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Benefits and Costs of Resource Policies Affecting Public and Private Land

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Introduction

This volume contains the proceedings of the 2000 W-133 Western Regional Project Technical Meeting on "Benefits and Costs of Resources Policies Affecting Public and Private Land." The meeting was held in conjunction with the 2000 Western Regional Science Association Meeting at the Sheraton Kauai Resort, Kauai, Hawaii, February 28 – March 1, 2000. The meeting included a joint WRSA-W-133 session that was attended by many WRSA participants.

The Kauai meeting was attended by academic faculty from many W-133 member universities in addition to researchers from non-land grant universities, federal agencies and private consulting firms. A list of those who attended the meeting follows.

The papers included in this volume represent a wide-range of current research addressing the W-133 project objectives, which are: 1) benefits and costs of agro-economic policies, 2) benefits transfer for groundwater quality programs, 3) valuing ecosystem management of forests and watersheds, and 4) valuing changes in recreational access. The complete program for the meeting follows the list of participants.

The trip to Kauai was a long one for most and made the meetings this year smaller than those in recent years. The overwhelming opinion of those who made the trip was that it was well worth it. The sessions were stimulating and the scenery and weather were superb. I'd like to thank Jerry Fletcher, John Loomis, Frank Lupi, Douglass Shaw for their help with this year's meeting and special thanks to David Plane of WRSA for taking care of so many of the logistics of the meeting.

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Using Contingent Valuation to Value a Noxious Weeds Control Program: The Effects of Including an "Unsure" Response Category

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Using Contingent Valuation to Value a Noxious Weeds Control Program: The Effects of Including an "Unsure" Response Category

I. Introduction

The National Oceanic and Atmospheric Administration (NOAA) Contingent Valuation Panel recommended the inclusion of an explicit "would not vote" response category in addition to the "vote in favor" and "vote against" response categories of a referendum contingent valuation (CV) question (Federal Register Vol. 58, No. 10). The implications of this recommendation have not been extensively investigated and the Panel did not provide guidelines for interpreting the "would not vote" option.

Subsequent to the NOAA panel recommendation, researchers have experimented with response formats to closed ended CV questions which, in addition to the "vote in favor" and "vote against" response categories, allow for refraining from voting altogether, or allow for expressions of uncertainty (Carson et al., Wang). The common finding in these studies is that when respondents are explicitly given the option of expressing uncertainty about the CV question, many respondents choose this option. Carson et al (1998) conclude that the majority of the respondents who abstained from voting would have vote against the proposed plan, had they been offered only two response categories. These responses should, therefore, be recoded as votes against the proposed environmental plan and statistically modeled as such.

By contrast, Wang (1997) treats the "not sure" responses as distinct from the votes in favor and against the plan, and hypothesizes that, in fact, the "not sure" responses are the

most informative about willingness to pay, since they reveal that the respondent's underlying willingness to pay amount is very close to the offer amount.

In this paper we explore three aspects of allowing respondents to express uncertainty about their vote on the program described in a CV survey. First, we examine how the distribution of responses to a contingent valuation question which includes an "unsure" response category compare to CV question with just the "vote in favor" and "vote against" response categories.2 We also examine the item non-response and determinants of the unsure responses.

II. Previous Research

Carson et al.'s working hypothesis is that inclusion of a "would not vote" option and recoding of those responses as "vote against" responses results in a distribution of response similar to that of a standard dichotomous-choice CV question. Two independent samples of respondents were administered versions of a CV survey about willingness to pay to prevent oil spills and the related damages to natural resources in Alaska.

Approximately 18 percent of the survey respondents chose the "would not vote" response category when the option was explicitly offered by the interviewer. The distribution of responses to the CV question was statistically similar between the standard dichotomous choice version and the version which offered the "would not vote" option, if the "would not vote" responses were conservatively re-coded as "would vote against."

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2 The Panel also called for research into alternative ways of presenting the "no vote" option. In this study we used an "unsure" response category as an alternative to

Moreover, median willingness to pay, the preferred welfare measure, was *not* statistically different between the standard dichotomous choice CV treatment and the treatment that included the "would not vote" option conservatively recoded as "vote against," when the "would not vote" responses were recoded as "would vote against." Carson et al. conclude that with a conservative interpretation of the responses inclusion of a "would not vote" option does not reduce estimates of willingness to pay relative to a standard dichotomous-choice CV response format.

Wang (1997) looks at the effects of including a "don't know" response category in addition to the standard "vote for" and "vote against" response categories. Wang develops a model for estimating mean willingness to pay that uses information provided by the "don't know" respondents and applies it to CV data collected via a mail survey. The model assumes that it is straightforward for people to answer "yes" ("no") to a dichotomous choice CV question when the offer amount assigned to the respondent is sufficiently low (high) relative to her true willingness to pay amount. By contrast, respondents answer "don't know" when the bid amount is close to their true willingness to pay. The corresponding statistical model is thus a variant of the ordinal probit (or logit), which identifies by how much willingness to pay must exceed (be less than) the bid for the respondent to say "yes" ("no").

Wang finds that for the four offer amounts used in the survey, a relatively large percentage (30%) of the respondents chose the "don't know" response category. Treating the "don't know" responses as "vote against" responses results in the lowest estimate of mean

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"no vote."

willingness to pay ($2.65). The ordinal logit model proposed by Wang uses the information from the "don't know" responses and produces an estimate of mean willingness to pay equal to $11.86, an estimate very close to the estimate of mean willingness to pay obtained from a standard logit model that removes the "don't know" responses from the willingness to pay estimates ($10.23). The standard error around mean willingness to pay is a bit less for the Wang model (1.527) than that from the model in which the "don't know" responses are removed (1.703). Despite this very small improvement in statistical efficiency, Wang concludes that the NOAA panel plea for including a "don't know" response category is appropriate, and recommends using information from the "don't know" respondents as described in his paper.

