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Economic Benefits of Critical Habitat for the Mexican Spotted Owl: A Scope Test Using a Multiple-Bounded Contingent Valuation Survey

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A split-sample design is used to test for a difference between mean willingness to pay (WTP) for protecting the Mexican spotted owl versus protecting 62 threatened/endangered species which includes the Mexican spotted owl. The multiple-bounded contingent valuation method is used in a mail survey of U.S. residents. The mean WTP amounts are statistically different at the 0.1 confidence level indicating the multiple-bounded mail survey passes the scope test. The range of estimated benefits of preserving the 4.6 million acres of critical habitat for the Mexican spotted owl substantially outweighs the costs of the recovery effort.

Key words: contingent valuation, endangered species, logit, willingness to pay

Introduction

The Mexican spotted owl (*Strix occidentalis lucida*) is related to its more famous relative the Northern spotted owl (*Strix occidentalis caurina*) by biology and controversy. Adding the Mexican spotted owl (MSO) to the endangered species list in April of 1993 severely restricted logging of old growth forests in the four-corner states of Arizona, Colorado, New Mexico, and Utah. In 1995 the U.S. Fish and Wildlife Service designated 4.6 million acres as critical habitat for the Mexican spotted owl. The lands included 3.6 million acres of National Forests and 871,000 acres of Native American lands. While economic analysis may not be used to evaluate the decision to add a species to the endangered species list, it can be used to evaluate critical habitat decisions. A large perceived cost is the net benefit of timber harvesting foregone. However, unlike the Pacific Northwest, the net benefits foregone are actually minimal in the four-corners region due to many of the timber sales being below cost. According to the U.S. Fish and Wildlife Service, costs of the recovery effort include amending federal resource management plans ($260,000), monitoring MSO populations ($19.8 million over 10 years), performing related research ($8.3 million over 10 years), and implementing other features of the recovery plan ($10.1 million). On average, $4 million is required each year for ten years for the recovery effort.

A natural question that arose in debates over designating critical habitat for the Mex-

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ican spotted owl related to the benefits of preserving the species and its habitat. Protecting the habitat from even-age timber harvesting maintains existing recreation benefits. However, more than recreation benefits are at risk. Some biologists believe that in the absence of the critical habitat designation, the Mexican spotted owl could become extinct in the next 15 years, while implementing the recovery plan could result in sufficient populations to delist the species in 15 years. Given the irreversibility of extinction, segments of the general population may receive "passive use" values such as existence and bequest values. Existence value refers to the utility obtained from knowing that a species and its natural habitat exist, even if no visitation is planned. Bequest value refers to the utility gained today from knowing that preservation provides this species and its habitat to future generations. Collectively, the recreation use, existence, and bequest values make up what Randall and Stoll describe as "total economic value." Freeman discusses the economic theory underlying these values. As noted by Kopp as well as Bishop and Welsh, the passive use value component of total economic value is a public good provided by preservation. As such it can be simultaneously consumed by all citizens, whether living in the four-corners region or throughout the United States. Thus, small values per household potentially translate into large total values.

At present the contingent valuation method (CVM) is the only method available to measure passive use values (Flores). CVM relies upon respondents' stated willingness to pay (WTP) rather than actual cash WTP. Concerns over the validity of stated WTP continue today (Diamond and Hausman; Cummings, Harrison, and Rutstrom; Neill et al.). While there is evidence that, for recreation activities, WTP values estimated by the CVM are not statistically different from revealed preference methods such as the travel cost method, the evidence is less encouraging for passive use values (Brown et al.). Concern about over-estimating passive use values in natural resource damage assessments prompted the National Oceanic and Atmospheric Administration to commission a "blue ribbon" panel cochaired by Kenneth Arrow and Robert Solow to evaluate the usefulness of CVM to measure such passive use values in natural resource damage assessment. While Arrow et al. did provide qualified support for using CVM to arrive at initial estimates of natural resource damages that could be used in judicial decisions, they suggested several criteria that an ideal CVM study should meet. One of those criteria is avoiding the "embedding problem" or "inadequate responsiveness" to the scope or scale of the environmental resource (Arrow et al.). In particular, Arrow et al. suggested that WTP should increase with increases in relevant quantity or quality of the good being offered. They further believed this should be tested by comparing WTP of independent samples; each asked to value an environmental resource of different scale or size.

