Introduction

The protection of old-growth forests was identified as a major concern at workshops on defining what fire managers thought were the major fire management issues in the Pacific Northwest (Gregory and von Winterfeldt 1992). These workshops were held in Regions 5 (California) and 6 (Oregon and Washington) of the Forest Service. The workshops' primary purpose was to develop an understanding of the nature and structure of the nonmarket forest resource values that could be affected by alternative fire management strategies. Participants specifically identified lack of economic values of protection of old-growth forest that could be formally represented in fire management models. This paper provides a case study of the contingent valuation method (CVM) for measuring the total economic value (the sum of recreation use, option, existence, and bequest values) (Randall and Stoll 1983) of protecting old-growth forests in Oregon from catastrophic fires.

Literature Review

Vaux, Gardner, and Mills (1984), in one of the first studies of the perception of fire-influenced landscapes and its effect on the land's recreation quality, stated, "Both economic and psychological methods could be used to evaluate the effects of fire on forest recreation. These methods rely on direct and inferential means to assess the values of outdoor recreation. The most suitable of these approaches appears to be contingent market valuation—a direct economic technique that uses personal interviews. A hypothetical market transaction environment is set up within which values are estimated." This approach has been used to assess the impact of insect infestations and timber cutting on forest environments. The effects of such infestations and cuttings are similar to the effects of fire. Vaux, Gardner, and Mills go on to state that "willingness-to-pay (WTP) is an appropriate measure for valuing the effects of fire on forest recreation" (Vaux and others 1984:1). Willingness-to-pay represents the maximum amount a person would be willing to pay for the resource in question under the proposed scenario (Mitchell and Carson 1989). The study by Vaux and others (1984) involved about 70 students rating photographs of burned and unburned forests and then expressing a willingness-to-pay for the preferred scene. The primary objective of their research was to demonstrate the viability of such an approach.

Our proposed research takes the study by Vaux and others (1984) forward in several directions. First, our sample is much larger in size than theirs and represents the general population rather than college students. Second, we are interested not only in how fire affects recreational benefits of the forest over time but also in the magnitude of what are sometimes called non-use or preservation values associated with maintaining the forest in its current condition (Walsh and others 1984). These preservation values include the option for future recreation use, the benefit from just knowing the forests are maintained as habitats for wildlife, and the knowledge that future generations will have these forests in much the same form as we do today. In this study, we emphasize these values as well as the benefits of ecosystem and critical habitat that old-growth forests provide for nongame wildlife such as spotted owls, salmon, and steelhead, as well as scenic beauty and water quality. Third, we explicitly include the concept of opportunity costs in that we ask participants to state their willingness-to-pay, in dollars of personal income, to receive the specified benefits.

In this sense, our study is an extension of the studies by Rubin and others (1991), Hagen and others (1992), and Lockwood and others (1993) in which individuals were asked their maximum WTP to protect old-growth forests from logging and to ensure their continued existence as habitat for spotted owls. In many cases, fire is the next major threat to the protection of these forests. Our study and survey design will draw from elements in each one of these CVM studies. In addition, we draw upon the workshops of Gregory and von Winterfeldt (1992), who investigated the nonmarket forest resource values that are affected by alternative fire management strategies.

Contingent valuation is a widely used method for obtaining WTP for recreation, option, existence, and bequest values (Mitchell and Carson 1989). It is recommended for use by Federal agencies for performing benefit cost analysis (U.S. Water Resources Council 1983), for valuing natural resource damages (U.S. Department of Interior 1986). Its use was upheld by the Federal courts (U.S. District Court of Appeals 1989).

The CVM obtains an individual's estimate of their WTP for use or preservation of natural resources through creation of a simulated market. The simulated market is conveyed in a mail questionnaire or a telephone or in-person interview.

Development of the Survey

Development of Technical Information on Fire

Before the survey design, the research team met with USDA Forest Service fire management specialists and wildlife biologists to ensure a good understanding of the natural resources at risk from fire in old-growth forests and spotted owl critical habitat areas. These specialists were from the Willamette National Forest in Eugene, Oregon and the USDA Forest Service Regional Office in Portland, Oregon. We went through a checklist of multiple uses and species and asked whether the forest resources would be either adversely affected by fire in the short term, positively affected by fire in the short term, or not affected by fire. The results of this discussion were used to describe to respondents the likely effects of fire.

In addition, this meeting provided initial information on the frequency and extent of actual fires under current management. As a result of this meeting, we secured map overlays from the Forest Service on fire frequency and from the USDI Fish and Wildlife Service on CHU's. From these overlays, we developed our statistics on frequency and extent of fire in spotted owl CHU's.

The other main accomplishment of this meeting was the initial development of a list of additional fire management actions that could be undertaken by the Forest Service and Bureau of Land Management (BLM) to reduce the frequency and extent of fire in the CHU's. We titled this the Fire Prevention and Control Program. After discussion with fire management officials, three main categories of this program were identified. These are: "greater fire prevention efforts," "earlier fire detection," and "quicker and larger fire control response." In the survey, the respondent is given one-sentence elaborations of each of these three management actions *(appendix A)*.

Focus Groups and Pretesting

Once the fire statistics and maps of CHU's for Oregon were developed, we held two small focus groups at Decision Research (a scientific research firm) in Eugene with Oregon residents. One of the primary objectives was to

determine whether our basic Fire Prevention and Control Program was understandable and realistic. We also sought to explore alternative ways to describe the extent or amount of area burned each year. Another objective was to discuss acceptable ways of funding this program. For example, we asked whether it was believable that only Oregon residents would pay for the program or whether all residents of the United States must pay. In addition, the focus groups provided us with a better understanding of the language that participants normally used to describe events related to forest fire.

After meeting with these focus groups, a complete survey was drafted by members of the study team. The revised instrument was pretested on a small sample of Oregon residents who filled out the survey at Decision Research in Eugene, by Forest Service employees at the Forest Fire Laboratory in Riverside, California, and by several staff members at the University of California, Davis. Each individual participating in the pretest was asked to answer a follow-up checklist to investigate several items that have been problems for past CVM surveys. For example, we checked to see whether individuals understood that the fire control program protected just spotted owl areas in Oregon and whether they realized that all residents of the United States would pay. Several modifications were made to the survey instrument on the basis of these results (e.g., bolding or underlining was added for emphasis or survey layout was changed). Finally the pretest was used to establish an appropriate range of bid amounts for the dichotomous choice question.

