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BENEFITS OF PRESERVING OLD-GROWTH FORESTS AND THE SPOTTED OWL

DANIEL A. HAGEN, JAMES W. VINCENT, and PATRICK G. WELLE*

This paper presents results from a national contingent-valuation study of the economic benefits of preserving old-growth forests in the Pacific Northwest. The study elicits "market-like" valuation responses from U.S. households concerning the benefits of a conservation policy for the northern spotted owl. These data provide a basis for estimating the benefits of preservation in terms of average household willingness to pay. Existing cost estimates are used to compute threshold prices that the benefits of the policy must exceed for the policy to be efficient. Benefit/cost ratios are calculated using "best" and "lower-bound" estimates of the benefits of preservation. Under all combinations of assumptions, the estimated benefits exceed the costs of the conservation policy.

I. INTRODUCTION

This paper estimates the economic benefits of a conservation policy for old-growth forests in the Pacific Northwest. The empirical results are from a national contingent-valuation study focusing on a conservation policy, the basis of which is the report of the Interagency Scientific Committee (ISC) to Address the Conservation of the Northern Spotted Owl. Charged with the task of developing a "scientifically credible conservation strategy for the northern spotted owl" (Thomas, et al., p. 49), the ISC issued the "Thomas Report," which recommends withdrawing forests from prospective timber sales within "habitat conservation areas" in Washington, Oregon, and northern California. While the final conservation strategy may differ from these recommendations, the Thomas report provides a useful bench mark for analysis.

The northern spotted owl's status is indicative of the overall health of the Pacific Northwest's old-growth forests. The issue thus goes beyond protection of the owl alone. Even if the spotted owl were not listed as threatened, concern about the old-growth forest ecosystem would focus on the numerous other species that depend on old-growth habitat and that could be candidates for protection under the Endangered Species Act (see Corn, 1989). Moreover, the state of old-growth forests has implications for fisheries, recreational and scenic values, water quality, and soil stability. As the Thomas Report authors caution, "The issues are not limited to questions of owls and timber supply, as important as those are. The matter is not that simple—it never has been" (Thomas, et al., 1990, p. 42).

*The authors are Assistant Professor of Economics, Western Washington University, Bellingham; Assistant Professor of Economics, University of St. Thomas, St. Paul, Minn.; and Professor of Economics, Bemidji State University, Bemidji, Minn., respectively. This is a revised version of a paper presented at the 66th Annual Western Economic Association International Conference, Seattle, June 30, 1991, in a session organized by Walter Mead. The authors thank (without implicating) Rich Bishop, Steve Henson, Dave Merrifield, T. J. Olney, Jack Reynolds, Ivan Weir and several anonymous referees for helpful comments and criticism. They also thank Roger Ford, Lance Olsen and numerous students at the University of St. Thomas for research assistance. Funding was provided by the University of St. Thomas, Western Washington University and Bemidji State University.

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The fundamental economic issue is not job loss, which has been at the center of the polarized debate over the proposed conservation policy. Rather, the economic issue underlying the study presented here involves determining which alternative—the conservation policy or the pre-existing timber development plans—represents the highest-valued use of the affected lands. If the old-growth forests have a higher net value under the preservation option, then continued logging would be a value-reducing activity. On the other hand, if timber production provides the greater net value, then the conservation strategy would be inefficient.

While this study considers efficiency to be the fundamental economic issue, this does not imply that job loss is unimportant. Institutional or political constraints may severely limit the amount of relief available to those suffering hardships as the result of preservation-related job loss. This possibility raises distributional concerns, and suggests a trade-off between the welfare of families dependent on local timber economies and the welfare of society at large.

To address the issue of economic efficiency, a contingent-valuation study was conducted to measure the benefits of preservation. The study surveyed 1,000 U.S. households to elicit "market-like" valuation responses on the benefits of the conservation policy. Data from this survey provide the basis for estimating some of the benefits of preservation, to which cost estimates can be compared. Section II discusses the conceptual basis for the benefit valuation measure and its comparison to existing cost estimates. Section III briefly describes the contingent-valuation method, and provides an overview of the study design. Analysis of the survey data is presented in section IV and in the appendix. Finally, section V presents conclusions regarding the likely net benefits of the conservation policy.

II. ECONOMIC FRAMEWORK

A. *Potential Benefits of Preservation*

Standing old-growth forests provide a number of potentially significant "outputs," including improved water quality, enhancement of commercial and recreational fisheries, recreational and scenic values, soil maintenance, and the protection of species that require old-growth habitat for their survival. These outputs may yield economic value in several distinct ways. Although no uniform standard exists for classifying these sources of value, the following categorization is consistent with the substantive economic-theoretic concepts: use value, option value, quasi-option value, and existence value. (See Mitchell and Carson, 1989, for an extensive discussion of these concepts.)