The purpose of this study is to assess whether per household estimates of the total economic value of the Mexican spotted owl pass a scope test by comparing those values with the WTP for a bundle of 62 threatened and endangered (T&E) species found only in the four-corners region that includes the MSO as one species. The other species include 15 fish, 39 plants, and 3 snails. We carry out this scope test combining a split-sample design with a recently developed innovation in CVM formats: the multiple-bounded approach of Welsh and Bishop that allows for uncertainty of respondent answers. In the process of this inquiry we shed light on the policy question of whether the benefits of protecting the 4.6 million acres of critical habitat for the Mexican spotted owl is worth the costs.

Methods

WTP Elicitation Format

There are various ways to elicit WTP. Arrow et al. recommended the dichotomous choice referenda approach where respondents simply indicate whether they would vote "yes" or "no" at a single, specific (but varying across respondents) dollar amount. This approach is statistically inefficient since the researcher only determines whether the respondent's WTP is greater or less than the individual's bid. The payment card approach provides a listing of several dollar amounts and asks the respondent to select the one closest to their maximum WTP. Cameron and Huppert (1989) have treated the payment card response as bracketing a respondent's WTP.

Both of these approaches assume the respondent has no uncertainty regarding her preferences, only that the researcher does not know all of the influences. However, when dealing with passive use values of unique species such as the MSO, respondents may have not thought about the economic trade-offs they would make for species preservation, as they may have for recreation or private good consumption decisions. Forcing respondents to answer "yes" or "no" may result in respondents who are uncertain about their answers to state "yes" to register support for the environmental program (Brown et al.) when validity studies show they would actually vote "no" (Champ et al.). Respondent uncertainty could take many forms such as: (*a*) doubts regarding the importance of the species to society relative to other pressing social issues; (*b*) uncertainty about their own preferences of infrequently thought about species; and (*c*) uncertainty regarding the votes of other individuals surveyed. As discussed below, results from our focus group and pretest suggest that nearly all respondent uncertainty falls into categories (*a*) and (*b*).

To allow for respondent uncertainty, Ready, Whitehead, and Blomquist let respondents answer "definitely yes, probably yes, unsure, probably no, and definitely no" to their single bid amount. The multiple-bounded approach, developed by Welsh and Bishop, allows respondents to convey their degree of certainty in responses using similar categories, but to a range of bid amounts like a payment card. Table 1 illustrates the basic design. To illustrate the ability of the multiple-bounded method to bracket a respondent's WTP, presume a person checks probably yes at \$5 but not sure at \$10. One way to interpret this response would be to treat the respondent as being willing to pay \$5 but not \$10. Thus her WTP would lie within the interval between \$5 and \$10. As noted by Poe and Welsh, there is some statistical distribution function of a respondent's WTP within this interval. Generalizing this to the sample of respondents that switch between "probably yes" at the lower dollar amount, $\$X_{iL}$, and not sure at the higher dollar amount, $\$X_{iH}$, the log-likelihood function is given in Poe and Welsh (p.282) as:

$$(1) \qquad \ln(L) = \sum_{i=1}^{n} \ln\{F(\$X_{iH};\, \beta) - F(\$X_{iL};\, \beta)\}.$$

β is the parameter vector to be estimated using a particular distribution function. Welsh and Bishop adopt the logistic distribution in the GAUSS program they developed to maximize (1). Using the logit model, nonnegative mean WTP is given by Hanemann as:

$$(2) \qquad \text{Mean } WTP = (1/\beta_1)\ln(1+e^{\beta_0}),$$

Table 1. Schematic of Multiple-Bounded Dichotomous Choice Format

Cost to You per Year ($)	Definitely Vote Yes	Probably Vote Yes	Not Sure	Probably Vote No	Definitely Vote No
1	☐	☐	☐	☐	☐
5	☐	☐	☐	☐	☐
10	☐	☐	☐	☐	☐
20	☐	☐	☐	☐	☐
.					
.					
50	☐	☐	☐	☐	☐
.					
.					
100	☐	☐	☐	☐	☐
200	☐	☐	☐	☐	☐
350	☐	☐	☐	☐	☐

where β_0 is the constant term and β_1 is the slope coefficient on the dollar bid amount variable ($\$X$).