The study described in this paper is similar to the Carson et al. study in that we also implement a split sample design to allow for comparisons between a standard dichotomous-choice CV format and a format that includes an "unsure" response category in addition to the "vote in favor" and "vote against" response categories. An important difference between Carson et al. and this study is that this study implemented a self-administered mail survey whereas the Carson et al. survey was administered in person. We extend the type of analyses conducted in the Carson et al. study by including an estimate based on the Wang model which allows for use of the information provide by the "unsure" respondents, and make extensive use of the information gathered through debriefing questions to explore reasons for the "unsure" responses.

III. Reasons for Unsure Responses

In attitude surveys, researchers have found that a low education level is strongly correlated with a "don't know" response. Schuman and Presser (1981) suggest this finding is reflective of the respondent not having knowledge or an opinion about the issue at question. While CV questions are specific statements about preferences rather than attitudes, it is possible that effects similar to those found with attitude elicitation occur when respondents are not sure about how to respond to a CV question. The decision heuristics respondents use when they do not have an opinion, but are asked to express one, may lead to invalid responses.

Decision heuristics may also vary with respondents. To illustrate, when unable to answer a CV question that offers a dichotomous choice response format, one respondent may randomize the response (i.e., flip a coin), while another might adhere to the simple rule "if in doubt, vote against."

When the willingness to pay question follows the dichotomous choice format, there may be many reasons that make it difficult for respondents to answer the question. Respondents may not understand the information presented in the CV scenario, or may not believe or may object to certain aspects of the scenario. In-person surveys may encourage the respondents to give responses they think will please the interviewer or responses that are socially desirable. It has also been hypothesized that it may be difficult for respondents to answer a closed ended willingness to pay question when the posited offer amount is close to their true willingness to pay.

To sum, respondents may have many reasons for finding it difficult to answer dichotomous choice CV questions, and different ways in which they overcome these difficulties to provide a definitive answer. Unless we understand how such processes work, we run the risk of ascribing similar willingness to pay information to respondents whose "yes" or "no" responses are driven by reasons other than the size of their willingness to pay amounts vis-à-vis the offer amount.

In this paper, we investigate two related questions. First, had the "unsure" response category not been explicitly offered, how would "unsure" respondents have answered a standard dichotomous choice CV question? Second, why are some respondents "unsure" about how they would vote?

We formalize possible plausible explanations for the "unsure" responses in a series of working hypotheses, and attempt to accept or refute the hypotheses by conducting statistical analyses of the responses to the payments questions from the two treatments.

Hypothesis 1. *Respondents who choose the "unsure" response category would have voted against the program in the absence of such a category.* Proponents of this hypothesis argue that some respondents feel that it is socially unacceptable, or offensive to the interviewer, to turn down the plan. The "unsure" response category provides a more socially gracious way of not supporting the program in question. It is unclear that providing a socially desirable response is an issue with a mail survey, but we feel that this hypothesis is worth investigating. The implication of this hypothesis is that "unsure" responses should be recoded as votes against the program.

Hypothesis 2. *"Unsure" responses are completely uninformative about willingness to pay.* Hence, they should be deleted from the sample used for statistical analysis.

Hypothesis 3. *Respondents who choose the "unsure" response category would vote in favor of the program in the absence of such a category.* Proponents of this hypothesis argue that some respondents may be in favor of the program in general but have some reservations (such as the cost of the program). When forced to provide a definitive response to the CV question they would "vote in favor," however they are a bit unsure and will give this response when it is offered explicitly. It is also possible some respondents feel compelled to say that they are in agreement with the program for fear that saying otherwise, or simply expressing their uncertainty about the benefits of the program, will offend the interviewer or not be socially unacceptable. The implication of this hypothesis is that "unsure" responses should be recoded as votes for the program.

Hypothesis 4 (Wang, 1997). *"Unsure" responses are very informative about willingness to pay: respondents who select this response category have willingness to pay amounts that are close to the bid.* If so, the "unsure" responses should be retained in the usable sample, modeled as distinct from the votes in favor and against, and modeled as implying that the underlying willingness to pay is close to the bid offer.

Hypothesis 5. *Respondents will select the unsure response category when they have considerable uncertainty about their income, their ability to commit to spending money within their household, and about the benefits of the program.* This proposed explanation calls for relating "unsure" responses to the subject's expressed uncertainty about these

matters, or to respondent characteristics, such as education or age, related to such uncertainty.

These explanations are not all mutually exclusive, and different explanations may be valid for different study participants.

IV. Study Design

The study implemented a split sample design. The two treatments were parallel in all aspects except the response format to the CV question. The final survey instrument was developed after conducting seven focus groups and a small pretest.

The topic of the survey was controlling invasive plant species or noxious weeds on National Forests. Noxious weeds are "a threat that affects 49 percent of the nation's imperiled or endangered organisms" (Stolzenberg 2000). Despite the seriousness of the threat posed to biodiversity by noxious weeds and the considerable coverage of this topic in the media, the focus groups revealed that many people were relatively unaware of the noxious weeds problem. It was therefore necessary to provide study participants with a substantial amount of information prior to asking them about their willingness to pay for a program to control noxious weeds in National Forests. After providing information about each topic (i.e National Forests and Noxious Weeds), study participants were asked a series of questions designed to measure their previous experience and attitudes.

The focus groups participants also made it clear that we needed to describe National Forests (to avoid confusion with public lands owned and managed by other entities), define

what noxious weeds are and describe how the program to control noxious could be implemented. Study participants were told that the Noxious Weeds Control Program would be financed with revenue from a special one-time tax. As it would take many years of treatment to control the noxious weeds, the revenue from the tax would be placed in an interest earning trust fund, and the funds would be used over the next ten years to implement the Noxious Weeds Control Program. The CV question was posed as a vote on a national referendum to impose a one-time tax to fund the *Noxious Weeds Control Program* and read as follows:

> If the ***Noxious Weeds Control Program*** is implemented, the cost to your household would be $ (offer amount). Would you vote in favor or against the program? ***(Circle one number)***

In Treatment 1, the standard dichotomous choice response format ("vote in favor," "vote against") was administered. In Treatment 2, the response format included an "unsure" response category in addition to the "vote in favor" and "vote against" categories, for a total of three response options. In both treatments, one of five offer amounts ($5, $10, $25, $50, $75) was randomly assigned to the CV question.