Use value derives from direct use of the forest for recreation, scenic enjoyment, fishing, improved water quality, etc. In contrast, the forests provide option value, quasi-option value, and existence value even in the absence of direct consumption of forest resources. Option value may arise when one use of a resource (e.g., development) irreversibly forecloses on the opportunity to obtain an alternative use (e.g., preservation) and when households are uncertain about their future demand for the resource in its preserved state. When demand (or supply) uncertainty and irreversibility exist, the relevant measure of economic valuation is option price, the *ex ante* valuation of potential future demanders (Bishop, 1982). Option price consists of two components: (1) the expected value of the household's consumer surplus from the consumption of the resource, and (2) option value. The option value component may be thought of as a "risk premium" that some consumers may be willing to pay to ensure that the resource will remain available at a specified price. Given the absence of markets for such options, no market-generated data exist for estimating option prices for public goods.

Quasi-option value relates to uncertainty regarding the value of some resources (e.g., medicinal values of some plants and animals). Information regarding the value of alternative uses may be revealed only over time. As more information accumulates, more precise estimates of the resource's value are possible. When irreversible development occurs, the resource and information flows are lost. The value associated with delaying an irreversible action to accumulate more information about the value of the resource is quasi-option value.

Existence value accrues simply from the knowledge that a resource exists, even if the consumer has no intention or ability to use the resource directly. Existence value applies to wildlife species, natural phenomena, works of art, and historical places. For example, people who would suffer a sense of loss if the northern spotted owl were to become extinct derive utility from its existence, even though they may have no realistic chance of ever seeing or otherwise making direct use of it. Existence value may also derive from knowing that a resource is preserved as a bequest to future generations.

The contingent valuation study presented here estimates some of these classes of benefits associated with forest preservation. The three major components of value reflected in the survey responses are recreation (a subset of use value), option value, and existence value. The survey households are unlikely to fully incorporate use values associated with commercial fisheries, stream-flow maintenance, and water quality, which would have to be estimated separately. The estimates in section IV thus represent only a partial accounting of the total benefits.

B. *An Overview of the Costs of Preservation*

The real economic cost of reducing timber harvests arises from withdrawing a factor of production from the national input stream. Reducing the material resource base (at least temporarily, because preservation is not irreversible) likely would cause losses of economic value in markets for which timber is an input. In estimating these costs, one should recognize that the price effects of withdrawing timber would induce these input markets to substitute non-timber alternatives and alternative timber supply sources. The cost measure should be based on the difference in supply costs between the withdrawn timber and its substitutes, plus the loss in economic value to consumers and firms due to higher prices.

Employing a measurement framework based on the concept of real opportunity costs, Mead, et al. (1990) measure the loss of economic surplus due to the timber withdrawals. Under the assumption that the ISC recommendations will be implemented only on public land, their discounted forecast of cumulative costs (out to a 50-year horizon) is approximately $26 billion (Mead, et al., 1990, p. v). The Mead, et al. study makes no adjustment to account for cost impacts of potential harvest restrictions on private land. Further extension of harvest restrictions would increase costs.

Other aspects of the Mead, et al. study may lead to overstatement of the costs of preservation. First, their model forecasts for the "west side" of Washington and Oregon. Given the national and international scope of wood-products markets, their forecasted supply response to increased timber prices probably is too small. Supply responses in timber markets beyond the Pacific Northwest will have a moderating impact on the opportunity cost of old-growth timber withdrawals. Second, although they mention the potential importance of timber-conserving construction technology, they do not appear to factor this effect into their timber-demand estimates. Given that timber prices may increase to historic highs, and given

that many timber-conserving construction technologies are achieving increasing market penetration, their estimated demand function quite possibly understates the long-run price elasticity for timber. Underestimating the long-run demand elasticity will lead to an overestimate of costs.

The Mead, et al. cost estimate applies only to the states of Oregon and Washington. To estimate costs for the geographic scope of the ISC study area, the analysis here extrapolates their results to California on the assumption that the California impact is on the order of 25 percent of the sum of the Oregon and Washington impacts (based on approximate harvest-volume impact estimates). Applying this somewhat arbitrary 25 percent adjustment factor to the Mead, et al. results expands the $26 billion figure to $32.5 billion for the three-state total. The $32.5 billion value is used to compute the threshold price.