For purposes of this analysis, we coded any "definitely yes" or "probably yes" responses as one, and the "not sure," "probably no," and "definitely no" responses as zero. This is consistent with the voting literature which treats not sure responses as no's (Polasky, Gainutdinova, and Kerkvliet; Magelby). While this approach is consistent with the voting literature, it does not fully exploit the full range of uncertainty information. Carson et al. and a recent paper by Wang provide models for explicitly incorporating a "won't vote" and "don't know" response, respectively, in more traditional dichotomous choice models. However, incorporating multiple categories of uncertainty recorded in the multiple-bounded estimator is more complicated and programming an estimator is not straightforward.[1] Note the Welsh-Bishop "switching interval" may be between the "probably yes" at $\$X$ and whatever lower category (not sure, probably no, or definitely no) is checked at the next highest dollar amount as long as there are not intransitivities. There were only four respondents that were intransitive, that is, changing between a "no," "yes," and a "no" response as the dollar amount increased (three of the four did this only once).

A potential concern with both the Ready, Whitehead, and Blomquist and Welsh-Bishop approach is whether respondents all interpret the categories in the same way, that is, do respondents use the same criteria for choosing to be in the "definitely yes" or "probably yes" categories. This appears to be assumed in equation (1). The problem of different people having different interpretations of scales has been addressed in conjoint analysis by using rating differences (Roe, Boyle, and Teisl) or by using the respondent's average rating across scenarios as an independent variable (MacKenzie). It is not clear these solutions would work in the multiple-bounded model and this issue awaits further research.

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[1] The authors have discussed with Anna Alberini at University of Colorado various options for incorporating the full information on uncertainty into the likelihood function. However, given the complexity of the resulting likelihood functions, such models are not operational at this time.

The multiple-bounded question format is like the double-bounded question format of Hanemann, Loomis, and Kanninen in that WTP can often be bracketed between a bid interval, which substantially increases the precision of WTP estimates for any given sample size. In addition, the multiple-bounded approach may avoid the problem of the double-bounded method identified by Cameron and Quiggin, whereby the response to the first bid amount is less than perfectly correlated to the response to the second bid amount. With the double-bounded format the respondent typically does not know of the follow-up question or its bid amount, but in the multiple-bounded design illustrated in table 1, the respondent sees the full range of bid amounts prior to giving any valuation response. This makes it more likely that the individual may formulate an overall response strategy that is consistently applied when answering all of the valuation questions. However, the multiple-bounded approach may also be susceptible to some of the same concerns expressed by critics of payment cards, that is, WTP may be sensitive to the range of dollar amounts presented on the card. However, Rowe, Schulze, and Breffle show that estimated WTP is not very sensitive across reasonable ranges of payment card amounts as long as the upper end of the range is not truncated.

Scope Test Hypothesis

The scope test involves testing whether annual mean WTP per household for the 62 T&E species which includes the MSO is greater than the corresponding WTP for the MSO itself. Therefore the null hypothesis is

$$WTP_{MSO} = WTP_{62T\&E}. \tag{3}$$

Theory suggests the alternative is

$$WTP_{MSO} < WTP_{62T\&E}, \tag{4}$$

which involves a one-tailed test.