The survey included a series of debriefing questions after the willingness to pay question. The intent of these questions was to better understand some of the reasons for and issues related to the response to the willingness to pay question. Respondents were asked to rate on a likert scale from 1 to 4 (1=definitely true, 2=somewhat true, 3=somewhat false, 4=definitely false) how true they thought the statements were about why they responded as they did to the willingness to pay question. These likert scale items were branched so

respondents who answered "vote in favor" to the willingness to pay question were given one set of statements and respondents who answered "vote against" received a different set of statements. There were also eight statements that both "vote in favor" and "vote against" respondents were to answer. The "unsure" respondents in Treatment 2 were asked to respond to all the debriefing statements. There was also a series of questions that were developed to measure attitudes toward the environment in general.

The data were collected via mail surveys. Since this research was for methodological purposes and we do not generalize the results, we used a convenience sample to compare the responses to the payment questions obtained from the two alternative approaches. We recruited participants via ads placed in the general news section of three Sunday newspapers.[3] The ads offered $10 for completing a mail questionnaire on a "current Colorado issue." The ad did *not* mention noxious weeds or National Forests. A total of 891 Colorado residents responded to the ad and were mailed surveys. Seven-hundred-forty-three surveys were returned, for a response rate of 84%.

V. Results

Before comparing responses to the CV question for the two treatments, we compared the distributions of the responses to the survey questions prior to the CV question and the demographic questions to assess whether the respondents in the two treatments are

[3]The ads ran in the Denver Post and the Rocky Mountain News (two Denver based daily newpapers) and The Gazzette (a Colorado Springs daily newspaper).

representative of similar populations. As shown in Table 1, the respondents in Treatment 2 are very similar in virtually all respects (demographics, rates of visitation of national forests, attitudes towards forests and environment, and prior knowledge of the weeds problem) to those the respondents in Treatment 1. This result suggests that the differences in the responses to the payment questions between the two treatments (if any) are due to treatment effects rather than response effect.

V.1. Responses to the willingness to pay question

In Treatment 1, 76% of the valid responses were "vote in favor" compared to 62% of the valid responses in Treatment 2. In treatment 2, 13% of the valid responses were "vote against" and 25% were "unsure." This result is consistent with previous studies that found that when an explicit opportunity to express uncertainty is provided, a non-trivial percentage of respondents chooses the response category rather than providing a definitive response to the willingness to pay question.4

One response a study participant may have when he feels conflicted or uncertain about how to respond to a dichotomous choice CV question is to skip the question. If this is the case, explicit inclusion of an "unsure" response category should reduce item non-response. We find that in Treatment 1 (vote in favor/vote against) 5% of the study participants did not answer the CV question. In treatment 2 (vote in favor/vote

[4] This finding also confirms that numerous "not sure" responses can be observed in *any* survey that explicitly allows for such response category, and not just with in-person surveys, where, it has been suggested, respondents may opt for the "not sure" response when they are truly against the plan, but are reluctant to say so for fear of offending the interviewer or

against/unsure), the item non-response on the CV question is 2% (Table 2). The difference in item non-response for the two treatments is significant (χ^2 =4.125, p=.039).

This result has two important implications. First, given the relatively large fraction of "not sure" responses, it would appear that explicit inclusion of an "unsure" response category does not just attract people who would have skipped the question anyway. Second, whether or not including an explicit "not sure" response category is advantageous, in terms of reducing item non-response and in turn providing more useable observations, depends on how the "unsure" responses are treated in the statistical modeling of the data. If information from the "unsure" respondents is used in deriving estimates of mean willingness to pay (as in Wang 1997), decreasing item non-response is very important. If "unsure" respondents are excluded from the sample of usable observations, including an "unsure" response category will inevitably reduce the usable sample size (the loss of observations in our case would be of 25% of the original number of respondents).

V.2. Comparisons of the two treatments

The next step in the analysis is to compare the distribution of response to the payment question for the two treatments. The intent of these comparisons is to answer the question of what respondents would do if they were not explicitly provided the "unsure" response category. Treatment 1 with the standard dichotomous choice response format serves as the benchmark for assessing the most appropriate way method of dealing with the "unsure" responses.

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appearing to be socially or politically incorrect.

There are four options for dealing with the "unsure" responses. One option is to take the conservative approach and recode the "unsure" responses as "vote against." This approach implicitly assumes that if the "unsure" response were not explicitly offered, all the "unsure" respondents would choose to "vote against," and is in agreement with hypothesis 1.

The second option is to remove the "unsure" responses from the data set and only use the "vote in favor" and "vote against" responses. While this approach eliminates the need for the analyst to decide what to do with the "unsure" responses, it comes at the cost of losing a substantial amount of data. This option is in agreement with hypothesis 2.

The third approach is to recode the "unsure" responses as "vote in favor" responses. This approach is appropriate if there is evidence that "unsure" respondents are similar to respondents who "vote in favor" in the dichotomous choice treatment, and is thus implied by hypothesis 3.

The final option is to keep the "unsure" responses as they are and estimate mean willingness to pay using a model such as suggested by Wang (1997). We investigate the appropriateness of each of the four options.

V.3 Recoding the "unsure" as "vote against"

For both versions of the survey, the percentage of "vote in favor" responses to the willingness to pay question is highest at the lowest offer amount, declining as the offer amount increases (Table 3). In treatment 2, the percentage of "unsure" and "vote against" responses increase with the offer amount, reaching 32% and 22%, respectively, at the top

offer amount of $75. This result would seem to suggest that the "unsure" responses could be interpreted and reclassified as if they were "vote against" responses. However, when we do so, the split between "vote in favor" and "vote against" at the various bid levels reproduces the distribution of responses from the standard dichotomous choice in Treatment 1 for only three of the five offer amounts (Table 3).