C. *The Threshold Price*

The contingent-valuation survey was designed to elicit a willingness to pay (WTP) for preservation expressed in annual terms. Respondent households were asked if they would support the conservation policy if it meant paying $X per year for the foreseeable future (and were instructed to base their response on their current level of income). Econometric analysis of the responses yields an estimate of the average amount each household would be willing to pay annually (at current income) to ensure forest preservation, called the "initial annualized value." By employing two alternative assumptions regarding the relationship between future annual WTP and income, and an assumption regarding the growth of national income, one can derive a stream of annualized WTP.

The threshold price is computed by solving for a starting value of benefits (on a per-U.S. household basis) such that, when this starting value grows at some rate and is discounted over an infinite horizon, it yields a present discounted value equal to the present value of the costs of preservation. This threshold price can be interpreted as the "break-even" point: the initial annualized value of average household WTP that would yield benefits of the conservation strategy equal to its costs.

All calculations use a *real* annual discount rate of 4 percent. First, a threshold price is calculated based on the plausible assumption that WTP remains constant as a percentage of income. Given that real income grows at a trend rate of about 3 percent (it has averaged 3.1 to 3.2 percent throughout this century), WTP growth would be 3 percent. The resulting threshold price is $3.39 per household.[1]

In this case, if the initial annualized average household benefit of preservation is over $3.39, the net present value of the stream of benefits associated with preservation would exceed that for timber development. This assumption that WTP will remain constant as a percentage of GNP is quite conservative. One may well argue that the demand for goods yielded by preservation will grow disproportionately (see Fisher and Krutilla, 1985), which would lower the threshold price. Alternatively, one can consider a WTP that does

1. Computation of the threshold price employs a function representing the present discounted value of the stream of future benefits. To derive the threshold price, the stream of benefits is assumed to have an initial value of B_o, with a real annualized growth rate of g. At any time t, the value of the benefit function is $B_o e^{gt}$. The present discounted value of this stream of benefits, where r is the real discount rate, is:

$$PV = \int_0^\infty (B_o e^{gt}) e^{-rt}\, dt. \qquad (1)$$

Computing the threshold price requires determining at what starting value B_o would yield a present value of benefits equal to the present value of the costs of preservation. If one uses the adjusted Mead, et al. cost estimate of $32.5 billion, the costs are $339 per household ($32.5 billion divided by 96 million U.S. households). Thus, solving for B_o, setting PV=$339, r=.04, and g=.03 yields a threshold price of $3.39.

not grow over time (i.e., falls as a percentage of income) to establish an "upper bound" estimate of the threshold price. In this case, the alternative assumption that g equals zero yields a threshold price of $13.56.

III. ISSUES IN THE MEASUREMENT OF BENEFITS

A. *Overview of the Contingent Valuation Method*

The conceptual framework in the previous section emphasizes the potential importance of option value and existence value as components of the benefits of preserving old-growth forests and the northern spotted owl. Conceptualizing the major components of value establishes a basis for selecting the appropriate estimation technique. The contingent valuation (CV) method is applied to this valuation problem because of its usefulness in estimating option and existence values. Given the absence of observable behavior, alternative approaches such as hedonic pricing or the travel-cost method are unsuitable. Ignoring these values may lead to substantially underestimating the benefits of environmental protection (see Fisher and Raucher, 1984).

The CV method asks people directly about the values they place on goods. Direct questioning elicits dollar values for the policy benefits, including option value and existence value. The dollar values that people assign to these consequences are contingent on the situation (or hypothetical market) described in the survey. The hypothetical market should realistically characterize the actual policy being analyzed. The CV method informs the respondents about the nature of the policy change and describes the impacts on their households in terms of the monetary cost of the policy and the manner of payment.

The CV method has precipitated a great deal of research on its validity and reliability. Recently concern has focused on the problem of embedding, often referred to as the part-whole problem. Kahneman and Knetsch (forthcoming) argue that embedding may produce "arbitrary" CV results. They interpret their telephone survey as demonstrating that the CV method exhibits a strong embedding effect. However, Smith (1991) argues that Kahneman and Knetsch's conclusions are incorrect, in part because their CV questions failed to define and frame the context of the good to be valued. This flaw alone could produce arbitrary CV results. As Mitchell and Carson (1989) and others point out, careful framing of CV questions is necessary to mitigate embedding, or part-whole bias.

The methodological studies designed to assess other forms of bias are too numerous to detail here (see Cummings, et al., 1986; Mitchell and Carson, 1989; Bishop and Heberlein, 1990; and Kealy, Montgomery, and Dovidio, 1990). This research provides encouraging evidence regarding the usefulness of CV results. Evincing acceptance of the method, the federal government's prescribed procedures for analysis include CV (Water Resources Council, 1979 and 1983; Department of the Interior, 1986). While CV studies can provide useful data, they must reflect the method's limitations and be implemented suitably for the policy issue at hand. The design of the CV instrument used in the present study seeks to avoid potential methodological weaknesses, while reflecting the circumstances pertaining to the conservation policy.

