

Do Fishermen Lie? Measuring Hypothetical Bias Across Response Formats

John W. Duffield*, **David A. Patterson**, and **Chris J. Neher**
Department of Mathematical Sciences, University of Montana
Patricia A. Champ
USDA Forest Service, Rocky Mountain Research Station

Corresponding Author:
John Duffield
Department of Mathematical Sciences
Mathematics Building
The University of Montana
Missoula, MT 59812.
Voice 406-243-5569
Fax 406-721-2265
Email john.duffield@mso.umt.edu.

Abstract

This paper presents the results of a study comparing question format effects in a contingent valuation experiment. Four treatments are implemented on samples of Montana licensed anglers comparing hypothetical and actual payments using a dichotomous choice format, and hypothetical and actual payments using a payment card question format. This paper is relevant to the W-1133 objective to Estimate Benefits of Ecosystem Management of Forests and Watersheds. The study replicates major elements of an earlier (1989-90) field experiment which solicited hypothetical and actual donations to benefit instream flows for Montana fisheries. Extensions of the earlier work include: repeat contacts to increase response rate, follow-up of the contingent valuation question to explore respondent certainty, and several question format treatments (payment card, as in the original study, and dichotomous choice). The partner for the cash treatment in the current study is Montana Trout Unlimited. Methods include interpretation of welfare measures based on an interval response model for both payment card and dichotomous choice. The study design allows investigation of some standard, and not yet fully resolved, major issues in stated preference methods including the extent of hypothetical bias, and how bias varies across question format (e.g. “what question format reveals the truth about public good values”).

*This study was funded by the USDA Forest Service, Rocky Mountain Research Station and Montana Trout Unlimited. We are grateful to Stan Bradshaw, Laura Ziemer, and Julie Eaton of Montana Trout Unlimited for their generous support and cooperation. We are indebted to Bob McFarland of Montana Fish, Wildlife and Parks for providing us our angler samples. As usual, remaining errors are the sole responsibility of the authors.

Do Fishermen Lie? Measuring Hypothetical Bias Across Response Formats

I. Introduction

This paper describes preliminary results from a field experiment designed to compare responses to a contingent valuation instrument to actual cash donations. This study is in part a replication of an earlier experiment (Duffield and Patterson 1991) aimed at measuring values for provision of a public environmental good. The resource in the 1990 survey was increased streamflow in several potentially important spawning tributaries for two endangered fisheries: a fluvial population of Arctic grayling and a population of Yellowstone cutthroat trout.

A limitation of the 1990 study was that the two treatments of most interest were implemented as one-time mailings to simulate typical fund-raising solicitations. Both of the latter went out under The Nature Conservancy letterhead and were designed to be very similar in content and wording. As a result of the single mail contact, the response rates were relatively low to these treatments, particularly for the cash response. There was a third treatment (contingent valuation) that paralleled the first two, but went out under University of Montana letterhead and included repeat mail contacts (a total of four) and achieved high response rates (74% and 77% for resident and nonresident anglers respectively). The University of Montana treatment was used to characterize the population and provide a contrast between a “typical” academic contingent valuation and the other treatments.

The objectives in replicating the 1990 survey in 2005 included achieving higher response rates in the comparable cash and contingent valuation treatments to provide a better measure of potential

differences in real and hypothetical economic commitments for this resource and setting. It was also anticipated that the replication over the span of 15 years would provide an opportunity to measure changes in values, and insights into what, if any, measures of attitudes, preferences, or socio-economic status and characteristics might explain any changes found. A previous paper (Duffield, Neher, Patterson, and Champ 2005) provided a preliminary summary of the results comparing the payment card question format responses in 1990 and 2005 across two quite different angler populations: resident Montana anglers and licensed nonresident anglers.¹

The focus of the current paper is on the question format effects (for dichotomous choice and payment card), across both actual and hypothetical treatments. There are two strands of related literature here: studies that have investigated cash and hypothetical payments, and studies that have investigated question format effects. The literature at the intersection of these two sets is quite limited. Brown et al. 1996 provided the first such study, comparing dichotomous choice and open-ended formats with both actual and hypothetical payments. Champ and Bishop (2001, 2006) investigate three treatments: dichotomous choice hypothetical and actual, and payment card actual. To our knowledge, the current study is the first to compare dichotomous choice and payment card formats using both actual and hypothetical treatments.

¹ Overall welfare measures for the payment card treatments based on a simple average of the bid amounts indicated were: resident cash \$2.78 and resident CV \$5.38 (ratio of 0.516 cash/CV), and nonresident cash \$13.18, CV \$29.28 (ratio 0.45). The resident values for both cash and CV treatments were about 20% of the nonresident values, consistent with some major differences between the two angler populations. Nonresidents were much more specialized (70 percent fly fish only versus 23 percent for residents), avid, had higher income (were two brackets higher than Montana residents), more likely to be male (86 percent versus 74 percent), older (mid-50's versus mid-40's) and much more likely to be a member of a conservation, sportfishing, or boating organization (48% versus 19%). In real (constant 2005 dollar) terms the 2005 values were similar (and for residents almost identical) compared to the 1990 estimates.

The remainder of this paper includes a brief summary of literature and methods, followed by a description of the preliminary results.

II. Literature

The comparison of real economic commitments with contingent valuation responses had its beginning in the work of Bohm (1972) and Bishop and Heberlein (1979). There have since been a number of laboratory and field experiments. Studies specifically investigating donation payment mechanisms include Duffield and Patterson 1991, Navrud 1992, Seip and Strand 1992, Brown et al. 1996, Champ et al. 1997, Byrnes et al. 1999, Champ and Bishop 2001, and Champ and Bishop 2004. The general finding of this literature is that hypothetical payments generally exceed actual payments. Other things equal, this provides evidence of hypothetical bias.