Structure of the Survey

Nonmonetary Measures of Relative Importance

Before directly asking how much respondents would pay for a fire protection program for old-growth forests, it is important to allow the respondents an opportunity to reflect on why they might care about these forests. Cummings and others (1986) call this "researching their preferences" or, in other words, collecting your thoughts on this topic. Certainly residents of Oregon have been exposed to large and repeated media coverage about old-growth forests and spotted owls. In the weeks before the first mailing of our survey, the President, Vice-President, and nearly half of the President's cabinet came to Portland, Oregon, for an "Owl Summit." This event was highlighted, in one way or another, in every local newspaper and received extensive television network coverage. Thus, we believe Oregon residents have some knowledge about the natural resources present in old-growth forests and have had much opportunity to reflect on what these resources mean to them.

The first set of questions asked about the relative importance of old-growth forests for recreation use, providing timber, as habitat for plants and wildlife, providing jobs, and providing scenic beauty in Oregon. A 5-point Likert scale allowed individuals to rate the relative importance of these various reasons for valuing old-growth forests in Oregon. This neutral response format (that precedes the dollar valuation questions) also aided in understanding the WTP amounts people provide later in the survey.

Steps in Developing a Contingent Valuation Method Survey

Any CVM survey design involves three elements: (a) portrayal of the resource to be valued; (b) description of the particular financial mechanism to be used to pay for the resource; e.g., property taxes, utility bills, trust funds, etc.; and (c) the question format used to elicit the respondent's dollar amount of WTP.

In this case, the resource to be valued was a fire prevention and control program for 3 million acres of old-growth forests in CHU's of Northern Spotted Owl in Oregon. This point was emphasized by the half-page map of western Oregon showing the CHU's on the third page of the survey (directly across from the WTP question). Discussion with USDA Forest Service fire management specialists suggested that increasing three fire program elements would reduce the number and extent of fires. After several focus groups and pretests (discussed above), these three elements were refined into the Fire Prevention and Control Program that were listed and briefly described to respondents in the survey: (a) Greater Fire Prevention; (b) Earlier Fire Detection; and (c) Quicker and Larger Fire Response. The respondents were told that greater effort and funding in all three of these areas would cut in half the current annual number of fires (300) and acreage (7,000) burned in the CHU's. The statistics on the current number of fires and acreage burned were developed from map overlays supplied by the USDA Forest Service and USDI Fish and Wildlife Service. To make the reduction more meaningful, we described the acreage relative to the number of city blocks and square miles involved.

The means by which all households would pay was framed as a voter referendum. Individuals were told *Because Oregon's old-growth forests are also Federally designated CHU's for the threatened Northern Spotted Owl, all households in the United States would pay into a Special Oregon Old-Growth Fire Control Program. By law this fund could be used only 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. Following this statement was the actual WTP question: Suppose the Oregon Old-Growth Fire Prevention and Control Program proposal were on the next ballot. This program would reduce by half the number of acres of old-growth forests in CHU's that would burn in Oregon each year. If it cost your household $___ each year, would you vote for this program? This was followed by the open-ended WTP question What is the maximum your household would pay each year for the Fire Prevention and Control Program to reduce in half the number of acres of old-growth forests in CHU's that burn each year in Oregon?* (See *appendix A* for the complete survey).

Questions to check comprehension following the pretest indicated that a majority of individuals understood that this program pertained only to Oregon's old-growth forests and that **all** U.S. households would pay.

Given the voter referendum question, the WTP question format was of the dichotomous (yes/no) type. The dichotomous choice format mimics an actual vote by simply asking whether the person would vote (e.g., pay) for the item if it would cost the household a particular dollar amount each year. In this case the individual must just decide whether the value to him or her is worth at least this price. Since the printed dollar amount varies across the sample, the dichotomous choice format allows the analyst to statistically trace out a demand relationship between the probability of a "yes" response and the dollar amount. The basic relationship is:

$$\text{Prob(Yes)} = 1 - \left\{1 + \exp\left[B_0 - B_1\overline{X}_1 + B_2\overline{X}_2 + B_3\overline{X}_3 + \ldots B_n\overline{X}_n\right]\right\}^{-1} \qquad (1)$$

where **B**'s are coefficients to be estimated using logit statistical techniques and **X** is the dollar amount the household is asked to pay.

From equation 1, Hanemann (1989) provides a formula to calculate the expected value of WTP as:

$$\text{Mean WTP} = \left(1/B_0\right) \times \ln\left(1 + \exp\left[B_0 - B_1\overline{X}_1 + B_2\overline{X}_2 + B_3\overline{X}_3 + \ldots B_n\overline{X}_n\right]\right) \qquad (2)$$

This formula applies if reducing fire is seen as beneficial by all respondents. However, if this is not the case, then the unrestricted WTP (B_0/B_1) is appropriate, which is also equal to the median in a linear model.

Twenty different bid amounts ranging from $2 to $300 were randomly assigned to survey respondents. The range was picked such that at the low end, anyone who valued old-growth forests or the Northern Spotted Owl would very likely indicate they would pay $2, while almost no one was expected to pay $300 each year.

Following the WTP question were two questions designed to investigate the reasons behind a person's answers to the WTP questions. One question probed responses for persons indicating they would not pay anything at all for the fire prevention and control program (respondents indicated whether they would pay or not when responding to the WTP questions). It is customary to determine whether such response represents a valid value or a protest to some feature of the simulated market. Six response categories were provided including: (a) this program is not worth anything to me; (b) I cannot afford to pay at this time; (c) I do not think the program would work; (d) It is unfair to expect me to pay; (e) I am opposed to any new government programs; (f) other. Categories (a) and (b) represent valid reasons for not being willing to pay. These responses are retained for calculating WTP. However, responses (c)-(e) represent rejection of the basic premise of the simulated market and are not retained for purposes of calculating WTP. These rejections may not reflect signals about the value of the commodity, but rather may reflect the respondent's concerns about the effectiveness of the program, equity of the financing, other features of the survey, or simply the political ideology of the respondent.

The second WTP check question was asked of those individuals who indicated they would pay the posited amount. The five categories were (a) This program is worth at least this much to me; (b) I feel we have a duty to protect old-growth forests; (c) to contribute to a good cause; (d) to pay my fair share to protect old-growth forests; (e) other. Clearly, category (a) is a valid response as this is what we are trying to measure. There has been some debate about whether those checking off (b), (c), or (d) are really valuing the resource or program, simply donating out of a sense of duty, or for a "warm glow" that donating to a good cause provides (Kahnemann and Knetsch 1992).

Finally, simple demographic questions such as age, education, membership in environmental organizations, and income were asked. The final survey instrument was typeset and made into a booklet containing text and graphics.

