons who would not pay anything for the proposed prevention and control program represent a valid value or a protest of some feature of the simulated market. We also asked why other individuals would pay for the prevention and control program. Finally, simple demographic questions were asked, such as age, education, membership in environmental organizations, and income. The final questionnaire was made into a six-page booklet.

Survey Development

USDA Forest Service fire management specialists were consulted before we began the survey to ensure a good understanding of the natural resources at risk from fire in old-growth forests and spotted owl critical habitat areas. We asked them if the forest resources would be either: (a) adversely affected in the short term; (b) positively affected in the short term; or (c) not affected. The resulting information was used to describe to respondents the likely effects of fire.

A meeting of two focus groups were held at Decision Research consulting firm in Eugene, Oregon. The main objectives were to determine if our basic Fire Prevention and Control Program was understandable and realistic and to discuss acceptable ways the program could be funded. A survey instrument was developed and pretested on a small sample of residents of Eugene, Oregon, and Riverside and Davis, California. The pretest was also used to establish an appropriate range of bid amounts for the dichotomous choice question.

Sample Design

The survey questionnaire was sent to a random sample of 1,000 Oregon households. The random sample was bought from Survey Sampling Inc.[3] which have all the names, addresses, and phone numbers of Oregon's households drawn randomly from Oregon telephone books on a computerized file. The overall survey design and mailing procedure followed Dillman's (1978) total Design method (first mailing, reminder postcard, second mailing). The first mailing was sent out the first week in May, with a remainder postcard 4 business days later. A second mailing of the survey with a new cover letter was sent to non-respondents the first week in June 1993.

Results

Out of the 1,000 total survey questionnaires mailed, 156 were not usable because they were refused, undelivered, or the addressees were deceased. A total of 425 completed questionnaires were returned for a response rate a little over 50 percent. This response rate is about average for general population surveys, using a first mailing-postcard-second mailing without any financial incentive.

The age of the sample of Oregon households exceeded the population level (*table 1*). This finding is typical in mail surveys. The income level and percent of males of the sample also exceeds the population level. The over-representation of males is due to Survey Sampling Inc., drawing the majority of names from the phone books, which traditionally lists addresses and phone numbers under male names.

Some people said they would not pay anything for the fire prevention and control program and offered reasons (*table 2*). The first two categories are considered valid responses that reflect legitimate reasons to decline to pay. We considered that people who indicated they could not afford to pay took their commitment to participate in the

[3] The use of trade or firm names in this publication is for reader information and does not imply endorsement by the U.S. Department of Agriculture of any product or service.

Table 1—*Demographic characteristics of sample and Oregon's households*

Characteristic	Sample	Oregon[1]
Mean age	52.76	49.00
Mean education (years)	14.28	13.00
Mean income	$37,831.00	$32,336.00
Percent male	69.00	49.00

[1]Source: 1990 U.S. Census

Table 2—*Reasons why people would not pay*

Reason	Percent
This program is not worth anything to me	3.35
I cannot afford to pay at this time	7.55
Subtotal[1]	10.90
I don't think this program would work	7.55
It is unfair to expect me to pay	5.45
I am opposed to new government programs	14.55
Fire is natural and benefits forest	6.05
Other	3.55
Subtotal[1]	37.15

[1]Totals from tables 2 and 3 do not total 100 percent since not everyone answered their respective questions.

survey seriously. The third through fifth categories are usually classified as protest responses. They are usually not considered valid representations of the individuals willingness-to-pay, although they represent valid concerns. These concerns may include a rejection of the basic premise of the CVM market, some feature of the scenario, or generalized concerns about the issue.

Protest responses are typically not included when computing WTP; thus they were not included in this analysis. Implicitly, though, the sample average WTP is applied to these individuals when expanding the sample to the population. Overall, an unusually high 37.1 percent of the responses were considered protests; therefore, the sample average WTP is conditioned on valid survey responses, as described above, of the remaining 63 percent.