Comparisons of the estimates of mean willingness to pay also suggest that recoding the "unsure" responses as "vote against" results in an estimated mean willingness to pay that is statistically different from mean willingness to pay from the standard dichotomous choice data.5 As shown in Table 4, estimated mean willingness to pay is $78.15 based on the Treatment 1 data (dichotomous choice). When the unsure responses in Treatment 2 are recoded as "votes against", the estimated mean willingness to pay is $61.65. These two estimates are not statistically different at the 5% significance level.

A multinomial logit (MNL) model which predicts the likelihood of selecting each of the three possible response categories as a function of respondent characteristics, acceptance of the scenario and environmental priorities and a vector of response-specific coefficients is used to explore how these variables relate to the response to the willingness to pay question. If the relationships are similar between the regressors and both the "vote against" or

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5 The mean willingness to pay is computed using a fully parametric approach. Specifically, we fit a probit model where the dependent variable is a dummy indicator that takes on a value of one if the respondent voted in favor of the Noxious Weeds Control Program at the stated offer amount, and zero otherwise. The right-hand side of the model includes the intercept and the offer amount. This procedure assumes that the latent WTP variable is normally distributed, and recovers mean/median WTP as minus the coefficient of the bid, divided by the intercept (Cameron and James 1987). The standard errors are calculated from the covariance matrix of the probit estimates using the

"unsure" responses to the willingness to pay question, this can be viewed as support for the approach of re-coding the "unsure" responses as "vote against." The MNL model assumes that each response is associated with a level of utility:

$$V_{ij} = \mathbf{x}_i \beta_j + \varepsilon_{ij} \tag{1}$$

where V is indirect utility, x is a vector of individual characteristics or attitudes, β is a vector of alternative-specific coefficients, and ε is a vector of i.i.d. error terms that follow the type I extreme value distribution. The subscripts i and j denote the individual and the response category, respectively. It can be shown that the probability that response k is selected by respondent i is:

$$\Pr(k) = \frac{\exp(\mathbf{x}_i \beta_k)}{\sum_{j=1}^{3} \exp(\mathbf{x}_i \beta_j)}. \tag{2}$$

The MNL model is useful in that it allows one to identify what kind of individuals are more likely to select each of the possible response category, but has the disadvantage that it is not possible to recover estimates of mean willingness to pay. The MNL was one of the tools that led Carson et al. to conclude that persons who declined to vote in one of their two versions of the Alaska oil spill contingent valuation survey should be interpreted as having meant a vote against the proposed program.

Estimation results from the MNL model are reported in Table 5. The model shows clearly that the offer amount is one of the strongest determinants of the "unsure" and "vote against" responses. The positive coefficients of this variable indicate that as the bid increases

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delta method (explained in Cameron 1991).

(and holding all else unchanged) the likelihood of selecting the "unsure" and "vote against" response categories, instead of a "vote in favor," increase. It is also important to note that the coefficients of the bid are virtually the same for the "unsure" and "vote against" response options: the appropriate Wald statistic takes on a value of 1.42, failing to reject the null hypothesis of no difference at all conventional significance levels. This result is very similar to that previously obtained by Carson et al. (1998).6

Similar results—in the sense that the coefficients associated with the "unsure" response are statistically indistinguishable from the corresponding coefficients for the "vote against" response—are seen with DEFKNOW, DEFSIDE, HARMIMP and DONAT. The coefficients of all of these variables are negative and significant, implying that persons who state they know their future income (DEFKNOW=1), would like to know more about the potential side effects of weed control techniques (DEFSIDE=1), are more seriously concerned about the harm caused by noxious weeds to wildlife (HARMIMP=1) and contribute money to environmental organizations (DONAT=1) and are less likely to respond "unsure" or "vote against" to the willingness to pay question than to respond "vote in favor."

The MNL model also indicate that respondents with higher incomes are more likely to respond with a definite "vote in favor" or "vote against" than persons with lower income, that persons that said they need more information about the effects caused by weeds are more likely to select the "unsure" response category, and that dissatisfaction with the available information about how the program would be funded leads people to respond "vote against"

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6 The statistic is distributed as a chi square with one degree of freedom under the null hypothesis of no dfference and for large sample size. The 5% critical level is 3.84.

the Noxious Weeds Control Program.

Concern about the effects of weeds on plants and soil do not seem associated with selection of any one of the response categories in particular, nor do ratings of national forests as habitat for plants and wildlife. Longer residence times in the state of Colorado appear to reduce the likelihood that a respondent will announce to be against the plan. We were rather surprised that familiarity with at least some common species of noxious weeds (as witnessed by having seen the plants shown in the pictures) does not affect the likelihood of choosing any one of three response categories. Overall the results of the MNL analysis suggest that the variables related to responding either "unsure" or "vote against" to the willingness to pay question are very similar, supporting hypothesis 1.

We conclude that while conditional analyses (i.e., the MNL model) support hypothesis 1, unconditional analyses based on the percentage of respondents in favor and against the program (after "unsure" responses in Treatment 2 are recoded conservatively as votes agaainst the plan) do not support hypothesis 1.

V.4 Removing the "unsure" responses from the data set

Inclusion of the "unsure" response category reduces the percent of both the "vote in favor" and "vote against" responses relative to the standard dichotomous-choice response format (Table 2). Carson et al report similar findings, and note that, when the "would not vote" response are excluded, the split between the "yes" and "no" in the remainder of the sample is similar to that observed when only two response categories are offered.