B. *Study Design*

The difficulty of conveying adequate policy information through a telephone survey, and the high costs of personal interviews relative to their advantages, led to the choice of a mail survey patterned after Dillman's Total Design Method (Dillman, 1978). A mail survey allows respondents ample time to consider the policy before deciding whether or not they favor it. However, allowing respondents more

time may enable them to formulate a plan for strategic behavior (Mitchell and Carson, 1989).

This study involved mailing a survey to a random sample of 1,000 U.S. households, mailing a reminder letter a week after the initial mailing, telephoning nonrespondents three to four weeks after the initial mailing, and sending replacement booklets as needed. Those not reached by phone were sent a follow-up certified mailing.

The survey began with a series of questions concerning the commodity to be valued and establishing the context of a budget constraint. After answering two introductory questions on the importance of "protection of the environment" and "protection of endangered species," respondents indicated whether they felt that the amount of money the nation currently spends on various policies is "TOO MUCH, THE RIGHT AMOUNT, or TOO LITTLE." The nine policies listed were: fight crime, help third-world countries, protect the environment, provide low-income housing, improve education, reduce unemployment, protect endangered species, defend the nation, and assist the elderly. This format helped respondents place the conservation policy in the context of other policies that compete for limited public resources.

Cummings, Brookshire, and Schulze (1986) encourage preliminary questions of this general type, and Mitchell and Carson (1989, p. 237) favor such questions as a way to avoid "budget constraint bias." Results could be biased if respondents fail to consider the impact that committing resources to the policy would have on their own household budgets. In addition to establishing a budgetary context, the preliminary questions help to refine respondents' perceptions of the good. In this case, the good of old-growth forest preservation is identified with the larger issues of "protection of the environment" and "protection of endangered species." By framing the larger contexts, these questions helped to mitigate biases resulting from the embedding, or part-whole, problem.

A full-page description of the conservation policy preceded the valuation questions contained in the middle section of the questionnaire. Based on the Thomas Report and its subsequent analysis, the description summarized the following points: (i) a "scientific committee" concluded that logging should be banned on some forest lands to prevent the extinction of the northern spotted owl; (ii) an independent group of scientists agreed with these conclusions; (iii) the well-being of the spotted owl reflects the well-being of the entire old-growth forest ecosystem; (iv) old-growth forests include trees which are 200 to more than 1,000 years old; and (v) the policy would create Habitat Conservation Areas, most of which are on public lands and some of which are currently protected in national parks and wilderness areas. The questionnaire included a map of the Habitat Conservation Areas not contained in national parks or wilderness areas. The description concluded with an outline of the costs of the policy, including: (i) higher prices for wood products due to a reduction in timber supply, (ii) government revenue losses due to reduced timber sales from publicly-owned lands, and (iii) the possibility of increased government costs for unemployment and other compensation for timber-dependent regions. The description stated that the costs to government "would require spending cuts or higher taxes from households like yours." The description of costs served to establish the means of payment—or the "payment vehicle"—for the valuation questions that followed. Intended to be both realistic and neutral, the payment vehicle was identified as "higher taxes and higher wood-product prices," a choice motivated by a growing body of literature in this area. As Mitchell and Carson (1989, p. 253) explain,

"One recent practice among CV practitioners has been to use the relatively neutral vehicle of higher taxes and prices whenever appropriate, in order to avoid the possibility of payment vehicle bias."

A policy referendum is the most appropriate way to frame the choice to respondents. The literature supports adopting the policy referendum format in such cases (Hoehn, 1987; Hoehn and Randall, 1987; Mitchell and Carson, 1989; Harris, et al., 1989). This format requires respondents to vote "yes" or "no" on the policy given a single, stated cost to their households. From these responses one can estimate an average WTP for all households in the sample. This approach also is "incentive compatible," reducing the likelihood of strategic bias (Hoehn and Randall, 1987). In order to emphasize the importance of answering the valuation question based on household preferences, the instructions stated that "The best answer is the one that most closely reflects the attitudes or values of your household." The valuation question was worded as follows:

> If adopting the conservation policy would cost your household $___ per year (for the foreseeable future) in higher taxes and higher wood-product prices, would you vote YES or NO?