Two Survey Versions for Hypothesis Testing

As part of the survey development process, we identified a critical CVM design issue that could be tested: whether making explicit to the respondent that there were many substitute public programs that needed funding and that their limited household budget would limit the respondent's WTP. Both of these points were recommendations of the National Oceanic and Atmospheric Administration's (NOAA) Blue Ribbon Panel on Contingent Valuation (Arrow and others 1993). To allow for testing of whether reminding respondents that they may have to pay for other environmental programs and that they had a limited budget, we added the following text immediately before the WTP question in one-half the surveys mailed: *Before you vote, we would like you to keep in mind that this fire control program would affect only old-growth forests and spotted owls in Oregon, not other states. Also remember that about 1,000 other endangered species in the United States need protection for their critical habitat. Additional money will be needed for these species and other costly environmental programs such as cleanup of abandoned hazardous waste sites and reducing air pollution. Money*

you spend on the fire program would reduce the amount of money your household will have available to spend on the other environmental problems mentioned as well as on the everyday products you buy.

If the NOAA panel is correct, WTP—with this statement included—will be lower than WTP elicited without the statement on substitute uses of their money. The difference in WTP for the open-ended question can be evaluated with a student's t-test using the sample means and their respective standard errors. In the case of dichotomous choice CVM, the differences in responses can be compared by a statistical likelihood ratio test that will be explained in more detail later.

Sample Design

The two versions of the questionnaire were sent to a random sample of 1,000 Oregon households during spring 1993. The sample was provided by Survey Sampling Inc. Survey Sampling Inc. assigned households randomly to the two treatment samples; no other selection criteria were imposed on the sampling. The overall survey design and mailing procedure follow Dillman's (1978) Total Design Method (first mailing/postcard/second mailing). Each individual was sent a personalized cover letter on Decision Research letterhead with a personal signature. The first mailing was sent out the first week in May, with a reminder postcard 4 business days later. A second mailing of the survey, with a new cover letter, was sent to nonrespondents the first week in June.

Results

Response Rate

Table 1 provides a tally of the response rate by version and the overall response rate. The response rates were nearly identical between versions, 50 percent for version 1 and 49 percent for version 2 *(table 1)*. This response rate is typical for a general population survey using a first mailing/postcard/second mailing without any financial incentives. In addition, Oregon residents may have become overwhelmed by all the attention to the Northern Spotted Owl controversy, and some persons may have just refused to devote further attention to the issue. Below, we provide two adjustments to account for the nonresponse when generalizing the sample results to the population.

Table 1—*Response rate of survey mailing*

Variable	Version 1	Version 2[1]
Total surveys mailed	500	500
Received	220	205
Undeliverable	59	66
Deceased	2	13
Refused	9	7
Response rate (pct)[2]	50.11	48.69

[1]Following the recommendation of the NOOA Panel (Arrow and others, 1991) this version of the questionnaire included reminder that they may have to pay for other environmental programs and that they have a limited budget.

[2]Response rate = Questionnaires received/(Total surveys mailed – Undeliverable – Deceased)

Respondents to the two versions of the survey questionnaire are similar in terms of education; but, as is typical in mail surveys, the educational level of the respondents in each sample is greater than the average educational level of residents of the State of Oregon *(table 2)*. The two samples are relatively close in terms of age; but again, as is typical in mail surveys, the age of the sample exceeds the average age of the population. The income of version-1 respondents is within 1.5 standard errors of the income of version-2 respondents, so they are not statistically different. Because Survey Sampling Inc. draws the majority of names from telephone books, which are traditionally listed under the male's name, the sample overrepresents males.

As discussed below, only education was statistically significant in explaining WTP responses in the dichotomous choice question format. We also use the average level of education in the State of Oregon rather than the sample average as one way of adjusting our estimated WTP values from the dichotomous choice CVM to better reflect state demographics.

Why People Answered the Willingness-to-Pay Questions as They Did

Why They Would Not Pay: Protest Responses

Table 3 presents the reasons why some people in the two samples said they would not pay anything for the fire prevention and response program. The first two categories are not considered protest responses but, in fact, reflect legitimate reasons for stating "no, they would not pay anything." We found it encouraging to see that people indicated they could not afford to pay. This meant they took the commitment in the survey seriously.

The third through fifth categories represent what are usually classified as protest responses. These responses are usually not considered valid

Table 2—***Comparison of Version 1 and Version 2 demographic characteristics with Oregon's households***

Demographic Characteristics	Version 1	Version 2	Oregon[1]
Age (yr)	53.45	51.78	49.00
Education (yr)	14.36	14.20	13.00
Annual income ($)	35,800	39,863	32,336
Percent male	74.00	65.00	49.00

[1]Source: 1990 U.S. Census

Table 3—***Reasons why the subset of people would not pay***

Reason	Version 1	Version 2
	————*percent*————	
This program is not worth anything to me	2.3	4.4
I cannot afford to pay at this time	6.8	8.3
Subtotal	9.1	12.7
I do not think program would work[1]	8.2	6.8
It is unfair to expect me to pay[1]	4.6	6.3
I am opposed to new government programs[1]	17.4	11.7
Fire is natural and benefits forest	6.8	5.3
Other	3.2	3.9
Subtotal	40.2	34.0
Total[2]	49.3	46.7

[1]Usually classified as protest responses.

[2]Total does not add to 100 percent because not all respondents answered their respective questions.

representations of the individual's willingness-to-pay, though they do represent valid concerns. These concerns may include a rejection of the basic premise of the CVM market, some feature of the scenario, other concerns about the survey, or generalized concerns about the overall issue. These WTP responses are normally not included when WTP is computed. Thus, implicitly, the sample average WTP is applied to these individuals when the sample is expanded to the population.

Overall, 40 percent of version-1 and 34 percent of version-2 responses were considered protests. This is an unusually high protest rate; therefore, the sample average WTP is conditioned on valid survey responses, as described above, of the remaining 60 and 66 percent. In part, some of this may be due to not convincing the respondent that the fire prevention and response program would work. Respondents can perhaps be convinced in future surveys by a better explanation of how such a program would work and examples of how similar programs had worked in other areas. Alternatively, these expressions may represent opinions about government programs in general or a feeling that too much attention has been focused on the spotted owl in Oregon. To resolve the motivations behind these responses would take an in-person interview and is an important priority for future research.

Table 4 presents reasons why individuals reporting positive WTP would pay such amounts. The first category most closely matches an economic interpretation, and 17 percent (46/266) of the people providing positive WTP gave this reason. The next motivations, including having a duty to protect and paying one's fair share, reflect the majority of the respondents. Only 7 percent indicated they would pay simply to give money to a good cause. Further research is needed to better analyze and evaluate how these motivations relate to both economic and psychological indicators of value. Future work should include refinement of these categories and perhaps linking with satisfaction gained from knowing that old-growth forests and habitat are protected (Stevens and others 1991). In keeping with the economic paradigm that what matters is willingness-to-pay regardless of motivation, all positive WTP amounts and nonprotest zeros are retained in the analysis that follows.