In this study, we find that dropping the "unsure" responses from the data provides statistically similar distribution of responses to the willingness to pay question between the two treatments at three of the five offer amounts (Table 3). When the "unsure" responses are dropped from the usable sample, the distribution shift to the right and in turn, increases both mean willingness to pay and the dispersion of willingness to pay estimate. Mean willingness to pay is now $103.61, but this estimate is not statistically distinguishable from that the $78.15 implied by the data from Treatment 1 respondents (Table 4).

V.5. Re-coding the "unsure" responses as "vote in favor"

Recoding the "unsure" responses to "vote in favor" results in an estimate of mean willingness to pay of about $140. This estimate of mean willingness to pay is significantly higher than the estimate of $78.15 from Treatment 1.

When comparing responses of "unsure" respondents to "vote in favor" respondents for a series of likert scale items developed measure the reasons for the response to the willingness to pay question, we see an interesting pattern. On four of the five items, contingency table analysis suggests that the distribution of response for the two groups ("vote in favor" and "unsure" respondents) is statistically different (Table 6). The consistent pattern is that more "vote in favor" respondents chose the extreme point on the scale which corresponds to "definitely true." Relative to the "unsure" respondents, more "vote in favor" respondents said it was "definitely true" that the program was worth the stated amount, that they wanted to show their support for the environment in general, that the goals of the

program were an important consideration when deciding how to vote, that preserving the health of National Forest was very important to them. These results seem intuitive and suggest that "unsure" respondents are different from respondents who "vote in favor."

This is confirmed by the results of the MNL model in Table 5, which suggests that the relationships between the independent variables and responding either "vote in favor" or "unsure" to the willingness to pay question are significantly different. There is no evidence that in the absence of an explicit "unsure" response category, the "unsure" respondents would "vote in favor" or that the "unsure" respondents are similar to the "vote in favor" respondents.

V.6 Retaining the "unsure" responses

The model proposed by Wang (1997) allows for retaining the information provided by the "unsure" respondents. In this model, the "unsure" responses are distinct from both the "votes in favor" and "vote against" responses. Indeed, "unsure" responses are very informative about the underlying distribution of willingness to pay because they signal that the respondent's maximum willingness to pay is very close to the offer amount. Wang's model assumes that respondents vote in favor of the program if their willingness to pay amount is sufficiently greater than the offer amount—in fact, if it exceeds the offer amount by more than a certain amount. In a simpler specification of the model, the "threshold" (denoted as t1) that must be exceeded for the respondent to announce that he would be in favor of the program is held the same across all respondents. In a more complex

specification, the threshold may be allowed to vary across respondents as a function of their economic circumstances, attitudes and beliefs, and acceptance of the scenario.

The model is completed by assuming that people that are against the program hold willingness to pay values that are sufficiently smaller than the offer amount. These persons will answer a firm "vote against" only if their willingness to pay is less than the offer amount, minus an appropriate threshold. For identification purposes, this threshold, denoted as t2, is assumed symmetric around mean willingness to pay with respect to the threshold t1. Finally, all persons whose willingness to pay lies between (bid-t2) and (bid+t1) will answer "unsure" to the willingness to pay question.

The contributions to the resulting likelihood function are thus:

(3) $$\Pr(yes \mid B_i, \mathbf{x}_i) = \Pr(WTP_i > B_i + t_1) = \Pr(x_i\beta + \varepsilon_i > B_i + t_1) =$$

$$= \Pr(\varepsilon_i / \sigma > -x_i\beta / \sigma + B_i / \sigma + t_1 / \sigma),$$

(4) $$\Pr(no \mid B_i, \mathbf{x}_i) = \Pr(WTP_i < B_i - t_1) = \Pr(\varepsilon_i / \sigma < -x_i\beta / \sigma + B_i / \sigma - t_1 / \sigma)$$

and

(5) $$\Pr(not\ sure \mid B_i, \mathbf{x}_i) = \Pr(B_i - t_1 < WTP_i < B_i + t_1)$$

$$= \Pr(\varepsilon_i / \sigma < -x_i\beta / \sigma + B_i / \sigma + t_1 / \sigma) - (\Pr(\varepsilon_i / \sigma < -x_i\beta / \sigma + B_i / \sigma - t_1 / \sigma).$$

If one assumes that willingness to pay follows the normal distribution, the three contributions become:

(4) $$\Pr(yes \mid B_i, \mathbf{x}_i) = \Phi\left(x_i\beta / \sigma - B_i / \sigma - t_1/\sigma\right),$$

(5) $$\Pr(no \mid B_i, \mathbf{x}_i) = \Phi\left(-x_i\beta / \sigma + B_i / \sigma - t_1/\sigma\right)$$

and

$$(6) \qquad \Pr(\textit{not sure} \mid B_i, \mathbf{x}_i) = \Phi\left(-x_i\beta/\sigma + B_i/\sigma + t_1/\sigma\right) - \Phi\left(-x_i\beta/\sigma + B_i/\sigma - t_1/\sigma\right),$$

where Φ denotes the standard normal cdf.

The results of the Wang model for normal willingness to pay are reported in Table 7. In this specification, the thresholds are allowed to vary with respondent characteristics. For the sake of simplicity, we work with a specification of the threshold that is linear in respondent characteristics or variables capturing acceptance of the scenario:

$$(7) \qquad t_1 = \mathbf{z}_i\delta.$$

Because this function is linear, all coefficients are identified only if the variables that enter in the determination of the threshold (the $\mathbf{z}_i$ s) do not overlap with variables than enter in the expression for mean willingness to pay (the $\mathbf{x}_i$ s).

The results make intuitive sense and confirm some of the insights learned from the MNL model. Mean willingness to pay increases significantly with respondent confidence about his or her future income (by \$34), with respondent need for more information about the side effects of weed control (by \$97; presumably, this signals seriousness about undertaking the program), and is typically greater among persons who contribute to environmental organizations (by about \$33). Concern over wildlife impacts of uncontrolled noxious weeds also tends to increase willingness to pay (by about \$55). By contrast, skepticism about the funding of the noxious weeds program reduces willingness to pay by about \$49.