There is a substantial literature on question format effects, as summarized in Table 2. Only a handful of these studies (six) include actual payments, while 20 report contingent valuation results. Most of the studies focus on the comparison of dichotomous choice to open-ended. The most common result is that $WTP_{DC} > WTP_{OE}$. With respect to dichotomous choice and payment card, the consistent finding based on 10 studies is that dichotomous choice estimates are greater than (8 studies) or equal to (two studies) payment card based estimates. The one study comparing actual payments (Champ and Bishop 2006) is typical and shows the ratios of dichotomous choice to payment card estimated mean WTP to be 2.25 (using a linear logit model and Hanemann mean) to 2.10 (nonparametric). This summary is simplistic given the great variation in methods and resources across these studies including estimation, choice of welfare measure, split or

combined samples, and public versus private goods.

III. Methods

The general finding from the literature is that hypothetical payments generally exceed actual payments. As noted, and other things equal, this provides evidence of hypothetical bias. The latter is more or less the Achille's heel of the contingent valuation method: "ask a hypothetical question and you get a hypothetical answer". Conversely, the holy grail for the field might be in identifying a contingent valuation procedure that consistently identifies the underlying latent willingness to pay, as presumably measured by actual payments. There are a number of promising approaches in the literature to developing such procedures. These include "cheap talk" (e.g. Cummings and Taylor 1999), and strategies for identifying respondents who are more certain about their hypothetical responses (e.g. Champ et al. 1997, Ready et al. 2001).² The approach here is focused on reconsidering the question Brown et al. 1996 posed: "Which response format reveals the truth about donations to a public good?". Brown et al.'s answer with respect to dichotomous choice and open-ended formats was "neither". The candidate being examined here is the payment card approach, again being compared to dichotomous choice.

The specific hypothesis we test measure the equivalence of question formats and response to hypothetical and actual donation payment vehicles: 1) Is the response to willingness to pay questions, overall contribute or not contribute, equivalent across treatments, and 2) Are willingness to pay estimates equivalent based on measures of central tendency?

² The current study includes a followup "certainty" question based on the Champ et al. 1997 methods. These results are not covered here.

The resource examined here is a public environmental good in that many of the services provided by the resource in question are not excludable. It is anticipated that existence and bequest motives (Krutilla 1967) relating to instream flow in these streams and the associated passive use are significant relative to direct use. In fact it is not very likely that any given angler respondent will ever fish any of the several small streams described in the 1990 and 2005 studies, or experience significantly improved angling in the larger rivers fed by these small tributaries. Nonetheless, direct use may still be an important motive. In any case, the specific payment vehicle used here is anticipated to capture both passive and direct use in a total valuation framework (Randall and Stoll 1983). The choice to make a donation can be modeled in the context of an indirect utility function framework (e.g. Boyle and Bishop 1987). The willingness to pay (donate) amount that will just make an individual ambivalent between the current level of services and one with adequate streamflow defines a Hicksian compensating variation welfare measure. Cameron and Huppert (1989, 1991) provide an empirical model for estimating WTP from payment card interval data. Symmetric parametric or nonparametric methods can be applied for both question formats.

The choice of a donation payment vehicle raises problems in interpretation due to a lack of incentive compatibility relative to a referendum format (Carson, Groves and Machina 2000). Nonetheless, a donation payment vehicle is the most plausible approach for the public environmental good at issue here, and can arguably provide a lower bound on the relevant Hicksian surplus (Champ et al. 1997). It is apparent that the general recommendation of the NOAA panel (Arrow et al. 1993) to utilize the referendum format for passive use valuation is too broad, since there are many cases where referendums are not feasible or plausible.

Table 1 summarizes and compares study methods between the 1990 and 2005 experiments. An important change in survey methods was to use Dillman method repeat mail contacts. The 2005 study included five contacts: an initial letter, first survey mailing, reminder postcard, second survey mailing, and a third survey mailing.

The basic structure (and most of the original questions) of the 1990 survey instrument was retained for 2005. The sequence is as follows: initial set of questions on angling use, questions designed to measure attitudes and preferences, valuation question sequence, and questions addressing respondent socioeconomic characteristics. The decision was made to use the same set of payment card amounts as in 1990 (10, 25, 50, 100, 250, other) for both payment card and dichotomous choice formats. Information on the resource and the Montana Streamflow Fund initiative were provided in the initial letter and prior to the donation questions in the survey instrument. The text for the donation question for all four treatments is provided in Figure 1.

The revised instrument was pretested in fall of 2004 with a mailing to a sample of 300 anglers. One important finding from the pretest was that the subsample of the 2003-2004 nonresident season angler license list made available to the researchers by Montana Fish, Wildlife and Parks included nonresidents who held season licenses by virtue of a “combination” elk and/or deer hunting license that included season fishing. The latter group had very low response rates to the 2005 pretest, and had not been included in the 1990 sample frame. For the main 2005 survey, this group was also excluded from the nonresident season license subsample.

The initial contact letter for the 2005 survey was mailed on January 21. The reminder postcard went out February 8, the first survey package January 27- 31, second survey package on February 25, and third survey package on April 13.

Table 3 summarizes the allocation of the total initial mailing list (of 2,500 nonresident anglers) across the four treatments, and response rates. Based on the pretest and 1990 study response rates, cash treatments were oversampled relative to contingent valuation in anticipation of lower relative response rates.