Statistical Analysis

A second data set for statistical analysis was created from the main data set by removing protest responses. This section provides estimates of WTP based on both the open-ended WTP and the dichotomous choice questions. The empirical advantage of the dichotomous choice relates to the ease of responding to this question format. Ease of responding is evidenced by the

Table 4—*Reasons why the subset of people would pay*

Reason	Version 1	Version 2
	———*percent*———	
This program is worth at least this much	10.0	11.7
I feel we have a duty to protect these old-growth forests	13.7	21.8
To contribute to a good cause	6.4	2.4
To pay my fair share to protect the old-growth forests	14.2	8.7
Other	0.9	3.4
Total[1]	45.2	48.0

[1]Total does not sum to 100 percent because not everyone answered his/her respective questions.

fact that about 10 to 15 percent more respondents answered the dichotomous question than the open-ended questions. Nonetheless, the open-ended format provides more information per respondent and allows for a simpler comparison of WTP across versions.

Table 5 summarizes the responses to the open-ended WTP question for both versions. Two conclusions can be reached from the results in the table. First, WTP in both versions is statistically different from zero. Second, as will be discussed more below, the responses are not statistically different between survey versions.

Figure 1 further illustrates the similarity of WTP responses between the two versions of the survey and reinforces the conclusion of the point estimates that the WTP distributions are similar. The highest dollar amount in the open-ended WTP responses were given by active forest users who thought fire had a very negative effect. However, each version had one bid amount ($200 in version 1 and $250 in version 2) that appeared to be outliers because reported income of these households was just $5,000, and one did not visit forests.

Table 5—*Comparison of open-ended "willingness-to-pay" (WTP) by version*

Version	Mean	Standard error	95 percent confidence interval
	——————————*dollars*——————————		
1	35.88	3.39	29.23 – 42.52
2	32.96	4.17	24.79 – 41.13

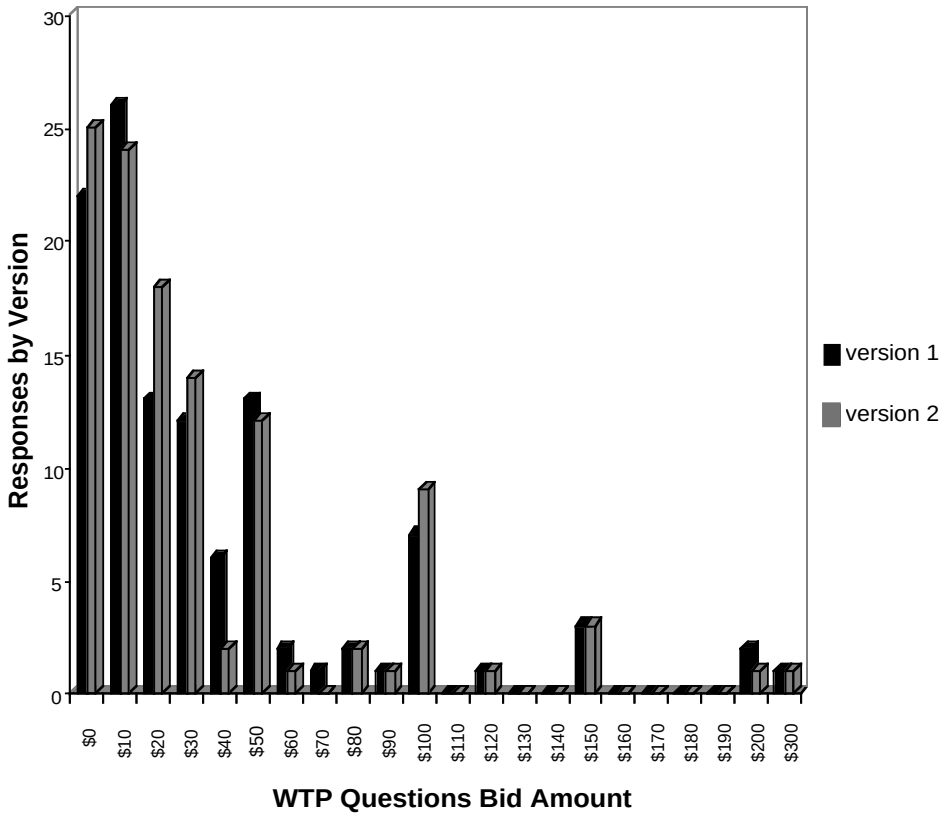


Figure 1—Comparison of response to the open-ended willingness-to-pay (WTP) question for the fire prevention and control program for old-growth forests in CHU's of Northern Spotted Owl in Oregon shows no difference between survey responses. The graph reinforces the conclusions of the point estimates that the distributions of WTP dollar amounts are similar.

Logit

Statistical Coefficients and Willingness-To-Pay

Mean WTP with the dichotomous choice WTP format is calculated from the coefficients relating the yes and no response to the bid amount using equation 2. The coefficients are typically estimated using a logistic regression (Hanemann 1984). The logit equations for the two versions are shown in *table 6*. *Appendix B* shows the distribution of yes/no responses by bid amount.

The coefficients are all statistically significant at the 0.01 level as are the overall goodness-of-fit statistics (the chi-square). The pseudo R squared, which is also calculated by comparing the restricted and unrestricted log likelihood, indicates that 13 percent (version 2) and 18 percent (version 1) of the variation in responses is explained by bid amount alone.

Using equation 2, WTP is calculated for the two versions. Once again the WTP values are quite close. As has been found in other studies (Kealy and Turner 1993), WTP from the dichotomous choice is higher than for open-ended questions *(tables 3* and *4)*. Hoehn and Randall (1987) rigorously discuss the incentives and decision process of individuals in the two response formats. They show that the open-ended WTP response format is likely to yield estimates of WTP below that of dichotomous choice, which is more incentive compatible. Of course, it is possible that more conservative open-ended results are more accurate estimates of WTP. Without asking for actual cash payment to test the validity of the two question formats, we cannot say definitely which is most accurate.

Results of Hypothesis Tests

Given the expectations of the NOAA panel, respondents who had received version 2 and had been reminded about competing programs and their own budget constraint should have produced lower WTP estimates than those of respondents who had received version 1. However, the means of responses to the open-ended WTP questions are similar ($33 versus $36), and the confidence intervals overlap *(table 5)*. Thus, there is no evidence of a difference between responses to the open-ended WTP questions elicited from the two versions.