The "unsure" region—the band around the bid within which the respondent is unable to provide a firm "vote in favor" or "vote against" response—is made considerably tighter

(by about $15) by each year of formal education and by personal experience with the species of weeds, although the effect of the latter (about $5) is less pronounced. Other research (Krupnick et al. 2000) finds that, holding all else constant, women are more likely to respond "unsure" to a trichotomous choice question. We do find that males seem to have somewhat tighter uncertainty regions, but the effect is not statistically significant. We also experimented with including among the determinants of the thresholds variables that capture the respondent's experience with vote situation, but neither a dummy for voting in national elections nor one for voting in local elections was found to have any explanatory power for the thresholds.

The estimated mean willingness to pay based on the Wang model $102.36 and the standard error is $13.94. The asymptotic t-test to compare the mean based on the Wang model to the estimate of mean willingness to pay based on the standard dichotomous choice data (which is equal to $78.15) results in a statistic of -1.4955. The difference between the two means is *not* statistically different.

V.7. Why are respondents unsure?

One way of attempting to explain the "unsure" responses is to link them to observable characteristics of the respondents that might plausible influence their ability to provide firm information about willingness to pay (such as age, education, income) and the information they provided in answering the Likert-scale debrief questions.

Uncertainty about future income (or ability to commit money on behalf of the

household) or uncertainty about aspects of the provision of the program could result in choosing the "unsure" response category when answering the vote question. To test this conjecture, several statements about the respondent's future income, ability to make decisions about spending in his or her household, and knowledge of the resource quality implied by the plan were included in the questionnaire. The respondent was asked to circle whether he "definitely" or "somewhat" agreed with each of the statement, or "definitely" or "somewhat" disagreed. We compare the percentage of respondents who find the statement "I know what my income will be in the near future" somewhat or definitely false.7 As shown in Table 8, among the 85 respondents who chose the "unsure" response category to the willingness to pay question in Treatment 2, 29 disagree with that statement (35 percent). By contrast, only 16 percent of the people who answered "vote in favor" to willingness to pay question felt uncertain about their future income. This suggests that uncertainty about income is one, but not necessarily the most important, of the reasons for choosing the "unsure" response category. This conclusion is further confirmed by the fact that 32% of the people who answered "vote against" disagreed with the statement about knowing their future income. A similar story emerges about the respondent's recognition that he or she makes spending decision in their household. More of the "unsure" respondents (62%) relative to the "vote in favor" (52%) and "vote against" (50%) respondents agreed that they needed more information about the problems that the weeds cause;

Looking for further insights into the reasons for choosing the "unsure" response

7 In these analyses, we pool together the "definitely" and "somewhat" response categories.

category to the vote question, we group together firm "vote in favor" and "vote against" respondents, and compare their answers to questions about resource quality in the absence of the program with those provided by "unsure" persons. Table 9 shows the measures for which the distribution of response for the "unsure" respondents is significantly different from the distribution of response for study participants who provided a definitive ("vote in favor" or "vote against") answer to the willingness to pay question. With respect to the statements about the reasons for having National Forests, relative to the "vote in favor" and "vote against" respondents, fewer of the "unsure" respondents thought it is extremely important that National Forest provide habitat for plants or habitat for fish and wildlife and the distribution at the low end of the scale (not at all concerned) is equivalent for the two groups. A consistent pattern is seen with the statements about the respondent level of concern about the various impacts of noxious weeds. Fewer of the "unsure" respondents said they were "extremely concerned" about the decreased soil stability, harm to wildlife, and decreased water quality. The "unsure" respondents were more likely (73% versus 50% of the "vote in favor" or "vote against" respondents) to say it was definitely or somewhat true that they needed more information about the problems weeds cause. It appears that the difference between the respondents who were able to provide a definite response to the willingness to pay question and those who said they were "unsure" is that "unsure" respondents find the reasons for having National Forests to be less important and they are less concerned about the impacts of weeds.

VI. Conclusions

The NOAA Panel recommended inclusion of a "no answer" response category, in addition to the "vote in favor" and "vote against" response categories. The Panel also recommended additional research in "alternative ways of presenting and interpreting the no-vote option" (Federal Register vol. 58, no. 10, p. 5910). This study has allowed us to compare the dichotomous choice format with a response format that includes an "unsure" response category in addition to the "vote in favor" and "vote against" response categories. We found that inclusion of the "unsure" response category changes the distribution of response to the willingness to pay question relative to the dichotomous choice format. If the "unsure" responses are conservatively recoded as "vote against" or if they are removed from the data set, we did not find the distribution of the "vote in favor" and "vote against" responses to be similar to the standard dichotomous-choice treatment.

We found that a substantial number of respondents across the range of offer amounts, chose the "unsure" response category to the willingness-to-pay question. This result is consistent with previous studies (Carson et al, Wang) and supports the call for research to better understand *why* respondents choose the "unsure" response category. Our study suggests that the causes of uncertainty are complex and likely vary among respondents. We recommend efforts be made during the design phase of the contingent valuation survey instrument to minimize uncertainty related to the information provided in the scenario, yet we acknowledge that even the best designed contingent valuation surveys are likely to leave some respondents unsure about how to respond to the willingness-to-pay question. Given this situation, it seems appropriate continue researching the effects of inclusion of an "unsure"

response category. Research to develop models to include the "unsure" responses in the willingness to pay estimates would particularly useful. Research is also needed into the determinants of "unsure" response to closed-ended contingent valuation questions.

From a statistical perspective, inclusion of an "unsure" or "no vote" response category has not been found to be superior over the standard dichotomous-choice format. Given the limited statistical tools currently available for interpreting these unsure responses and the lack of a theoretical model for motivating the "unsure" responses, the standard dichotomous choice format has an advantage over the trichotomous response format. We did not find evidence of a simple decision heuristic whereby unsure respondents "voted against" when forced to make a decision in the dichotomous-choice format. We found that some of the individuals who chose the "unsure" response category would likely answer "vote in favor" while others would choose "vote against" in a standard dichotomous choice situation. Given our current inability to appropriately model "unsure" responses, it may be better to use the standard dichotomous-choice format in actual CV applications as suggested by Carson et al.