IV. Results

Table 4 provides means of respondent characteristics by subsample (proportions for binary variables). Characteristics include angler specialization, days fishing, preferences across fishery types, general environmental attitudes (intended to measure bequest and existence motives), knowledge of trust funds, and socioeconomic characteristics (including age, income, gender, and education). Inspection of these means indicates that the subsamples are generally similar with respect to these measures. One-way ANOVA's on all variables in that table of means found only one statistically significant difference in "priority is cutthroat/bull trout" ($P=.009$). This variable measured respondent priorities for the type of stream to get additional instream flow resources; PC hypothetical was higher than the other three. To summarize, only one of the 20 measures of respondent characteristics showed a significant difference across the subsamples. This supports the interpretation that any differences found across question format are likely treatment effects rather than due to differences between subsamples.

With respect to response rates, using five mail contacts in 2005 (compared to one in 1990) significantly improved survey participation. The overall response rate is 47%. Relative response rates across treatments could provide an indication of the relative difficulty respondents have in answering a given question format or an actual compared to a hypothetical donation question. The cash response rates average about 85% of the corresponding contingent valuation treatment response rate. For both the payment card format and the dichotomous choice format, these differences were significant ($P=.010$ and $P=.042$, respectively, Table 5). The dichotomous choice response rates were also systematically lower (and also in about an 85% ratio) compared to the corresponding nonresident payment card response both overall, across cash treatments and across hypothetical treatments ($P=.000$, $P=.003$, and $P=.013$, respectively).

Item nonresponse to the donation question across treatments is as follows: DC actual 6.7%, DC hypothetical 6.9%, PC actual 13.2%, and PC hypothetical 5.8%. Combining response rates and item nonresponse for the treatments to estimate aggregate nonresponse shows the following percentile of useable surveys relative to delivered surveys: DC actual 40.2%, DC hypothetical 46.3%, PC actual 44.2%, and PC hypothetical 55.7%. This tabulation counts cash responses as “missing” if the donation question was not marked. However, in a number of cases respondents donated cash amounts other than the bid amount for both question formats, particularly for dichotomous choice. For purposes of estimating willingness to pay, missing donation question responses were coded as “no” in the dichotomous choice format and “zero” in the payment card format. Sample sizes for each treatment are close to the study goal of about 200 in each cell for

the contingent valuation treatments and well in excess of that number for the cash treatments (Table 3).

Turning to our specific hypothesis, overall response to the donation question, in terms of contributing or not, is shown for all four treatments in Table 6. The hypothesis of equivalent responses across cash and hypothetical treatments for the dichotomous choice format is rejected (chi-square test statistic 14.608, $P=.000$), as well as for the payment card format (test statistic 25.705, $P=.000$). The percentage of respondents contributing some amount is greater in the hypothetical payment treatment compared to the actual payment treatment for both question formats. For actual and hypothetical respondents, the percentage of respondents contributing is significantly higher for the payment card respondents (cash chi-square 4.90, $P=.027$; hypothetical 5.73, $P=.017$).

Response distributions for both question formats are shown in Table 7. For dichotomous choice the data displayed is the usual percent “yes” by bid level. For payment card, the reported parameter is cumulative indicating the percent willing to pay that amount or greater. These distributions are plotted in Figure 2. By inspection, the dichotomous choice hypothetical response distribution stands out from the other three treatments as not converging to near zero; this appears to be evidence of the oft-noted “fat tails” problem. In fact, the divergence is not just in the tails. Interestingly, the absolute differences between cash and hypothetical “yes” response are fairly stable in absolute terms. For example, the ratios at \$10, \$50 and \$250 are quite similar (0.235, 0.218, and 0.189). With respect to the payment card data, the CV response proportions drop off very significantly at the highest bid level in the payment card (only 3.1 percent check

this amount in the hypothetical payment card treatment, compared to 19.4 percent answering “yes” to this bid amount in the hypothetical dichotomous choice). Actual percentages at this highest bid are quite similar to the hypothetical payment card response: 0.9 % for actual payment card at the \$250 bid and 1.6% for actual dichotomous choice. An interesting twist is that the payment card CV responses intersect and appear to fairly closely match the cash dichotomous choice responses (Figure 2).

Turning to estimated WTP results, Table 8 summarizes bivariate log logistic models for the dichotomous choice treatments and Tables 8 and 10 give the estimated welfare measures. The estimated truncated mean (truncated at the highest bid amount) is \$76.17 in the hypothetical treatment and \$36.90 in the cash treatment. The standard error of differences between truncated means is 10.56, the z-statistic is 3.72, and differences are significant ($P=.0002$). Medians are \$25.43 and \$8.86 are also significantly different (SE of difference equals 7.46, z equals 2.22 and $P=.026$).

The distribution of bid amounts selected for the payment card treatments is shown in Table 9. The simple mean of these bids is \$29.28 for the hypothetical donation and \$13.18 for the actual donation.

Table 10 provides welfare measures for both dichotomous choice and payment card estimated WTP. Table 10 provides results from a log logistic model using the payment card interval data estimated by maximum likelihood (Cameron and Huppert 1989). The estimated truncated mean for the payment card hypothetical is \$43.27, which is significantly greater than the truncated

mean for payment card actual of \$21.94 (SE of the difference equals 10.56, z equals 3.72 and $P=.0002$). The estimated medians are also significantly different (SE of the difference is 2.23, z equals 3.91, and $P=.0001$).

Comparing question formats, the DC hypothetical truncated mean of \$76.17 is significantly greater than the payment card hypothetical mean of \$43.27 (SE of the difference is 10.11, z equals 3.26, $P=.00011$). The differences for actual truncated means are also significantly different (\$36.90 for dichotomous choice and \$21.94 for payment card), SE of the difference 5.28, z equals 2.83, and $P=.0046$. The differences between the medians are only marginally statistically significant.