In the case of dichotomous choice CVM *(table 6)*, the estimates of WTP are also similar across the two versions ($92 versus $98). Testing the statistical significance of differences in dichotomous choice responses involves performing a likelihood ratio test, which tests the equality of the logit equation's slope and intercept for the two survey versions. If the

Table 6—***Bivariate logistic regressions by version***

Variable	Version 1	Version 2
Constant	1.048	1.482
(t statistics)	(3.720)	(5.050)
Bid	–0.015	–0.017
(t statistics)	(–3.760)	(–4.540)
Log-likelihood	–75.280	–73.880
Chi-square	23.309	32.917
Pseudo R squared	0.134	0.182
Mean willingness-to-pay (WTP > 0)	$91.57	$98.32
Median WTP	$71.28	$86.69

response behavior (e.g., slope and intercepts) is the same in the two versions, there should be no difference between the log likelihood value when the data are pooled i.e., the coefficients in equation 1 are restricted to being equal across the two versions) versus the sum of the separately estimated log likelihoods (i.e., the coefficients are allowed to be different across the two versions). The likelihood ratio test (LLR) is two times the difference in the pooled log likelihood value and the sum of the individual log likelihood value (–2[–149.85 – (–75.28 + –73.88)]). The test statistic has a chi-square distribution when the coefficients are not different across versions.

The pooled log likelihood is –149.85. As reported in *table 6*, the individual log likelihoods are –75.28 and –73.88. Given the fact that the sum of the two individual log likelihoods is nearly identical to the pooled value (–149.85 vs 149.16), it is not surprising that the LLR test for the bivariate logit equations produces a calculated chi-square of 1.36. This is well below the critical value at the 0.01 level of significance of 6.635. Thus we can say that no difference was detected in the response to dichotomous choice with the two different versions of the survey. This is consistent with what we found with responses to the open-ended WTP questions as well.

Discussion

There are several interpretations of the similarity of WTP responses across survey versions. The most optimistic is that respondents in a WTP framework already take into account their budget and expenditures for competing public and private alternatives when providing their WTP responses. This is similar to what Boyle and others (1990) found with regard to explicitly reminding respondents about substitute hunting opportunities. If we continue to find this in other studies, then there may be no need to remind respondents about competing public demands or their budget constraint as originally recommended by the NOAA panel.

An alternative interpretation is that when dealing with any hypothetical scenario, people do not seriously consider the real dollar consequences of their survey responses. Thus, the budget reminder statement does not modify behavior since the dollars to be paid in the survey are still hypothetical. Without a validity test forcing respondents to actually pay (Bishop and Herberlein 1979, Duffield and Patterson 1992), we cannot definitely distinguish between these two possible explanations. The fact that the bid amount has a negative coefficient, however, does indicate that households were less likely to pay the higher (hypothesized) dollar amounts.

A third interpretation is that, although participants understood the task, the dollar values were sufficiently vague and respondents with or without considering their own budget constraints could not distinguish a specific value. Thus their own unfamiliarity with the valuation process overwhelmed the finer distinction about considering their budget and competing needs.

In this case, subjects who were not used to thinking about a fire protection program in dollar terms may simply have been unable to sufficiently optimize their response (this is consistent with Hoehn and Randall [1987] for the open-ended responses), and thus the additional reminder about their household budget and other species was not used.

Multivariate Dichotomous Choice Results

Since the LLR tests indicate similarity of dichotomous choice WTP behavior across versions, we can safely pool the data for the two versions.

Doing so allows us to investigate the effect of other independent or explanatory variables on dichotomous choice WTP responses.

Table 7 provides the coefficients and t-statistics for this multivariate equation. As can be seen, all of the coefficients have the intuitively expected sign and are significant at the 0.05 level or higher. The pseudo R squared is 0.31, much higher than that in the bivariate model. The multivariate logit equation variables are the following:

Fire Harm: A person's perception of whether fire is harmful to diversity of plants and animals, health of trees, muddying of salmon spawning habitat, or Northern Spotted Owl habitat. Responses are –1 for "fire is beneficial," 0 for "fire has no effect," and +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 that fire has neither a positive or negative effect.

Existence Importance: The importance of knowing old-growth forests exist in Oregon. It is measured on a 1-to-4 scale, 4 being very important and 1 being not important.

Education: The level of education in years.

Forest Recreation: A dummy variable for whether participants had visited forests for recreation in the past 12 months; 1 if they have visited the forest, 0 if not.

Bid Amount: The dollar amount participants were asked to pay.

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 were relatively small compared to their income or because in reality, there is no association of the response with income.

Figure 2 presents the logit curve derived from the multivariate logit model in *table 7*. The distribution is relatively symmetric and well-behaved. This is evidenced by the median (i.e., the 50th percentile) being $81 while the mean is $90. The median of $81 allows for some people to be adversely affected by the fire program.

Expanding the Sample to the Population: Preliminary Estimates

When applying the results from the sample to the population, one critical concern is the external validity or generalizability of the sample values to the population. This is partly dependent on the representativeness of the sample frame and the survey response rate. While our sample frame was a random sample of Oregon's households, the response rate was a little lower than

Table 7—***Multivariate logit equation for data pooled across versions***

Variable	Coefficient	t-Statistic
Constant	–3.840	–3.93
Fire harm	0.308	3.79
Existence importance	0.409	2.46
Education	0.241	3.99
Forest recreation	0.717	1.98
Bid amount	–0.021	–3.94
Chi-square	102.465[1]	
Pseudo R squared	0.309[2]	

[1]There are 5 degrees of freedom for the chi-square (Kmenta, Jan. 1986. 2nd. ed., 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."

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

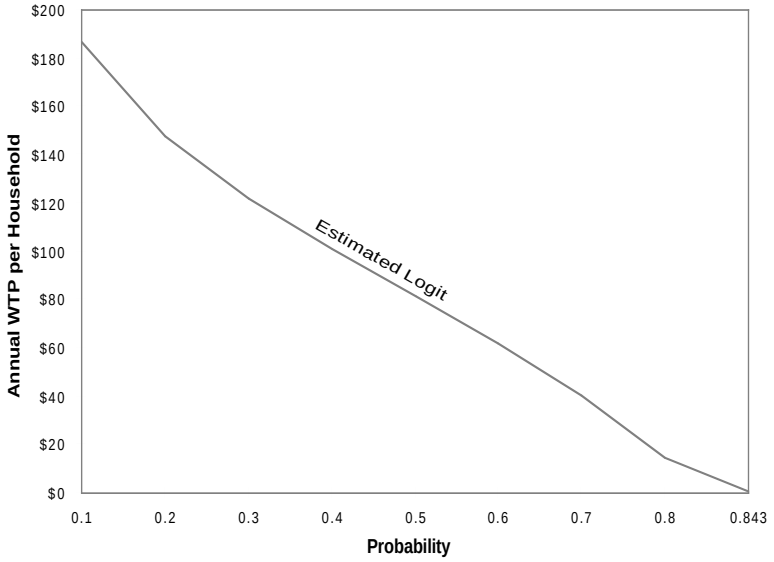


Figure 2—Oregon households' willingness-to-pay (WTP) function for prevention of fire in old-growth forests.

desirable. Our sample had about 1.3 years more education than the residents of the State of Oregon as a whole *(table 2)*.