As discussed by Carson and Mitchell our scope test would be classified as a test of categorical nesting rather than either quantitative nesting or geographic nesting. What changes across survey versions is the inclusion of additional types of T&E species protected. It is important to recognize that our broader good, while labelled 62 species, is not numerically equivalent to 62 times more than 1 species. This is true for several reasons. First, unlike visitor days, our bar chart emphasized eight different categories of species such as birds (Mexican spotted owl), fish, mammals, snails, snakes, cacti, mustard plants, pea plants, and other plants. Strictly speaking, then the 62-species package is more T&E species, but it is not equivalent to 61 other species of owls or even birds. Second, Metrick and Weitzman show that different types of species are viewed differently depending on their characteristics such as size. The geographic region is the same for both survey versions, namely the four-corners states. As noted below, this was emphasized by including identical base maps of the areas in each survey.

To test whether these two WTP amounts are significantly different we adopt the method of convolutions proposed by Poe, Severance-Lossin, and Welsh. This method involves two steps. First, as shown in (2) estimated mean WTP is the ratio of two estimated coefficients and therefore confidence intervals around mean WTP are simulated using a technique of Park, Loomis, and Creel. This technique incorporates the joint variability of the coefficients in the numerator and denominator of (2), by using the information contained in the variance-covariance matrix to simulate a distribution of WTP estimates using (2). The second step compares these two simulated distributions of WTP estimates for the MSO and the 62 T&E species to determine if they are significantly different. The method of convolutions is less prone to type II errors than simply comparing confidence intervals around the respective WTP estimates. See Poe, Severance-Lossin, and Welsh for more details.

Data

Development of Survey Instrument

Two mail survey instruments were developed that were identical except that in one the first WTP question was for the Mexican spotted owl and in the other the first WTP question was for 62 T&E species that included the Mexican spotted owl. Both survey instruments were developed through a series of focus groups held in three out of the four states with MSO habitat. The draft survey instrument was pretested by mailing a survey to a sample of U.S. households and then conducting an interview over the phone. The interviewers discussed the survey question by question to elicit answers as well as probe the respondent for their thought processes and interpretations in answering each question. Feedback from these interviews resulted in reorganization of material to reduce redundancies and clarify the labelling of the bar charts. Pretests also provided feedback for determining the range of dollar amounts to be presented to all respondents in the multiple-bounded WTP question. In specifying the range of the final dollar amounts, we also relied upon previously published dichotomous choice CVM studies of the northern spotted owl (Hagen, Vincent, and Welle; Loomis, Gonzalez-Caban, and Gregory) and the California spotted owl (Loomis and Gonzalez-Caban). The cost per U.S. taxpaying household was $1, 3, 5, 10, 15, 20, 30, 40, 50, 75, 100, 150, 200, and 350. The five possible response categories are shown in table 1 and are framed as different levels of certainty regarding voting "yes" or "no."

The final survey booklets were both 12 typeset pages plus a map insert showing the critical habitat areas for the MSO and the 62 T&E species. Unfortunately, out of the 61 other T&E species only nine fish species have formally designated critical habitat, so the 4.6 million acres of MSO critical habitat tended to dominate the map. We attempted to counter this by including a bar chart showing the number of T&E species in each category that would be protected under the broader T&E proposal. However, the majority of the other T&E species in the four-corners region are "uncharismatic" species such as cacti, mustard plants, and snails. As shown by Metrick and Weitzman, even the U.S. Fish and Wildlife Service puts much less importance on these species, allocating just 5% of its recovery budget to these types of species. A copy of the two survey instruments are available upon request from the authors.

Sample Frame

Previous research (Loomis and Gonzalez-Caban) showed a national extent of the public good market for preservation of the not yet listed California spotted owl. Because of this a nationwide sample seemed appropriate for the MSO. Survey Sampling Inc. provided a systematic sample of U.S. households. The two survey versions were randomly assigned. The survey design, cover letter, and mailing procedure followed a modified Dillman design. An original cover letter with a postage paid return envelope was sent along with the survey. We included a dollar bill in the first mailing to encourage responses. All respondents received a reminder postcard. A second mailing (without the $1) was sent to nonrespondents.