Interestingly, the payment card hypothetical truncated mean of \$43.27 and the dichotomous choice cash truncated mean of \$36.90 are not statistically significantly different (SE of the difference 6.19, $z=1.03$, $P=.30$).

A final study result relating to question format effects is the effect on overall participation. This has implications for which of the response formats is most efficient for creating effective demand for public goods. From the standpoint of fund raising, the resident payment card approach generated \$1.13 per initial list and 4.1 percent contributed, nonresident PC \$6.00, and 14 percent, and nonresident DC \$3.06 and 8.6 percent. As a one-time fund raising drive, the two question formats are actually potentially quite similar in total take, it's just that the dichotomous choice needs to be done in two stages: a pretest to identify the optimal bid, and then a mailing to implement at that one bid level. For the case at hand, a dichotomous choice mailing just asking

for donations of \$100 would return \$5.88 per initial list name, statistically identical to the \$6.00 for the payment card. The advantage of the payment card, however, is much higher participation (total percent of contributors is 5.9 percent for the second stage of a DC design versus 14.0 percent for a PC design). For creation of a pool of donors to draw on in the future, the PC yields a much more valuable list. By the standards of the direct mail world, the nonresident list is obviously very lucrative. In marginal returns per mailing, there was a smooth decline as contacts progressed, but the nonresident mailing was still more than breaking even on the third mailing against costs (\$0.60 per address marginal return), while the resident mailing was only cost effective for one mailing (and slipped to earning 4 cents on the third mailing).

V. Discussion

With respect to the comparison between hypothetical and actual donation responses, the findings of this study are consistent with the existing literature. Hypothetical contributions were found to be significantly greater than actual contributions for both question formats. What we found in addition, similar to the findings of Brown et al. 1996, was that the tendency for contingent valuation to overestimate WTP seems to be exacerbated by use of the dichotomous choice question format.

However, the interesting finding here is that the payment card question format does relatively well in terms of more closely matching the actual WTP distributions, particularly in the tail of the distribution. If one is willing to accept the view that either of the actual WTP distributions (payment card or dichotomous choice) is an equally plausible measure of the true latent WTP,

then it is noteworthy that the payment card hypothetical response provides a reasonable approximation to one of these measures, the actual dichotomous choice responses. Needless to say, this result is limited to the current study, and for the case where a donation payment vehicle is used to value a public environmental good. Further studies would be needed to support the proposition that the payment card question format can be used to reliably identify actual latent willingness to pay – at least within the range of our ability to measure this construct. In any case, these findings suggest that the payment card may be the most promising of the three basic question format approaches (dichotomous choice, payment card, open-ended) for at least a subset of public environmental goods. Future research should continue to explore the influence of question format, perhaps most usefully in conjunction with the other approaches being developed to minimize hypothetical bias, including cheap talk and correction for respondent certainty.

Do fishermen lie? Yes, but the story you get depends on how you ask the question.

References

- Alberini, A. 1995. "Optimal Designs for Discrete Choice Contingent Valuation Surveys: Single-Bound, Double-Bound, and Bivariate Models." *Journal of Environmental Economics and Management* 28 (3):287-306.
- Arrow, K., R. Solow, P. R. Portney, E. E. Leamer, R. Radner, and H. Schuman. 1993. Report of the NOAA Panel on Contingent Valuation. Federal Register 58(10):4601-4614.
- Blaine, T.W., F.R. Lichtkoppler, K.R. Jones, and R.H. Zondag. 2005. "An Assessment of Household Willingness to Pay for Curbside Recycling: A Comparison of Payment Card and Referendum Approaches." *Journal of Environmental Management* 76:15-22.
- Bohara, A.K., M. McKee, and R.P. Berrens. 1998. "Effects of Total Cost and Group-Size Information on Willingness to Pay Responses: Open Ended vs. Dichotomous Choice." *Journal of Environmental Economics and Management* 35:142-163.
- Boyle, Kevin J. and Richard C. Bishop. 1987. Valuing Wildlife in Benefit-Cost Analysis: A Case Involving Endangered Species. *Water Resources Research* 23:943-950.
- Boyle, K.J., F.R. Johnson, Daniel W. McCollum, W.H. Desvousges, R.W. Dunford, and S.P. Hudson. 1996. "Valuing Public Goods: Discrete versus Continuous Contingent Valuation Responses." *Land Economics* 72 (3):381-96.
- Brown, Thomas C., Patricia A. Champ, Richard C. Bishop, and Daniel W. McCollum. 1996. "Which Response Format Reveals the Truth about Donations to a Public Good?" *Land Economics* 72 (2):152-166.
- Byrnes, B., C. Jones, and S. Goodman. 1999. Contingent Valuation and Real Economic Commitments: Evidence from Electric Utility Green Pricing Programmes. *Journal of Environmental Planning and Management* 42(2):149-166.
- Cadsby, Charles Bram, and Elizabeth Maynes. 1999. "Voluntary Provision of Threshold Public Goods with Continuous Contributions: Experimental Evidence." *Journal of Public Economics* 71:53-73.
- Cameron, Trudy Ann, and Daniel D. Huppert. 1989. "OLS versus ML Estimation of Non-market Resource Values with Payment Card Interval Data." *Journal of Environmental Economics and Management* 17:230-246.
- Cameron, Trudy Ann, and Daniel D. Huppert. 1991. Referendum Contingent Valuation Estimates: Sensitivity to the Assignment of Offered Values. *Journal of the American Statistical Association* 86(416): 910-918.