Table 8 provides a range of benefit estimates based on three approaches to applying the sample results to the population. 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 value is applied to nonresponding households as well. To generate a lower WTP estimate we assume that the proportion of households not responding to the survey holds a zero value for the fire prevention and control program. Since our sample response rate was nearly 50 percent, this means a value per household of $45 ($90/2) and a state aggregate value of $49.5 million annually. Finally, a medium estimate would be obtained by replacing the average education level of our sample, 14.3 years, with the average education level of the State of Oregon residents, 13.0 years, in our logistic regression equation *(table 7)*. This procedure attempts to make the resulting sample more representative of the State population using the only statistically significant demographic variable. The result provides an overall WTP estimate of $77 per household for the State of Oregon, which translates into $84.6 million annually for the old-growth forest fire prevention and control program.

All the above estimates should be recognized as preliminary, subject to further refinement. These values do not include any values that households in the other 49 states in the United States would place on reducing the risk of wildfire in Oregon's old-growth forest and spotted owl habitat. The United States population has about 100 million households, and Oregon has about 1 million households. Even if the rest of the households in the United States hold a much lower value toward fire protection in Oregon's

Table 8—*Applying the sample's willingness-to-pay to the State of Oregon*

Statistic	90 pct confidence interval	Mean WTP per household	Households	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 (Zero for nonrespondents)	$35-$56	$45	1.105	$49.460

old-growth forests, the rest of the United States' value would likely dwarf the value held by just Oregon's residents. Respondents were told in the survey that the fire prevention and control program would reduce by half the number of acres of old-growth forests that would burn each year. This represents a reduction of 3,500 acres of old-growth forest that would no longer burn each year. If we take the middle WTP estimate of $84.6 million annually and divide it by 3,500 acres that would no longer burn, the resulting value to the public per acre saved from fire is $24,170. Additional reduction in acres burned would be valued less on a per-acre basis.

In terms of putting the values on a per-acre basis consistent with how economic values are used in USDA Forest Service National Fire Management Analysis System (NFMAS), we would divide the $84.6 million by the 3 million acres of old-growth forests in protected CHU's of Northern Spotted Owl. This results in a value to the public of $28 per acre protected.

Conclusion and Future Research

Overall, the survey was relatively successful in eliciting willingness-to-pay values for protecting old-growth forests in Oregon from wildfire. The survey did receive nearly a 50 percent response rate, and the WTP amounts from both open-ended and dichotomous choice were statistically different from zero. There was no difference between results from the two survey versions, leading us to believe that individuals took their budget constraint into account when answering WTP even without being reminded. This does not preclude different interpretations of the findings as presented in the section on Statistical Coefficients and WTP. The annual value per household in the sample was $90. Depending on how this is generalized to the State, the total annual Oregon residents' willingness-to-pay ranges from $49.5 to $99 million with a middle estimate of approximately $85 million annually. On a per-acre basis of old-growth forest protected from fire, this is $28.

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 use in dealing with this issue would be to identify those aspects of the fire prevention and control program that elicited this anti-government response, and determine how the program can be differentiated from other general government programs. Another possibility is to frame the forest protection effort as a private, local or nonprofit (i.e., not State or Federal government) fire prevention district or insurance program. For example, WTP 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.

Although demographics of the sample were similar across survey versions, they over-represented older, better-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. Therefore, in applying the result from the sample to the population, we accounted for the difference in education level of the sample and the State residents in our midlevel estimate of WTP. More

representative demographics could be obtained in future surveys if the sample frame is generated from a more expensive random-digit dialing approach of all households.

References

Arrow, Kenneth; Solow, Robert; Portney, Paul; Leamer, Edward; Radner, Roy; Schuman, Howard. 1993. **Report of the NOAA Panel on contingent valuation.** Federal Register 58(10): 4602-4614.

Bishop, Richard; Herberlein, Thomas. 1979. **Measuring values of extra market goods: are direct measures biased?** American Journal of Agricultural Economics 61(5): 926-930.

Boyle, Kevin; Reiling, Stephen; Phillips, Marcia. 1990. **Species substitution and questions sequencing in contingent valuation surveys evaluating the hunting of several types of wildlife.** Leisure Science 12: 103-118.

Cummings, Ronald; Brookshire, David; Schulze, William. 1986. **Valuing environmental goods.** Totowa, NJ: Roman and Allanheld; 270 p.

Dillman, Donald. 1978. **Mail and telephone surveys.** New York: John Wiley and Sons; 325 p.

Duffield, John; Patterson, David. 1992. **Field testing existence values: comparison of hypothetical and cash transactions values.** In: Rettig, Bruce, ed. Benefit and costs in natural resource planning. Fifth Interim Report. Corvallis, OR: Oregon State University, Department of Agriculture and Resource Economics; 226 p.

González-Cabán, Armando. 1993. **The economic impact of fire on forest resources: Improving the U.S. Forest Service's Fire Management Planning System capabilities to use non-market values.** Wildfire 2(4): 16-21.

González-Cabán, Armando; Chase, Richard. 1991. **Nonmarket commodities valuation problem and its implications for the Forest Service National Fire Management Analysis Planning System.** USDA Forest Service, Pacific Southwest Research Station, Forest Fire Laboratory, Riverside, CA. (Unpublished report).

Gregory, Robin; von Winterfeldt, Detlof. 1992. **Incorporating noncommodity values in forest fire management planning.** Value Scope, Eugene, OR. (Unpublished report).

Hagen, Daniel; Vincent, James; Welle, Patrick. 1992. **Benefits of preserving old-growth forests and the Spotted Owl.** Contemporary Policy Issues 10(2): 13-26.

Hanemann, Michael. 1984. **Welfare evaluations in contingent valuation experiments with discrete responses.** American Journal of Agricultural Economics 66(3): 332-341.

Hanemann, Michael. 1989. **Welfare evaluations in contingent valuation experiments with discrete responses data: reply.** American Journal of Agricultural Economics 71(4): 1057-1061.

Hoehn, John; Randall, Alan. 1987. **A satisfactory benefit cost indicator from contingent valuation.** Journal of Environmental Economics and Management 14(3): 226-247.

Kahnemann, David; Knetsch, Jack. 1992. **Valuing public goods; the purchase of moral satisfaction.** Journal of Environmental Economics and Management 22(1): 57-70.

Kealy, Mary Jo; Turner, Robert. 1993. **A test of the equality of close-ended and open-ended contingent valuations.** American Journal of Agricultural Economics 75(2): 321-331.

