Confidence Intervals for Evaluating Benefits Estimates from Dichotomous Choice Contingent Valuation Studies

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I. INTRODUCTION

The estimation of willingness to pay (WTP) or willingness to accept (WTA) compensation using the contingent valuation method (CVM) has been increasingly performed with the dichotomous choice (DC) or referendum approach. The practical advantages of the dichotomous choice approach over alternative open-ended willingness-to-pay questions or iterative bidding sequences are extensively documented elsewhere (Hoehn and Randall 1987; Boyle and Bishop 1988; and Bowker and Stoll 1988).

As with any technique, the fundamental issues of validity, reliability, and accuracy must be addressed. The issue of concurrent validity of DC CVM with actual cash transactions has been researched by Bishop and Heberlein (1979). Direct comparison with WTP estimates from the travel cost method (TCM) have been presented by Sellar, Stoll, and Chavas (1985), as well as Bishop and Heberlein (1979) to name a few. The issue of reliability has been researched by Loomis (1990). The linkage of utility theory to the functional form of the econometric model and the resulting logit equation has also received detailed attention in work by Hanemann (1984), Sellar, Chavas, and Stoll (1986), and McConnell (1990).

Previous empirical comparisons, whether between alternative functional forms or between different methodologies such as TCM and DC CVM, have focused relatively little attention on presentation of confidence intervals. Development of confidence intervals allows a more rigorous comparison of WTP estimates. Without confidence intervals for the WTP measures, it is difficult to conclude whether different functional forms or estimation methods generate statistically significant differences.

The need to develop confidence intervals around benefit estimates is of policy relevance as well. A series of dichotomous choice questions is often asked in surveys to quantify the benefits associated with alternative levels of environmental quality. In a contingent valuation study of WTP for water quality, Edwards and Anderson (1987) estimated separate logit models for three levels of improved water quality. Boyle et al. (1987) estimated a series of separate logit models for alternative river flow scenarios in the Grand Canyon.[1] Confidence intervals are required to address the essential policy questions of whether the benefit estimates associated with varying quality levels of a resource are significantly different.

The primary purpose of this paper is to adapt Krinsky and Robb's approach for calculating confidence intervals for elasticities to the calculation of confidence intervals for benefits measured with DC CVM using

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[1] A reviewer has suggested that an alternative to the estimation of separate logit models for each quality model is to pool the data across quality levels and estimate a single model with a variable indicating different levels of quality. This appears to be one alternative specification. However, before implementing such a model a more detailed specification of the multivariate random utility function of the respondents to justify the pooling procedure should be undertaken. We have not pursued this approach in this paper.

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a logit model. The method is applied to determine if WTP estimates for elk hunting under three different quality levels are statistically different. Two functional forms which have been used to evaluate WTP in the literature are also compared to see whether statistically different results are obtained.

II. WELFARE MEASURES FROM DICHOTOMOUS CHOICE MODELS

The utility difference model applied by Hanemann (1984) to dichotomous choice CVM provides one approach to developing a theoretical foundation for deriving Hicksian compensating and equivalent surplus measures from dichotomous choice, contingent valuation data. Respondents are assumed to derive utility from income and from participating in recreation, where utility is an increasing function of the quality of the recreation experience. Income is denoted by y and other individual characteristics which may influence preferences are denoted by s.

The indirect utility function for each respondent, which contains unobservable stochastic components, is a random variable with a given parametric probability distribution with mean $\mathbf{V}(y; s)$ and stochastic element denoted by ε_j. The random variable ε_j is an independently and identically distributed random variable with zero mean. If the difference in indirect utility ($d\mathbf{V}$) from paying the offer amount (or posted price) and having access to the recreation site is positive, respondents will maximize utility by answering "yes" they would pay.

The willingness-to-pay probability is defined as

$$P_1 = F_\eta(d\mathbf{V}) \quad [1]$$

where $d\mathbf{V}$ is the difference in indirect utility and F_η $(d\mathbf{V})$ is the cumulative distribution function of the respondent's true maximum WTP, which is a random variable. Expected WTP is calculated as

$$E(WTP) = \int_0^\infty [1 - F_\eta(d\mathbf{V})]\, d\mathbf{V}. \quad [2]$$

$F_\eta(d\mathbf{V})$, which represents the probability of a no response to the discrete choice question, is a function of the bid amount the individual is asked to pay. The indirect utility difference model yields the logit specification when the probability of a yes response is specified as the cumulative distribution function of a standard logistic variate:

$$\text{Prob (Yes)} = [1 + e^{-d\mathbf{V}}]^{-1}. \quad [3]$$

The functional forms for $d\mathbf{V}$ are specified more completely in Section IV.