- Cameron, Trudy Ann, Gregory L. Poe, Robert G. Ethier, and William D. Schulze. 2002. "Alternative Nonmarket Value-Elicitation Methods: Are the Underlying Preferences the Same?" *Journal of Environmental Economics and Management* 44:391-425.
- Carson, Richard T., Theodore Groves, and Mark J. Machina. 2000. "Incentive and Informational Properties of Preference Questions." Paper presented at Kobe Conference on Theory and Application of Environmental Valuation. Kobe, Japan.
- Champ, Patricia A., Richard C. Bishop, Thomas C. Brown, and Daniel W. McCollum. 1997. Using Donation Mechanisms to Value Nonuse Benefits to Public Goods. *Journal of Environmental Economics and Management* 33:151-162.
- Champ, Patricia A. and Richard C. Bishop. 2001. "Donation Payment Mechanisms and Contingent Valuation: An Empirical Study of Hypothetical Bias." *Environmental and Resource Economics* 19:383-402.
- Champ, Patricia A. and Richard C. Bishop. 2006. "Is Willingness to Pay for Public Goods Sensitive to Elicitation Format?" Forthcoming: *Land Economics*.
- Clinch, J.P. and A. Murphy. 2001. "Modelling Winners and Losers in Contingent Valuation of Public Goods: Appropriate Welfare Measures and Econometric Analysis." *The Economic Journal* 111:420-443.
- Donaldson, Cam, Ruth Thomas, and David J. Torgerson. 1997. "Validity of open-ended and payment scale approaches to eliciting willingness to pay." *Applied Economics* 29(1): 79-84.
- Duffield, John W. and David A. Patterson. 1991. Field Testing Existence Values: An Instream Flow Trust Fund for Montana Rivers. AERE contributed paper session, ASSA meetings New Orleans, January.
- Duffield, John W. and David A. Patterson. 1992. Field Testing Existence Values: Comparison of Hypothetical and Cash Transaction Values in R. Bruce Rettig, ed., *Benefits and Costs in Natural Resource Planning*, Oregon State University.
- Duffield, J.W., C.J. Neher, D.A. Patterson, and P. Champ. "Replication of a cash and contingent valuation experiment. Proceedings for 2005 Western Regional Research Project W-1133: Benefits and Costs in Natural Resource Planning, Salt Lake City, UT.
- Frykblom, P., and J.F. Shogren. 2000. An Experimental Testing of Anchoring Effects in Discrete Choice Questions. *Environmental and Resource Economics* 16:329-341.
- Holmes, Thomas P. and Randall A. Kramer. 1995. "An Independent Sample Test of Yes-Saying and Starting Point Bias in Dichotomous -Choice Contingent Valuation." *Journal of Environmental Economics and Management* 29:121-132.

- Haab, Timothy C., Ju-Chin Huang, and John C. Whitehead. 1999. "Are Hypothetical Referenda Incentive Compatible? A Comment." *Journal of Political Economy* 107(1):186-196.
- Haefele, M., R.A. Kramer, and T. Holmes. 1992. "Estimating the Total Value of Forest Quality in High-Elevation Spruce-Fir Forests." In *The Economic Value of Wilderness*. General Technical Report SE-78, Southern Forest Experiment Station, Research Triangle Park, NC.
- Hanemann, W. Michael. 1989. Welfare Evaluations in Contingent Valuation Experiments with Discrete Response Data: Reply. *American Journal of Agricultural Economics* 71:1057-61.
- Huang, Ju-Chin, and V. Kerry Smith. 1998. "MonteCarlo Benchmarks for Discrete Response Valuation." *Land Economics* 74 (2):186-202.
- Johnson, Rebecca, N. Stewart Bregenzler, and Bo Shelby. 1990. "Contingent Valuation Question Formats: Dichotomous Choice versus Open-ended Responses." In *Economic Valuation of Natural Resources*, eds. Rebecca L. Johnson and Gary V. Johnson. Westview Press.
- Kealy, Mary Jo, and R.W. Turner. 1993. "A Test of the Equality of Closed-Ended and Open-Ended Contingent Valuations." *American Journal of Agricultural Economics* 75 (2):321-331.
- Kramer, R.A. and D.E. Mercer. 1997. "Valuing a Global Environmental Good: U.S. Residents' Willingness to Pay to Protect Tropical Rain Forests." *Land Economics* 73(2):196-210.
- Krström, Bengt. 1990. A Non-Parametric Approach to the Estimation of Welfare Measures in Discrete Response Valuation Studies. *Land Economics* 66: 135-39.
- Krstrom, Bengt. 1993. "Comparing Continuous and Discrete Contingent Valuation Questions." *Environmental and Resource Economics* 3:63-91.
- Krutilla, John V. 1967. Conservation Reconsidered. *American Economic Review* 57(4):77-86.
- Loomis, John, Thomas C. Brown, Beatrice Lucero, and George Peterson. 1997. "Evaluating the Validity of the Dichotomous Choice Question Format in Contingent Valuation." *Environmental and Resource Economics* 10:109-123.
- Lunander, Anders. 1998. "Inducing Incentives to Understate and to Overstate Willingness to Pay within the Open-Ended and the Dichotomous-Choice Elicitation Formats: An Experimental Study." *Journal of Environmental Economics and Management* 35:88-102.
- McFadden, D. 1994. "Contingent Valuation and Social Choice." *American Journal of Agricultural Economics* 76 (November 1994):689-708.