The dollar amounts inserted in the blank varied across the sample and were randomly assigned to different households. These values elicited a high concentration of observations in the vicinity of the threshold price (discussed above in Section II). For the distribution employed in the final survey, somewhat more than 80 percent of the values were less than $100, and only about 4 percent of the values were above $200. In the case where the mean WTP is very high, this distribution interferes with accurate estimation of the mean WTP. In this case, the approach trades off increased confidence in the region of the threshold price against reduced confidence in obtaining an accurate point estimate of the true mean WTP.

Following the valuation question, respondents explained why they would favor or oppose the policy. Respondents answered a different subsequent series of questions depending on whether they answered yes or no to the valuation question. These questions, which were designed to determine if respondents would favor the policy at some other cost, provide a crude, "open-ended" measure of WTP which, while subject to extreme starting-point bias (Welle, 1986) and strategic bias (Mitchell and Carson, 1989), nonetheless provides some useful information. This measure permits differentiation between households that would oppose the policy even at zero cost and households that would favor the policy at some positive (or non-negative) cost. Sorting households according to whether or not they view the conservation policy as yielding an economic good—that is, as something for which a positive demand exists at zero price—proves useful in estimating a WTP function.

The last section surveyed background information and demographics, containing questions on state of residence, size of community of residence, household income, age, gender, and education. These data help explain why a respondent might favor or oppose the policy.

Pretests of earlier versions of the questionnaire led to substantial revisions. Professionals with CV expertise, a reading-level expert, and individuals who might use the information generated completed these pretests and suggested revisions. In addition, members of the general population were observed completing pretest questionnaires in order to identify trouble spots. Participants were asked a series of questions following completion to elicit information on the quality of the survey instrument. The experts suggested including additional information in the description of the policy and the map, and includ-

ing additional policy categories in the series of questions on spending priorities. The general population pretest led to eliminating questions that attempted to separate use value from total value and questions that posed an alternative willingness-to-accept compensation framework. These latter questions were considered confusing and unnecessary.

IV. ESTIMATED BENEFITS AND BENEFIT/COST RATIOS

An explanation of the survey and estimation procedure used to calculate the benefits of preservation appears in the appendix. Table 1 presents the results in the form of benefit/cost ratios. The benefits greatly exceed the costs under all assumptions. Even when the highest threshold price is combined with extremely conservative assumptions regarding the benefits, the benefit/cost ratio is approximately 3.53. Although a significant inverse relationship exists between the likelihood of a "YES" response to the CV question and the cost confronting the household, respondents strongly supported the policy up to relatively high levels of household cost. This support, combined with the low threshold prices, produces the results recorded in table 1.

V. SUMMARY AND CONCLUSIONS

Under all combinations of assumptions, the estimated benefits exceed the costs of the conservation policy. The lower-bound estimate of benefits (for responding households) comes from calculating the lower 98 percent confidence bound of the lowest point estimate of mean household WTP. Even when this lower bound is combined with the extreme assumption that all non-responding households receive no benefits from preservation, the benefit/cost ratio lies between 3.53 and 14.14 (depending on which threshold price is used). The benefit/cost ratios range as high as 42.56 when WTP is assumed to grow at the same rate as income. Overall, the results reflect the respondents' very strong support for the policy.

While this study focuses on the ISC policy recommendations, the findings have larger implications. For example, the Endangered Species Act may require a more stringent conservation strategy than the moderate ISC proposal, which allows for a decline in the owl population. Even with strongly diminishing returns to preservation, the overall benefits of a more rigorous policy would probably outweigh the overall costs. However, this conclusion does not mean that the *marginal* benefits of a more rigorous policy would outweigh the *marginal* costs. It suggests only that more lands could be set aside from timber harvest, if necessary to save the spotted owl, before the total net benefits would become negative. For example, if a 100 percent increase in the acreage set aside caused costs to increase proportionately, total benefits still would exceed total costs, even if total benefits remained constant.

Finally, the distributional consequences of the proposed conservation policy are disturbing. While the benefits of preservation would be distributed over the entire nation, the costs would be geographically concentrated. Reduction in timber sales would impose severe economic hardships on many timber-dependent communities. If the benefits of the conservation policy do greatly exceed its cost, then perhaps policymakers should direct some of these benefits to communities suffering adverse effects. Regional development assistance, job training programs, or direct cash transfers could accomplish this objective. The results of the survey indicate that the American public would support tax increases for this purpose. An enlightened policy of benefit sharing befits a nation whose concern extends both to the natural environment and to those who would be adversely affected by ambitious conservation strategies.