Kmenta, Jan. 1986. **Elements of econometrics.** New York: MacMillan Publishing; 655 p.

Krutilla, John. 1967. **Conservation reconsidered.** American Economic Review 57: 777-786.

Lockwood, Michael; Loomis, John; DeLacy, Terry. 1993. **A contingent valuation survey and benefit cost analysis of forest preservation in East Gippsland, Australia.** Journal of Environmental Management 38(3): 233-243.

Mitchell, Robert; Carson, Richard. 1989. **Using surveys to value public goods: the contingent valuation method.** Washington, DC: Resources for the Future; 463 p.

Randall, Alan; Stoll, John. 1983. **Existence value in a total valuation framework.** In: Rowe, Robert; Chestnut, Lauraine, eds. Managing air quality and scenic resources at national parks and wilderness areas. Boulder, CO: Westview Press; 314 p.

Rubin, Jonathan; Helfand, Gloria; Loomis, John. 1991. **A benefit-cost analysis of the Northern Spotted Owl.** Journal of Forestry 89(12): 25-30.

Stevens, Thomas; Echeverria, Jaime; Glass, Ronald; Hager, Tim; More, Thomas. 1991. **Measuring the existence value of wildlife.** Land Economics 67(4): 390-400.

U.S. Department of Interior. 1986. **Natural resource damage assessments**; Final rule. Federal Register 51. Washington, DC.

U.S. District Court of Appeals (for the District of Columbia). July 14, 1989. **State of Ohio v. U.S. Department of Interior.** Case No. 86-1575.

U.S. Water Resources Council. 1983. **Economic and environmental principles for water and related land resources implementation studies.** Washington, DC: U.S. Water Resources Council.

Vaux, Henry; Gardner, Phillip; Mills, Thomas. 1984. **Methods for assessing the impact of fire on forest recreation.** Gen. Tech. Rep. PSW-79. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 13 p.

Walsh, Richard; Loomis, John; Gillman, Richard. 1984. **Valuing option, existence and bequest demand for wilderness.** Land Economics 60(4): 14-29.

Appendix A — Survey Instrument

YOUR THOUGHTS ON OREGON'S OLD GROWTH FORESTS

Since the public's desired uses of Oregon's old growth forests have been changing we would appreciate your thoughts on how these forests should be managed. Your responses are completely confidential. **Please mail the survey back in the postage paid return envelope we provided.**

In this survey the term **old growth forest** means natural forests composed of a variety of trees of different ages but dominated by many large, old trees. These forests take about 200 years to regenerate following severe fire or cutting.

THE IMPORTANCE TO YOU OF OREGON'S OLD GROWTH FORESTS

Please circle the level of importance for each reason why you might care about old growth forests in Oregon.

Reasons you might value Old Growth forests	Not Important	Slightly Important	Important	Very Important
To be able to visit old growth forests in Oregon	1	2	3	4
To provide timber	1	2	3	4
To protect its plants & wildlife	1	2	3	4
To provide jobs	1	2	3	4
To know that old growth forests exist in Oregon	1	2	3	4
To protect the scenic beauty of Oregon	1	2	3	4

Appendix A — (continued)

THE EFFECT OF FIRE ON OREGON'S OLD GROWTH FORESTS

People often have differing opinions about the short term (1 to 5 years) effects of fires on old growth forests. Some people feel that fire is harmful, while others feel fire can have beneficial effects on old growth forests and its wildlife.

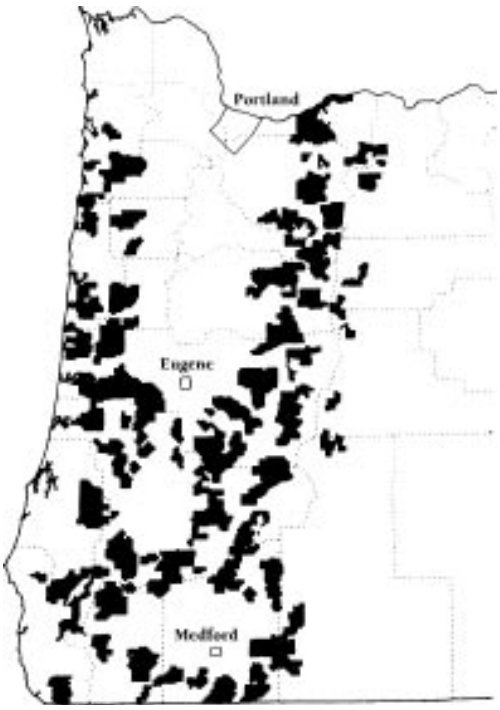
Please tell us whether you think fires have a harmful effect, no effect or a beneficial effect on the following natural resources or uses of Oregon's forests. Please check the box that best reflects your feelings.

	FIRE HAS…		
RESOURCES/USES	A Harmful Effect	No Effect	A Beneficial Effect
Scenic beauty of forests	☐	☐	☐
Spotted Owl habitat	☐	☐	☐
Tourism	☐	☐	☐
Air quality	☐	☐	☐
Soil erosion	☐	☐	☐
Water quality	☐	☐	☐
Muddying of salmon spawning habitat	☐	☐	☐
Risk of floods	☐	☐	☐
Health of trees	☐	☐	☐
Recreational enjoyment of forests	☐	☐	☐
Fishing	☐	☐	☐
Diversity of plants and animals	☐	☐	☐

Appendix A — (continued)

OREGON'S OLD GROWTH FORESTS AND CRITICAL HABITAT FOR THE NORTHERN SPOTTED OWL

The **map** below shows the areas of U.S. Forest Service and Bureau of Land Management old growth forests in Critical Habitat Units that have been set aside from logging to protect the Northern Spotted Owl. In total this amonnts to about 3 million acres or one- third of western Oregon's Federal forests.



Spotted Owl Critical Habitat Units in Oregon

CURRENT NUMBER AND SIZE OF FIRES IN OREGON'S OLD GROWTH FORESTS

Currently, Federal forest management agencies spend several million dollars each year for fire prevention and control in Oregon's old growth forests. Even with this effort, an average of 300 fires occur per year in the Critical Habitat Units shown above These fires burn about 7,000 acres of publicly owned Critical Habitat Units. The area burned each year is e(lual to about 1,200 city blocks or 11 square miles, equivalent to an area 2 miles wide by 5.5 miles long. About half these fires are natural and half are caused by humans.

Many of these fires damage the old growth forests and decrease their ability to provide habitat for species such as the Northern Spotted Owl, salmon, and steelhead Fires also reduce recreation opportunities and scenic beauty of forests for many residents and visitors.