- Navrud, Ståle. 1992. Willingness to Pay for Preservation of a Species – an Experiment with Actual Payments, in *Pricing the European Environment*. New York: Oxford University Press.
- Poe, Gregory L., Kelly L. Giraud, and John B. Loomis. 2005. Computational Methods for Measuring the Difference of Empirical Distributions. *American Journal of Agricultural Economics* 87(2): 353-365.
- Randall, Alan, and John R. Stoll. 1983. Existence Value in a Total Valuation Framework, in R.D. Rowe and L.G. Chestnut, eds. *Managing Air Quality and Scenic Resources at National Parks and Wilderness Areas*. Boulder: Westview.
- Ready, Richard C., Jean C. Buzby, and Dayuan Hu. 1996. "Differences between Continuous and Discrete Contingent Value Estimates." *Land Economics* 72(3):397-411.
- Ready, Richard C., Stale Navrud, and Richard W. Dubourg. 2001. "How do Respondents with Uncertain Willingness to Pay Answer Contingent Valuation Questions?" *Land Economics* 77(3): 315-326.
- Reaves, Dixie Watts, Randall A. Kramer, and Thomas P. Holmes. 1999. "Does Question Format Matter? Valuing an Endangered Species." *Environmental and Resource Economics* 14:365-383.
- Rowe, R.D, William D. Schulze, and W.S. Breffle. 1996. "A Test for Payment Card Biases." *Journal of Environmental Economics and Management* 31 (2):178-185.
- Seip, K. and Jon Strand. 1992. Willingness to Pay for Environmental Goods in Norway: A Contingent Valuation Study with Real Payment. *Environmental and Resource Economics* 2(1): 91-106.
- Sheatsley, Paul B. 1983. Questionnaire Construction and Item Writing. In *Handbook of Survey Research*, eds. P. H. Rossi, J. D. Wright and A. B. Anderson. San Diego: Academic Press, Inc.
- Welsh, Michael P., and Gregory L. Poe. 1998. "Elicitation Effects in Contingent Valuation: Comparisons to a Multiple Bounded Discrete Choice Approach." *Journal of Environmental Economics and Management* 36:170-185.

Study characteristic	1990 Study	2005 Study
Resource examined	Instream Flows / Threatened Fisheries	Instream Flows / Montana Fisheries
Cooperating group	The Nature Conservancy	Trout Unlimited
CV Question format	Payment Card	Payment Card and Dichotomous Choice
Surveys mailed	7,662	3,750
Survey contacts	One	Five
Sample Frame	Licensed anglers	Licensed anglers

Table 2: Recent Elicitation Studies since 1990

Authors	The Good	Public or Private Good	Response Formats	Results
<i>Actual Payment Studies</i>				
Champ and Bishop (2006)	Wind generated electricity	Public	DC, PC	$WTP_{DC} > WTP_{PC}$
Fyrkblom and Shogren (2000)	A Swedish national atlas	Private	DC, OE	$WTP_{DC} = WTP_{OE}^a$
Cadsby and Maynes (1999)	Tokens which are converted into Canadian Dollars	Public	DC, OE	$WTP_{DC} < WTP_{OE}$
Lunander (1998)	Preview of a movie	Private	DC, OE	$WTP_{DC} > WTP_{OE}$
Loomis et al. (1997)	Art Print	Private	DC, OE	$WTP_{DC} = WTP_{OE}$
Brown et al. (1996)	Road removal in the North Rim of Grand Canyon	Public	DC, OE	$WTP_{DC} > WTP_{OE}$
<i>Contingent Valuation Studies</i>				
Blaine et al. (2005)	Curbside Recycling	Public	DC, PC	$WTP_{DC} > WTP_{PC}$

Ready, Navrud, and Dubourg (2001)	Avoidance of an episode of illness	Private	DC, PC ³	$WTP_{DC} > WTP_{PC}$
Cameron, Poe, Ethier, Schulze (2002)	Green Power Program	Public	DC, OE, PC	$WTP_{DC} > WTP_{PC} > WTP_{OE}$
Reaves, Kramer, and Holmes (1999)	Recovery of an endangered species	Public	DC, ⁴ OE, PC	$WTP_{DC} = WTP_{OE} = WTP_{PC}$
Bohara et al. (1998)	Protection of Instream Flows	Public	DC, OE	$WTP_{DC} \geq WTP_{OE}$ ⁵
Lunander (1998)	Preview of a movie	Private	DC, OE	$WTP_{DC} > WTP_{OE}$
Welsh and Poe (1998)	Reduced fluctuations in Glen Canyon Dam releases	Public	DC, PC	$WTP_{DC} > WTP_{PC}$
Kramer and Mercer (1997)	Tropical Rain Forest Protection	Public	DC, PC	$WTP_{DC} = WTP_{PC}$
Loomis et al. (1997)	Art Print	Private	DC, OE	$WTP_{DC} = WTP_{OE}$
Donaldson, Thomas, and Torgerson (1997)	A bone mineral density scan	Private	OE, PC	$WTP_{PC} > WTP_{OE}$
Boyle et al. (1996)	Ex post WTP to hunt moose in Maine	Private	DC, OE	$WTP_{DC} = WTP_{OE}$
	WTP of individuals who applied for a moose hunt permit but did not get one	Private	DC, OE	$WTP_{DC} > WTP_{OE}$

³ Ready, Navrud and Dubourg refer to the payment card treatment as open ended. However the treatment was like a payment card in that respondents were shown a card with offer amounts and asked to check the amount they would like.

⁴ The DC question used a double-bounded format where respondents who said yes to the initial offer were asked a follow-up question with a higher offer amount and respondents who said no to the initial offer amount were asked a follow-up question with a lower offer amount.

⁵ $WTP_{DC} > WTP_{OE}$ when a log normal distribution was used and $WTP_{DC} = WTP_{OE}$ when a Weibull or Gamma distribution was used.