Often the upper limit of integration in equation [2] is set at $X_{\max}$, the highest bid amount in the valuation survey of respondents, rather than integrating out to infinity. Calculation of the expected WTP must be adjusted to account for truncation in the range of integration. Boyle, Welsh, and Bishop (1988) developed one approach for adjusting the estimated cumulative density function by normalizing it to reflect this truncation. The mean WTP is calculated as

$$E(WTP) = \int_0^{X_{\max}} \left[1 - \frac{F(z)}{F(X_{\max})}\right] dz \quad [4]$$

where z is the truncated random variable and $F(X_{\max})$ is the cumulative distribution function evaluated at the maximum value of the closed-end bid amount used in the survey. This adjustment makes the estimated cumulative density function consistent with the level of truncation. It does not eliminate the potential underestimation problem introduced by truncating the upper limit of integration.

Calculating Confidence Intervals for Welfare Measures

Bockstael and Strand (1987) have emphasized that the parameter estimates used to calculate welfare measures are themselves random variables. The technique used here to develop confidence intervals for the WTP measure accounts for the variability associated with all the estimated coefficients and is based directly on the logit specification for the choices of respondents.

Confidence intervals are developed using a simulation method proposed by Krinsky and Robb (1986). This method can be applied to establish the empirical distribution of any estimator which is a nonlinear function of the estimated parameters. The technique was first applied to develop confidence intervals for elasticities which are complicated nonlinear functions of the estimated parameters. By examining the methods used to estimate the logit model and the derivation of WTP from the logit model, the applicability of the Krinsky and Robb technique to develop confidence intervals for WTP is demonstrated.

As Amemiya (1981) noted, estimating the logit model using the method of maximum likelihood (ML) leads to estimators which are asymptotically normal and have desirable asymptotic properties. In turn, the willingness-to-pay functions in equations [2] and [4] are nonlinear functions of the maximum-likelihood estimates of the logit model. For specific functional forms for dV derived from an underlying indirect utility function, Hanemann (1984) showed that the formula in equation [2] can be integrated to yield closed-form solutions for WTP. The closed-form solutions for WTP presented by Hanemann are nonlinear functions of the estimated parameters of the logit model.

However, for the renormalization procedure proposed by Boyle et al. (1988), no closed-form solution for WTP is available. Numerical integration techniques applied to equation [4] yield an estimate of WTP which is a complicated nonlinear function of the maximum-likelihood estimates from the logit model. This situation is analogous to the case of elasticities which are nonlinear functions of maximum-likelihood estimates, thus justifying the application of the Krinsky and Robb technique to develop confidence intervals for WTP.

Alternative techniques are available for estimators which are ratios of random variables. Mood, Graybill, and Boes (1974) noted that no simple exact formulae for the mean and variance of ratios of random variables exist. While a Taylor series approximation is possible, Krinsky and Robb demonstrate the potentially significant errors which may occur in attempting to approximate a nonlinear function with a linear approximation. Rather, this application of the Krinsky and Robb approach uses the information on the distribution of $\hat{\beta}$ contained in the variance-covariance matrix to approximate the distribution of willingness to pay.

The technique can be implemented using information readily available from the estimated logit model: the estimates of the parameter vector, denoted by $\hat{\beta}$, and the estimated variance-covariance matrix, denoted by $\hat{V}$. Multiple random drawings to create a new parameter vector $\hat{\hat{\beta}}$ are made from a multivariate normal distribution with variance-covariance matrix $\hat{V}$ and mean $\hat{\beta}$. For each drawing of $\hat{\hat{\beta}}$, WTP is calculated using either equation [2] or [4]. An empirical distribution for WTP is then obtained for the logit model using the complete set of replications (random drawings).