Appendix A — (continued)

DESCRIPTION OF FIRE PREVENTION AND CONTROL PROGRAM

Public land management agencies such as the U.S. Forest Service could reduce the number of acres of old growth forests and Spotted Owl hahitat that burn each year in Oregon. This program involves 3 parts:

1. GREATER FIRE PREVENTION: This includes more fire patrols maintenance of existing firebreaks surrounding these old growth forests, fire safety eductation and enforcement of fire regulations.

2. EARLIER FIRE DETECTION: This includes more flre lookouts and fire detection airplane flights.

3. QUICKER AND LARGER LIRE CONTROL RESPONSE: This requires having more firefighters and equipment located closer to the old growth forests in Oregon.

Adoption of this improved fire prevention and control program would on average reduce the number of acres of Critical Habitat Units that burn by half, a reduction of 3,500 acres a year (from 11 square miles to 5.5 square miles) on pubicly owned old growth forests in Oregon.

PAYING FOR THE FIRE PREVENTION AND CONTROL PROGRAM

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 Fund. By law this fund could only be used to pay for fire protection in Federally owned old growth forests shown on the map. Adoption of this program would he decided as part of a national election.

YOUR CHANCE TO VOTE

1. Suppose this Oregon Old Growth Fire Prevention and Control Program proposal was on the next ballot. This program would reduce by half the number of acres of old growth forests in Critical Habitat Units that burn in Oregon each year. If it cost your household $__35__each year would you vote for this program?

(Please circle one) a. YES b. NO

2. What is the maximum your household would pay each year for the Eire Prevention and Control Program to reduce by half the number of acres of old growth forests in Critical Habitat Units that burn each year in Oregon? $_____

Appendix A — (continued)

Answer Question #3 only if you said you would not pay anything, otherwise go to Question #4.

3. What was the main reason you said you would pay zero?

(Please check **only** the most important **one**).

____ This program is not worth anything to me.

____ I can't afford to pay at this time.

____ I don't think the program would work.

____ It is unfair to expect me to pay for this program.

____ I am opposed to any new government programs.

____ Other Reasons (Please explain) _____

_____

_____

Please go to the top of the next page.

---

4. Why would you pay your amount? (Please check **only** the most important **one).**

____ This program is worth at least this much to me.

____ I feel we have a duty to protect these old growth forests.

____ To contribute to a good cause.

____ To pay my fair share to protect the old growth forests.

____ Other Reasons (Please explain) _____

_____

_____

Appendix A (continued)

YOUR VISITS TO OREGON'S FORESTS

1. In the past 12 months have you taken any trips specifically for forest recreation such as picnicking, hiking, camping, fishing, bird watching, hunting, etc.?

YES NO

If YES, about how many trips have you taken in the last 12 months?

☐1-2 ☐3-4 ☐5-9 ☐10-14 ☐15-19 ☐20 or more

DEMOGRAPHICS

These last few questions will help us understand how well our sample represents the State of Oregon. Your answers are strictly confidential and will be used only for statistical purposes. You will not be identified in any way.

1. Are you: ☐male ☐female

2. What is your age? _____ # YEARS

3. Are you currently a member of a conservation or environmental organization?
YES NO

4. Did you make any donations or contributions for wildlife or environmental protection in the past year? (Please Circle)
YES, if YES About how much did you donate $ _____?
NO

5. Did you vote in the last presidential election?
YES NO

6. Please circle the highest number of years of education you have completed.

1 2 3 4 5 6	7 8 9	10 11 12	13 14 15 16	17 18 19 20 21
Elementary	Jr. High	High School	College or Trade	Graduate or Professional

7. About how much was your household income (before taxes) in 1992?

☐under $9,999	☐$10,000-14,999	☐$15,000-19,999
☐$20,000-24,999	☐$25,O0O-29,999	☐$30,000-34,999
☐$35,000-39,999	☐$40,O00-44,999	☐$45,000-49,999
☐$50,O0O-59,999	☐$60,O0O-69,999	☐$70,0OO-79,999
☐$80,OOO-89,999	☐$90,000-99,0O0	☐$100,000 +

THANK YOU VERY MUCH UOR COMPLETING THE SURVEY. PLEASE MAIL IT BACK TODAY IN THE STAMPED RETURN ENVELOPE.

If you have anything you would like to tell us about forest and wildlife management in Oregon feel free to write your suggestions on the hack of the survey

Appendix A — (continued)

Thank you for your participation!

Please add any additional comments here:

DECISION RESEARCH
1201 Oak Street
Eugene, Oregon 97401

Appendix B — Percent "Yes" responses by bid amount for the two survey versions

	Version 1			Version 2		
Bid	Yes	No	Yes	Yes	No	Yes
$	*no.*	*no.*	*pct*	*no.*	*no.*	*pct*
2	3	2	60.0	8	1	88.9
5	6	2	75.0	7	1	87.5
8	4	1	80.0	5	4	56.6
10	5	1	80.0	8	2	80.0
12	6	4	60.0	7	1	87.5
15	10	0	100.0	4	1	80.0
20	6	1	87.5	3	2	60.0
25	0	1	00.0	2	1	66.7
30	3	1	75.0	5	0	100.0
35	3	2	60.0	6	0	100.0
40	4	2	66.7	2	0	100.0
50	3	2	60.0	4	2	66.7
60	4	6	40.0	4	5	44.4
70	1	10	9.1	2	5	28.6
80	2	3	40.0	2	5	28.6
90	3	3	50.0	4	3	57.1
120	3	0	100.0	3	4	42.9
150	1	6	14.3	3	4	42.9
200	2	2	50.0	1	7	12.5
300	0	8	00.0	0	6	00.0

The Forest Service, U.S. Department of Agriculture, is responsible for Federal Leadership in forestry. It carries out this role through four main activities:

- Protection and management of resources on 191 million acres of National Forest System lands
- Cooperation with State and local governments, forest industries, and private landowners to help protect and manage non-Federal forest and associated range and watershed lands
- Participation with other agencies in human resource and community assistance programs to improve living conditions in rural areas
- Research on all aspects of forestry, rangeland management, and forest resources utilization.

The Pacific Southwest Research Station

- Represents the research branch of the Forest Service in California, Hawaii, American Samoa, and the western Pacific.

The U.S. Department of Agriculture prohibits discrimination in its programs on the basis of race, color, national origin, sex, religion, age, disability, political beliefs, and marital or familial status. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communications of program information (braille, large print, audiotape, etc.) should contact the USDA Office of Communications at (202) 720-5881 (voice) or (202) 720-7808 (TDD). To file a complaint, write the Secretary of Agriculture, U.S. Department of Agriculture, Washington, DC 20250 or call (202) 720-7327 (voice) or (202) 720-1127. USDA is an equal employment opportunity employer.