	Creation of a local response center to clean up oil spills	Public	DC, OE	$WTP_{DC} = WTP_{OE}$
Brown et al (1996)	Road Removal in the North Rim of the Grand Canyon	Public	DC, OE	$WTP_{DC} > WTP_{OE}$
Ready, Buzby, Hu (1996)	Food safety improvements	Private	DC, PC	$WTP_{DC} > WTP_{PC}$
Holmes and Kramer (1995)	Protection of a forest ecosystem	Public	DC, PC	$WTP_{DC} > WTP_{PC}$
McFadden (1994)	Wilderness Preservation	Public	DC, OE	$WTP_{DC} > WTP_{OE}$
Kriström (1993)	Protection of forest areas in Sweden	Public	DC, OE	$WTP_{DC} > WTP_{OE}$
Kealy and Turner (1993)	Candy Bar	Private	DC, OE	$WTP_{DC} = WTP_{OE}$
	Reduction in acid rain damage in Adirondacks	Public	DC, OE	$WTP_{DC} > WTP_{OE}$
Haefele, Kramer and Holmes (1992)	Forest quality	Public	DC, PC	$WTP_{DC} > WTP_{PC}$
Johnson, Bregenzer, and Shelby (1990)	Permit for one whitewater recreation trip on the Rogue River	Private	DC, OE	$WTP_{DC} > WTP_{OE}$

Table 3. Response Rate Characteristics, 2005 Survey

Sample	Surveys mailed	Bad Addresses	Delivered	Surveys returned	Response rate
Nonresident Payment Card					
- Cash sample	850	89	761	387	50.9%
- Hypothetical Sample	400	48	352	208	59.1%
Subtotal-Nonresident PC	1250	137	1113	595	53.5%
Nonresident Dichotomous Choice					
- Cash sample	850	122	728	314	43.1%
- Hypothetical sample	400	50	350	174	49.7%
Subtotal-Nonresident DC	1250	172	1078	488	45.3%

Table 4. Means of respondent characteristics by subsample (proportions for binary variables).

	DC		PC	
	Cash (n=314)	Hypo (n=174)	Cash (n=387)	Hypo (n=208)
How often do you participate in river-related recreation (1=Never to 5=Very frequently)	3.73	3.90	3.84	3.93
Preferred type of water				
Lakes/reservoirs	.22	.22	.18	.21
Smaller streams	.25	.29	.26	.29
Rivers	.53	.49	.56	.51
Fished a Montana stream or river in last 3 years	.80	.86	.80	.87
Days fishing in Montana in 2004	10.39	10.84	10.80	13.06
Use flies only	.66	.70	.65	.70
Rate fishing (1=favorite to 4=prefer other activities)	1.80	1.67	1.82	1.76
Member of any conservation, sportfishing or boating organization	.51	.56	.48	.51
Own or lease recreational property in Montana	.25	.29	.24	.25
Importance of adequate streamflows for Montana fisheries (1=very important to 4=not important)	1.24	1.14	1.24	1.20
Priority rainbow/brown	.45	.43	.41	.37
Priority cutthroat/bull	.27	.29	.28	.40
Attitudes (1=strongly agree to 5=strongly disagree)				
• I enjoy knowing my friends can visit rivers for recreation	1.51	1.47	1.50	1.42
• I have little concern for endangered species	4.29	4.24	4.25	4.32
• I'm glad there's wilderness in Montana even if I never get to see it	1.51	1.47	1.44	1.48
• I feel I should be doing more for Montana's rivers and streams	2.60	2.48	2.61	2.48
• Protecting the environment should be responsibility of state and federal government	2.99	2.83	2.94	2.69
• Private conservation organizations should play a major role in protecting environmental resources	2.09	2.02	2.12	2.18
• I think most Montana rivers already have enough water in them to be a healthy resource	3.73	3.71	3.71	3.77
• Rivers have spiritual or sacred values for me	2.61	2.56	2.62	2.53
• I would be willing to contribute money or time to help Montana rivers even if I could never visit them	2.90	2.70	2.83	2.68
Trust fund knowledge (1=never heard of them to 4=know a great deal about them)	2.57	2.68	2.55	2.71

Heard of Trout Unlimited	.90	.92	.91	.93
Member of Trout Unlimited	.34	.34	.35	.38
Heard of TU projects	.54	.58	.58	.57
Age (years)	55.35	53.98	55.24	54.06
Male	.87	.86	.85	.84
Education (1=some grade school to 8=finished postgraduate)	6.26	6.31	6.17	6.09
Income level (1=less than \$15,000 to 9=\$150,000+)	6.03	5.61	5.52	5.61

Table 5. Comparison of response rates across subsamples.

Table 5a. Nonresident, Payment card, cash v. hypothetical

		Responded to survey		Total
		No	Yes	
Treatment	Cash	374 49.1%	387 50.9%	761 100.0%
	Hypo	144 40.9%	208 59.1%	352 100.0%
Total		518 46.5%	595 53.5%	1113 100.0%

Table 5 b. Nonresident, Dichotomous choice, cash v. hypothetical

		Responded to survey		Total
		No	Yes	
Treatment	Cash	414 56.9%	314 43.1%	728 100.0%
	Hypo	176 50.3%	174 49.7%	350 100.0%
Total		590 54.7%	488 45.3%	1078 100.0%

Table 6: Response to Willingness to Pay Question, Contribute or not Contribute across treatment.

	Dichotomous Choice		Payment Card	
	Cash (n=314)	Hypo (n=174)	Cash (n=387)	Hypo (n=208)
Yes	23.2%	39.7%	30.7%	51.9%
No	76.8%	60.3%	69.3%	48.1%

Table 7. Response distributions. For dichotomous choice, percent responding “yes”. For payment card, percent indicating that amount or greater.