TABLE 1
Benefit/Cost Ratios Under Various Assumptions

	High threshold price	Low threshold price
Assumptions: • Best Est. of Benefits • Upper-Bound Approach to Non-respondents		
Implied Benefits: $144.28	10.64	42.56
Assumptions: • Best Est. of Benefits • Lower-bound Approach to Non-respondents		
Implied Benefits: $86.32	6.37	25.46
Assumptions: • Lower-bound Est. of Benefits • Lower-bound Approach to Non-respondents		
Implied Benefits: $47.93	3.53	14.14

"Implied Benefits" refers to the initial annualized value of benefits (per household).

Estimate of Benefits:

- "Best Estimate of Benefits": Uses mean HWTP for all in-sample households implied by Equation (2b) in the appendix.
- "Lower-bound Estimate of Benefits": Uses Equation (1b), which has the lowest estimated mean HWTP for all in-sample households, and then takes the lower 98 percent confidence bound to yield an even lower figure. (See the appendix.)

Approaches to Non-respondents:

- Upper-bound: Uses the extrapolation approach (extrapolating to DAY = ∞) described in the appendix.
- Lower-bound: Assumes that *all* non-respondents (including those not contacted due to incorrect addresses) would derive no value from preservation.

Threshold Prices:

- High: Based on the adjusted cost estimate of Mead, et al. and the assumption that the benefits of preservation do not grow over time (i.e., are a declining percentage of income). This yields a threshold price of $13.56.
- Low: Based on the adjusted cost estimate of Mead, et al., and the assumption that the benefits of preservation grow over time at the assumed rate of real income growth (3 percent per year), yielding a threshold price of $3.39.

APPENDIX

SURVEY AND ESTIMATION PROCEDURE

One thousand copies of the survey instrument were mailed to randomly selected U.S. households. Of these, 895 were delivered. The remaining 105 were not deliverable due to an incorrect or incomplete address, or (in a few cases) because the addressee was deceased. Respondents completed and returned a total of 409 completed (or mostly completed) booklets, for a response rate of 46 percent of potential respondents (or 41 percent of the initial mailing). This return compares favorably with other national CV mail surveys on land use or wildlife issues (Mitchell and Carson, 1989). However, when interpreting the survey results, one must take into account the fact that somewhat more than half of the potential respondents chose not to participate.

Use of dichotomous-choice referendum data in estimating WTP has been the subject of much analysis. The response variable is the respondent's yes-or-no answer to a willingness to pay a given amount, C_i, which is the stated cost of the policy to household *i*. The survey procedure varied this amount across the sample. The standard approach has been to treat the probability of a "yes" response as a function of the cost of the policy to the household C_i. (Other explanatory variables, such as income, also are sometimes included.) A binary logistic regression model can estimate this type of function. The area under the function (found through numeric integration) equals the estimated mean household WTP (HWTP). In a recent article, Cameron (1988) provides an "alternative" approach using censored logistic regression, which calculates the estimated mean HWTP while avoiding the rather clumsy process of numerical integration. One can estimate the mean HWTP directly either by re-interpreting the parameters of the standard logistic regression model or by maximizing a censored logistic log-likelihood function. Cameron recommends the latter approach because it provides accurate asymptotic standard errors of the parameters. In a published comment on this approach, Patterson and Duffield (1991) show that one can find accurate asymptotic standard errors of the censored logistic parameters by estimating the standard logistic regression model. The analysis presented here used both approaches, which produced identical results for the parameter estimates (as claimed by Cameron) *and* for the standard errors (as claimed by Patterson and Duffield).

The follow-ups to the valuation question help estimate the relationship between HWTP and C_i by distinguishing between two categories of "no" responses: (i) respondents who rejected the stated cost of the policy to their households, and (ii) respondents who would not support the policy at *any* cost (even zero). For the latter group, the policy does not yield an economic good, and the probability of a "yes" response is *not* a function of C_i. Thus, the logistic regressions excluded this group. A two-step estimation procedure was employed. First, the mean HWTP was estimated for those households who view the conservation policy as yielding an economic good (referred to below as the G-households). Next, the proportion of the population consisting of households that do *not* view the policy as yielding an economic good (referred to as the NG-households) was estimated. This is simply the sample proportion of such households. The mean HWTP for the G-households and the mean HWTP of the NG-households (which is zero) are then averaged together using a weighted average. This procedure yields a mean HWTP for *all* in-sample households. Of the 409 booklets returned, 15 were missing the response to the CV question, and thus were not usable. Of the remaining 394, a total of 319 were from households that would be willing to support the policy at some cost (although not necessarily the stated cost C_i). The remaining 75 (approximately 19 percent) would not support the policy even at zero cost.