Table 1: Comparison of Treatments

	Treatment 1 (vote in favor/vote against)	Treatment 2 (vote in favor/vote against/unsure)
Ever Visited or Seen a National Forest?		
Yes	92%	95%
No	5%	3%
Unsure	3%	2%
Prior to this survey, had you heard about noxious weeds?		
Yes	52%	56%
No	48%	44%
In the last year have you contributed money to an environmental organization?		
Yes	25%	22%
No	75%	78%
Demographic Measures:		
Percent Female	39%	43%
Mean Age	48 years	46 years
Mean Years in CO	24 years	24 years
Educ:		
Eighth or less	0%	0%
Some high school	4%	3%
High school graduate	11%	10%
Some College or technical school	31%	27%
Technical or trade school graduate	9%	9%
College graduate	24%	26%
Some graduate work	7%	10%
Advanced degree	14%	14%
Household Income:		
less than $10,000	9%	8%
$10,000-19,999	12%	14%
$20,000-$29,999	15%	15%
$30,000-$39,999	13%	12%
$40,000-$49,999	12%	13%
$50,000-$59,999	13%	11%
$60,000-$69,999	8%	5%
$70,000-$79,999	4%	5%
$80,000-$89,999	4%	6%
$90,000-$99,999	5%	4%
$100,000-$149,999	4%	5%
over $150,000	2%	1%

Table 2: Response to Willingness to Pay Question by Treatment

	Treatment 1 (vote in favor/vote against) n=379	Treatment 2 (vote in favor/vote against/unsure) n=345
Vote in Favor	72%	61%
Vote Against	23%	12%
Unsure		25%
No Response	5%	2%

Table 3: Response to Willingness to Pay Question by Offer Amount

	Treatment 1 (vote in favor/vote against)	Treatment 2 (vote in favor/vote against/unsure)		
		No recoding	**Unsure dropped**	**Unsure recoded as no**
$5	n=72	n=65	n=55	n=65
Vote in favor	89%	78%	93%	78%
Vote against	11%	6%	7%	22%
Unsure		16%	χ^2=.537[8]; p=.464	χ^2=2.76[1]; p=.097
$10	n=74	n=66	n=50	n=66
Vote in favor	86%	67%	88%	67%
Vote against	14%	9%	12%	33%
Unsure		24%	χ^2=.061[1]; p=.805	χ^2=7.77[1]; p=.005
$25	n=75	n=64	n=49	n=64
Vote in favor	79%	70%	92%	70%
Vote against	21%	6%	8%	30%
Unsure		24%	χ^2=3.80[1]; p=.051	χ^2=1.28[1];p=.258
$50	n=65	n=73	n=51	n=73
Vote in favor	74%	51%	72%	51%
Vote against	26%	19%	28%	49%
Unsure		30%	χ^2=.025[1]; p=.875	χ^2=7.80[1];p=.005
$75	n=73	n=69	n=47	n=69
Vote in favor	49%	46%	68%	46%
Vote against	51%	22%	32%	54%
Unsure		32%	χ^2=4.10[1];p=.043	χ^2=.123[1]; p=.726
Overall	n=359	n=337	n=252	n=337
Vote in favor	76%	62%	83%	62%
Vote against	24%	13%	17%	38%
Unsure		25%	χ^2=4.88[1];p=.027	χ^2=14.745[1];p=.00

[8]Testing the distributions of responses at the specified offer amount between Treatment 1 and the Treatment 2 with "unsure" recoded as described in the column heading.

Table 4: Mean WTP by Treatment.

	Treatment 1 (vote in favor/vote against)	Treatment 2 (vote in favor/vote against/unsure)		
		Unsure recoded as yes	Unsure dropped	Unsure recoded as no
Mean WTP (Standard Error)	**$78.15 (8.23)**	**$140.61 (30.97)**	**$103.61 (17.82)**	**$61.65 (8.71)**

Asymptotic t tests for the difference in mean WTP

	T statistic	Statistically different?
Treatment 1 v. treatment 2 with "unsure" recoded as "vote in favor"	-1.96	Yes, at 5% significant level
Treatment 1 v. treatment 2 with "unsure" dropped	-1.30	No
Treatment 1 v. treatment 2 with "unsure" recoded as "vote against"	-1.38	No

Table 5. Multinomial logit model of responses. Treatment 2. Omitted category: "vote in favor." N=339.

Variable	UNSURE	NO	Likelihood ratio statistic that coefficients are both equal to zero[a] (P value in parentheses)
	Coefficient (T statistic)	Coefficient (T statistic)	
Constant	2.56276 3.57	0.39655 0.41	14.2429 (0.001)
Bid level	0.02421 3.88	0.03358 4.23	23.4486 (less than 0.001)
Household income (thou.dollars)	-0.01482 -2.55	0.00692 1.09	10.6162 (0.005)
DEFKNOW (Respondent knows future income)	-0.96480 -2.68	-1.05015 -2.23	8.8001 (0.012)
DEFWEED (Respondent needs more information about the problems caused by weeds)	1.20869 3.07	-0.11612 -0.24	11.3701 (0.003)
DEFSIDE (Respondent needs more information about the side effects of weed control techniques)	-2.04829 -3.46	-3.45762 -5.22	29.0606 (less than 0.001)
DEFPROG (Respondent needs more information about how the program would be funded)	0.71191 1.50	1.78596 2.90	8.8405 (0.012)
DONAT (Respondent contributes to environmental orgs.)	-0.98205 -2.13	-0.95317 -1.65	5.9756 (0.050)
SOILIMP (respondent is extremely concerned about the soil stability impacts of noxious weeds)	-0.35196 -0.74	0.20489 0.34	0.8535 (0.653)
WATERIMP (respondent is extremely concerned about the water quality impacts of noxious weeds)	0.23084 0.48	0.01861 0.03	0.2529 (0.881)
HARMIMP (respondent is extremely concerned that noxious weeds will harm wildlife habitat)	-2.02458 -4.02	-1.53207 -2.56	17.5873 (less than 0.001)
PLANTIMP (respondent is extremely concerned about the effects of noxious weeds on native plants)	0.41126 0.86	-0.95961 -1.62	4.3016 (0.116)
HABPLANT (respondent strongly agrees with the statement that national forests provide habitat for plants)	-0.69582 -1.84	-0.18445 -0.37	3.4875 (0.175)
HABLIFE (respondent strongly agrees with the statement that national forests provide habitat for fish and wildlife)	-0.37773 -0.82	0.38169 0.54	1.6835 (0.431)
LIVECO (years lived in Colorado)	-0.00759 -1.01	-0.02634 -2.31	5.4608 (0.065)
Log likelihood	-226.06		