The majority (22 percent) of the protest responses included reasons such as the respondents "didn't think the program would work" and that they "were opposed to new government programs." To resolve the motivation behind the responses would most likely require personal interviews and is an important priority for future research.

Table 3—*Reasons why respondents would pay*

Reason	Percent
This program is worth at least this much	10.85
I have a duty to protect these old-growth forests	17.75
To contribute to a good cause	4.40
To pay my fair share to protect these old-growth forests	11.45
Other	2.15
Total[1]	46.60

[1]Totals from tables 2 and 3 do not total to 100 percent since not everyone answered their respective questions.

Almost 47 percent of the respondents reported a positive WTP (*table 3*). Almost 11 percent of the respondents providing a positive response chose the first reason listed in the table. This is the category that most closely matches an economic interpretation. The next motivations, including a "duty to protect" and "paying a fair share," reflect the majority of the respondents. Only about 4.4 percent indicated they would pay simply to give money to a good cause. In accordance with the economic paradigm that what matters is willingness-to-pay regardless of motivations, all positive WTP amounts and non-protest zeros, are retained in the analysis.

Statistical Analysis

WTP can be estimated either through open-ended or dichotomous choice questions in contingent valuation studies. The empirical advantage of dichotomous choice relates to the ease of responding to this question format. For example, 10 to 15 percent more of the respondents answered the dichotomous choice as compared to the open-ended questions. However, the open-ended format provides more information per respondent. In our research we obtained similar results whether computing WTP using the dichotomous choice or open-ended questions format (Loomis and others, in press). The results presented here are from the dichotomous choice format.

Mean WTP under the dichotomous choice format is calculated from equation (2), using the coefficients relating the yes/no responses to the bid amount (dollar amount respondents are asked to pay). The coefficients are typically estimated by using logistic regression (Hanemann 1984). A multivariate dichotomous choice equation allows us to investigate the effect of other independent or explanatory variables on dichotomous choice WTP responses. (A more extensive treatment of the data and the different regression models estimated could be found in Loomis and others (In Press)).

Our analyses provided the coefficients and t-statistics of the multivariate equation (*table 4*). All the coefficients have the intuitive expected sign and are statistically significant at

Table 4—*Multivariate logit equation*

Variable	Coefficient	T-statistic
Constant	-3.8395	-3.93
Fire harm[1]	0.3081	3.79
Existence importance[2]	0.4085	2.46
Education[3]	0.2411	3.99
Forest recreation[4]	0.7165	1.98
Bid amount[5]	-0.2075	-3.94
Chi-square (5 of)	102.4652[6]	
Pseudo R^2	0.3094[7]	

[1]A person's perception of whether fire is harmful to a) diversity of plants and animals, b) health of trees, c) muddying of salmon spawning habitat, and d) northern spotted owl habitat. Responses are -1 for fire is beneficial, 0 for fire has no effect, +1 for fire is harmful. Thus a score of +4 would be fire is harmful to all, while a -4 would be fire is beneficial to all. Scores close to zero indicate fire having neither a positive nor negative effect.

[2]Importance of knowing that old-growth forests exist in Oregon. It is measured on a 1 to 4 scale, 4 being very important and 1 being not important.

[3] Level of education in years.

[4] A dummy variable for whether they have visited forests for recreation in the past 12 months; 1 if they have visited the forest, 0 otherwise.

[5] Dollar amount they were asked to pay.

[6] The degrees of freedom for the chi-square is five (Kmenta 1986, p. 556). He states "Note that in general the number of degrees of freedom of the chi-square variable is given by the number of explanatory variables in the model."

[7] See Kmenta (1986). The computational formula is $1-(LLF_{max}/LLF_{null})$ where LLF_{max} is the log likelihood function value under the full model and LLF_{null} is the log likelihood function under the null hypothesis (all the B's set equal to zero).

the .05 alpha level or higher. The multivariate logistic regression equation had a pseudo R square of 31 percent.