Amount(\$)	Dichotomous choice		Payment card	
	Cash	Hypo	Cash	Hypo
10	44.1	70.6	35.4	55.1
15			25.6	
20			25.3	47.4
25	32.8	44.4	24.1	46.4
50	18.2	36.4	13.7	25.0
100	16.4	29.4	6.3	12.8
250	1.6	19.4	0.9	3.1
500				0.5
<i>n</i>	345	178	387	208

Table 8. Logit models, dichotomous choice.**Table 8a. Hypothetical treatment**

Variable / statistic	coefficient	S.E.	p.
Intercept	2.1987	0.6159	0.0004
LN(BID)	-0.6795	0.1577	0.00001
N	173		
median	\$25.43		
T-mean (\$250)	\$76.17		
S.E. of T-mean	\$9.36		

Note: SE of mean simulated using 10,000 iterations.

Table 8b. Cash treatment

Variable / statistic	coefficient	S.E.	p.
Intercept	1.8355	0.5090	0.0003
LN(BID)	-0.8414	0.1456	0.00001
N	314		
median	\$8.86		
T-mean (\$250)	\$36.90		
S.E. of T-mean	\$4.88		

Note: SE of mean simulated using 10,000 iterations.

Table 9. Payment card question format, response distribution by bid level and means of selected bid levels.

Amount(\$)	cash	hypo
0	69.3	48.1
10	8.5	7.2
15	0.3	
20	1.0	1.0
25	9.0	20.2
50	6.5	11.5
100	4.7	9.1
250	0.8	2.4
500		0.5
<i>n</i>	387	208
mean	13.18	29.28

Table 10. Estimated (SE) of median and truncated mean WTP based on log-logistic model for WTP. SE's based on 1000 bootstraps.

	<i>n</i>	Median	Mean truncated at \$250
DC-Hypo	173	25.43 (7.11)	76.17 (9.36)
DC-Cash	314	8.86 (2.26)	36.90 (4.88)
PC-Hypo	208	12.78 (2.13)	43.27 (3.81)
PC-Cash	387	4.08 (0.65)	21.94 (2.02)

Figure 1. Willingness to donate questions.

A. Dichotomous choice, cash treatment.

4. We would like to know how much you would be willing to contribute to Trout Unlimited's Montana Streamflow Fund.

Every dollar contributed to this fund would go directly to increasing streamflows in Montana trout streams through the purchase or lease of water rights on Watkins Creek, a rainbow and cutthroat tributary of the Madison River and Sweet Grass Creek a stream that will benefit recruitment of brown trout in the Yellowstone River.

All administrative costs as well as the costs of this survey are being covered by other sources. These specific waters, on which Trout Unlimited is currently working to purchase water rights, are further described on the back of the cover letter.

Are you willing to make a donation of \$ _____ to the Montana Streamflow Fund to help purchase water rights for instream flows on these streams? **(Please check one.)**

yes → **Please complete the enclosed pledge form and return it with the survey.**

no

B. Dichotomous choice, hypothetical treatment.

4. We would like to know how much you would be willing to contribute to Trout Unlimited's Montana Streamflow Fund. As this survey is part of a research project, we are not asking you to make a donation. Nonetheless, we would like you to answer the following question as you would a solicitation for an actual donation.

Every dollar contributed to this fund would go directly to increasing streamflows in Montana trout streams through the purchase or lease of water rights on Watkins Creek, a rainbow and cutthroat tributary of the Madison River and Sweet Grass Creek, a stream that will benefit the recruitment of brown trout in the Yellowstone River.

All administrative costs as well as the costs of this survey are being covered by other sources. These specific waters, on which Trout Unlimited is currently working to purchase water rights, are further described on the back of the cover letter.

If you were asked today, would you be willing to donate \$ _____ to the Montana Streamflow Fund to help purchase water rights for instream flows on these streams? **(Please check one.)**

yes

no → Please skip to Question 6

C. Payment card, cash treatment.

4. We would like to know how much you would be willing to contribute to Trout Unlimited's Montana Streamflow Fund.

Every dollar contributed to this fund would go directly to increasing streamflows in Montana trout streams through the purchase or lease of water rights on Watkins Creek, a rainbow and cutthroat tributary of the Madison River and Sweet Grass Creek a stream that will benefit recruitment of brown trout in the Yellowstone River.

All administrative costs as well as the costs of this survey are being covered by other sources. These specific waters, on which Trout Unlimited is currently working to purchase water rights, are further described on the back of the cover letter.

How much are you willing to donate to the Montana Streamflow Fund to help purchase water rights for instream flows on these streams? **(Please check one)**

\$10 \$25 \$50 \$100 \$250 \$_____ Other

\$0, I would choose not to make a donation at this time

If you are making a donation:

Please complete the enclosed pledge form and return with the survey.

D. Payment card, hypothetical treatment.

4. We would like to know how much you would be willing to contribute to Trout Unlimited's Montana Streamflow Fund. As this survey is part of a research project, we are not asking you to make a donation. Nonetheless, we would like you to answer the following question as you would a solicitation for an actual donation.

Every dollar contributed to this fund would go directly to increasing streamflows in Montana trout streams through the purchase or lease of water rights on Watkins Creek, a rainbow and cutthroat tributary of the Madison River and Sweet Grass Creek, a stream that will benefit the recruitment of brown trout in the Yellowstone River.

All administrative costs as well as the costs of this survey are being covered by other sources. These specific waters, on which Trout Unlimited is currently working to purchase water rights, are further described on the back of the cover letter.

If you were asked today, how much would you be willing to donate to the Montana Streamflow Fund to help purchase water rights for instream flows on these streams? **(Please check one.)**

\$10 \$25 \$50 \$100 \$250 \$_____ Other

\$0, I would choose not to make a donation at this time

Figure 2. Plot of percent “yes” for dichotomous choice, and percent indicating that amount or greater for payment card.