A. *The Regression Results*

Although this study estimated a large number of alternative equation specifications, the presentation here includes only two. The others yield WTP estimates that are similar to or greater than the results provided below. In the simplest specification, the probability of a "yes" response is a function only of the policy's cost to the household C_i. This specification was used in estimating an equation with standard logistic regression on 317 observations, including all 319 G-households, minus two households whose C_i far exceed the others (one at $620). The small number of observations (2) dictated excluding households in this extreme range. Because both responded "yes," including these extreme values would increase the estimated mean HWTP. The results for the 317 observa-

tions, where P_i is the probability of a "yes" response, are:

(1a) $$\ln[P_i/(1 - P_i)] = \underset{(9.85)}{2.38} - \underset{(-3.95)}{0.0102}\, C_i$$

(t-values in parentheses)

Likelihood Ratio Chi-square:	14.90
Percent correctly predicted:	85.17
Number of observations:	317

The corresponding censored logistic regression equation, where E is the estimated expected value, is:

(1b) $$E(HWTP_i) = \underset{(5.22)}{234.12}$$

(t-value in parentheses)

Implied mean HWTP: *G-households* $234.12; *all in-sample households* $189.64

Consistent with economic theory, equation (1a) shows that the probability of a "yes" response is inversely related to the stated cost of the policy (C_i). The corresponding t-value shows that the result is statistically significant. The likelihood ratio chi-square (which allows a test of overall model significance similar to the F-test for simple regression) implies a confidence level of approximately 1. Of greatest interest is the censored logistic equation, which directly yields an estimate of mean HWTP that is simply a constant since C_i is the only explanatory variable in the logistic regression (see Cameron, 1988). This value, $234.12, is the estimated mean WTP for the G-households (those who view the conservation policy as yielding an economic good). Averaging in the NG-households, which represent 19 percent of the sample, yields an overall mean HWTP of (.81 x 234.12), or $189.64. Adjusting the estimate for non-respondents (as is done below in sub-section B) reduces this figure still further.

In comparison, estimating the regression equation by using data on *all* in-sample households—as opposed to estimating mean HWTP for the G-households before taking the NG-households into account—results in a higher estimated mean HWTP, and in a deterioration of the fit of the censored logistic regression equation. The approach used here represents a more efficient use of the available data, and thus can be expected to yield more reliable results.

Treating all NG-households as having zero value ignores the possibility that some responses represent protests to the nature of the valuation exercise itself. In explaining why they would not support the policy even if it imposed no cost on their households, respondents could choose from among several alternatives, two of which were clearly "protest" alternatives: (i) that they "object to the idea of placing a value on the environment in this way," and (ii) that they "object to the way in which the question was asked." Twenty-nine percent of NG-households gave *only* protest reasons for their response. Smith and Desvousges (1987) argue that these respondents should be removed from the sample. However, the respondents have been left in, possibly biasing downwards the estimates of the benefits of preservation.

The specification used in Equation (1) yields the *lowest* estimated mean HWTP of all the specifications attempted. Including other explanatory variables (such as income) or altering the functional form raises the estimated mean HWTP. Additionally, this specification facilitates the construction of a confidence interval. Again, the one term on the right-hand side of the censored logistic regression equation is the estimated mean HWTP. The standard error of this estimate (as implied by the t-value) is 44.9. This can be used to calculate an approximately 98 percent confidence interval, the lower bound of which is 234.12 - (2 x 44.9) or $144.32. Multiplying this value by .81 (to account for the NG-households) yields an overall value of $116.90 for all households within the sample.

A richer specification of the logistic regression equation can test a number of relevant hypotheses regarding the determinants of HWTP. First, if the goods yielded by conservation are normal, then HWTP should be positively related to household income (INC). Second, a respondent's willingness to support the policy at a given cost may be driven by a general willingness to spend on "worthwhile causes." As indicated in Section III, the respondents assessed spending levels in nine areas of public spending. The data reveal that individuals' general willingness to spend on publicly funded goods differs markedly. Measuring this willingness to spend is a SPEND variable created by subtracting the number of items on which the respondent would like to spend less from the number of items on which

the respondent would like to spend more. Third, prior familiarity with the issue may affect a household's WTP. The survey instrument included a question with a familiarity scale. The FAMILIAR variable has been adjusted for this analysis to range from 1 for those "not at all familiar" to 4 for those "very familiar."