A $(1 - \alpha)$ confidence interval is obtained by ranking the vector of calculated WTP values and dropping the $\alpha/2$ values from each tail of the ranked vector. Krinsky and Robb suggest that past experimentation has indicated that a thousand drawings is sufficient to generate a sufficiently accurate empirical distribution. However, the number of draws (m) must be set high enough so that if the procedure is repeated the confidence intervals derived from a given $\hat{\beta}$ and $\hat{V}$ are essentially indistinguishable.

The Krinsky and Robb technique explicitly takes into account the variability associated with all the estimated coefficients from the logit model along with the interactions among the coefficients. It should be viewed as providing a more complete statistical foundation for previous methods for developing confidence intervals for WTP from DC CVM. Sellar et al. (1985) first proposed a method to calculate confidence intervals to compare estimates of the WTP from the CVM and TCM. The "quasi-confidence" intervals were derived using the upper and lower bounds for only the estimated trips coefficient. The demand curve was then shifted about the horizontal (trips) intercept to calculate upper and lower bounds on WTP. This procedure neglects the variability inherent in the other estimated coefficients of the logit equation.

III. APPLICATION TO ELK HUNTING BENEFITS

Elk hunting in Montana is both a prized big game hunting experience and an increasingly scarce one. The opportunity to harvest a trophy elk (six points or larger) is threatened by timber harvesting and the associated loss of elk habitat. One issue facing both the Montana Department of Fish, Wildlife and Parks and the U.S. Forest Service is to estimate the increment in hunting benefits arising from the opportunities to harvest a trophy elk. Montana is also known for its "wilderness" type elk hunts in remote settings where hunters can avoid seeing large groups of other hunters. However, maintaining such solitude is not without its costs.

To quantify and compare the WTP for hunting under current conditions, increased opportunities to harvest trophy elks, and the benefits of reduced congestion, a DC CVM study of Montana elk hunting was undertaken. This study also develops comparisons of the influence of different functional forms on the benefit estimates.

Data Sources

The sampling frame was resident and nonresident hunters with the appropriate Montana big game hunting license and elk tags for the Fall 1986 season. Based on the guidelines of the Total Design Method proposed by Dillman (1978), a mail questionnaire in booklet form was mailed with a postage paid return envelope to the hunters. Following the procedures developed by Dillman, a reminder postcard and follow-up mailing of a replacement survey to non-respondents was implemented. The response rate after deleting nondeliverables was 73 percent.

A series of three DC CVM questions was asked about the most recent elk hunting trip. First, hunters were asked a DC CVM question to value the most recent elk hunting trip. This was followed by a scenario which asked each hunter to value the trip if everything else had been the same, except their chances of harvesting a six point or larger elk were doubled. Lastly, each hunter was asked a DC CVM question to value the most recent elk hunting trip if everything had been the same, except they saw half as many hunters. The exact wording of the questions are provided in Appendix A. For more details see Loomis et al. 1988.

IV. ECONOMETRIC SPECIFICATION, RESULTS, AND BENEFIT ESTIMATES

One functional form for $d\mathbf{V}$ which is consistent with the indirect utility difference model developed in Section II is the linear specification. The linear logit model includes the bid amount and the number of elk seen but does not contain the respondent's income:

$$YPAY = \alpha_0 + \beta_1 BID + \beta_2 ELK \qquad [5]$$

where

$YPAY$ = hunter's yes/no response to the willingness-to-pay question;
BID = the increase in trip costs the hunter is asked to pay for the alternative hunting conditions;
ELK = the number of elk seen on the most recent hunting trip.

A second functional form for $d\mathbf{V}$ based on a logarithmic specification is also developed in order to compare WTP estimates across functional forms. As Hanemann (1984) noted, this specification is not strictly compatible with the indirect utility difference model.

Continued examination of the logarithmic specification is justified for three main reasons. As Johansson, Kristöm and Mäler (1989) and Bowker and Stoll (1988) have pointed out, the logarithmic specification can be considered a first-order approximation to a well-behaved indirect utility function. Approximating the difference in indirect utility functions may be a reasonable alternative to assuming the existence of a common well-behaved indirect utility function for each respondent. The logarithmic specification for discrete choice CV responses has the convenient property that negative estimates for WTP are ruled out, a property highlighted by Hanemann (1989). Finally, on an empirical basis, a logarithmic specification has been shown to outperform the linear logit model derived from the indirect utility difference model.