Income, age, and gender were not statistically significant. A statistically significant effect was not found for income even when education was excluded from the equation. This may be because the dollar amounts people were asked to pay being relatively small compared to their income.

Expanding the Sample to the Population

One critical concern when expanding the sample to the population is the external validity or generalizability of the sample values to the population. The external validity is partly dependent on the representativeness of the sample frame and the survey response rates. While our sample frame was a random sample of Oregon's households, the response rate is a little lower than desirable. The net effect is that our sample education is about 1.3 years more than the State of Oregon as a whole (*table 1*).

We developed a range of benefit estimates based on three approaches to expanding the sample to the population (*table 5*). The first approach, sample average, generates a WTP of $90 per household and about $99 million annually by generalizing the sample average to the entire Oregon population. In this approach the sample average values is applied to non-responding households as well. A lower estimates of $45 per household and a State aggregate value of $49.5 million annually is generated by assuming that the proportion of households not responding to the survey hold a zero value for the prevention and control program. Finally, a medium estimate of $77 per household and $84 million annually for Oregon would be obtained by replacing our sample average education level of 14.3 years with the State average education level of 13.0 years in our logistic regression equation (*table 4*). This procedure implicitly makes the resulting sample representative of the State population on the only statistically significant demographic variable.

The benefit estimates are preliminary and do not include any values from households in the other 49 States of the U.S. regarding reducing the risk of wildfire in Oregon's old-growth forests and spotted owl habitat. The U.S. has about 100 million households and Oregon has about 1 million. Even if the rest of the U.S. households maintained a much lower value toward fire protection in Oregon's old-growth forests, the rest of the U.S. value would dwarf the value of Oregon residents alone.

Respondents were told in the survey that the fire prevention and control program would reduce by half the number of acres of old-growth forest that would burn each year. This represents a reduction of 3,500 acres of old-growth forests that would no longer burn each year. If the middle estimate of WTP of $84.6 million annually is divided by 3,500 acres that would no longer burn, the resulting value per acre saved from fire is $24,170. In addition, if we divide the $84.6 million by the 3 million acres of old-growth forests in Northern Spotted Owl Critical Habitat Units that are protected results in a value of $28 per acre protected. These methods correspond to the Forest Service fire management planning process.

Conclusions And Future Research

The overall response rate for the survey was a little over 50 percent and the WTP amounts from both open-ended and dichotomous choice formats were different from zero. The annual WTP value per household in the sample was $90. The total annual Oregon resident's willingness-to-pay ranged from $45.6 to $99 million with a medium estimate of $85 million annually. And, old-growth forests protected from fire was $28 per acre.

The absence of well documented statements that the fire prevention and control program would technically work may have contributed to the relatively high protest response to the willingness-to-pay question. Even so, many people indicated they were opposed to any new government programs. This opposition is a difficult issue that must be dealt with in future focus groups and survey pretesting. One possible strategy to deal with this issue would be to identify those

Table 5—*Expanding sample willingness-to-pay to the State of Oregon*

Item	90 Percent Confidence Interval	Mean WTP Per Household	Households (Millions)	Total (Millions)
Sample Average	$70 - $111	$90	1.105	$98.920
Middle Estimate (Adjusted for Education)	$64 - $96	$77	1.105	$84.588
Lower Estimate	$35 - $56	$45	1.105	$49.460

aspects of the fire prevention and control program that elicited this anti-government response and differentiate those program aspects from other general government programs. Another possibility is to frame the forest protection effort as a private or local or non-profit (i.e., not State or Federal government) fire prevention district or insurance program. For example, willingness-to-pay could be asked as an annual insurance premium for the fire prevention and control program. Another more promising alternative is to conduct in-person interviews, so that respondents are clearly focused on the economic issue of the study.

The sample demographics over-represented older, higher educated, and higher income households. The sample also over-represented males. Only education was statistically significant in explaining WTP in the dichotomous choice logit regression. More representative demographics could be obtained from a more expensive random digit dialing approach of all households.

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