[a] Each likelihood ratio test is distributed as a chi square with two degrees of freedom under the null hypothesis.

Table 6: Comparing "unsure" respondents to "vote in favor" respondents

How true is each statement?		**Definitely True**	**Somewhat True**	**Somewhat False**	**Definitely False**
I felt the ***Noxious Weeds Control Program*** would be worth the amount I was asked to pay. (χ^2=110.85;p=.000)	Unsure	10%	64%	23%	3%
	Vote in Favor	75%	23%	1%	1%
I would vote for the program to show my general support for the environment (χ^2=119.25; p=.000)	Unsure	10%	69%	16%	5%
	Vote in Favor	80%	17%	1%	1%
The goals of the ***Noxious Weeds Control Program*** were an important consideration when deciding how to vote (χ^2=37.01;p=.000)	Unsure	27%	60%	12%	1%
	Vote in Favor	65%	32%	2%	1%
The use of herbicides was an important factor when deciding how to vote (χ^2=2.078;p=.556)	Unsure	32%	48%	14%	5%
	Vote in Favor	31%	42%	18%	9%
Preserving the health of the National Forests is very important to me (χ^2=14.681;p=.002)	Unsure	74%	23%	3%	0%
	Vote in Favor	90%	9%	0%	1%

Table 7. Wang model of responses. Treatment 2. N=339.

Variable	Coefficient	T statistic
β coefficients		
Constant	-15.9407	-0.760
Household income (thou.dollars)	-0.0195	-0.074
DEFKNOW (Respondent knows future income)	34.4657	2.369
DEFWEED (Respondents needs more information about the problems caused by weeds)	-10.7381	-0.864
DEFSIDE (Respondent needs more information about the side effects of weed control techniques)	96.6999	3.880
DEFPROG (Respondent needs more information about how the program would be funded)	-49.8911	-2.684
DONAT (Respondent contributes to environmental orgs.)	32.6722	1.977
SOILIMP (respondent is extremely concerned about the soil stability impacts of noxious weeds)	5.5245	0.340
WATERIMP (respondent is extremely concerned about the water quality impacts of noxious weeds)	-4.2428	-0.263
HARMIMP (respondent is extremely concerned that noxious weeds will harm wildlife habitat)	54.6235	2.855
PLANTIMP (respondent is extremely concerned about the effects of noxious weeds on native plants)	12.7086	0.799
HABPLANT (respondent strongly agrees with the statement that national forests provide habitat for plants)	13.6427	0.997
HABLIFE (respondent strongly agrees with the statement that national forests provide habitat for fish and wildlife)	-6.3212	-0.400
Standard deviation of WTP (σ)	72.4869	4.870
γ coefficients		
Constant	81.0222	3.732
Education	-12.5910	-1.775
MALE	-16.1810	-1.428
SEEN1 (Respondent has seen the noxious weeds)	-4.2811	-1.967
MEAN WTP:	**$102.36 (s.e. 13.94)**	

Table 8: Reasons for vote on the Noxious Weeds Control program (all respondents). Treatment 2

Statement	Percent of "vote in favor" respondents who agree	Percent of "vote against" respondents who agree	Percent of "unsure" respondents who agree
I know what my income is in the near future	84%	68%	65%
I make the spending decision in my household	90%	79%	66%
I need more information on the problems that weeds cause	52%	50%	62%
I need more information on the possible side effects of the methods that would be used to control weeds	90%	57%	79%
I need more information about how the program would be funded	71%	70%	72%

Table 9: Comparing "unsure" respondents to "vote in favor" and "vote against" respondents

Importance of reasons for having National Forest....		**Not at all important**	**Slightly important**	**Important**	**Extremely Important**
Habitat for Plants (χ^2=12.13; p=.007)	Unsure	1%	4%	37%	58%
	Vote in Favor and Vote Against	1%	2%	19%	78%
Habitat for Fish and Wildlife (χ^2=14.11; p=.003)	Unsure	1%	5%	18%	76%
	Vote in Favor and Vote Against	1%	1%	8%	91%
Level of concern about impacts of noxious weeds....		**Not at all Concerned**			**Extremely Concerned**
Decreased Soil Stability (χ^2=7.70; p=.053)	Unsure	4%	21%	42%	33%
	Vote in Favor and Vote Against	2%	12%	38%	48%
Harm to Wildlife (χ^2=19.28; p=.000)	Unsure	1%	45%	38%	48%
	Vote in Favor and Vote Against	2%	4%	21%	73%
Decreased Water Quality (χ^2=12.65; =.005)	Unsure	5%	14%	29%	52%
	Vote in Favor and Vote Against	2%	5%	25%	68%
How true is each statement?		**Definitely True**	**Somewhat True**	**Somewhat False**	**Definitely False**
I need more information about the problems weeds cause (χ^2=15.72; p=.001)	Unsure	26%	47%	23%	4%
	Vote in Favor and Vote Against	16%	34%	30%	20%

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