The logarithmic specification for the logit model is:

$$YPAY = \alpha_0 + \beta_1 \ln(BID) + \beta_2 \ln(INC) + \beta_3(ELK) \quad [6]$$

where, in addition to the variables defined above,

INC = the income of the elk hunter.

Income is included in the logarithmic specification of the indirect utility difference model. Hanemann (1984) demonstrated that the linear specification of the indirect utility function yields the only model in which income effects do not appear. Hence the variables included in each logit model are different in the two specifications. Bowker and Stoll (1988) take a similar tack in comparing logit models which were derived from the Hanemann (1984) indirect utility difference approach along with a logarithmic specification. Both specifications examined here are consistent with McConnell's (1990) demonstration that endogenous variables such as the number of trips must be omitted from the valuation function.

The maximum-likelihood estimates of the two specifications are presented for alternative quality levels of elk hunting in Montana. The estimated logit equations for a major elk hunting region in western Montana under current conditions, double chances of trophy elk, and reduced crowding are examined in Tables 1 through 3.

Coefficient estimates are consistent with prior expectations. For both the linear and logarithmic models, the coefficient on the bid amount is negative and highly significant across all three quality levels. Higher bid amounts are negatively related to the probability of a yes response. Improvements in the quality of hunting, represented by more elk seen, increase the probability that the respondent will pay the bid amount to continue hunting. In the logarithmic model, the coefficient on the income variable is positive and significant for the valuation of the alternative elk hunting conditions. Respondents with higher incomes

TABLE 1

LOGIT EQUATIONS FOR CURRENT ELK HUNTING CONDITIONS

Current Conditions[a,b]	Linear	Logarithmic
Intercept	0.1324	−1.4798
	(0.9125)	(−1.0198)
Bid Amount	−0.0038	−0.7714
	(−5.0695)*	(−7.6355)*
Income		0.4475
		(3.1816)*
Elk Seen	0.0022	0.0812
	(1.1175)	(2.4768)*
Model χ^2	36.215	
Model χ^2		87.181
Percent Correct Predictions	69.85	71.31
McFadden R^2	0.06	0.13
N	481	481

[a] Asymptotic *t*-values in parentheses.
[b] Asterisk indicates significance at .01 confidence level.

TABLE 2

LOGIT EQUATIONS FOR DOUBLE CHANCES OF HARVESTING A TROPHY ELK

Bigger Elk Conditions[a,b]	Linear	Logarithmic
Constant	0.8063	1.4313
	(5.4874)*	(1.1305)
Bid Amount	−0.0049	−0.7794
	(−6.7072)*	(−7.7789)*
Income		0.2232
		(1.7572)
Elk Seen	0.0046	0.0488
	(1.5424)	(1.5905)
Model χ^2	67.330	
Model χ^2		80.270
Percent Correct Predictions	64.87	63.20
McFadden R^2	0.10	0.12
N	481	481

[a] Asymptotic *t*-values in parentheses.
[b] Asterisk indicates significance at .01 confidence level.

TABLE 3
LOGIT EQUATIONS FOR REDUCED CROWDING FOR ELK HUNTING CONDITIONS

Crowded Conditions[a,b]	Linear	Logarithmic
Constant	0.6297	−0.9369
	(4.2245)*	(−0.6887)
Bid Amount	−0.0064	−0.8709
	(−6.8263)*	(−8.7368)*
Income		0.4561
		(3.3822)*
Elk Seen	0.0041	0.0565
	(1.4752)	(1.7458)
Model χ^2	78.360	
Model χ^2		112.107
Percent Correct Predictions	70.89	72.97
McFadden R^2	0.12	0.17
N	481	481

[a] Asymptotic t-values in parentheses.
[b] Asterisk indicates significance at .01 confidence level.

had a higher probability of a positive response to the contingent valuation question.

Summary statistics for the linear and logarithmic specification indicate the close similarity between the fit of each model. The results for the logarithmic model are consistent with the estimates produced by the linear model. Goodness-of-fit measures based on the McFadden R^2 and the percentage of correct predictions are highest for the valuation of reduced crowding. The valuation of current conditions has the lowest goodness-of-fit measures.