Results

Response Rate

Six hundred surveys of each version were mailed out. Two hundred eighty-six of the MSO version and 287 of the 62 T&E species versions were returned. After deleting undeliverables and deceased addressees (89 in the MSO version and 96 in the 62 T&E species version), we obtained response rates of 56% and 57%, respectively, for the two survey versions. The equivalence of response rates aids in comparability of the data sets for purposes of the scope test. However, these response rates may be somewhat lower than are desirable if the primary purpose is to generalize sample WTP to the population.

Protest Check Questions

It is customary in CVM studies to probe respondents that answer "no" to determine if this response represents a valid refusal to pay because they simply do not value the good or cannot afford to pay. Alternatively, respondents that value the good may refuse to pay for other reasons such as (*a*) they feel it is unfair to expect them to pay; (*b*) they reject the scenario, believing that protecting critical habitat will not help preserve these species; (*c*) being opposed to paying for government programs; and (*d*) other reasons which typically include statements such as "the government wastes money." Reasons (*a*)–(*d*) do not necessarily reflect a zero WTP for the species but rather a lack of faith that payment of the amounts specified in the survey would actually result in preservation. In this study any respondent that answered "no" to all bid amounts were asked to check their main reason from a list or write in their own. Individuals refusing to pay $1 and checking off categories (*a*), (*b*), (*c*), and (*d*) above were considered protests.

Overall the protest rate is fairly low at 12% for the MSO version and 14% for the 62 T&E species version. Only about 3% rejected the scenario that designating critical habitat would protect the species. For the MSO, one of the most common protests was category (*a*), it is unfair to expect me to pay.

Multiple-Bounded Logit Equations

Table 2 provides the logit coefficients for the MSO and 62 T&E species. The coefficients on the bid amount are significant at the 0.01 level as is the Wald statistic. To incorporate different tastes and preferences of respondents into the WTP function, an independent variable called *Protect* is calculated from the responses to four attitude questions. The response categories ranged from strongly agree to strongly disagree along a five-point

Table 2. Multiple-Bounded Logit Coefficients for the Mexican Spotted Owl and 62 T&E Species

	62 T&E Species		Mexican Spotted Owl	
Variable	Coefficient	*t*-Statistic	Coefficient	*t*-Statistic
Constant	3.418	9.42	2.099	6.74
Protect[a]	0.5438	7.77	0.2913	4.83
Dollars[b]	−0.0256	−14.22	−0.02819	−14.63
N	205		218	
Wald Statistic	215.434		220.524	

[a] *Protect* is the sum of four Likert scale questions regarding the importance of protecting endangered species.
[b] *Dollars* is the dollar amount or bid that the respondent was asked to pay.

scale. The questions are (*a*) All species endangered due to human activities should be protected from extinction whether or not they appear important to human well being; (*b*) Plants and animals have as much right as humans to exist; (*c*) I am glad that the endangered species of the four-corners region are protected even if I never see them; and (*d*) Protection of threatened and endangered species is a responsibility I am willing to pay for. As can be seen in table 2, the *Protect* variable is also significant at the 0.01 level. This means the more important the respondent views protection of endangered species the more likely they are to pay.

Mean WTP, Confidence Intervals, and Hypothesis Tests

Table 3 shows that mean WTP for the MSO and its 4.6 million acres of old growth habitat is $40.49, with a 90% confidence interval of $35.65 to $46.15. This is substantially less than the $95 that Hagen, Vincent, and Welle estimated for protecting the Northern spotted owl and its critical habitat in the Pacific Northwest using the dichotomous choice method. However, other studies have shown that the dichotomous choice CVM results in higher estimates of mean WTP than an interval method such as the multiple-bounded method (Hanemann, Loomis, and Kanninen). Our value, however, is nearly identical to the $44 that Rubin, Helfand, and Loomis estimated for the Northern spotted owl using the open-ended WTP question.