The variables EDUC and AGE (both in years) examine the effects of a respondent's educational level and age. WAORE, a regional dummy variable for Washington and Oregon, tests for a significant difference in average valuation for households in the region most heavily impacted by the conservation policy. Finally, the EARLY variable measures the effect of early versus delayed responses, and is defined as $(DAY^{-1} + 1)$, where DAY is the number of days elapsed before the survey booklet was returned, lagged by one week. If the earlier responses express a higher WTP than the later responses, the likely valuation of non-respondents can be assumed to be lower than the in-sample households. This issue and the interpretation of this variable are addressed in greater detail below. The results of this specification are:

(2a)
$$\ln[P_i/(1-P_i)] = \underset{(-2.24)}{-22.7} \underset{(-3.76)}{-0.111\ C_i} + \underset{(2.78)}{0.168\ INC_i} + \underset{(0.47)}{0.0373\ EDUC_i} + \underset{(0.99)}{0.0113\ AGE_i} + \underset{(1.53)}{0.139\ SPEND_i} + \underset{(0.64)}{0.137\ FAMILIAR_i} + \underset{(2.21)}{21.5\ EARLY_i} \underset{(-0.66)}{-0.567\ WAORE_i}$$

(t-values in parentheses)

Likelihood Ratio Chi-square: 35.39
Percent correctly predicted: 86.94

Number of observations: 291 (Observations with missing values for one or more of the independent variables were deleted.)

The corresponding censored logistic regression equation is:

(2b)
$$E(HWTP_i) = \underset{(-2.06)}{-2050} + \underset{(2.26)}{15.2\ INC_i} + \underset{(0.47)}{3.37\ EDUC_i} + \underset{(0.95)}{1.01\ AGE_i} + \underset{(1.44)}{12.5\ SPEND_i} + \underset{(0.63)}{12.4\ FAMILIAR_i} + \underset{(2.06)}{1942\ EARLY_i} \underset{(-0.66)}{-51.2\ WAORE_i}$$

(t-values in parentheses)

Implied mean HWTP: *for G-households* $259.91; *for all in-sample households* $210.53

Evaluating the censored logistic equation (2b) for each household and then averaging these together (or evaluating the equation at the sample means of the independent variables) yields the mean HWTP for this specification. This procedure results in a higher estimate than the simpler specification of Equation (1): $210.53 (for all in-sample households) versus $189.64.

The coefficients and the associated t-values suggest that income has the expected positive influence on HWTP, and is statistically significant. Education, age, and prior familiarity with the issue have positive coefficients, which are not significant at the 10 percent level. The WAORE coefficient (which is a dummy equal to 1 if the respondent lives in Washington or Oregon) is negative, but is not statistically significant. The SPEND variable has the expected positive coefficient, which is not significant at the 10 percent level. Finally, the EARLY variable has a positive coefficient and is statistically significant. The following section, which deals with the issue of non-respondents, details the interpretation of the estimated parameter value for EARLY.

B. *Incorporating the Non-Respondents*

The benefits derived from the conservation policy possibly are lower for the non-respondents than for those included in the sample. The simplest approach—to assume that all non-respondents derive no value from preservation—can define a lower bound. For example, under the assumption that the lowest mean HWTP, $189.64, applies only to the 41 percent of the original sample that responded (and that

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the remaining 59 percent has zero value), the mean HWTP drops to $77.75. An even lower figure results from using the 98 percent lower confidence bound of the estimated G-household mean HWTP, which yielded a mean HWTP for *all* families in the sample of $116.90. If this figure applies to only 41 percent of the population, the mean HWTP is $47.93. The "lower-bound" estimates used in the benefit/cost ratios presented below utilize this approach.

The assumptions underlying this approach to defining a lower bound are not consistent with the available evidence: (i) the coefficient on the EARLY variable estimated in equation (2b) above, and (ii) changes in the proportion of NG-households that occurred over the course of the survey.

The EARLY variable is a function of elapsed time between the initial survey mailing and the return of the completed booklet. The earlier a booklet is returned, the higher the value of EARLY. As DAY approaches infinity, EARLY approaches a value of 1. Hypothetically, the infinite continuation of the survey would be necessary to achieve (in the limit) a 100 percent response. As EARLY approaches 1, this term in the censored logistic equation would thus approach (from above) the estimated coefficient on EARLY. Substituting DAY = ∞ into the equation for EARLY yields the upper-bound estimate of mean HWTP for the G-households at a 100% response rate: $178.12 for the G-households (versus $259.91 in the actual sample). In order to extrapolate this figure to all households, one must take into account the percentage of NG-households in the sample. This proportion declined from approximately 24 percent after the first week to approximately 19 percent at the end of the survey period. While the percentage of NG-households declined over the survey period, this number is assumed to stabilize at 19 percent, placing the highest estimate of the initial annualized mean household benefits at $144.28.

Using equation (2b) and assuming that all non-respondents receive zero benefit from preservation yields an intermediate estimate of the initial annualized value of benefits. In this case, the estimated mean HWTP equals 0.41 (the response rate) times $210.53 (the mean HWTP for all households among the respondents). This yields the intermediate estimate of $86.32.

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