The probability of a yes response to the WTP question is presented in Table 4 along with the valuation of the alternative elk hunting conditions. Standard errors for the probability of a yes response are developed. These probabilities and standard errors are summarized in Table 4 along with the WTP measures for each hunting condition. The valuation of the opportunity to harvest larger elk results in the highest probability of a yes response, exceeding 50 percent of the respondents. The proportion of yes responses for the valuation of a decrease in crowding conditions exceeds the proportion of yes responses for the valuation of current conditions. For valuation of current conditions the probability of a yes response is the lowest.

Empirical Results

The confidence intervals for WTP are used to address three issues for valuing elk hunting in Montana. First, the empirical

TABLE 4
MEAN AND 95 PERCENT CONFIDENCE INTERVALS ON WILLINGNESS TO PAY FOR MONTANA ELK HUNTING—RENORMALIZATION ADJUSTMENT

	Current Conditions		Trophy Elk		Reduced Crowding	
		Norm[b]		Norm		Norm
Linear Model						
Upper Bound	$264	$212	$213	$206	$218	$208
Mean	202	182	173	170	173	171
Lower Bound	160	155	143	143	144	143
Prob [Yes]	.397		.524		.462	
	(0.025)[a]		(0.025)		(0.027)	
Logarithmic Model						
Upper Bound	$263	$143	$382	$200	$276	$159
Mean	213	126	317	179	223	141
Lower Bound	171	110	260	160	180	124
Prob [Yes]	.397		.524		.462	
	(0.025)		(0.025)		(0.026)	

[a] Standard error for Prob [Yes] noted in parentheses.
[b] Norm denotes the calculation of WTP using the renormalization procedure derived by Boyle et al. (1988).

relevance of the Boyle et al. (1988) renormalization procedure in evaluating WTP is highlighted in the results. After demonstrating the impact of the normalization procedure on mean WTP, two additional comparisons are presented based on the confidence intervals which account for the normalization. Second, confidence intervals are employed in a comparison of WTP derived from alternative functional forms for the logit model. Third, confidence intervals are applied to test for significant differences in the WTP for changes in the quality of hunting conditions.

The mean welfare measure is estimated by using equation [4], which specifies the expected value of WTP. The area between the normalized cumulative distribution function and 1.0 is integrated over the range of bids. The results are presented in Table 4. The range of integration for calculation of the welfare measures is truncated at \$1,100, the highest bid amount in the sample.

The Krinsky and Robb approach (1986) is applied to generate confidence intervals. Based on 1,000 drawings from a multivariate normal distribution with mean $\hat{\beta}$ and variance-covariance matrix $\hat{V}$, the 95 percent confidence intervals for the welfare measure are calculated and presented for each logit equation in Table 4. (Ninety-nine percent and 90 percent confidence limits were also calculated and are available from the authors.)

Comparing the Impact of the Renormalization Procedure

In evaluating the quality changes for elk hunting, the renormalization procedure appears to be empirically important in adjusting WTP for the effects of truncation. The mean WTP and the confidence intervals for each specification are also calculated by incorrectly neglecting any attempt to account for truncation in the range of integration. The effect of renormalization in this data set is empirically larger for the logarithmic specification as compared to the linear specification.

Using the renormalization procedure, the logarithmic specification no longer yields higher estimates of mean WTP across each of the hunting scenarios. The mean WTP derived from the logarithmic model is lower than that for the linear model for current hunting conditions and reduced crowding in hunting when using the Boyle et al. (1988) procedure. As demonstrated in this assessment, the Boyle et al. renormalization can change the ranking of WTP estimates across alternative functional forms. These findings highlight the important role for confidence intervals in testing for statistically significant differences in WTP estimates across functional forms and alternative quality levels.

Comparing Functional Forms

The normalized mean WTP procedure for current conditions derived from the logarithmic specification is lower than that based on the linear specification. For current elk hunting conditions the linear specification yields an estimate of mean WTP which exceeds that derived from the logarithmic specification by \$56. Based on the benefit estimates using the normalization procedure, the 95 percent confidence intervals for WTP for *current* elk hunting conditions calculated from the linear specification is significantly higher than that derived from the logarithmic specification, because the confidence intervals do not overlap.