WTP is $48.70 for the 62 T&E species which includes the MSO and its habitat along

Table 3. Mean WTP, 90% Confidence Intervals, and Results of Hypothesis Test

Program	Mean ($)	90% CI ($)
Mexican Spotted Owl	40.49	35.65–46.15
62 T&E Species	48.70	43.32–55.05
H_0: $WTP_{MSO} = WTP_{62T\&E}$	Reject at 0.095 level	

with 15 fish, 39 plants, and 7 other species such as 3 snails. The 90% confidence interval is $43.32 to $55.05. The statistical efficiency of the multiple-bounded approach is evident by the fairly tight confidence intervals around the mean WTP amounts. However, since the confidence intervals for the MSO and 62 T&E species overlap slightly in the tails, the method of convolutions provides an accurate estimate of the significance level of the hypothesis test of equality of these two WTP distributions. The method of convolutions shows these distributions are significantly different at the 10% level. Thus, the null hypothesis of equality is weakly rejected and the MSO CVM survey passes the scope test.[2] While it does not pass at a high significance level, the results are encouraging for at least three reasons. First, the scope test was carried out in a mail survey, which is believed by some (Mitchell and Carson; Arrow et al.) to be the least reliable survey mode. Second, the 61 other species are not necessarily perceived as equivalent to the MSO and its old growth habitat, using the criteria in Metrick and Weitzman's analysis of determinants of federal T&E expenditure decisions. In particular, birds had the largest positive coefficient in the U.S. Fish and Wildlife Service's listing decision (Metrick and Weitzman). While plants make up the bulk of listed T&E species, they receive less than 5% of the recovery funds. Thus, the scope test is not necessarily an unambiguous test of more equally desired species versus less equally desired species. Third, Carson and Mitchell suggest sample sizes must be large enough to have sufficient power to detect reasonable differences. Our effective sample sizes of slightly more than 200 observations may not be large enough when using discrete choice models (Cameron and Huppert 1991).

To answer the benefit-cost question posed at the beginning of the article, we computed a range of benefit estimates, each corresponding to a more and more conservative assumption of how widespread the benefits are. If we take our mean WTP of $40.49 and multiply it by the number of households in the U.S., we obtain a national benefit estimate of $3.7 billion. However, this assumes our mean WTP is applicable to nonrespondents. If we conservatively assume that the same proportion of U.S. households would be nonrespondents as our sample, and that nonrespondents have a zero WTP, a more conservative estimate would be about $2 billion. If we take the lower 90% confidence interval estimate of our benefits ($35.65), the conservative estimate is reduced further to $1.8 billion. Given the cost estimates presented at the beginning of this article, implementation of the Mexican spotted owl recover program and its critical habitat clearly pass the test of economic efficiency.

Conclusions

This article used a recently developed multiple-bounded contingent valuation question format that allows respondents to reveal the level of certainty in their answers at each of several dollar amounts. The multiple-bounded approach provides for substantial precision in the confidence intervals surrounding WTP like the double-bounded method, but

[2] As suggested by a reviewer, we tested the robustness of our scope test by adopting the coding strategy of Champ et al. and coded as "yes," only the persons reporting "definitely yes" to a given bid amount, and all other responses ("probably yes," "not sure," "probably no," and "definitely no") as a "no" response. The coefficients in the multiple-bounded logit model were all significant at well beyond the 1% level, although the Wald statistics were slightly lower than the model presented in table 1. The method of convolution alpha level for the scope test is 0.106, just slightly higher than the 0.095 alpha level using the "probably yes" coding. Multiple-bounded logit model results are available from the first author.

since the entire set of bid values are presented, the multiple-bounded method may avoid some of the concerns regarding the double-bounded method. A mail survey using the multiple-bounded method passes the scope test at the 10% significance level when estimating the total economic value of protecting the Mexican spotted owl and its 4.6 million acres of critical habitat in the four corner states. This limited test of the multiple-bounded method suggests further research evaluating the relative performance of the multiple-bounded question format against the traditional single-question dichotomous choice question may be warranted. From a policy perspective, the economic value of protecting the 4.6 million acres of critical habitat for the Mexican spotted owl is substantial. If nonrespondents are treated as having a zero willingness to pay, the mean and lower 90% confidence interval of benefits is $2.6 billion to $1.8 billion. Either of these benefit estimates greatly outweighs the estimated costs.

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