For valuation of the opportunity to hunt trophy elk, the logarithmic model yields an estimate of mean WTP which exceeds that derived from the linear model by \$9. By contrast, in valuing the hunting conditions with reduced crowding, the mean WTP estimated using the linear model was \$30 higher than mean WTP based on the logarithmic specification. The differences in valuation across functional forms are relatively smaller than the difference obtained for current elk hunting conditions. Therefore, it is not surprising that for these two higher quality levels, the differences in mean WTP estimates between functional forms are not statistically significant at the 95 percent level.

Comparing Changes in Hunting Quality

Examining the logarithmic specification, the mean WTP for doubling the chance to harvest a trophy elk ($179) is larger than the mean WTP measures derived for both current conditions ($126) and for reduced crowding conditions ($141). Based on the 95 percent confidence intervals, WTP for doubling the chances of harvesting a trophy elk exceeds the WTP associated with both current hunting conditions and that associated with decreased crowding. The mean WTP for reduced crowding is not significantly higher than mean WTP for current conditions. However, for the linear model the mean WTP estimates for the three quality levels are not statistically different since the confidence intervals overlap.

Differences in WTP for alternative hunting conditions may not be closely linked to statistical significance of estimated coefficients in the logit models. The confidence intervals are based on estimates of the parameter vector, denoted by $\hat{\beta}$, and the estimated variance-covariance matrix, denoted by $\hat{V}$. The confidence intervals take into account the variability of the estimated coefficients and interactions among the coefficients, information which is not available by examining *t*-statistics alone.

A comparison of the logarithmic specification for current conditions and increased chances of harvesting a trophy elk illustrates this point. In the logarithmic specification for current conditions, the coefficients on bid amount, income, and elk seen are asymptotically significant at the 0.01 level. For improved chances of hunting trophy elk, only the bid coefficient is asymptotically significant at the 0.01 level. But the mean WTP for improved chances of hunting trophy bigger elk exceeds that for current hunting conditions based on the 95 percent confidence levels. Bowker and Stoll (1988) have also confirmed that models with similar statistical fit may generate estimates of WTP which differ dramatically, emphasizing the need to develop confidence intervals.

The range between the upper and lower bounds on WTP provides some information for evaluating the precision of WTP estimates based on the logit model. For the logarithmic specification, the width of the confidence intervals between the upper and lower bounds differed by no more than $40 across any of the alternative elk hunting conditions.

V. CONCLUSIONS

Consistent with the findings of other researchers, different functional forms do result in different mean estimates of net willingness to pay. However, the confidence intervals indicated that the differences between functional forms were not always statistically significant. Proposed changes in the quality of the elk hunting experience also resulted in differences in the willingness to pay for hunting. Confidence intervals around the valuation of alternative elk hunting conditions indicated that willingness to pay for increased chances of harvesting a trophy elk was significantly higher than the valuation of alternative elk hunting conditions considered for the logarithmic model.

The important role played by the renormalization procedure in evaluating WTP was also highlighted in the empirical study. When any renormalization procedure was neglected the valuation of willingness to pay was higher than when the Boyle et al. (1988) procedure was used.

This research has suggested that methods for evaluating welfare measures for non-market resources should examine not only differences in mean willingness-to-pay measures but also the confidence intervals for the point estimates of WTP. Improved econometric methods for estimating willingness to pay should be supplemented with explicit comparisons with alternative methods using confidence intervals for the estimated welfare measures. In this way progress can be made in determining which differences are real and which differences are of little significance. Future research can then be directed at understanding the important differences between alternative methods and functional forms.

APPENDIX A
CVM Questions in Survey

"The next questions ask you about your recent elk hunting trip in Montana during the General Season."

Current Condition CVM Question

"Would you still have made the trip if your share of the expenses had been $X more?"

_____ Yes _____ No

"Imagine everything about this last trip was the same except that your chance of getting a 6-point or better bull elk was *twice* as great AND your trip costs $X more than your actual costs. Would you still have made the trip under these circumstances?

_____ Yes, I would have still made the trip
_____ No, I would not have made the trip."

"Imagine everything about this last trip was the same except you saw *half* as many hunters as you actually did AND your trip costs were $X more than they actually were. Would you still have made the trip under these circumstances?

_____ Yes, I would have still made the trip
_____ No, I would not have made the trip."

References

Amemiya, T. 1981. "Qualitative Response Models." *Journal of Economic Literature* 19 (Dec.):1483–1536.

Bishop, R. C., and T. A. Heberlein. 1979. "Measuring Values of Extramarket Goods: Are Indirect Measures Biased?" *American Journal of Agricultural Economics* 61: 926–30.

Bockstael, N. E., and I. E. Strand, Jr. 1987. "The Effects of Common Sources of Regression Error on Benefit Estimates." *Land Economics* 63 (Feb.):11–20.

Bowker, J. M., and J. M. Stoll. 1988. "Dichotomous Choice in Resource Valuation." *American Journal of Agricultural Economics* 70:372–82.

Boyle, K. J., M. P. Welsh, and R. C. Bishop. 1988. "Validation of Empirical Measures of Welfare Change: Comment." *Land Economics* 64 (Feb.):94–98.

Boyle, K. J., M. P. Welsh, R. Bishop, and R. Baumgartner. 1987. "Analyzing the Effects of Glen Canyon Dam Releases on Colorado River Recreation Using Scenarios of Unexperienced Flow Conditions." Paper presented at the American Agricultural Economics Association Meetings, August 1987.

Boyle, K. J., and R. C. Bishop. 1988. "Welfare Measurement Using Contingent Valuation: A Comparison of Techniques." *American Journal of Agricultural Economics* 70:20–29.

Dillman, D. E. 1978. *Mail and Telephone Surveys: The Total Design Method.* New York: John Wiley & Sons.

Edwards, S. F., and G. D. Anderson. 1987. "Overlooked Biases in Contingent Valuation Surveys: Some Considerations." *Land Economics* 63 (May):168–78.

Hanemann, W. M. 1984. "Welfare Evaluations in Contingent Valuation Experiments with Discrete Responses." *American Journal of Agricultural Economics* 66:332–41.

———. 1989. "Welfare Evaluations in Contingent Valuation Experiments with Discrete Responses Data." *American Journal of Agricultural Economics* 71:1057–61.

Hoehn, J., and A. Randall. 1987. "A Satisfactory Benefit Cost Indicator from Contingent Valuation." *Journal of Environmental Economics and Management* 14 (Sept.):226–47.

Johansson, P-O., B. Kristöm, and K. G. Mäler. 1989. "Welfare Evaluations in Contingent Valuation Experiments with Discrete Response Data: Comment." *American Journal of Agricultural Economics* 71:1054–56.

Kling, C. L., and R. J. Sexton. 1989. "Confidence Intervals for Welfare Estimators From Recreation Demand Models." Paper presented at the Western Agricultural Economics Association meetings, Coeur d'Alene, Idaho, July 1989.

Krinsky, I., and A. L. Robb. 1986. "On Approximating the Statistical Properties of Elasticities." *Review of Economics and Statistics* 68 (Nov.):715–19.

Loomis, J. 1990. "Comparative Reliability of Dichotomous Choice and Open Ended Contingent Valuation Methods." *Journal of Environmental Economics and Management* 72 (Jan.):78–85.

Loomis, J., J. Cooper, and S. Allen. 1988. *The*

Montana Elk Hunting Experience. Montana Department of Fish, Wildlife and Parks.

McConnell, K. E. 1990. "Models for Referendum Data: The Structure of Discrete Choice Models for Contingent Valuation." *Journal of Environmental Economics and Management* 72 (Jan.):19–34.

Mood, A., F. Graybill, and D. Boes. 1974. *Introduction to the Theory of Statistics*. New York: McGraw-Hill Book Company.

Sellar, C., J-P. Chavas, and J. R. Stoll. 1986. "Specification of the Logit Model: The Case of the Valuation of Nonmarket Goods." *Journal of Environmental Economics and Management* 13 (Dec.):382–90.

Sellar, C., J. R. Stoll, and J-P. Chavas. 1985. "Validation of Empirical Models of Welfare Change: A Comparison of Nonmarket Techniques." *Land Economics* 61 (Feb.): 156–75.